DISCUSSION PAPER Nº IDB-DP-01072

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August 2024

IDB

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August 22, 2024

Abstract

This paper investigates the effectiveness of different interventions to promote teacher adoption and sustained use of a Computer-Assisted Learning (CAL) platform in public schools in Lima, Peru. The study evaluates three strategies: school-wide workshops, targeted workshops for selected teachers, and a combination of workshops and personalized coaching. Using a large-scale randomized controlled trial involving low-performing schools, we find that all strategies significantly increased teacher registration and initial student engagement with the platform. Teachers who participated in workshops exhibited more than double the registration rates compared to the control group, and those who received both workshops and coaching demonstrated higher sustained use, as evidenced by a greater share of students connecting regularly and completing exercises. Spillover effects were important. Non-treated teachers in treated schools use the platform significantly more than control teachers. However, platform use declined markedly one year post-intervention, highlighting the necessity for continuous support.

JEL: I21, I25, D91

Keywords: Technology Adoption; Technology Diffusion; Education; Experiments.

*Messina acknowledges financial support from Project PID2021-124237NB-I00 (financed by MCIN/ AEI /10.13039/501100011033/ and by FEDER Una manera de hacer Europa) and from Generalitat Valenciana, Consellería de Innovación, Universidades, Ciencia y Sociedad Digital through project Prometeo CIPROM/2021/068.

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1 Introduction

Technology's integration into educational settings has been the focus of much research in recent years, particularly as schools in developed countries increasingly adopt digital tools. Although there is some controversy, studies emphasize that ed-tech, that is, technology applications aimed at improving education, when strategically used to enhance instructional practices can significantly improve student learning outcomes (Escueta et al., 2020).

Computer-assisted learning (CAL) stands out among prominent ed-tech applications. Software properly designed to master a particular set of skills can be a powerful complement to a teacher's instruction. Some attractive features of CAL platforms include the adaptability of the software to student needs and the capacity to offer individualized and immediate feedback to students and teachers. Gamification elements embedded in the software may also render the learning experience more attractive to students. Small-scale interventions that have been experimentally evaluated have shown mostly positive impacts of CAL programs on academic skills, particularly in mathematics.

Despite the potential of CAL platforms, their use in education remains fairly limited, especially in developing economies. This is striking considering that developing countries may benefit more from CAL programs due to larger class sizes, shorter school days, and teachers with limited support. Moreover, traditional remedial interventions like tutoring are significantly more expensive and, hence, less feasible when resources are tight. On the other hand, capacity constraints such as inadequate technological infrastructure and insufficient teacher digital skills may render ed-tech solutions particularly difficult to implement in a developing country context.

This raises the question of whether effective CAL platforms can be implemented in schools at scale. Successful integration of CAL software in the classroom largely hinges on teacher buy-in, as appropriate implementation may require effortful changes in teaching practices. Although various obstacles to the integration of technology in educational settings have been recognized, strategies for surmounting these hurdles

remain largely unexplored. Thus, a key question is how to promote teachers' effective use of technology.

This paper examines how to encourage teachers to utilize a CAL platform in a large-scale experiment involving 188 low-performing public schools in Lima, Peru. During the intervention period, A CAL platform, called Conecta Ideas, was made available to all public schools in Peru for grades 4th to 6th. School randomization facilitated an experimental evaluation of three support strategies aimed at promoting usage among teachers. The first strategy, termed "school-wide workshops," entailed three 1.5-hour online workshops provided to all teachers of 4th, 5th, and 6th grades in the treated schools. The second and third strategies targeted one randomly selected 4th-grade and 6th-grade teacher in each treated school. This additional layer of teacher randomization allows for the examination of technology diffusion patterns within the school, both within the same grade (among non-treated teachers in the 4th and 6th grades) and across different grades (by assessing adoption among 5th-grade teachers). The second strategy, labeled "workshops", involved the same workshops as the first strategy but was restricted to the randomly selected teachers in each school. All teachers who received only workshops ("school-wide workshops" and "workshops") also received weekly text messages employing different nudging strategies during the intervention period. The third strategy involved providing workshops plus additional support through weekly personalized coaching sessions to selected teachers. We term this strategy "workshops+coaching".

The interventions occurred in 2021 during school closures due to the COVID-19 pandemic. Additionally, we non-experimentally assess the effectiveness of supplementary workshops offered to all teachers in 2022, when in-person instruction resumed, and in 2023. This approach enables us to examine the medium-term effects of the initial interventions and evaluate the impact of retraining existing teachers and training newly-hired teachers. Because of the challenges associated to testing students during remote instruction, we do not assess effects on student academic achievement.

We report five sets of results. First, all three interventions produced similar and

substantial positive effects on teacher registration to the platform, with increases of approximately 54-58 percentage points. However, the more intensive intervention led to higher sustained student use. Teachers who participated in workshops experienced a 29 percentage point increase in the percentage of students who connected to the platform at least once, compared to a 51 percentage point increase for those who received workshops plus coaching.[1] Similarly, the average weekly connection rate of students (fraction of weeks connecting to the platform) increased by 12 percentage points for the workshops group, compared to a 27 percentage point increase for the "workshops+coaching" group.

Second, the results indicate positive though modest spillover effects within schools. Indirectly-treated teachers, who were not the primary targets of the intervention but were in schools where some teachers were treated, showed increased platform use. Both workshops and workshops plus coaching treatments increased student average weekly connection by 4 percentage points for indirectly-treated teachers.

Third, there is large treatment effect heterogeneity in teacher characteristics. Female teachers, younger teachers, and those identified as leaders or with higher digital skills exhibited larger treatment effects. In particular, the effect on student average weekly connection was 6 percentage points higher for female teachers and 9 percentage points higher for younger teachers compared to their male and older counterparts, respectively. Moreover, using recent techniques on treatment effect heterogeneity (e.g. Athey et al., 2023), we document large variation in treatment effects across teachers sorted by their predicted treatment effects. In particular, the treatment effect for teachers in the highest quartile of predicted treatment effect have three times larger effects in student average weekly connection compared to teachers in the lowest quartile of predicted treatment effect (22pp and 7pp, respectively).

Fourth, the effects of all the interventions diminished markedly during the subsequent academic years after implementation. Treated teachers in 2021 might have

[1]The effects on various adoption measures for teachers in schools with only two treated teachers were similar to those in schools where all teachers were treated. Therefore, we describe the results for these two treatments collectively as the effects of "workshops."

formed initial habits, but these skills seemed to fade after the three-month summer break. The reluctance to reinvest time in re-learning the platform might explain this drop in usage, but the fact that in 2022 teachers returned to in-person instruction might have also been a contributing factor. Interestingly, teachers who participated in workshops in 2022, especially those who were also part of the treatment group in 2021, displayed much higher levels of platform use in 2022 and 2023. This suggests that refresher workshops can serve as effective boosters, significantly benefiting teachers who have received prior training.

Lastly, our analysis reveals significant differences in the cost-effectiveness of the three interventions studied. The most cost-effective strategy was providing "workshops" to two teachers per school, which proved to be 15 times more cost-effective than the "workshops+coaching" strategy The substantially lower costs of the less intensive strategy more than offset its lower impact on student use. Additionally, the "workshop" approach was 2.5 times more cost-effective than offering workshops to all teachers in grades fourth to sixth ("school-wide workshops"). This higher cost-effectiveness is primarily due to the substantial reduction in costs when training only two teachers, combined with the beneficial spillover effects within schools.

This paper contributes to the nascent literature evaluating promising interventions to encourage teachers' use of technology in the classroom. Asanov et al. (2023) examines school-system, teacher, and student interventions to promote the use of a Computer-Assisted Learning (CAL) platform in Ecuador. Teacher interventions were light-touched and included (i) a benchmarking treatment, in which teachers received a weekly email comparing their students' performance on the platform with that of other classes, (ii) SMS messages reminding teachers that their classes were being monitored and encouraging timely course completion, and (iii) emails of encouragement featuring videos of successful student experiences with the platform aimed at increasing teacher motivation. None of the teacher interventions yielded positive adoption results. Our interventions differ by providing hands-on training to teachers. The encouraging results we obtain suggest that a lack of know-how is an important binding

constraint in the process of technology adoption in schools across developing countries.

(Oreopoulos et al., 2024) experimentally examines the effectiveness of a teacher coaching program to encourage student use of a CAL platform across schools in selected districts of the US. The program consisted of an initial training session followed by weekly meetings between coaches and teachers. They find positive effects of the coaching program on teacher adoption. Student learning increases significantly when student practice on the platform is high, highlighting the importance of implementation practice and teacher buy-in. Our study achieves similar conclusions in a developing country setting. In addition, we show that teachers need continuous support. Teacher use of the platform drops significantly in the years following the intervention. It is only when refresher workshops are offered that engagement levels observed during the initial intervention year are retained.

Our study also connects with an abundant literature that examines the process of technology adoption across developing countries in other fields outside education. Several recent studies have examined the barriers to the adoption of technology in the context of agriculture ((Foster and Rosenzweig, 2010), (Beaman and Mobarak, 2021)); manufacturing ((Hunt and Greenstone, 2012), (Atkin et al., 2017) , and microfinance ((Banerjee and Jackson, 2013)).

Our paper contributes to the literature on three fronts. First, we show that scalable, low-cost training programs can significantly encourage teachers' use of CAL in developing countries. Workshops or coaching had similar effects on teacher registration on the platform, which is the primary hurdle for student use. However, teachers who received coaching exhibit much larger effects on actual platform use by students. Teacher adoption increases with the intensity of the treatment. We also study and document modest spillover effects of technology use within schools. Lastly, we show that one-time interventions are unlikely to be successful in encouraging sustained technology use. For high and sustained levels of use continuous support is necessary over time.

The remainder of the paper is organized as follows. Section 2 introduces the institutional setting of the education system in Peru and outlines the main characteristics of the interventions proposed to promote technology adoption among teachers. Section 4 explains our empirical strategy and discusses the main features of the data. Section 5 presents the main results. Section 6 discusses robustness checks. Section 7 performs a cost-benefit analysis. Section 8 concludes.

2 Context and intervention

2.1 Education in Peru

Education is mandatory at the primary and secondary levels in Peru. Primary school attendance is almost universal (97.2% in 2022 according to the Educational Census from the Ministry of Education-MINEDU), with the majority of students attending public schools (75%). The academic year runs from March to December and primary school students attend school for 4.5 hours a day.

Despite improvements in access to education, learning outcomes in Peru remain low. According to the Student Census Evaluation (ECE in Spanish), only 34 percent of 4th-grade students met a basic math standard in 2019. The Peruvian government closed schools in March 2020, right at the beginning of the academic year, and schools remained closed for two years. To support remote learning, the Ministry of Education (MINEDU) in Peru launched the national program "Learning at Home" ("Aprendo en Casa" in Spanish) in April 2020 to distribute educational content through radio, TV and a website loaded with digital content in all subjects to guide teachers, students, and families. One of the learning platforms endorsed by the Peruvian Ministry of Education was called Conecta Ideas.

2.2 The learning platform

Conecta Ideas is a learning platform originally developed in Chile by the Center for Advanced Research on Education at the Universidad de Chile. In 2017, an experi-

mental evaluation found that 4th grade students who used the platform twice a week in computer labs for seven months showed achievement gains of 0.27 standard deviations in the national standardized exam (Araya et al. 2019). Between 2018 and 2019, the platform was adapted to the Peruvian context by developing new exercises aligned with the national math curriculum, and piloted in a sample of primary public schools in Lima. In 2020, the platform was further modified to support home-based learning during the Covid-19 pandemic. In 2021, the NGO GRADE, the implementing partner, signed an agreement with the Ministry of Education to promote the use of the learning platform among students in 4th to 6th grade in public schools.

To use the Conecta Ideas app, teachers need to register themselves and their students on a website. Once the students are enrolled, teachers provide login credentials to parents.

The learning app provides students with a weekly set of 30 math exercises, accessible through smartphones, tablets, or computers (with the predominant usage being smartphones). These exercises are aligned with the curriculum and during the Covid-19 pandemic were aligned with the weekly topics proposed by the national strategy to support learning from home. To minimize parental financial burdens, the app does not require continuous internet access. Students need to connect briefly once a week to the internet to download the new set of exercises for the week and upload their responses to the previous week's exercises. The use of the app was freely available for all students in grades 4th to 6th in public schools starting in 2021. Upon logging in, students encounter math exercises that they need to solve. Automatic feedback is provided to students after solving each exercise. To increase motivation, students earn "flags" for correctly solving exercises. Upon successfully completing all 30 exercises, students receive a summary reporting the number of "flags" earned for the week, month, and year to foster a sense of achievement and progress over time.

