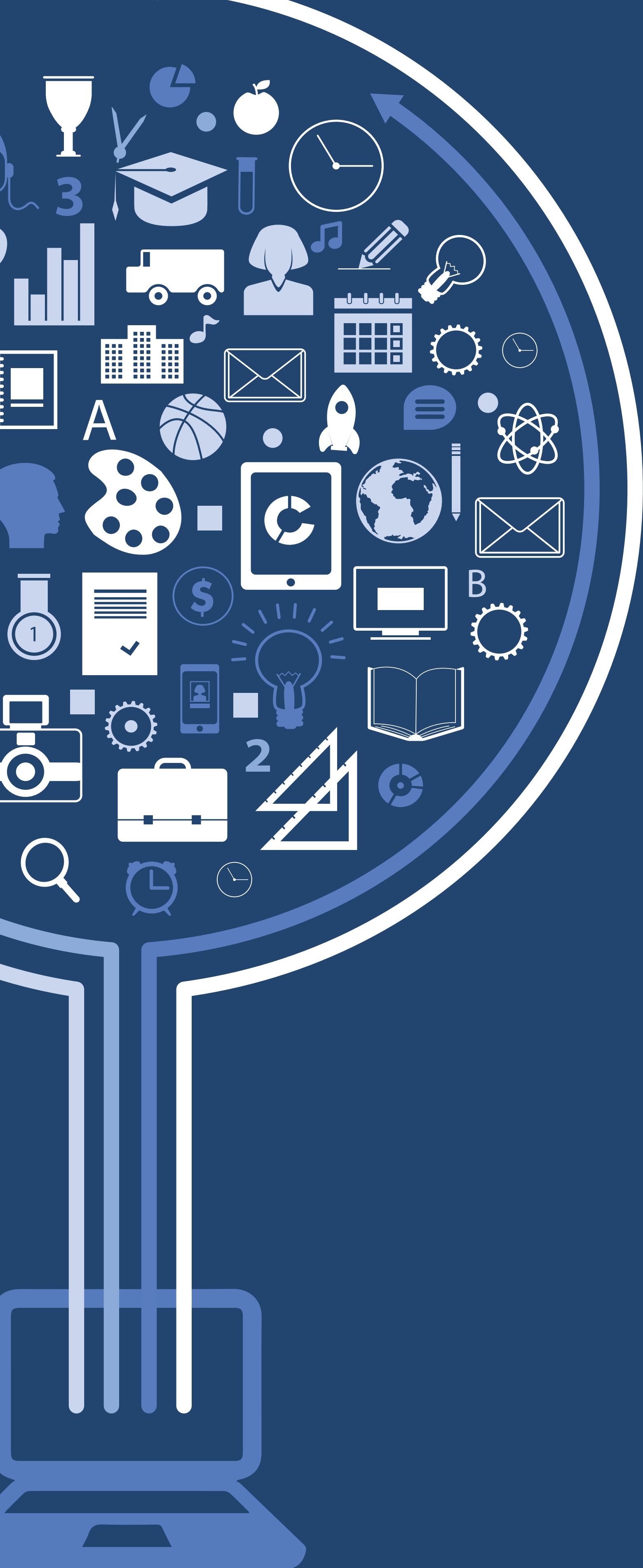
WORLD BANK GROUP
Education

Using Education Technology to Improve K-12 Student Learning in East Asia Pacific:

Promises and Limitations



1818 H Street NW Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

This research was financed in part by the China-World Bank Partnership Facility.

Attribution—Noah Yarrow, Cody Abbey, Sharon Shen, Kevin Alyono (co-authors). With thanks and appreciation for Pinyi Chen, Neil Butcher, Mike Michalec, Chuyu Song, Lauri Pynnonen (contributors) and Andrew Mason, Mike Trucano and Yue Ma (reviewers).

Cover photo credits, Alamy Stock Photo and World Bank Flckr. Designed by Veronica Gadea.

