



Is it the way they use it? Teachers, ICT and student achievement



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ABSTRACT

We provide evidence on whether ICT-related teaching practices affect student achievement. We use a unique student-teacher dataset containing variables on a wide set of very specific uses of computer and ICT by teachers matched with data on national standardized tests for 10th grade students. Our identification strategy relies on a within-student between-subject estimator and on a rich set of teacher's controls. We find that computer-based teaching methods increase student performance when they increase students' awareness in ICT use and when they enhance communication. Instead, we find a negative impact of practices requiring an active role of the students in classes using ICT. Our findings suggest that the effectiveness of ICT at school depends on the actual practice that teachers make of it and on their ability to integrate ICT into their teaching process.

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1. Introduction

In the past two decades, Information and Communications Technology (ICT) has progressively acquired a prominent role in teaching and learning. Most countries have made huge public investments in the purchase and maintenance of ICT related educational devices. As a result, the majority of developed countries have reached high rates of school ICT access.

In 2009, 97% of the teachers in public primary and secondary schools in the US had one or more computers located in the classroom every day (93% of them with Internet access), and the ratio of students to computers in the classroom was 5.3 to 1 (Gray, Thomas, & Lewis, 2010). In the same year, in Europe, at least 75% of the students had the availability of one computer for up to four students. The latest EU-survey on ICT in schools confirms that ICT has become more pervasive also in European countries. In the 2011–2012 school year, there were approximately twice as many computers per one hundred students in secondary schools compared with 2006, and the share of schools with websites, e-mail for both teachers and students and a local area network has been steadily increasing at all levels of education (European Commission, 2013). In view of the large public outlays for ICT in schools in many countries, there has been an increasing research interest

aimed at identifying the effect of ICT at school on learning, and scientific literature developed. Most of these studies focus on the mere availability of ICT equipment in schools or on the use of computers (including specific software) to teach.

In this paper we focus on a different aspect of this process, providing insights about the impact of a large set of specific ICT-related teaching methods on student achievement. The empirical analysis is based on a unique and rich matched student-teacher dataset developed in Italy, combining information from two *ad-hoc* ICT surveys, one administered to a sample of 10th grade students and the other to their teachers, with administrative data on standardized tests assessing the same pupils' achievement in math and Italian language.

A number of studies estimate the causal effect of ICT on students' performance by exploiting the exogeneity of national or local programs aimed at increasing ICT infrastructure in schools and find either little or no effect (Barrera-Osorio & Linden, 2009; Checchi, Rettore, & Girardi, 2015; Cristia, Ibararán, Cueto, & Santiago, 2012; Goolsbee & Guryan, 2006; Leuven, Lindahl, Oosterbeek, & Webbink, 2007). A partial exception is Machin, Sandra, and Olmo (2007), who investigate the effects of a change in the rules governing ICT funding across different school districts of England and find a positive impact on primary school students' performance in English and science, but not in mathematics. However, the above papers do not specify how ICT is used.

A few studies have gone beyond the analysis of the effects of the availability of ICT equipment and looked at the role of computer-aided instructions (CAI), such as the use of specific

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software programs to teach and promote learning. These studies often employ a dichotomous variable capturing the usage of CAI and generally find no statistically significant effects on student performance (Angrist & Lavy, 2002; Rouse & Krueger, 2004), except for mathematics achievement, particularly in early school years and where computers replace lower quality traditional instruction (Banerjee, Cole, Duflo, & Linden, 2007; Barrow, Markman, & Rouse, 2009; Bulman & Fairlie, 2015).

Altogether, these findings appear to suggest that ICT use is not more effective than traditional teaching methods. A potential explanation is that the introduction of computers may have displaced alternative investments of school resources and the related educational activities which, had they been maintained, would have prevented a decline in student achievement. Another reason for the weak ICT effects in schools may be the difficulty to actually integrate ICT into educational practices. The availability of ICT-related educational devices (such as computers, tablets, software or educational programs) is not enough to improve student achievement, but it is the actual practice that teachers make of these devices – together with teachers' digital literacy, level of ICT skills and ICT-related beliefs – that makes the difference (OECD, 2001).

The educational literature provides some theoretical insight on the potential effects of ICT-related teaching practices on students' achievement. Teachers can use ICT to prepare teaching material, making lessons more complete, attractive and personalized thanks to the extended opportunity to find textual and audiovisual contents; the use of pc and ICT in class might push teachers to plan lessons more efficiently and make them more attractive for students thanks to a greater visual appeal. ICT-related teaching practices can also affect students' performance through a process in which teachers "activate" their students, for instance assisting and guiding them when using specific educational software, providing new prospects in the student-teacher relationship. Finally, ICT can be used in teaching for enhancing communication and collaboration both between school and families and with other colleagues, for instance favoring co-production of knowledge among teachers.