Teachers have access to the following resources on a website specifically designed for them: pedagogical videos, a document describing how the exercises aligned with specific curriculum topics, weekly activities complete with correct answers, and per-

sonalized performance reports generated by the platform. The reports provided aggregate information on the number of connected students, their performance for each activity/exercise, and the list of students who accessed the app during each week.

2.3 The interventions

We implemented an experimental evaluation in 188 public primary schools in Lima during the second semester of the 2021 academic year.

The study focused on students in 4th to 6th grade. Three promotional strategies were examined: (i) school-wide workshops; (ii) workshops; (iii) workshops+coaching. In the school-wide workshops strategy, all teachers in fourth, fifth and sixth grades were invited to participate in training workshops. In contrast, in schools assigned to the workshops treatment only one randomly selected teacher from fourth grade and one from sixth grade were invited to participate in the workshops. Similarly, in the workshops+coaching treatment, only one randomly selected teacher in fourth grade and one teacher in sixth grade were selected.

The workshops offered to teachers were provided online. These workshops comprised three sessions, each lasting 1.5 hours, conducted via Zoom. The initial workshop covered the registration process and how to download the app. The second workshop delved into how to use the reports offered by the platform. The third workshop described a feature of the learning platform which allowed teachers to assign extra practice to students matched to their level of achievement. The workshops were provided by two instructors in each session, who were primary or secondary school teachers with a minimum of eight years of teaching experience. In addition to the presentations given by the instructors, the workshops featured a designated time where teachers could ask questions and even share their screens to receive feedback from the instructors. Random assignment of teachers in the three treatment arms to different workshops was implemented to avoid confounding the effects of the treatments with those of the instructors. Approximately 30 teachers attended each workshop.

In workshops+coaching schools, weekly private support sessions were provided

by instructors for 15 weeks[2]. The instructors had access to a database updated weekly containing information on the registration status and the percentage of connected students for each teacher. Instructors were expected to contact teachers weekly and offer guidance on how to use the platform tools and resources and assist the teachers with any challenges encountered during the week. These support sessions typically lasted around 30 minutes and utilized various communication channels, such as video calls, recorded tutorials, phone calls, and text or WhatsApp messages, though WhatsApp was the most used channel of communication. On average teachers participated in 7.5 coaching sessions, with a maximum of 14 sessions.

During the 2022 and 2023 academic years, the implementation partner conducted virtual workshops offered to all teachers in Lima, including those from the sample of teachers who participated in the experiment in 2021. The 2022 and 2023 workshops were similar to those implemented in 2021. It is important to note the app was used exclusively at home during 2021 (as remote learning was in place due to the Covid-19 pandemic). In contrast, the app could be used at home or at school during 2022 and 2023. In 2022, 225 out of 1,019 teachers directly treated in 2021 participated in at least one Conecta Ideas workshop. Until September 2023, 71 teachers attended at least one workshop.

3 Sample Definition

Among 933 primary public schools in Metropolitan Lima in 2021, 927 were classified into quintiles based on their academic performance, utilizing the average math and language scores from the Student Census Evaluation (ECE in Spanish) for 2016 and 2018. As the intervention aimed to assist underperforming schools, the focus was directed towards the 240 schools falling within the second and third quartiles,

[2]In schools with workshops school-wide and workshops, teachers received weekly text messages for 13 weeks (starting in mid-September, right after the three workshops ended). The content of the messages varied depending on the registration status and the percentage of students connected. In general, the text messages were designed to encourage teachers to participate in the program, stay motivated and promote the use of the platform among students. However, analysis from another experiment in Lima during the same period (CITATION) shows that sending text messages did not affect the adoption and use of the platform.

excluding those involved in a prior pilot program in 2019 (59 schools). This exclusion occurred because the Regional Directorate of Education of Metropolitan Lima (DRELM in Spanish) had already conducted specific interventions for schools in the first quartile of academic performance.

In 2021, the DRELM extended invitations to principals from the 240 schools to introduce the program and required personal information (such as names and contact details) about their teachers in grades 4th to 6th. Information was received from 188 schools,[3] which were then randomly assigned to control and treatment groups: (i) school-wide workshops, (ii) workshops, and (iii) workshops+coaching sessions. [4]Teachers in the control group remained in the National Strategy of the program Conecta Ideas. That is, teachers in this group could have access to the platform or consult resources available nationwide for schools. See Table 1.

	Control	Workshops School-wide	Workshops	Workshops + coaching	N
Total	47	47	47	47	188

A second randomization occurred among the schools assigned to the "workshops" and " workshops + coaching" groups at the teacher level. Within these groups, two teachers per school were randomly chosen to participate in the intervention, one from grade 4th and the other from grade 6th. The selected teachers were called "direct teachers", while those not selected were labeled "indirect teachers". For the "workshops school-wide" group, all teachers in 4th to 6th grades received the treatment. See Table 2 for a summary of the number of teachers with available information in each group.

[3]135 belongs to the second quintile and 53 to the third quintile

[4]The treatment assignment was conducted in two rounds. The first round included schools with complete personal information from teachers before the first week of August 2021. Subsequently, the second round involved the remaining schools with complete information. Stratification was performed based on the average math and language scores of ECE in 2016 and 2018. Within each stratum, schools were randomly assigned to one of the four groups

	Control	Workshops School-wide	Workshops	Workshops + coaching
Teachers in grade 4 and 6 (direct)	283	282	94	94
Teachers in grade 4 and (indirect)	-	-	181	175
Teachers in grade 5	151	139	131	127
Total teachers	434	421	406	396

Administrative and platform data was collected for all teachers in 4th, 5th, and 6th grades, except for individual surveys, which only collected data for teachers in 4th and 6th grades.

4 Empirical Strategy

4.1 Data

We use three main sources of data for our analysis: (a) platform data on take-up and use of the app, (b) survey data on teachers at baseline and endline, and (c) administrative data on school characteristics.

The platform data is drawn directly from the app and comprises our main outcomes of interest. The four outcomes analyzed roughly correspond to key stages in the adoption process. The process starts with teachers registering on the platform. For this adoption stage, we compute (i) the share of teachers that register to the platform. Then, teachers need to promote that students use the platform for the first time, which involves distributing login information and instructions about how to use the app. For this adoption stage, we compute the (ii) the fraction of students that connect

to the platform at least once. Note that these two outcomes are cumulative, that is, they can only increase during the academic year. Hence, these variables are computed by the end of the 2021 academic year [5]

Finally, teachers need to manage high levels of use by reminding students to continue performing the set of weekly exercises assigned to them. For this last stage we include two outcomes in the analysis: (iii) the average fraction of weeks that students connect to the platform (student average weekly connection), and (iv) the average fraction of weekly exercises completed by students. These two variables are averaged during the second semester of the 2021 academic year [6]. All variables are aggregated at the teacher level, which is our main unit of analysis.

We surveyed teachers in grades 4 and 6 at both baseline and endline. The baseline teacher survey was administered over two weeks in mid-August 2021 and collected information about teachers characteristics, their education and experience, their use of technology,self-reported digital skills, attitudes towards technology, and the communication inside the school. In addition, a baseline principal survey was administered from late July to mid-September 2021 which collected information about principal characteristics, their education and experience, their use of technology in school, their perceptions of teachers, and the communication inside the school. We use these baseline surveys to check for balance and to examine heterogeneous effects with respect to teacher characteristics.

A follow-up teacher survey was administrated from late November to mid-December and included information about their use of technology and time, communication inside the school, attitudes towards technology, their knowledge about the platform and attendance to activities related to the intervention.

The administrative data comes from an annual school census and national stan-

[5]The official calendar ended the week of Monday, December 13, 2021, though many schools had limited academic activity during that week. Hence, we measure the cumulative outcomes until the end of the week of December 6, 2021.

[6]Specifically, we average student weekly connections and the fraction of weekly exercises completed across 14 weeks starting on the week of Monday, August 30 (right after workshops 1 and 2 took place) until the end of the week of Monday, December 6, 2021. Also, we do not include the week of Monday, October 11 because there were no classes due to a national holiday.

dardized tests. The former are reported by principals to the Peruvian Ministry of Education, and contain school-level information on enrollment, teachers, resources, and infrastructure, including technological inputs such as the number of computers and internet access. The latter includes achievement tests administered to second grade students across Peru, and we focus on average test scores at the school level for the years 2016-2018. We use these data to check for balance in baseline characteristics at the school-level.

4.2 Sample Construction and Randomization

4.3 Regression models

Recall that we have three main treatment groups in addition to the control group: (1) "school-wide workshops" in which all teachers from the school in grades 4, 5, and 6 were invited to participate in the workshops, (2) "workshops" in which only one randomly selected teacher from grade 4 and one randomly selected teacher from grade 6 were invited to participate in the workshops; and (3) "workshops+coaching" in which only one randomly selected teacher from grade 4 and one randomly selected teacher from grade 6 were invited to participate in the workshops, also workshops were followed by weekly private support sessions.

We first estimate the effects of our interventions on outcomes associated with teachers who were randomly assigned to receive treatment ("directly-treated teachers") using the following regression model:

$$Y_{isg} = \beta_0 + \beta_1 SchoolwideWorkshops_{isg} + \beta_2 Workshops_{isg} + \beta_3 Coaching_{isg} + \epsilon_{isg} \quad (1)$$

where Y_{isg} is one of our main outcomes associated with teacher i in school s and grade g, $SchoolwideWorkshops_{isg}$ is an indicator for teachers in schools assigned to that treatment arm, $Workshops_{isg}$ is an indicator for teachers who were randomly assigned to receive workshops only, $Coaching_{isg}$ is an indicator for teachers who were

randomly assigned to receiving workshops plus coaching, and ϵ_{isg} is an error term. For simplicity, our preferred specifications do not include any covariates except for a constant β_0; our results are also similar whether or not we include strata fixed effects. Thus, the coefficients β_1, β_2 and β_3 are intention-to-treat (ITT) estimates for the effect of being assigned to receive workshops in the partial or school-wide treatment arm, or workshop plus coaching. Note that only directly-treated teachers and those in schools assigned to the control group are included in this regression. These and all of our subsequent regressions report heteroskedasticity-robust standard errors that are clustered at the school level.

We then estimate the effect of the interventions on teachers in the same school and grade as those who were randomly assigned to receive treatment even though they were not treated themselves (indirectly-treated teachers) using the following regression model:

$$Y_{isg} = \gamma_0 + \gamma_2 WorkshopsIndirect_{isg} + \gamma_2 CoachingIndirect_{isg} + \epsilon_{isg} \tag{2}$$

where Y_{isg} is our outcome of interest as before. $WorkshopsIndirect_{isg}$ is an indicator for indirectly-treated teachers in the same school and grade as those who were randomly assigned to receive only the targeted workshops, and $CoachingIndirect_{isg}$ is an indicator for indirectly-treated teachers in the same school and grade who were randomly assigned to receive the targeted workshops plus coaching. Thus, the coefficients γ_1 and γ_2 are intention-to-treat (ITT) estimates for the effect of being exposed to teachers who were randomly assigned to receive workshops or workshops plus coaching. This represents the spillover of treatment on teachers who were not directly-treated but may have been affected indirectly. In this regression, we include all indirectly-treated teachers and those in control schools.

We also estimate a regression on indirectly-treated teachers who are in the same school but in a *different* grade as those who were randomly assigned to receive the targeted workshops or the targeted workshops plus coaching. Specifically, we examine how exposure to treated teachers in grades 4 and 6 may have affected the indirectly-

treated teachers in grade 5. This specification is analogous to the one immediately above, except that it is estimated at the school level (since we only have one grade 5 in each school).

We examine the heterogeneous effects of our treatments by interacting our indicators for treatment in equations (1) and (2) with various teachers baseline characteristics. The choice of these teacher characteristics was determined by our beliefs about which factors were most likely to affect take-up of the learning platform. They include (i) gender, (ii) age, (iii) whether the teacher was considered a leader by the principal, (iv) whether they were considered leaders by other teachers, (v) a measure of digital skills and (vi) positive attitudes towards technology. To gain power, we pool the three treatment groups when estimating these heterogeneous treatment effects. For example, when examining the differential effects of our pooled treatments by gender for directly-treated teachers, we define a variable $Treated_{isg}$ which equals 1 for directly-treated teachers who received workshops with or without coaching and 0 for control teachers. estimating the following regression model:

$$Y_{isg} = \delta_0 + \delta_1 Treated_{isg} + \delta_2 Female_{isg} + \delta_3 Treated_{isg} \cdot Female_{isg} + \epsilon_{isg} \tag{3}$$

The coefficient δ_3 captures the differential effect of treatments for female vs. male teachers who are directly-treated on our various measures of take-up. We also present complementary results were we analyze the treatment effects separately for each of the three treatments (see appendix Table A3). We also estimate the corresponding regressions where we focus on indirectly-treated teachers and report the differential effects of indirect exposure to treatment.