Contents

Abstract

We use global and regional data to show that it is possible to use EdTech to improve student learning in EAP. We present evidence that the broadcast/dual teacher model often supports student learning gains, while other approaches, including assistive EdTech, show promise. Others, such as e-readers, remote teacher-training and AI interventions have yet to demonstrate positive impacts on student learning at scale in the EAP context. Based on evidence from the EAP region and globally, we show that as the scale of EdTech interventions increases, the effect on learning generally decreases. The largest impacts tend to come from smaller-scale interventions conducted by non-governmental institutions rather than large-scale interventions by governments. We find that as the use of EdTech expands in the EAP region, it tends to increase existing learning inequalities, since not all families and schools are able to pay for, access, and use it effectively. In this companion paper to the EAP regional flagship "Fixing the Foundation: Teachers and Basic Education in East Asia and Pacific" (Afkar et al, 2023), we present the results of a regional survey of middle-income countries showing that, contrary to available evidence, most education decision makers believe that EdTech was effective in supporting student learning during COVID-19 school closures. We recommend several evidence-based EdTech interventions in EAP including the "broadcast" or dual-teacher model, and call for improved approaches for future research that consider scale, dosage and heterogeneity of impact to evaluate EdTech interventions.

Definition of Terms

In this report, our primary focus is the use of Educational Technology (EdTech) among K-12 student populations in the East Asia Pacific (EAP) region.[1] We define EdTech as the use of hardware, software, digital content, data, and information systems in education, following "Reimagining Human Connections: Technology and Innovation in Education" (World Bank, 2020). Students and teachers use different devices to communicate and share information in voice, text, and video formats, and they use platforms established by governments, non-profits, and for-profit firms. Within this diversity of use, we consider radio and TV-based instruction to be distance education but not specifically EdTech, while we consider teaching and learning using messages on a one-to-one or group chat function to be EdTech use. As discussed in the paper, these distinctions become less and less clear as tech becomes more and more a part of everyday life, including education processes. Another concept is the uptake and dosage of education interventions. While these two terms are generally associated with medical contexts, we define "uptake" as whether the intervention is used by the teacher and/or students (Wilichowski & Cobo, 2021; World Bank, 2020), and "dosage" refers to the amount of instruction provided, which typically includes the number of intervention sessions and the length of each session (Mason & Smith, 2020).

1 This is with the exception of one study conducted in Tonga (Macdonald et al., 2017), which discusses the effect of an educational intervention on pre-K-12 students.

Limits and challenges: EdTech as a means for post-COVID-19 learning recovery

Available evidence indicates that EdTech has promise in specific settings, but whether it can improve student learning at scale is harder to say. During the COVID-19 pandemic, high-income countries experienced an average learning loss equivalent to one-third to one-half of a typical academic year (Patrinos et al., 2022). Countries with shorter school closures and faster implementation of distance-learning programs generally faced lower learning loss levels (Patrinos et al., 2022; Schady et al., 2023). A key lesson from prolonged school closures during the pandemic is the need for more adaptive and equitable remote learning systems in EAP countries, which can be utilized during future crises from pandemics, climate change and other risks. In this section, we present evidence to help answer the question of how effective will EdTech be in supporting recovery from the COVID-19 pandemic and addressing the human capital gap in the EAP region?

We have attempted to compile all published rigorous impact evaluations of education interventions in EAP that include measurements of student learning outcomes. Altogether, we found 52 education studies with a total of 109 effect sizes on student learning in Middle Income Countries in the EAP region before, during, and slightly after the COVID-19 pandemic.[2] Among these, 24 are EdTech interventions, with 19 focusing on a specific mode of EdTech: Computer-Assisted Learning interventions.[3] Examples of other EdTech studies in the dataset include an intervention providing digital textbooks to primary school students for use in social studies and science in the Republic of Korea (Lee et al., 2022); IT investment and recorded instruction in rural Chinese middle schools (Bianchi et al., 2022); recorded class videos for students at home during COVID-19-related school closures (Clark

2 We would like to thank David Evans and Fei Yuan for sharing their database, as well as Daniel Rodriguez-Segura for sharing his database. If you are aware of additional evaluations not included here, please let us know.

3 Computer assisted learning (CAL) refers to EdTech interventions in which students learn independently (i.e., engage in self-directed learning) with the assistance of a computer software program, though teachers or monitors are often present to provide technical support, encouragement and oversight.