The actual practice that teachers make of ICT and their ability to integrate it into the teaching process is then a key issue (UNESCO, 2000), which may reconcile the existing mixed evidence on the effectiveness of ICT on student achievement. Indeed, educational research has clearly pointed out that teachers are crucial in determining the way ICT is adopted and used inside and outside the classroom (OECD, 2015) and complementarities between ICT and teacher skills could counterbalance the negative effect on traditional instruction (Bulman & Fairlie, 2015).

The importance of what teachers do in the classroom has been emphasized in the recent literature on the effects of teaching practices on students' academic performance, which has focused on the effect of traditional versus modern teaching style. The results generally show that teaching style matters (Aslam & Kingdon, 2011; Schwerdt & Wuppermann, 2011; Zakharov, Carnoy, & Loyalka, 2014), but the empirical evidence is not conclusive with regard to the comparative effectiveness of modern and traditional practices (Lavy, 2011; Van Klaveren, 2011).

Bringing together the literature on the effects of ICT at school and the literature on the effects of teaching practices on student performance, in this study we investigate the effect of ICT-related teaching practices on students' achievement. Our main contribution to the existing literature consists in enlightening the relevance of teachers' practices in making ICT in classrooms effective or not for student achievement.

As far as we know, Falck, Mang, and Woessmann (2015) is the only study analyzing the effect of computer-based teaching practice on students' outcomes. Employing data from the 2011 Trends in International Math and Science Study (TIMSS), they show that the null effect of classroom computers on student achievement is a

combination of positive and negative effects of different computer uses. More specifically, they find positive effects of using computers to look up information, negative effects of using computers to practice skills and no effect of using computers to process and analyze data.

However, their analysis refers only to the students' use of computers during lessons, and it is limited to three computer-based activities. With respect to them, we focus mainly on ICT-related practices performed by the teachers, and we consider a much greater array of ICT-related teaching methods, covering a broader spectrum of teaching-related activities both in the classroom and outside, both with students and alone. The main contribution of our research builds on detailed questions asking the teachers how often they use computers for a wide array of teaching-related practices. On the basis of these questions, we identify five distinct groups of teaching practices: backstage activities, such as preparing and printing files to be distributed in class; computer use for knowledge transmission during lessons, such as projecting slides or sharing files with students; teaching practices implying active involvement of students, for instance through the use of general or specific software; media education practices, such as teaching students how to use social media or blogs; and communication-enhancing activities, favoring teacher-to-teacher collaboration and communication with students and families.

Thanks to the availability of information for two subjects for the same students, as in previous contributions in the literature we adopt an identification strategy that exploits within-student between-subject variation to control for unobserved students' traits. Moreover, differently from previous studies based on countries, such as the US, in which students can self-select into classes within schools, the specific Italian institutional setting, prohibiting class choice within schools, helps us circumvent the potential non-random sorting of students to teachers because the actual student-teacher match within school is substantially random.

In addition, when estimating the effects of teaching practices on students' achievement, we control for both a subjective and an objective measure of teachers' digital skills. This latter is measured by means of teachers' scores in a detailed ICT performance test. Indeed, each practice might have a different effect depending on teachers' ICT knowledge, also because the lack of it could make teachers anxious, primarily in classrooms of students whose ICT knowledge is higher than their own. Moreover, we have information regarding past ICT-related training, which may affect both teachers' ICT knowledge and its pedagogical use through specific practices.

Another important factor we are able to control for are teachers' beliefs about ICT use for teaching and learning. Existing evidence demonstrates that these latter affect the frequency of ICT use in schools more than the availability of infrastructures: students taught by teachers who are positive about ICT use in education but face low access and high obstacles to utilizing it at school report more frequent use of ICT during lessons compared to students taught by teachers having high access to ICT but being less positive about its usefulness for teaching (European Commission, 2013).

We find that the effect of the computer-based teaching practices outlined above is quite heterogeneous. They increase student performance primarily if they are used to teach students a critical use of the Internet or to support communication with students, families and colleagues. On the contrary, a negative effect is found for practices requiring more active involvement by students in classrooms, such as utilizing common or specific software. We also find heterogeneous effects of computer-based practices by subject (Italian language and math).

Our results are not driven by specific groups of teachers, such as those who strongly believe in the usefulness of ICT for teaching or those who are very familiar with it.

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