4.4 Baseline balance

We assess baseline balance between directly-treated teachers in our three treatment arms and teachers in the control group in Table 1. This table also provides useful sample statistics for schools and teachers on several dimensions. Panel A uses admin-

istrative data to compare average school characteristics between treatment and control groups, showing no significant differences in average test scores in 2016-2018 or in the number of classrooms and students in fourth and sixth grades. Note that there were, on average, 3 classrooms and 90 students per grade in each school. Panel B uses data from the platform to compare our main measures of take-up in the week prior to the assignment to treatments. All these measures indicate low take-up of the platform before the start of our interventions. The fraction of teachers registered prior to the start of our interventions is around 5-8 percent, with no significant differences across the treatment arms and the control group. The average fraction of students who connected at least once is below 1 percent in all treatment arms while the average weekly connection and the average fraction of exercises completed are both at 0 percent.

Panel C uses baseline survey data to compare teacher demographics, technological skills, attitudes to technology, and leadership. We see that this sample of teachers are approximately 80 percent female and, on average, about 50 years of age with no significant differences by treatment arm. Approximately 20 percent of teachers are on fixed-term contracts and 30 to 40 percent have masters degrees (with a significant difference between the control group and the school-wide workshops arm generating this larger range). There are no significant differences between treatment arms in terms of self-reported digital skills and attitudes towards technology (both of which are standardized to have mean zero) or in the likelihood of being considered a leader by the principal or fellow teachers. The only baseline outcome where there is a significant difference between treatment arms and the control group is in reports of using any math app, where treated teachers are significantly more likely to report using one than teachers in the control group.

We also examine baseline balance by comparing indirectly-treated teachers in the workshop and workshop+coaching groups with teachers in the control group in Appendix Table A1. We observe no significant differences for school characteristics from administrative data (Panel A) or for pre-treatment measures of platform take-up (Panel B) for teachers in 4th and 6th grade. Neither are there any significant differ-

ences in baseline take-up measures for teachers in 5th grade, who could be indirectly-treated by exposure to treated teachers in the grades just above or below (Panel C). We do observe a few instances of significant differences between indirectly-treated teachers and their counterparts in control schools in terms of our survey data. As in Table 1, there is a significant difference between treatment arms and the control group in reports of using any math app as well as some differences in the fraction of female teachers and those with a masters degree.

4.5 Compliance

We examine compliance between directly-treated teachers in our three treatment arms and teachers in the control group using data collected automatically during the online workshops as well as during the coaching sessions. Table 2 documents large and significant differences in participation in workshops and coaching. All three treatment arms included workshops and we observe that approximately 82 to 84 percent of treated teachers in all three groups attended at least one workshop, compared to zero for control teachers. On average, treated teachers attended about 2 workshops (with slightly lower levels when the workshops were provided school-wide). We distinguish between the workshops offered as part of our intervention (intervention workshop) and other Conecta Ideas workshops that were offered in conjunction with the Ministry of Education (included in any CI workshop), but the latter represents a very small fraction. In terms of coaching, we see that approximately 90 percent of teachers in the workshops+coaching group received any coaching, with an average of 7 weeks of coaching, compared to zero for the other groups.

Appendix Table A2 explores whether indirectly-treated teachers also attended workshops and received coaching, even though our interventions did not target them directly. There is some evidence that between 5 and 10 percent of the indirectly-treated teachers in the treated groups did attend workshops, but this is only significant in the administrative data for 4th and 6th grade. There is no indication that any of the indirectly-treated teachers received any coaching.

5 Results

5.1 Short-term average effects

We start the discussion with the short-term effects of providing access to workshops and coaching to teachers. We analyze the impacts on directly treated teachers, those who were invited to participate in the workshops, and indirectly treated teachers, those who were not offered workshops but worked in schools where two of their colleagues were invited to participate in the workshops. The four adoption outcomes considered in the analysis are expressed as percentages, such that the tables report treatment effects in percentage points.

5.1.1 Direct effects

The impact on the adoption of all interventions across directly-treated teachers is substantial. Table 3 presents the results, including the mean outcomes for teachers in the control group (column 1) and the differences in average outcomes for directly treated teachers in the treatment groupsSchool-wide workshop, Workshops, and Workshops+coachingcompared to teachers in the control group (columns 2 to 4). These results are estimated using equation (1).

The effects on teacher registration are large and show minimal variation across treatment arms. The intervention increased teacher registration by 48 percentage points for the School-wide workshops group, 54 percentage points for the Workshops group, and 58 percentage points for the Workshops+coaching group, from a baseline of 23 percent in the control group. The effects on the percentage of students connecting at least once are also substantial but smaller than those on registration, especially for teachers offered only workshops. The School-wide workshops and Workshops treatments increased this outcome by 28 and 29 percentage points, respectively, while the Workshops+coaching treatment increased student registration by 51 percentage points, from a baseline of 6 percent in the control group.

As expected, the estimated impacts of the different interventions decrease as we

progress through the adoption process. The effects on students average weekly connection are positive but smaller than the effects on the share of students connecting at least once, particularly for teachers who only received workshops. Specifically, the School-wide workshops (Workshops) treatments led to increases of 11 (12) percentage points compared to the control group (2 percent). The Workshops + coaching group stands out compared to the other treatment arms in terms of student connections, resulting in a 27 percentage point increase over the control group. The effects on students average completed exercises closely mirror those for students average weekly connection.[7] This pattern repeats throughout the paper. For brevity, we will refer only to the student average weekly connection outcome in the text.

An interesting feature of the results is that the School-wide workshops and Workshops treatments show very similar outcomes across the adoption process. This need not have been the case. For one, teachers in the School-wide workshops group could have benefited from stronger positive spillovers from their colleagues, as all teachers in grades 4 to 6 at these schools were invited to the workshops. Additionally, the fact that all teachers were invited, coupled with the shared awareness that their use of the platform was being monitored, could have established a norm where adopting the platform was expected as part of a school-wide initiative. We expected these two mechanisms to trigger greater platform use among teachers in the School-wide workshop group. On the other hand, teachers in the Workshops group might have been more motivated to adopt the learning platform, feeling "gifted" by being the only teachers in their school and grade invited to participate in the workshops. The results suggest that, if these effects were present, they seem to have counteracted one another, as the overall adoption outcomes were similar across the two groups.

Figure 1 shows the weekly evolution of adoption outcomes between June and December 2021 across the four treatment arms. Panel A of Figure 1 shows that the significant effects of the workshops on teacher registration occurred right after the first two workshops. Since these workshops provided teachers with instructions on how to

[7] This is because students who connect in a given week tend to complete about 80 to 85 percent of the 30 weekly assigned exercises.

register for the platform and encouraged them to do so, this pattern is understandable. The large increase can be attributed to high workshop attendance (over 80 percent of teachers attended) and the fact that most teachers were willing to register during these sessions. The figure also indicates that teachers in the Workshops+coaching group experienced a slight continued increase in registration during the weeks they received coaching. Lastly, teachers in the control group exhibited a slow but steady increase in registration rates over the analysis period.

Panel B in Figure 1 shows that the significant increase in the share of students connecting at least once for the School-wide workshops and Workshops treatment arms occurred immediately after the first two workshops. A similar initial jump is observed among teachers receiving coaching, but they also experienced a continued increase throughout the school year, suggesting that ongoing support was able to cumulatively drive higher overall adoption levels. Panel C confirms these differences across treatment arms for the Student average weekly connection outcome. While all treated teachers show a significant rise during the workshop weeks, those receiving coaching continue to exhibit increased levels afterward.[8]

An interesting feature of the adoption dynamics is that we observe relatively stable levels of student average weekly connection for teachers who were offered only workshops throughout the second semester. This stability suggests that the significant drop-offs in technology use due to "novelty effects" documented in other technological interventions targeting students and teachers were not present in our context.[9]

In conclusion, while workshops and coaching enhanced student engagement with the platform, achieving consistently high levels of use remained challenging. Analyzing the stages of the adoption process, workshops significantly increased teacher registration, indicating that this intervention effectively addressed informational gaps and stimulated teachers' interest in the platform. However, student platform use was

[8]As mentioned, the patterns Student average exercises completed closely mirror those for Student average weekly connection (see Figure A1 in the online Appendix).

[9]Malamud et al. (2019) document substantial novelty effects with personal laptops and internet access, noting a drastic drop in use two months after delivery. Similarly, Kirabo and Makarin (2018) report significant decreases in the use of online learning materials and workshops by teachers two months after these resources were provided.

still limited, suggesting that additional measures are needed to address remaining barriers. Nevertheless, the substantial additional effects of providing ongoing support through coaching highlight that limited teacher know-how and continued motivation are critical barriers. We will return to these issues in Section XXX, where we examine the mechanisms through which the interventions operated.

5.1.2 Spillover effects

We now explore how the intervention affected indirectly-treated teachers. Column (1) in Table 4 presents means for teachers in the control group while columns (2) and (3) present differences in adoption outcomes for indirectly-treated teachers in the workshops and workshops+coaching schools compared to teachers in the control group. These results are estimated using equation (2) [10]. Results presented in Panel A suggest that the interventions produced some spillover effects on adoption measures for indirectly-treated teachers in grades 4 and 6 (note that these are the grades of the directly-treated teachers). However, effects are considerably smaller than those for directly-treated teachers. For the Workshops treatment, effects on student average weekly connection are 12pp for directly-treated teachers and 4pp for indirectly-treated teachers. For the workshops+coaching treatment, the differences are even starker: 27pp for directly-treated teachers compared to only 4pp for indirectly-treated teachers. These results suggest that providing coaching to some teachers in a school after providing them with workshops generates large effects in adoption for these teachers but no additional spillover effects in other untreated teachers in these schools.

Results in Panel B of Table 4 show that spillover effects for indirectly-treated teachers in grade 5 (a grade in which no teacher was directly-treated) are positive but mostly insignificant and smaller than those in grades 4 and 6. These results suggest that within-grade spillover effects (in grades 4 and 6) are larger than across-grade spillover effects (in grade 5) though we cannot reject the null hypothesis of similar effects across grades 4 and 6 versus grade 5. Appendix Figure A2 shows that indirectly-

[10] We do not report spillover effects for the Workshops school-wide group because, by design, all teachers in fourth to sixth grade in these schools were invited to participate in workshops.

treated teachers in grades 4 and 6 exhibited gradual increases over time in adoption outcomes compared with the flatter trends documented for directly-treated teachers in Figure 1. The more gradual increases in adoption for indirectly-treated teachers are consistent with effects emerging later due to interactions with directly-treated teachers [11]. Overall, these results suggest that spillovers effects are present though they are small and that making a strong effort to generate high adoption among some teachers through coaching will not translate in increased adoption among other teachers in these schools.

5.2 Short-term heterogeneous effects

In this subsection, we explore whether the interventions produced heterogeneous effects across teachers in 2021, when the interventions were implemented. We start by analyzing heterogeneous effects on directly-treated teachers pooling all three treatments (we discuss later separate effects by treatment groups). We run one regression per outcome and teacher characteristic. We assess, for example, whether the treatment effect on student average weekly connection for female teachers is larger compared to the treatment effect for male teachers. Specifically in this case, we run a regression where the dependent variable is student average weekly connection and the independent variables are a dummy for treatment, a dummy for female teacher, and a dummy for the interaction of treatment and female teacher (see equation 3). Table 5 reports the coefficients and standard errors of the interaction of the treatment dummy and the characteristic analyzed (e.g. female). Hence, coefficient results can be interpreted as the increase in the treatment effect associated with the characteristic shown in the title of the column.

Table 5 shows that there is large variation in treatment effects across teachers characteristics. Focusing on effects on student average weekly connection, we see that treatment effects are larger for teachers that are female, younger than 52 years old

[11] This pattern of a more gradual upward trend for indirect teachers in 5th grade is less pronounced compared to the results for indirectly-treated teachers in grades 4th and 6th. However, the sample size for teachers in 5th grade is smaller, so results are noisier.