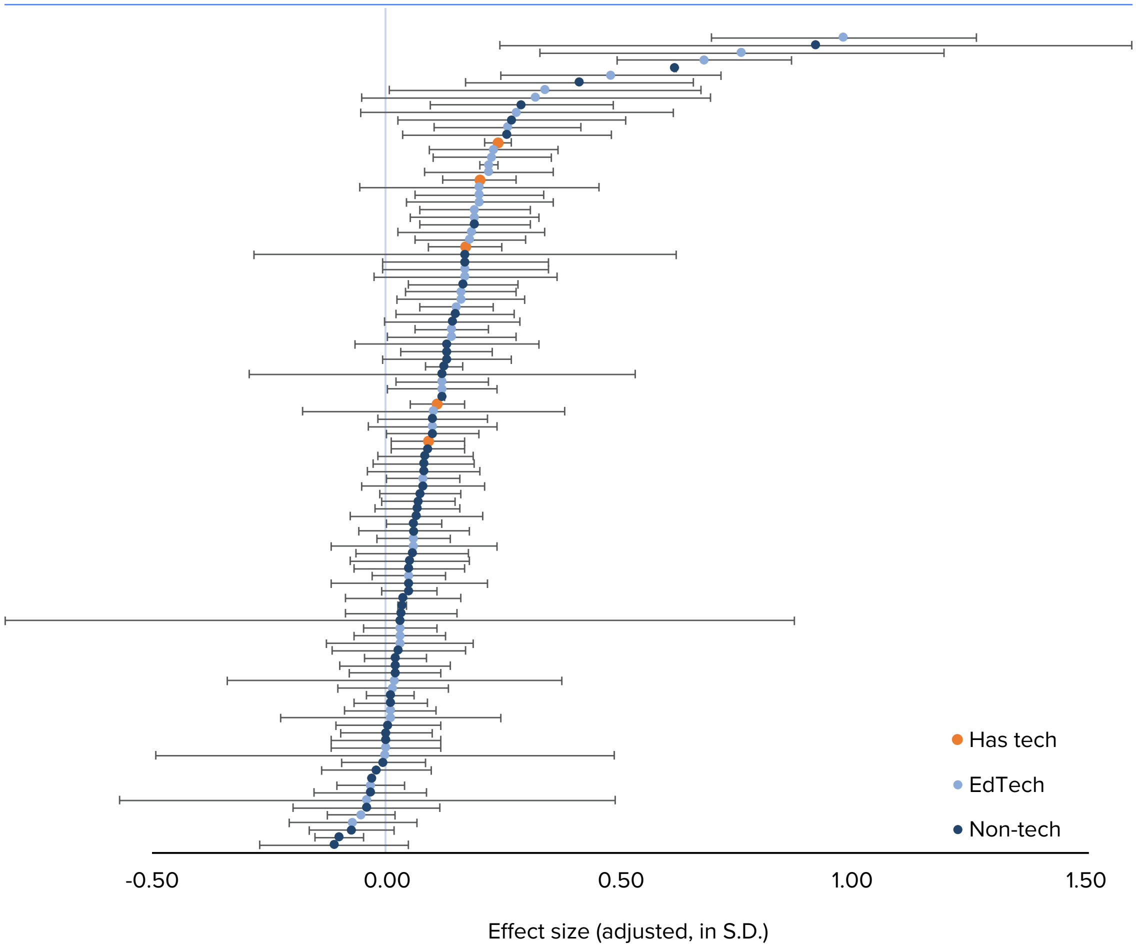
Photo: imtmphoto / Alamy Stock Photo

et al., 2021); and the "Dual-teacher program" in China for rural secondary students, allowing them to watch live lectures from urban elite schools while receiving guidance from local teachers (Li et al., 2023).

The non-tech studies in the database evaluate a broad range of education interventions aimed at improving student learning outcomes, such as pre-primary reading instruction (Abeberese et al., 2011), community-based playgroups (Brinkman et al., 2017a; Macdonald et al., 2017), teacher training (Loyalka et al., 2013; Fuje and Tandon, 2018; L. Zhang et al., 2013), student scholarships or financial incentives for teachers (Barrera-Osorio & Filmer, 2016; X. Chen et al., 2013; Filmer & Schady, 2009; Loyalka et al., 2019a; Yi et al., 2015), and interventions aimed at improving student health outcomes linked to poor school performance, such as reducing rates of anemia or myopia (Du et al., 2022; Wong et al., 2014; Kleiman-Weiner et al., 2013; Nie et al., 2020; Sylvia et al., 2013). In addition, there is one study involving the use of a camera and community engagement to improve teacher attendance (Gaduh et al., 2020) and another employing a video-based teacher development tool (Chen et al., 2020). These types of studies are classified as "has tech" (rather than "EdTech"), since tech is part of the intervention but not the focus of the treatment. We note that, given its role in society, it is likely that technology is present to some extent in all education interventions, even if not explicitly specified by the evaluation authors.

Within the 52 education studies that measure student learning impacts in EAP MICs, we observe a wide variation in the effect sizes of educational interventions. EdTech studies exhibit the most extensive variation in impact. Although EdTech interventions (depicted as light blue dots in Figure 1) have demonstrated negative, null, and low-impact outcomes, they also account for the majority of impacts in the top quartile of the distribution. Furthermore, the largest effect size in our dataset is from an EdTech intervention (0.978 SD). At first glance, this visualization may lead one to believe that EdTech represents the most promising avenue for allocating marginal investment dollars to enhance student learning. However, an in-depth examination of the characteristics of each study reveals a more complex reality.

Figure 1 Comparison of effect sizes (adjusted) with confidence intervals for EdTech, Has Tech, and Non-Tech educational interventions in the EAP region across prepandemic, pandemic, and post-pandemic



Source: World Bank, EAP Education Interventions, 2023. See Annex 1 for a complete list of studies and effect sizes (adjusted).

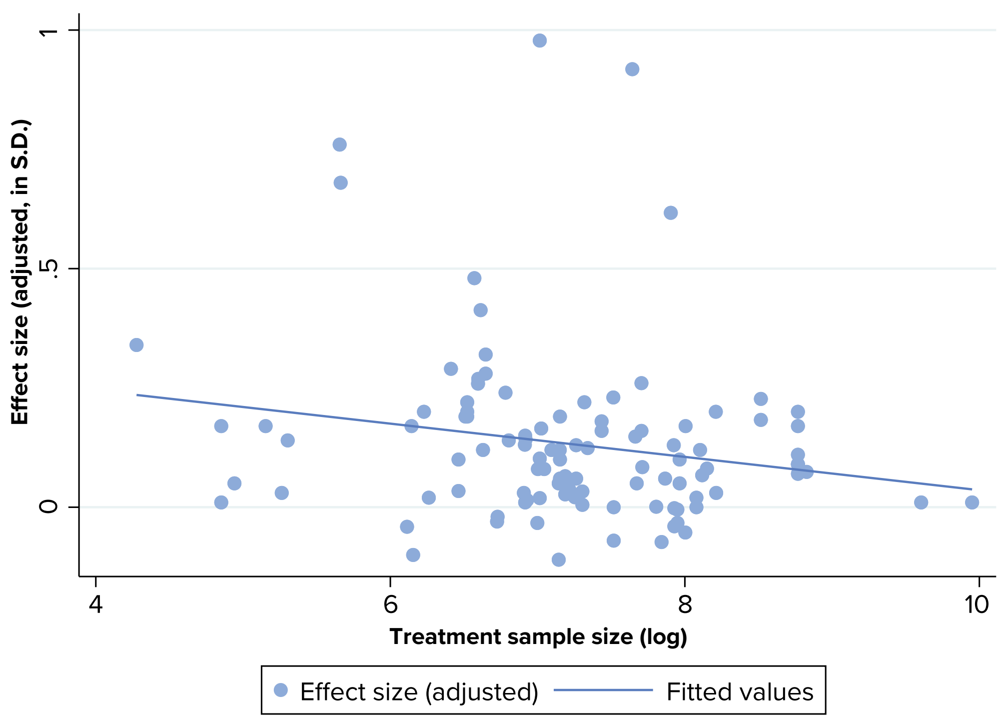
1.1 Intervention scale matters for drawing policy-relevant lessons

Most studies in our sample are pilot studies, meaning that they are not part of larger education interventions or policy actions, and therefore operate within only a small population of students, teachers and schools. As a result, the "total treatment size" is frequently not reported by researchers, since the "treatment sample size" (the number of students, for example, receiving the intervention) is the same as the total treatment size. Only 19 percent (10 out of 52) of the studies in our EAP sample reported the overall intervention size, focusing on the effects of education programs at the national or regional level. Conversely, 81 percent (42 out of 52) did not disclose the total treatment size and appear to be small-scale pilot studies, leading to a significant research literature gap.