(the median age in the sample), those that are considered as leaders by the principals or by their fellow teachers and those reporting higher digital skills and more positive attitudes towards technology at baseline. Moreover, these differences are quantitatively large. For example, treatment effects on student average weekly connection are 6pp larger for females compared to males, 9pp larger for younger compared to older teachers and 6pp larger for those considered as leaders by their principals compared to those not considered as leaders. As a benchmark, the average effects of the workshops treatment on this outcome was 12pp. Effects on percent of students that connect at least once also suggest important differences in treatment effects across subgroups of teachers. However, results are more tentative in the case of teacher registration presumably due to the lower variation across teachers in this outcome (close to 80 percent of teachers registered).[12]

Why do some groups of teachers, such as female teachers and younger teachers, have higher levels of adoption? Is it because they have higher attendance rates to the workshops or rather that with the same level of attendance to workshops they achieve higher levels of adoption? To explore this issue, Appendix Table A4 reports differences in attendance rates to workshops across teachers in different subgroups. For example, column (1) reports that female teachers had 1pp higher attendance rate to at least one workshop compared to male teachers (who had an average attendance rate of 84 percent). Results indicate that subgroups that presented higher adoption levels of the platform, such as younger teachers or those considered as leaders by their principals, also displayed higher levels of attendance to workshops (differences are statistically significant at the 10 percent level in all cases with the exception of female teachers). However, the magnitudes of these effects are rather small and account for a small fraction of the increases in effects documented. For example, we document that younger teachers had treatment effects on student average weekly connection that are 86 percent larger than older teachers (20pp versus 11pp) but younger teachers have

[12]We also explore heterogeneous effects separately by treatment and find tentative evidence suggesting that differences in treatment effects across groups are present for the three treatment groups, though the smaller sample sizes render many of the estimates statistically insignificant (see Appendix Table A3).

attendance rates that are only 15 percent larger than their older colleagues.

Considering the large heterogeneity in treatment effects across teachers in observable characteristics, could governments target their limited funds for promotional activities to some group of teachers with high expected treatment effects? And how much higher will the effects would be for these high-treatment teachers? To answer these questions, we apply recent methodological advances in the estimation of Conditional Average Treatment Effects which essentially involve estimating effects for specific regions of the covariate space (Athey et al. 2023). As described in section 3, we predict these treatment effects for each teacher and then estimate treatment effects for groups of teachers categorized by quartiles in their predicted treatment effects.[13]

Figure 2 shows that there is large variation in treatment effects across teachers sorted by their predicted treatment effects. For example, the treatment effect for teachers in the highest quartile of treatment effects have three times larger effects in student average weekly connection compared to teachers in the lowest quartile of teacher effect (22pp and 7pp, respectively). Moreover, Appendix Table A5 shows that teachers in the top quartile of estimated treatment effects present stark different average characteristics compared to those that are in the bottom quartile which are consistent with the heterogeneous treatment effects by observable characteristics presented above. We see that high treatment-effects teachers tend to be much younger, more likely to be considered a leader by the principal or their fellow teachers, have higher self-reported digital skills and more positive attitudes towards technology compared to low treatment-effects teachers. These results suggest that targeting limited resources to teachers with high expected treatment effects seems a promising strategy to improve the cost-effectiveness of promotional activities.

We documented large heterogeneity in treatment effects across directly-treated teachers. But, do we observe similar patterns for indirectly-treated teachers? More specifically: are the characteristics that make teachers more prone to adopt the use of

[13]We follow the procedure describe in Athey et al. (2023) to use different samples to predict treatment effects and estimate treatment effects by quartiles of their predicted treatment effects in an unbiased way.

learning platform when they are directly treated also make them more likely to adopt when their fellow teachers are treated? To answer this question, Table 6 presents analogous results to those in Table 5 but now focusing on indirectly-treated teachers. The table reports, for example, whether the treatment effects on student average weekly connection are larger for indirectly-treated female teachers compared to indirectly-treated male teachers. Looking at individual coefficients there seems to be little evidence of heterogeneous effects for indirectly-treated teachers considering that only three out of 24 coefficients are statistically significant (and at the 10 percent level). However, all 24 reported coefficients are positive (as they tended to be for directly-treated teachers) providing some suggestive evidence supporting the notion that the characteristics that make teachers more likely to adopt the platform when given direct support also make them more susceptible to adopt it when their fellow teachers are supported.

5.3 Medium-term effects

In this subsection we assess whether the short-term effects documented for 2021 persist in 2022 and 2023. When interpreting these results, it is important to note that in-person classes for students and teachers resumed in March 2022 (after the Covid-19 pandemic subsided) and continued for the 2022 and 2023 academic years. Also, the research center GRADE, the implementer of Conecta Ideas Peru, organized online workshops for primary school teachers in Lima between July and August 2022 and also in the first semester of 2023 to promote the use of the platform. In particular, GRADE partnered with the Ministry of Education to promote that teachers in Lima attended these workshops (there were no additional targeted promotional activities to teachers that participated in the 2021 experiment). To have a better understanding of how these additional workshops that took place in 2022 and 2023 affected adoption in the treatment and control groups within an academic year, we report estimated effects for three periods: before, during and after the workshops implemented in each year. Hence, for 2022, we define week 0 as when the workshops started and report effects

separately for weeks -16 to -1 for the before period, weeks 0 to 6 for the during period and weeks 7 to 21 for the after period.[14]

Column (1) in Table 7 presents the mean adoption outcomes for 2022 for teachers that were in the control group in 2021. Columns (2) to (4) present the average difference in outcomes for directly-treated teachers in 2021 that were in the school-wide workshop, workshops and workshops+coaching treatment groups[15]. Results indicate that in the months prior to the 2022 workshops, the use of the platform among students assigned to control and treated teachers was extremely low (student average weekly connection was 0.1 percent among students in the control group and those in the treatment groups had only 0.4-0.8pp higher levels of use). As the workshops were implemented roughly in July and August 2022, the student average weekly connection increased slightly to 0.6 percent for students in the control group while the effects for the treatment groups increased to 2pp-3pp. After the workshops, student average weekly connection in the control group increased slightly to 0.8 percent and the treatment effects increased to 3pp-5pp.[16] Differences with respect to the control group are statistically significant.

5.4 Boosters?

The workshops that took place in 2022 seem to have produced a slight increase in average use among students in the control and treatment groups. But how does this increase in use varied by whether teachers participated in workshops in 2022 or not? To explore this issue, Figure 3 plots the fraction of students who had connected to

[14]We can follow teachers across years in the platform data set and track their students use. However, we do not have information on which teachers were able to continue using the platform in 2022 or 2023 because they were teaching in public schools in the grades covered by Conecta Ideas Peru in those years. For example, we do not know if a teacher moved to a private school or stopped teaching altogether. Consequently, the reported measures of platform use are slightly downward biased because they are not adjusted to incorporate that some teachers cannot use the platform. Still, adjusting our estimates for this issue should change only slightly our estimates. If we assume that in 2022 80% of teachers continued teaching in the targeted years in public primary school, then we should multiply our estimates by 1.25 (1/0.8). Because we estimate small treatment effects in years 2022 and 2023, such multiplicative adjustments will produce only minor absolute changes in the estimated effects on the adoption outcomes.

[15]We estimate these differences using equation (1).

[16]Focusing on the fraction of students that connect at least once yields similar findings. Also, similar patterns are observed for 2023 (see Table A6).

the platform in 2022 separately for students of teachers in four groups: (i) those in the control group who did not attend a workshop in 2022; (ii) those in the control group who attended a workshop in 2022; (iii) those in the treatment group who did not attend a workshop in 2022; and (iv) those in the treatment group who attended a workshop in 2022. The figure presents some clear patterns. Teachers who did not attend a workshop in 2022, irrespective of whether they were in the treatment or control group in 2021, exhibited low levels of use during the complete 2022 academic year. In contrast, teachers in the control and treatment groups that participated in a workshop in 2022 increased markedly their platform use after the workshops suggesting large effects of receiving this support. Moreover, the effects of participating in a workshop during 2022 are much larger for teachers in the treatment group compared to those in the control group.

To explore these patterns in more depth, we construct a data set at the teacher-week level in 2022 and regress the outcome Students Connected at Least Once on a dummy for having attended a workshop in 2022, dummies for the three time periods described above (before, during and after the workshops) and the interaction of the dummy for attending a workshop in 2022 and the three time periods.[17] Column 1 in Table 8 presents the results when focusing on teachers in the treatment group of the 2021 experiment. Results indicate that attending a workshop in 2022 increases the outcome Students Connected at Least Once by six percentage points during the workshops and 29 percentage points after the workshops.[18] Estimated effects for attending a workshop in 2022 for teachers in the control group in 2021, presented in Column 2, suggest positive effects but more muted compared to those for teachers in the treatment group in 2021. To determine whether the difference in effects between

[17]We omit period -1 from the before period so that all coefficients are relative to this week. We also clustered the observations at the teacher level to incorporate the high serial correlation for the teacher outcomes

[18]The interaction of attending a workshop in 2022 with the before period shows a negative effect of two percentage points statistically significant at the 10 percent level. This can be expected considering the results presented in Figure 3 which shows that treatment teachers attending a workshop in 2022 experienced a slight increase in Students Connected at Least Once during the pretreatment period relative to those that did not attend. However, trends for both groups of teachers are flat in the four weeks prior to the start of the treatment suggesting that, in the absence of the treatment, we could have expected similar trends for both groups of teachers in the rest of the year.

the treatment and control groups in 2021 is statistically different, we run a regression that includes both sets of teachers and uses a richer specification that includes periods fixed-effects, a dummy for attending a workshop in 2022 and a dummy for being part of the treatment group in 2021 and the interactions of all these dummy variables.

Column 3 shows the estimated effects for the triple interaction of the time periods with the dummy for attending a workshop in 2022 and the dummy for belonging to the treatment group in 2021 (which basically shows the difference in effects between the treatment and control groups). Results indicate that the effects for teachers in the treatment groups are 16 pp larger than those in the control group after the implementation of the workshops. Columns 4 to 6 presents analogous results for the outcome Student Average Weekly Connection and suggest similar qualitative findings.[19]

These results should be interpreted with caution because they are not based on experimental variation. However, they do suggest that the effects of providing workshops in 2022 were quite different had the teachers were also supported in 2021 or not. That is, effects for newly-trained teachers who were receiving a first dose (those in the control group) are considerably smaller than for re-trained teachers who were receiving a second dose (those in the treatment group).

These findings suggest several conclusions. First, there is limited persistence across years of the effects of supporting teachers to promote the adoption of the platform. This is surprising considering the high persistence of effects that was documented within the implementation year. One potential explanation for these results is that many teachers who received support to start using the platform through workshops developed a habit of using the software during the 2021 academic year. By the start of the 2022 academic year, after the 3-month summer break, most of these teachers may have forgotten how to operate the platform and may have not desired to make the time investment needed to re-learn how to use it and also register students [COMPLETE]. Alternatively, teachers may have limited incentives to continue using the platform during 2022 when in-school instruction resumed. Second, the intensive

[19] Appendix Figure A3 presents results in a week-by-week basis by presenting event-study figures for both outcomes.

additional support that teachers in the workshops+coaching treatment group received in 2021 (compared to the workshops treatment) generated substantial larger use during that year but this additional increase in use did not translate in higher use in 2022 and 2023. Third, teachers in the treatment group in 2021 that received workshops in 2022 had substantially higher levels of use compared to those in the control group in 2021 that also received workshops in 2022. Though this evidence has be interpreted with caution, these results could suggest that a new workshop in a year could act as a booster with a larger effect for those already trained teachers. Consequently, it is not that investments in helping teachers to use a platform do not have effects on future use. Rather, the human capital generated may be dormant and could be activated with additional support.