To account for the absence of complete intervention size data, we employ treatment sample size as an imperfect proxy for total treatment size. The average treatment sample size in our dataset is only 2,145 students, and we have no treatment sample involving more than 25,000 students. While we recognize the costs and logistical challenges associated with conducting high-quality, large-scale studies, it is essential to provide data with high external validity and scalability potential to enable education policy makers to rely on data-driven insights.

Effect size appears to decline with increasing intervention scale proxied by treatment sample size because implementation at scale is very different from implementing a pilot program (Figure 2 and Table 1). Based on discussions with authors of some of the studies, the high levels of expertise and monitoring provided during research with studies involving hundreds or thousands of students, as well as technical support and encouragement to teachers and administrators, may lead to higher levels of treatment from teachers and students. When these smaller trials are expanded without the same quality and quantity of support and attention, competing priorities and business-as-usual practices may negatively affect both implementation and impact. This negative association holds regardless of whether the intervention is EdTech, non-tech, or involves varying degrees of technology in the learning environment.

Figure 2 Relationships between treatment sample size (log) and effect size (adjusted) for EAP studies



Source: World Bank, EAP Education Interventions, 2023.

Table 1 Continuum of technology from no/low to high tech

Tech	(1) EAP Effect Size (SE)	(2) EAP Effect Size (SE)	(3) EAP Effect Size (SE)	(4) EAP Effect Size (SE)
Log treatment sample size	-.0348521* (.017592)	-.050755 (.1552634)	-.0369909*** (.0086817)	-.1364512** (.0490839)
Log treatment sample size ^2		.0011235 (.0108972)		.0076679* (.0037248)
Constant	.3843002 ** (.1280345)	.4394985 (.5506411)	.4053289*** (.0611044)	.7122272*** (.1610507)
Adjusted R-squared	0.0264	0.0173	0.0299	0.0355

Note: *p<0.05, **p<0.01, ***p<0.001

Source: World Bank, EAP Education Interventions, 2023. Sample of global studies is drawn from David K. Evans and Fei Yuan, 2022, "How Big Are Effect Sizes in International Education Studies?," Educational Evaluation and Policy Analysis 44(3), https://doi.org/10.3102/01623737221079646

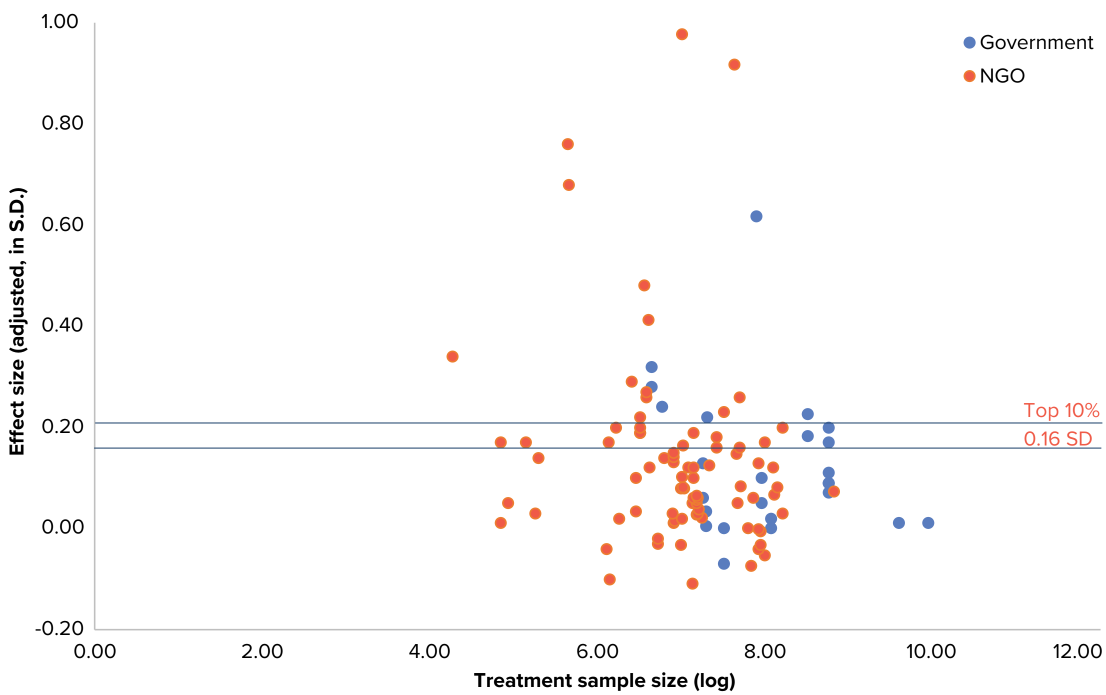
Based on the evidence we have available, there are few studies that would allow us to predict with confidence the impact of any nationwide education intervention, including an EdTech intervention. We cannot confidently predict the learning impact of even a subnational scale-up. This issue is not unique to EdTech or EAP and is a major concern in the education sector and beyond.[4] In this sense, many if not most of the education studies in our EAP dataset are closer to studies of efficacy rather than effectiveness. Efficacy trials (explanatory trials) determine whether an intervention produces the expected result under ideal circumstances, whereas effectiveness trials (pragmatic trials) measure the degree of beneficial effect under "real world" clinical settings. This has large, and limiting, implications for the advice we can confidently give to governments on the expected learning impacts of implementing specific EdTech and other learning programs nationally. In light of these findings, we believe it is crucial for researchers in the EAP region to focus on conducting more larger-scale effectiveness studies that provide reliable insights into the real-world implications of implementing specific EdTech and learning programs, ultimately guiding decision-making for meaningful, nationwide policies in education.

4 See for example, Lant Pritchett and Justin Sandefur (2013) "Context Matters for Size: Why External Validity Claims and Development Practice Don't Mix." CGD Working Paper 336. Washington, DC: Center for Global Development ; Jonathan Stern, Matthew Jukes, Benjamin Piper et al. (2021), Learning At Scale Interim Report; Vivalt (2020), "How much can we generalize from impact evaluations?". Specifically, in this second report from Stern et al. (2021), the authors propose a definition for working at scale in education, which is to implement in at least 500 schools and have universal or near-universal coverage in at least two sub-national areas. In their global review, they found eight programs that met this criteria and for which student-learning impact data were available based on an evaluation.

1.2 “The Implementor Effect”: education interventions by NGOs versus governments

The entity implementing the activity affects the effectiveness of studies (an “implementor effect”), in addition to the scale of intervention. In our EAP dataset, studies yielding the largest impacts tend to be conducted by NGOs or other non-state actors such as research institutions or thinktanks (Figure 3). Within the EAP sample, among the top 10 percent of effect sizes, 8 out of 11 (or 73 percent) are interventions implemented by NGOs, while only three of these large-effect interventions (27 percent) are carried out by governments. Considering effect sizes greater than or equal to 0.16 SD,[5] 27 out of 36 (or 75 percent) are associated with NGO implementation, as opposed to 25 percent with government implementation. This pattern is also observed in the global sample of Evans and Yuan (2020). Among the top 10 percent effect sizes, 62.50 percent are jointly implemented by NGOs and governments, 32.81 percent solely by NGOs, and 4.69 percent exclusively by governments. Meanwhile, among the effect sizes equal to or greater than 0.16 SD, 45.19 percent are dual implementation, 39.90 percent with NGO implementation, and only 14.90 percent with government implementation. We call this the “implementor effect.” While non-governmental interventions tend to be more effective, they are also smaller in sample size. Therefore, it is difficult to say to what extent their higher effectiveness is related to the implementor or the treatment sample size.