6 Robustness

This section presents robustness checks to running regressions including strata fixed-effects. Recall that the randomization of schools to treatment involved sorting schools by baseline academic achievement, generating groups of four schools with similar baseline academic achievement and then randomizing one school in each group into a treatment arm. One option to estimate treatment effects involved regressing an adoption outcome (e.g. average weekly student connection) on treatment dummies and strata fixed-effects. Though this approach would have produced sensible results in most of our analyses, in some cases, it would entailed estimating effects reducing substantially the effective sample size used[20]Hence, our preferred specification, and the one used to generate all results discussed, did not include strata fixed-effects. To show the robustness of the results to this analytical choice, we have re-done the main tables of our paper using a specification which includes, in addition to the regressors included in the baseline analysis, randomization strata fixed-effects. Results

[20]For example, to follow the procedure described by Athey et al. (2023) to estimate Conditional Average Treatment Effects (CATE), we would need to estimate effects in 10 folds of our data which each includes small random samples of the teachers data. In one specification of this analysis, we would run the analysis with just 70 or 71 observations. If we had included 47 strata fixed effects, then we would have lost a substantial share of the effective sample size in this analysis.

from this analysis indicates that the presented findings are robust to this alternative specification.[21]

7 Cost-effectiveness

This section presents information on the effects and costs of the analyzed interventions. Panel A of Table 9 presents the effects and costs when including only directly-treated teachers in the analysis. The first row presents the effects of the three interventions on average weekly student connection (these results were reported in Table 3). The second row presents estimated marginal costs per student of providing workshops or coaching (see Appendix 1 for a description of the costs involved and underlaying assumptions).[22] The third row presents the expected effect per dollar spent by dividing the estimated effects by the estimated per-student cost. Results indicate that the effects of providing workshops and coaching are about 2.3 larger compared to just providing workshops (e.g. 26.55pp/12.26pp). However, the costs associated to providing workshops and coaching are about 23 times larger (7.68/0.34). Consequently, the effects per dollar spent are about 10 times larger for the workshops treatment compared to the workshops+coaching treatment.

These results do not consider the spillover effects on indirectly-treated teachers. Hence, in panels B and C, we enlarge the sample of teachers focused in the analysis to incorporate these teachers. In Panel B we add the indirectly-treated teachers in grade 4 and 6 and in Panel C we add the indirectly-treated teachers in grades 4, 5 and 6. To estimate effects in both panels, we run regressions similar to the ones estimated to generate tables 3 and 4 but pooling outcomes for all directly- and indirectly-treated

[21] Appendix Table A8, Table A9, Table A10 reproduces main Table 1, Table 2, Table 3 (which present balance, compliance and short-term effects on directly-treated teachers, respectively). In all cases, the alternative tables included in the appendix present similar findings to those reported in the main tables.

[22] In the baseline cost-effectiveness analysis presented here, we include financial costs borne by the implementer and we do not include opportunity costs for teachers for two reasons. First, for governments in developing countries a key constraint are the financial resources that their Ministries of Education have. Second, estimating opportunity costs require making additional assumptions based on limited data. However, as a robustness check, we present a cost-effectiveness analysis in Table A11 where we do include opportunity costs for teachers. We discuss how including these costs affect the estimates presented here.

teachers in the relevant grades in each school. From a governmental perspective, the most relevant analysis is the one presented in Panel C which incorporates spillovers on all potential beneficiary teachers in the school. Focusing on this panel, we see that the effect for teachers in the Workshops school-wide group are slightly smaller than those presented in Panel A[23]. In contrast, in the case of teachers in the workshops group, the effects are reduced by about half because the effects on indirectly-treated teachers are substantially smaller to those for directly-treated teachers (and this panels presents a weighted average of the effects on directly- and indirectly-treated teachers). And for teachers in the workshops+coaching group, the effect is reduced even more (about two thirds) because the effects on indirectly-treated teacher are much smaller than for directly-treated teachers.

In short, as we incorporate the indirectly-treated teachers in the analysis, the effects of the workshops and workshops+coaching interventions are reduced. But, importantly, the costs are reduced even more. Essentially, the costs are reduced by almost 80 percent because the total school cost associated to providing these interventions (that previously was divided by 2 teachers in each school), it is now divided among all teachers in the targeted grades (on average, 9 teachers). Consequently, the cost-effectiveness ratios for these two interventions surge, especially for teachers in the workshops group. Overall, once we consider all teachers in targeted grades in the school, the workshops intervention is 2.5 times more cost-effective than the workshops school-wide due to the spillovers generated by the former intervention. And the workshops intervention is about 15 times more cost-effective than the workshops+coaching intervention.[24] Hence, governments with limited funding seeking to maximize the ef-

[23]This is just because the effects on directly-treated teachers in grade 5 for this treatment are somewhat smaller.

[24]Appendix Table A11 presents a similar cost-effectiveness analysis but incorporating opportunity costs for teachers. The qualitative findings of the analysis remain though the differences between the Workshops and the Workshops+coaching in cost-effectiveness shrank. This is because incorporating opportunity costs in the case of workshops more than doubles total costs per student because as are many teachers per trainer in a workshop (hence, opportunity costs are large relative to financial costs). In contrast, the cost per student only increases by 15 percent for the case of Workshops+coaching as the opportunity cost of the teacher that receives personalized support from a trainer is minor compared to the financial cost of hiring a trainer. Finally, incorporating fixed costs (e.g. costs for developing the platform or the content in the platform) also reduces the cost-effectiveness of the interventions especially for the Workshops intervention because it raises the costs in percentual terms more than

fects of promotional activities could prioritize first the workshops intervention, then the workshops school-wide intervention and finally the workshops+coaching intervention.

8 Conclusion

This paper presents results from a large-scale experimental evaluation conducted in 188 public primary schools in Lima, Peru, aimed at analyzing how to best promote the adoption of a math learning platform. The interventions were implemented in 2021 during remote instruction induced by the Covid-19 pandemic. We use comprehensive platform data to measure effects on platform adoption in that year and also during 2022 and 2023 when students returned to in-school instruction. The study assesses three interventions: (i) workshops for all teachers in targeted grades (fourth and sixth), (ii) workshops for two teachers per school, and (iii) workshops combined with coaching for two teachers per school. The evaluation employed a two-level randomization. First, schools were randomized into one of the three treatment groups or a control group. Second, for the two treatments directed to two teachers per school, one teacher in fourth grade and one in sixth grade were randomly selected for treatment. This design enabled the measurement of direct effects and spillover effects on indirectly-treated teachers within the treatment schools.

Results indicate that workshops, and particularly the combination of workshops and coaching, significantly increased teacher registration and student use of the platform. We observe modest spillover effects of similar magnitude for both the workshops and workshops plus coaching interventions. There was substantial heterogeneity in treatment effects based on specific dimensions such as age and gender, as well as when combining different covariates to predict individual-level treatment effects across teachers. We document a large fade-out of treatment effects in subsequent years, though re-trained teachers exhibited higher platform use compared to newly-

for the other two interventions. Still, assuming a fixed cost of 0.20 dollars per student (based on ConectaIdeas Peru expenditures) does not alter the main conclusions of this analysis.

trained teachers, suggesting the presence of "booster" effects. Additionally, there were significant differences in cost-effectiveness across treatments: providing workshops to two teachers per school was 15 times more cost-effective than providing workshops plus coaching, and 2.5 times more cost-effective than providing workshops to all teachers in targeted grades.

Our findings suggest several policy implications. First, the large positive effects on teacher registration and student engagement underscore the effectiveness of both workshops and workshops combined with coaching in promoting platform adoption. However, given the substantially higher cost-effectiveness of providing workshops to a limited number of teachers per school, policymakers should consider this strategy to maximize impact under budget constraints. The considerable heterogeneity in treatment effects across teachers suggests that cost-effectiveness could be further enhanced by targeting interventions to teachers with high predicted treatment effects. Finally, the substantial decline in platform use in subsequent years highlights the necessity for continuous support, such as periodic refresher workshops, to sustain long-term technology adoption.

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Tables and Figures

Table 1: Baseline Balance - Comparison of Control Teachers and Directly-Treated Teachers

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Panel A. Administrative data					
School characteristics					
Average test score 2016-2018	543.62	0.99	0.20	-0.02	*188*
		(1.95)	(1.68)	(1.64)	
Number of classrooms in 4th and 6th grade	5.98	-0.04	-0.15	-0.28	*188*
		(0.54)	(0.61)	(0.52)	
Number of students in 4th and 6th grade	183.96	1.32	-3.51	-10.57	*188*
		(18.28)	(20.82)	(17.47)	
Panel B. Platform data					
Pre-Treatment Use of the Platform at the teacher level					
Teachers registered (%)	6.71	0.02	-1.39	1.80	*753*
		(3.89)	(3.75)	(3.78)	
Students connected at least once (%)	0.33	0.68	0.30	-0.33	*753*
		(0.96)	(0.71)	(0.33)	
Student average weekly connection (%)	0.00	0.00	0.00	0.00	*753*
		(0.00)	(0.00)	(0.00)	
Student average exercises completed (%)	0.00	0.00	0.00	0.00	*753*
		(0.00)	(0.00)	(0.00)	
Panel C. Survey data					
Teacher characteristics					
Female (%)	77.27	1.73	4.25	1.14	*706*
		(4.16)	(4.76)	(5.87)	
Master degree (%)	36.36	-9.65**	-7.02	4.55	*706*
		(4.79)	(6.63)	(6.69)	
Age	50.50	1.23	-0.74	-0.3	*706*
		(0.80)	(1.10)	(1.11)	
Fixed-term contract (%)	20.15	-1.38	3.71	0.54	*699*
		(4.47)	(5.34)	(5.27)	
Use of any math app (%)	27.65	10.90*	14.74**	15.53**	*706*
		(6.21)	(6.72)	(6.41)	
Self-reported digital skills (standardized)	0.00	-0.08	-0.03	0.01	*706*
		(0.10)	(0.13)	(0.14)	
Positive attitudes on technology (standardized)	0.00	0.00	-0.11	0.18	*706*
		(0.13)	(0.14)	(0.15)	
Considered as a leader					
By the principal	27.92	0.10	7.19	-2.38	*753*
		(2.74)	(6.36)	(4.93)	
By other teachers	45.94	0.87	-1.26	7.26	*753*
		(4.52)	(6.19)	(5.85)	

Notes: Standardized average test is the mean of the score in math and spanish in 2016 and 2018. After that, we create a z-score with the control group score (x - mean/sd). The use of Conecta Ideas in the week prior to the workshops refers to the week of August 2, 2021. Regression at teacher level include cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table 2: Compliance - Participation in Workshops and Coaching by Control and Directly-Treated Teachers

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Administrative data					
Attended a treatment workshop (%)	0.00	82.27***	84.04***	82.98***	*753*
		(3.25)	(4.30)	(4.35)	
Numbers of treatment workshops	0.00	1.67***	1.98***	1.96***	*753*
		(0.10)	(0.13)	(0.13)	
Attended any CI workshop (%)	2.83	80.15***	81.22***	80.15***	*753*
		(3.47)	(4.49)	(4.53)	
Numbers of CI workshops	0.04	1.66***	2.03***	1.96***	*753*
		(0.10)	(0.14)	(0.14)	
Received coaching (%)	0.00	0.00	0.00	90.43***	*753*
		(0.00)	(0.00)	(3.26)	
Number of weeks that received coaching	0.00	0.00	0.00	7.50***	*753*
		(0.00)	(0.00)	(0.44)	

Notes: Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table 3: Effects on Platform Use by Directly-Treated Teachers

		Differences			
		Directly-Treated Teachers			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Teachers registered (%)	22.97	48.31***	53.63***	57.88***	*753*
		(6.76)	(7.09)	(6.71)	
Students connected at least once (%)	5.73	28.12***	28.65***	50.53***	*753*
		(4.27)	(4.46)	(4.61)	
Student average weekly connection (%)	1.59	10.94***	12.26***	26.55***	*753*
		(1.92)	(2.05)	(2.70)	
Student average exercises completed (%)	1.27	9.02***	10.46***	22.58***	*753*
		(1.63)	(1.78)	(2.41)	

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively. N=753

Table 4: Effects on Platform Use by Indirectly-Treated Teachers

		Differences		
	Control	Workshops	Workshops + coaching	*N*
	(1)	(2)	(4)	(5)
Panel A. Indirect in 4th and 6th grade				
Teachers registered (%)	22.97	14.05*	14.17*	*639*
		(7.65)	(7.69)	
Students connected at least once (%)	5.73	11.51**	8.08**	*639*
		(4.44)	(3.97)	
Student average weekly connection (%)	1.59	3.63**	3.65**	*639*
		(1.51)	(1.62)	
Student average exercises completed (%)	1.27	2.92**	3.09**	*639*
		(1.26)	(1.37)	
Panel B. Indirect in 5th grade				
Teachers registered (%)	17.88	8.84	9.68	*409*
		(8.09)	(7.11)	
Students connected at least once (%)	5.49	6.58	3.73	*409*
		(4.23)	(3.76)	
Student average weekly connection (%)	1.33	3.73**	2.40	*409*
		(1.83)	(1.60)	
Student average exercises completed (%)	1.05	3.31**	2.31	*409*
		(1.62)	(1.50)	

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table 5: Heterogeneous Effects - Who Are the Best Adopters Among Directly-Treated Teachers?

	The coefficient shows the interaction of treatment with:					
	Female	Young	Considered as leader by principal	Considered as leader by other teachers	Digital skills	Positive attitudes towards technology
	(1)	(2)	(3)	(4)	(5)	(6)
Teachers registered (%)	2.29	17.94**	-0.14	5.49	3.80	-1.15
	(7.34)	(7.01)	(6.08)	(5.69)	(3.25)	(3.54)
Students connected at least once (%)	10.60**	17.30***	4.53	13.19***	4.39**	3.79
	(4.28)	(4.88)	(4.12)	(3.85)	(2.03)	(2.29)
Student average weekly connection (%)	5.68**	9.06***	6.05***	6.89***	1.94*	2.76**
	(2.19)	(2.43)	(2.30)	(1.87)	(1.06)	(1.15)
Student average exercises completed (%)	4.92**	7.66***	5.82***	6.21***	1.77*	2.66**
	(1.90)	(2.14)	(2.01)	(1.61)	(0.93)	(1.02)

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table 6: Heterogeneous Effects - Who Are the Best Adopters Among Indirectly-Treated Teachers?

	The coefficient shows the interaction of treatment with:					
	Female	Young	Considered as leader by principal	Considered as leader by other teachers	Digital skills	Positive attitudes towards technology
	(1)	(2)	(3)	(4)	(5)	(6)
Teachers registered (%)	9.99	2.52	13.78*	9.67	2.31	1.61
	(8.87)	(7.66)	(7.64)	(7.45)	(3.83)	(3.98)
Students connected at least once (%)	4.13	4.56	2.40	5.50	2.64	2.69
	(3.29)	(4.74)	(4.38)	(3.62)	(2.12)	(2.24)
Student average weekly connection (%)	2.37*	2.06	2.01	0.98	1.14	1.14
	(1.32)	(1.82)	(1.92)	(1.39)	(0.86)	(0.92)
Student average exercises completed (%)	2.05*	1.92	1.95	0.7	0.97	0.99
	(1.15)	(1.56)	(1.71)	(1.22)	(0.74)	(0.78)

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively. The number of observations in the table is 706, except for columns (3) and (4), where it is 753.

Table 7: Medium-Term Effects on Platform Use for Directly-Treated Teachers in 2022

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Panel A: Before workshops started (weeks -16 to -1)					
Students connected at least once (%)	0.73	2.09*	1.38	2.90	*753*
		(1.12)	(1.30)	(1.80)	
Student average weekly connection (%)	0.14	0.73*	0.36	0.82*	*753*
		(0.40)	(0.30)	(0.48)	
Student average exercises completed (%)					
Panel B: During the workshops (weeks 0 to 6)					
Students connected at least once (%)	2.44	4.83**	8.81***	7.59***	*753*
		(1.90)	(3.38)	(2.73)	
Student average weekly connection (%)	0.61	2.24***	3.13***	2.69***	*753*
		(0.85)	(1.14)	(0.98)	
Student average exercises completed (%)					
Panel C: After workshops finished (weeks 7 to 21)					
Students connected at least once (%)	4.05	7.88***	10.69***	11.09***	*753*
		(2.88)	(3.99)	(3.93)	
Student average weekly connection (%)	0.82	2.86***	4.61***	3.65**	*753*
		(0.98)	(1.75)	(1.54)	
Student average exercises completed (%)					

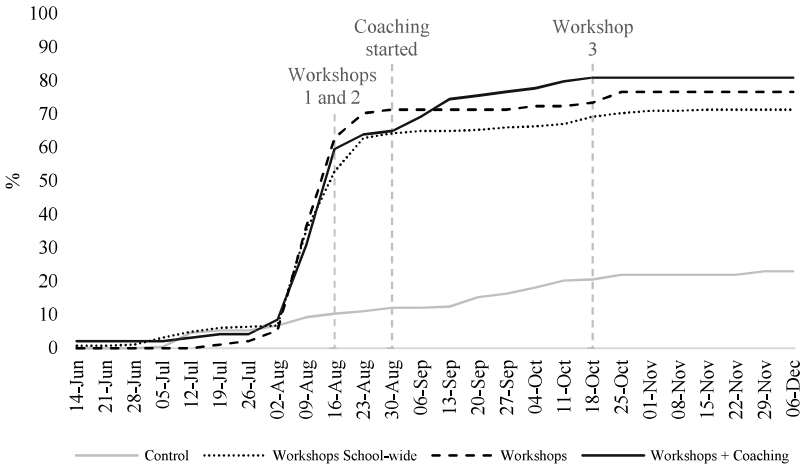
Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table 8: Cost-Effectiveness Ratios by Treatment Group and Teacher Sample

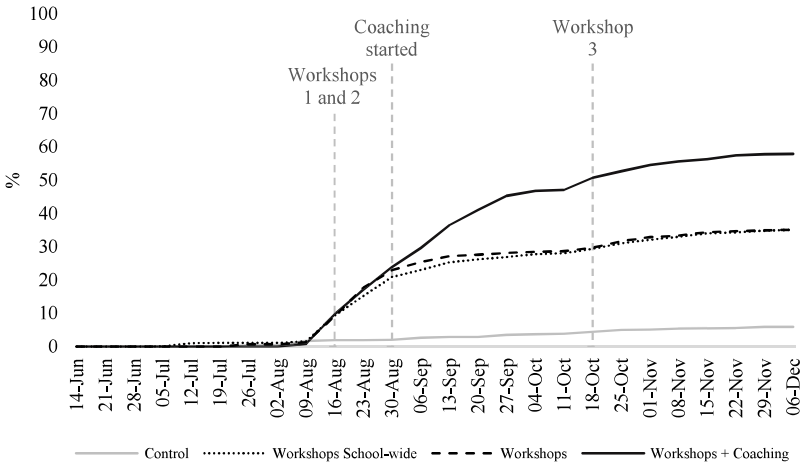
	Workshops school-wide (1)	Workshops (2)	Workshops + coaching (3)
Panel A: Directly treated teachers (4th and 6th grade)			
Effects on average weekly connection	10.94	12.26	26.55
Cost per student	0.34	0.34	7.68
Effect per dollar invested per student	32.54	36.47	3.46
Panel B: Directly and indirectly treated teachers (4th and 6th Grade)			
Effects on average weekly connection	10.94	6.58	11.65
Cost per student	0.34	0.11	2.56
Effect per dollar invested per student	32.54	58.72	4.55
Panel C: Directly and indirectly treated teachers (4th, 5th and 6th Grade)			
Effects on average weekly connection	10.32	5.68	8.64
Cost per student	0.34	0.07	1.71
Effect per dollar invested per student	30.70	76.03	5.06

Figure 1: Platform Use Over Time

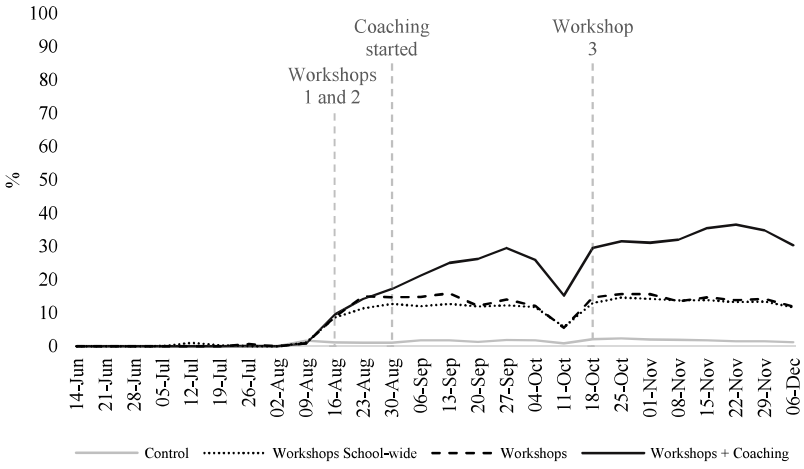
Panel A: Teachers registered (%)



Panel B: Students connected at least once (%)



Panel C: Student average weekly connection (%)



Notes: Coaching ended in the week of December 6. The week of October 11 was a school vacation.

Figure 2: Average Effects on Average Weekly Student Connection by Quartlies of Estimated Treatment Effects

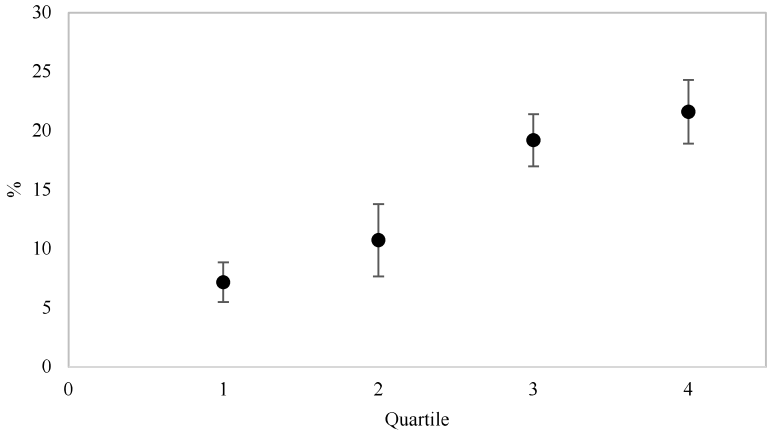
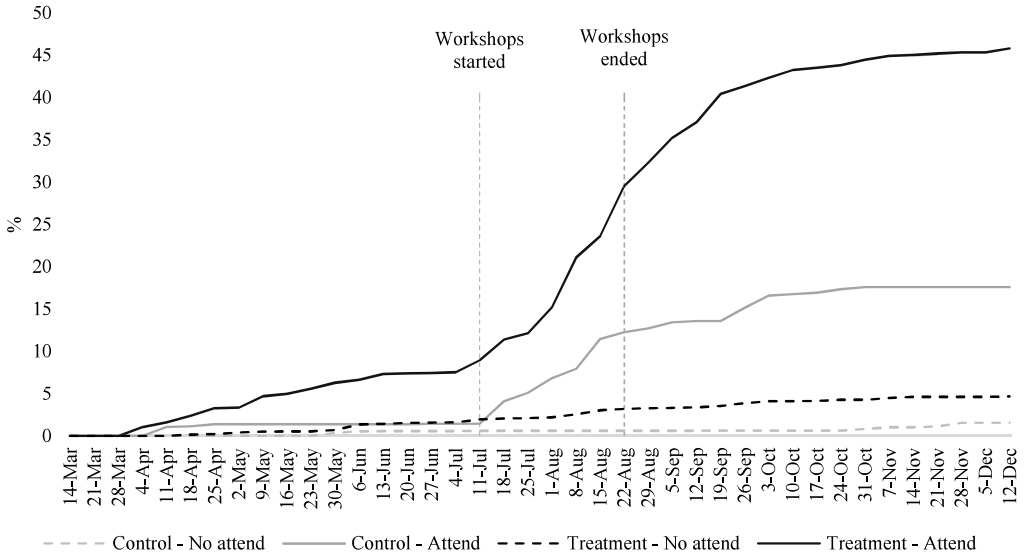


Figure 3 - Evolution of Platform Use in 2022 by Treatment and Attendance to Workshops in 2022

A.1 Students connected at least once (%) in 2022 separared by control and treatment (group)



A.2 Student average weekly connection (%) in 2022 separared by control and treatment (group)

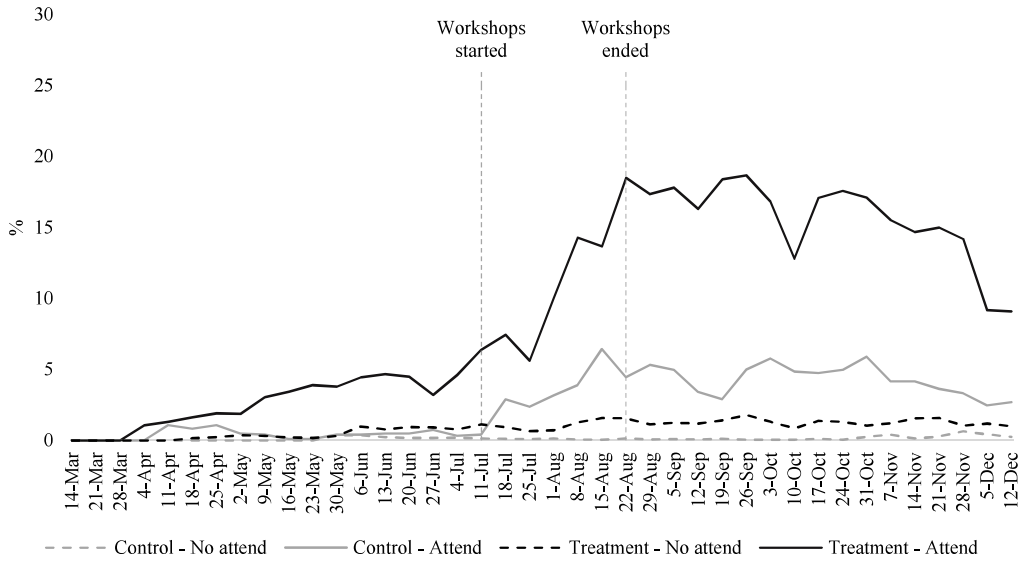


Table A1: Baseline Balance - Comparison of Control Teachers and Indirectly-Treated Teachers

		Differences		
	Control	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)
Panel A. Administrative data				
School characteristics				
Average test score 2016-2018	543.62	0.20	-0.02	*141*
		(1.68)	(1.64)	
Number of classrooms in 4th and 6th grade	5.98	-0.15	-0.28	*141*
		(0.61)	(0.52)	
Number of students in 4th and 6th grade	183.96	-3.51	-10.57	*141*
		(20.82)	(17.47)	
Panel B. Platform data in 4th and 6th grade				
Pre-Treatment Use of the platform at the teacher level				
Teachers registered (%)	6.71	-1.19	0.71	*639*
		(4.70)	(3.51)	
Students connected at least once (%)	0.33	0.03	-0.33	*639*
		(0.48)	(0.33)	
Student average weekly connection (%)	0.00	0.00	0.00	*639*
		(0.00)	(0.00)	
Number of CI exercises completed by student	0.00	0.00	0.00	*639*
		(0.00)	(0.00)	
Panel C. Platform data in 5th grade				
Pre-Treatment Use of the platform at the teacher level				
Teachers registered (%)	4.64	2.23	0.88	*409*
		(4.22)	(3.27)	
Students connected at least once (%)	0.27	-0.27	-0.27	*409*
		(0.27)	(0.27)	
Student average weekly connection (%)	0.00	0.00	0.00	*409*
		(0.00)	(0.00)	
Number of CI exercises completed by student	0.00	0.00	0.00	*409*
		(0.00)	(0.00)	
Panel D. Survey data				
Teacher characteristics				
Female (%)	77.27	11.55***	1.87	*606*
		(4.15)	(3.82)	
Master degree (%)	36.36	-10.67**	-6.92	*606*
		-4.88	(5.00)	
Age	50.50	0.73	0.23	*606*
		(0.92)	(0.88)	
Fixed-term contract (%)	20.15	0.09	-0.64	*595*
		(4.23)	(4.31)	
Use of any math app (%)	27.65	18.16***	27.56***	*606*
		(6.92)	(6.35)	
Self-reported digital skills (standardized)	0.00	0.05	0.07	*606*
		(0.12)	(0.12)	
Positive attitudes on technology (standardized)	0.00	0.06	0.16	*606*
		(0.13)	(0.15)	
Considered as a leader				
By the principal	27.92	-6.92*	-0.49	*639*
		(3.94)	(3.64)	
By other teachers	45.94	5.44	6.06	*639*
		(4.70)	(5.22)	

Notes: The use of Conecta Ideas in the week prior to the workshops refers to the week of August 2, 2021. Information about number of students in grade 5 was not avaiable, we impute this figure as the average mean of students in grade 4 and 6. Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A2: Compliance - Participation in Workshops and Coaching by Control and Indirectly-Treated Teachers

		Differences		
	Control	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)
Panel A. Teachers in 4th and 6th grade				
Administrative data				
Attended a treatment workshop (%)	0.00	4.42**	8.00***	*639*
		(2.15)	(2.88)	
Numbers of treatment workshops	0.00	0.07**	0.09***	*639*
		(0.03)	(0.03)	
Attended any CI workshop (%)	2.83	2.70	6.89**	*639*
		(2.69)	(3.40)	
Numbers of CI workshops	0.04	0.05	0.08*	*639*
		(0.04)	(0.05)	
Received coaching (%)	0.00	0.00	0.00	*639*
		(0.00)	(0.00)	
Number of weeks that received coaching	0.00	0.00	0.00	*639*
		(0.00)	(0.00)	
Endline survey data				
Attended a workshop (%)	19.01	7.18	8.43	*595*
		(5.97)	(6.32)	
Numbers of workshops	0.32	0.18	0.23	*595*
		(0.12)	(0.14)	
Received coaching (%)	14.07	-6.33	-1.87	*595*
		(3.85)	(3.95)	
Panel B. Teachers in 5th grade				
Administrative data				
Attended a treatment workshop (%)	0.00	4.58*	3.15*	*409*
		(2.61)	(1.89)	
Numbers of treatment workshops	0.00	0.05*	0.04*	*409*
		(0.03)	(0.02)	
Attended any CI workshop (%)	1.99	4.12	1.95	*409*
		(3.36)	(2.52)	
Numbers of CI workshops	0.02	0.06	0.03	*409*
		(0.04)	(0.03)	
Received coaching (%)	0.00	0.00	0.00	*409*
		(0.00)	(0.00)	
Number of weeks that received coaching	0.00	0.00	0.00	*409*
		(0.00)	(0.00)	

Notes: Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A3: Heterogeneous Effects - Who Are the Best Adopters Among Directly-Treated Teachers?

	The coefficient shows the interaction of treatment with:					
	Female	Young	Considered as leader by principal	Considered as leader by other teachers	Digital skills	Attitudes towards technology
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Workshops						
Teachers registered (%)	9.94	10.03	-9.22	-9.54	5.47	0.90
	(12.21)	(10.48)	(11.46)	(9.40)	(3.93)	(5.67)
Students connected at least once (%)	13.61	17.99**	4.92	9.16	12.63***	7.40**
	(9.12)	(7.60)	(8.60)	(7.42)	(3.25)	(3.43)
Student average weekly connection (%)	5.40	11.14***	4.29	5.69	6.24***	2.72
	(4.73)	(4.18)	(4.46)	(3.99)	(2.14)	(1.71)
Number of weekly exercises solved per student	1.36	3.04***	1.26	1.66	1.69***	0.75
	(1.23)	(1.10)	(1.15)	(1.07)	(0.57)	(0.46)
Panel B: Workshops school-wide						
Teachers registered (%)	0.32	24.16***	1.48	8.22	2.86	-2.61
	(7.88)	(8.04)	(6.96)	(6.06)	(3.83)	(4.15)
Students connected at least once (%)	9.59**	19.19***	3.63	11.91**	0.98	1.61
	(4.72)	(5.83)	(4.52)	(4.65)	(2.95)	(2.78)
Student average weekly connection (%)	4.68**	8.87***	4.92*	5.05**	0.53	1.60
	(2.23)	(2.97)	(2.50)	(2.22)	(1.46)	(1.40)
Number of weekly exercises solved per student	1.12*	2.21***	1.38**	1.32**	0.16	0.49
	(0.59)	(0.79)	(0.65)	(0.56)	(0.38)	(0.38)
Panel C: Workshops + coaching						
Teachers registered (%)	1.09	6.34	5.67	10.80	3.89	0.30
	(12.85)	(8.97)	(9.48)	(9.09)	(4.47)	(4.16)
Students connected at least once (%)	12.13	8.27	10.97	16.31**	3.60	3.75
	(9.76)	(8.18)	(9.32)	(7.05)	(3.36)	(3.73)
Student average weekly connection (%)	9.69*	5.07	14.30**	10.38***	0.22	3.96*
	(5.51)	(5.48)	(6.16)	(3.79)	(2.49)	(2.38)
Number of weekly exercises solved per student	2.83**	1.14	4.14**	2.87***	0.05	1.17*
	(1.43)	(1.47)	(1.68)	(1.00)	(0.68)	(0.64)

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A4: Attendance to Workshops of Directly-Treated Teachers by Observable Characteristics

	Female (1)	Young (2)	Considered as leader by principal (3)	Considered as leader by other teachers (4)	Digital skills (5)	Attitudes towards technology (6)
Panel A. Administrative data						
Attended a treatment workshop (%)	1.38	11.66***	6.66*	7.34**	3.03**	3.34*
	(3.52)	(3.52)	(3.61)	(2.92)	(1.40)	(1.69)
Attendance rate of reference group	83.52	79.34	80.84	79.27	-	-
Panel B. Endline survey data						
Attended a workshop (%)	2.47	14.11***	11.24***	6.44	3.81*	2.38
	(6.58)	(4.24)	(4.23)	(4.55)	(2.04)	(2.37)
Attendance rate of reference group	71.08	66.52	68.28	68.44	-	-

Notes: Cluster standard errors at the school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively. The attendance rates for directly-treated teachers are 84.62% and 73.06% in administrative and endline survey data, respectively. In columns (3) and (4), the rates are 82.77% and 71.56%, respectively, in both administrative and endline survey data.

Table A5: Average Characteristics of Teachers by Quartiles of Estimated Treatment Effects

	Quartiles			
	1 (bottom)	2	3	4 (top)
Grade	5.07	5.02	4.97	4.95
Female	0.75	0.76	0.80	0.84
Young	0.00	0.28	0.65	0.97
Considered as leader by principal	0.12	0.13	0.39	0.51
Considered as leader by other teachers	0.00	0.70	0.61	0.69
Digital skills	-0.39	-0.28	-0.14	0.67
Positive attitudes towards technology	-0.39	-0.29	-0.09	0.81
N	*177*	*177*	*176*	*176*

Table A6: Medium-Term Effects on Platform Use for Directly-Treated Teachers in 2023

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Panel A: Before workshops started (weeks 1 to 2)					
Students connected at least once (%)	0.00	0.26	0.00	1.00	*753*
		(0.19)	(0.00)	(0.87)	
Student average weekly connection (%)	0.00	0.13	0.00	0.50	*753*
		(0.10)	(0.00)	(0.43)	
Panel B: During workshops (weeks 3 to 21)					
Students connected at least once (%)	3.32	4.23	7.79**	5.42	*753*
		(2.74)	(3.50)	(3.35)	
Student average weekly connection (%)	0.47	1.73**	3.30***	2.40*	*753*
		(0.80)	(1.23)	(1.25)	

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A7: Event Study

	Students connected at least once			Student average weekly connection		
	Treatment	Control	Treatment vs control	Treatment	Control	Treatment vs control
	(1)	(2)	(3)	(4)	(5)	(6)
Before intervention (weeks -16 to -2)	-0.02*	0.00	-0.03*	0.00	0.00	0.00
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.01)
During intervention (weeks 0 to 6)	0.06***	0.04**	0.02	0.05***	0.02*	0.03**
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
After intervention (weeks 7 to 21)	0.29***	0.13***	0.16***	0.12***	0.04***	0.09***
	(0.04)	(0.03)	(0.05)	(0.02)	(0.01)	(0.02)
N	*17,860*	*10,754*	*28,614*	*17,860*	*10,754*	*28,614*

Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A8: Baseline Balance - Comparison of Control Teachers and Directly-Treated Teachers - Results Including Strata Fixed-

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Panel A. Administrative data					
School characteristics					
Average test score 2016-2018	543.62	0.99	0.20	-0.02	*188*
		(1.95)	(1.68)	(1.64)	
Number of classrooms in 4th and 6th grade	5.98	-0.04	-0.15	-0.28	*188*
		(0.54)	(0.61)	(0.52)	
Number of students in 4th and 6th grade	183.96	1.32	-3.51	-10.57	*188*
		(18.28)	(20.82)	(17.47)	
Panel B. Platform data					
Pre-Treatment Use of the Platform at the teacher level					
Teachers registered (%)	6.71	-1.22	-2.44	0.75	*753*
		(3.26)	(3.21)	(3.86)	
Students connected at least once (%)	0.33	0.53	0.28	-0.35	*753*
		(0.72)	(0.76)	(0.54)	
Student average weekly connection (%)	0.00	0.00	0.00	0.00	*753*
		(0.00)	(0.00)	(0.00)	
Number of weekly exercises solved per student	0.00	0.00	0.00	0.00	*753*
		(0.00)	(0.00)	(0.00)	
Panel C. Survey data					
Teacher characteristics					
Female (%)	77.27	2.07	3.75	-0.02	*706*
		(3.22)	(4.21)	(5.63)	
Master degree (%)	36.36	-7.09**	-6.19	5.84	*706*
		(3.51)	(5.72)	(6.06)	
Age	50.50	0.83	-0.92	-0.37	*706*
		(0.62)	(1.01)	(1.03)	
Fixed-term contract (%)	20.15	0.07	5.07	3.27	*699*
		(3.22)	(5.80)	(4.92)	
Use of any math app (%)	27.65	8.24*	14.33**	14.15**	*706*
		(4.19)	(6.13)	(6.24)	
Self-reported digital skills (standardized)	0.00	-0.09	-0.05	-0.03	*706*
		(0.09)	(0.11)	(0.12)	
Positive attitudes on technology (standardized)	0.00	-0.01	-0.12	0.15	*706*
		(0.10)	(0.12)	(0.13)	
Considered as a leader					
By the principal	27.92	-0.89	5.89	-3.69	*753*
		(2.70)	(5.70)	(4.76)	
By other teachers	45.94	1.30	-1.91	6.60	*753*
		(3.51)	(6.31)	(5.59)	

Notes: Standardized average test is the mean of the score in math and spanish in 2016 and 2018. After that, we create a z-score with the control group score (x - mean/sd). The use of Conecta Ideas in the week prior to the workshops refers to the week of August 2, 2021. All regressions contain strata fixed effects. Regression at teacher level include cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A9: Compliance - Treaments on Directly Treated Teachers - Results Including Strata Fixed-Effects

		Differences			
	Control	Workshops school-wide	Workshops	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Panel A. Administrative data					
Attended a treatment workshop (%)	0.00	82.23***	84.43***	83.37***	*753*
		(2.96)	(4.41)	(4.55)	
Numbers of treatment workshops	0.00	1.67***	1.99***	1.97***	*753*
		(0.09)	(0.13)	(0.13)	
Attended any CI workshop (%)	2.83	79.81***	81.39***	80.33***	*753*
		(3.21)	(4.49)	(4.72)	
Numbers of CI workshops	0.04	1.65***	2.04***	1.97***	*753*
		(0.09)	(0.15)	(0.14)	
Received coaching (%)	0.00	-0.18	0.05	90.48***	*753*
		(0.62)	(0.64)	(2.91)	
Number of weeks that received coaching	0.00	-0.01	0.01	7.51***	*753*
		(0.08)	(0.09)	(0.40)	
Panel B. Endline survey data					
Attended a workshop (%)	19.01	51.19***	61.61***	51.53***	*699*
		(4.17)	(5.50)	(6.08)	
Numbers of workshops	0.32	1.34***	1.68***	1.50***	*699*
		(0.11)	(0.21)	(0.19)	
Received coaching (%)	14.07	10.17**	5.70	61.48***	*699*
		(3.92)	(4.97)	(5.49)	

Notes: All regressions contain strata fixed effects. Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A10: Effects on Platform Use - Results Including Strata Fixed-Effects

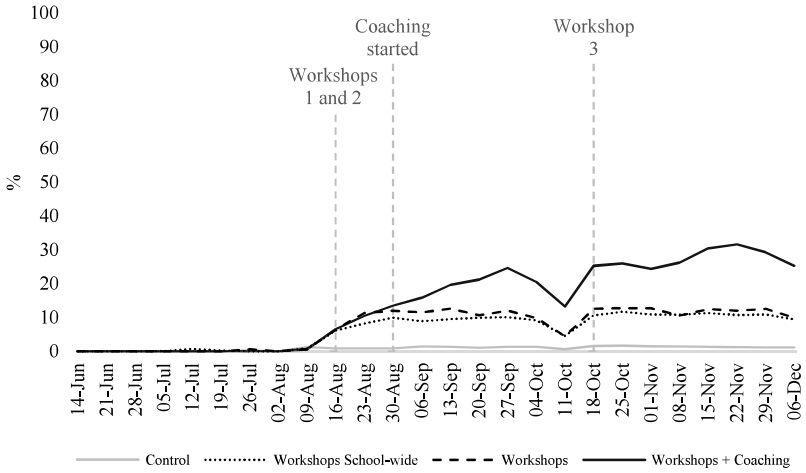
		Differences			
		Directly-Treated Teachers			
	Control	Workshops	Workshops school-wide	Workshops + coaching	*N*
	(1)	(2)	(3)	(4)	(5)
Teachers registered (%)	22.97	52.68***	46.17***	56.94***	*1,109*
		(6.34)	(5.93)	(6.04)	
Students connected at least once (%)	5.73	27.13***	28.21***	50.09***	*1,109*
		(3.88)	(4.47)	(4.64)	
Student average weekly connection (%)	1.59	10.80***	12.20***	26.49***	*1,109*
		(1.66)	(2.04)	(2.66)	
Number of weekly exercises solved per student	0.38	2.67***	3.12***	6.76***	*1109*
		(0.42)	(0.52)	(0.71)	

Notes: The average weekly connection rate is from the week following the workshops until the end of the intervention, excluding one week of vacation (week of October 11, 2021). Cluster standard errors at school level. Significance at one, five, and ten percent indicated by ***, **, and *, respectively.

Table A11. Cost-Effectiveness Ratios by Treatment Group and Teacher Sample when Incorporating Opportunity Costs

	wide	Workshops	coaching
	(1)	(2)	(3)
Panel A: Directly treated teachers			
Effects on average weekly connection (%)	10.94	12.26	26.55
Cost per student	0.83	0.83	8.69
Effect per dollar invested per student (%)	13.24	14.83	3.05
Panel B: Directly and indirectly treated teachers (4th and 6th Grade)			
Effects on average weekly connection (%)	10.94	6.58	11.65
Cost per student	0.83	0.28	2.91
Effect per dollar invested per student (%)	13.24	23.33	4.00
Panel C: Directly and indirectly treated teachers (4th, 5th and 6th Grade)			
Effects on average weekly connection (%)	10.32	5.68	8.64
Cost per student	0.83	0.19	1.94
Effect per dollar invested per student (%)	12.49	30.21	4.45

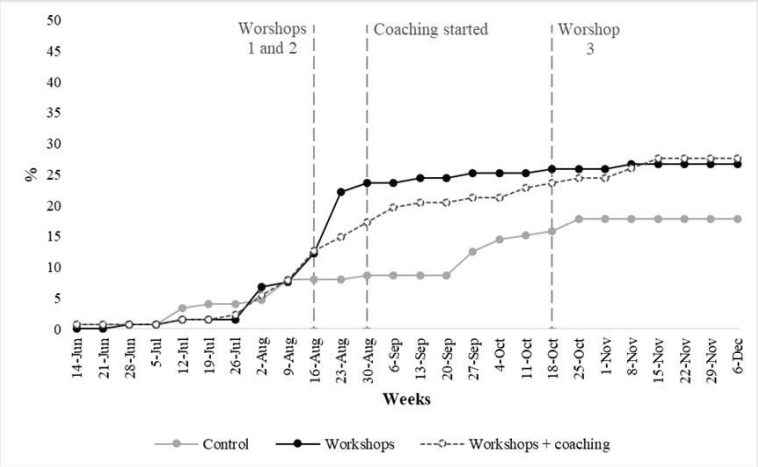
Figure A1: Platform Use Over Time - Student average exercises completed (%)



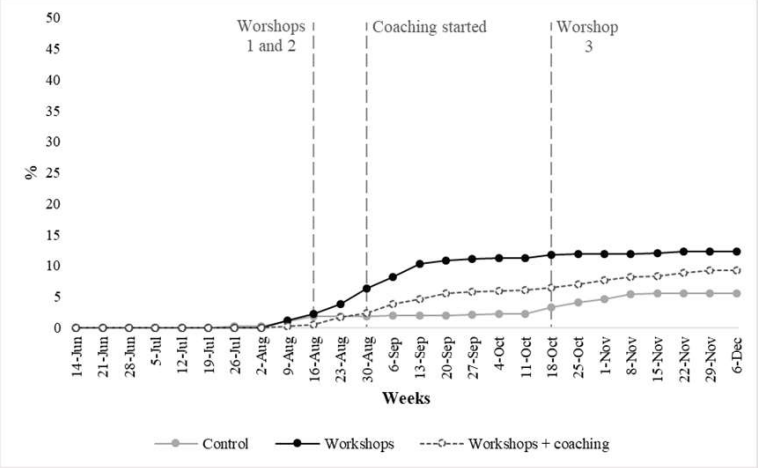
Notes: Coaching ended in the week of December 6. The week of October 11 was a school vacation.

Figure A2: Use of Conecta Ideas for Indirect Teachers in 5th grade

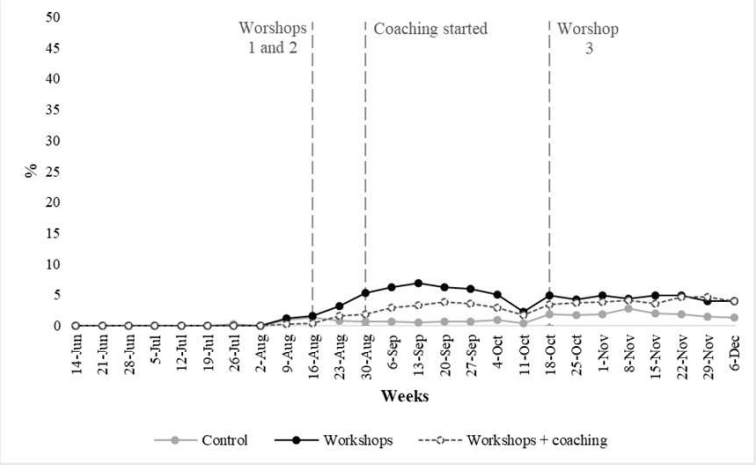
Panel A: Teachers registered (%)



Panel B: Students connected at least once (%)



Panel C: Weekly average connection (%)

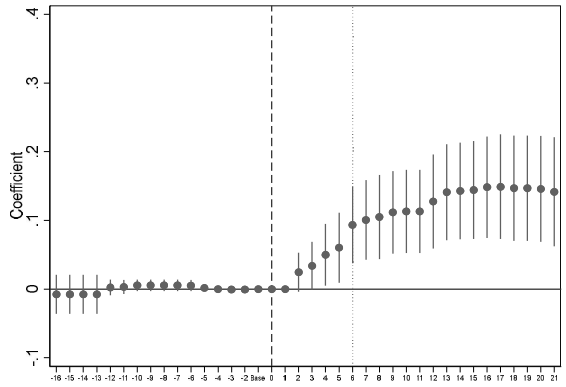


Notes: Coaching ended in the week of December 6. The week of October 11 was a school vacation.

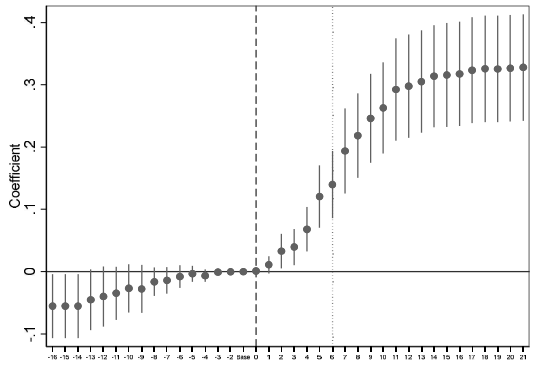
Figure A3: Time-event graphs

Students connected at least once

Control

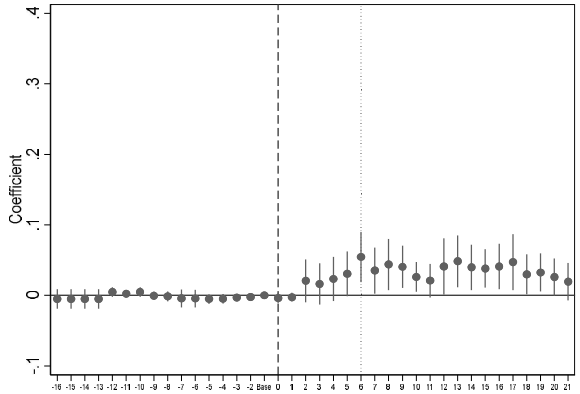


Treatement



Average weekly connection

Control



Treatement