Figure 3 Comparison of effect sizes and treatment sample size (log) associated with NGOs versus government in EAP studies

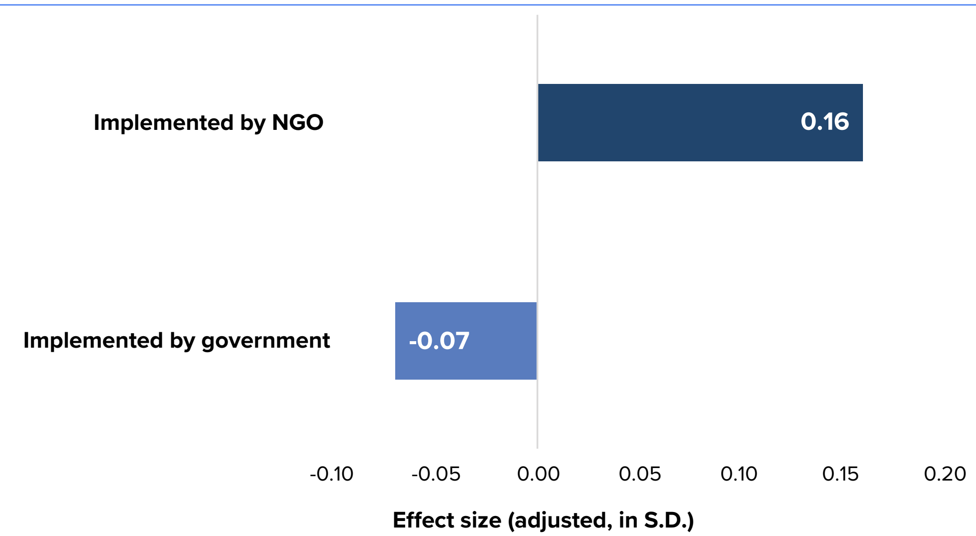


Source: World Bank, EAP Education Interventions, 2023.

5 Reported to be the median effect size of education interventions across low- and middle income countries in Evans and Yuan, 2022.

In our EAP dataset, a study conducted by Mo et al. (2020) provides a clear illustration of the "implementor effect." The study investigated the extent to which variations in implementation agencies influence program effectiveness. A total of 120 rural Chinese schools employed the same Computer Assisted Learning (CAL) treatment to facilitate English-language learning. The treatment was implemented by an NGO in one group of schools, by the government in another group, and a third group served as a control. The authors discovered that, in contrast to the control condition and unlike the NGO program, the government program did not improve student achievement in English. In fact, it led to a decrease in student performance on average (effect size = -0.07 SD), although the negative impact was not statistically significant (Figure 4). This outcome was attributed to the fact that teachers in the government arm were more likely to substitute the EdTech intervention for regular instruction, which was contrary to the required protocol. The authors hypothesized that this might be due to government officials being less likely than NGO implementers to directly monitor program progress (Mo et al., 2020).

Figure 4 Impact of in-school CAL on English scores of grade-4 students in rural China with different implementation agencies from Mo et al., 2020



Source: Mo, Di, Bai, Yu, Shi, Yaojiang, Abbey, Cody, Zhang, Linxiu, Rozelle, Scott, & Loyalka, Prashant. "Institutions, implementation, and program effectiveness: Evidence from a randomized evaluation of computer-assisted learning in rural China," Journal of Development Economics Vol. 146, 2020: 102487. .org/10.1016/j.jdeveco.2020.102487.

Apart from the propensity to implement interventions on a smaller scale than governments, there are other factors that may contribute to NGOs and other non-state actors being more likely to implement interventions with large impacts. One plausible explanation is that, in certain instances, NGOs possess greater skill and experience in effectively implementing specific interventions. These organizations, which often devise the interventions that they carry out (such as the NGO responsible for the CAL curriculum implementation in China), typically have the technical expertise and practical knowledge required for designing evaluations and implementing EdTech interventions. Furthermore, NGOs, which generally manage a smaller number of externally-funded projects and thus have a high incentive for the success of their interventions in order to generate future financial support, may exhibit a stronger commitment to high-quality implementation than government entities. The latter may oversee a number of projects simultaneously and may be less concerned about securing funding.

"The available evidence tends to come from smaller-size interventions conducted by NGOs, with impacts that governments are unlikely to achieve when implementing at national scale. These findings imply that the impact evaluation revolution of the past decades is not particularly helpful as a guide for addressing the learning inequalities in EAP."

Our findings imply that the impact evaluation revolution of the past decades is not particularly helpful as a guide for addressing the learning inequalities in EAP. Specifically, the limitations of scale and implementor effects are essential to consider when selecting education interventions. Decision makers may ask questions such as "does EdTech work" or "what is the most effective education intervention", and the answer in many cases is that we simply do not know. The available evidence tends to come from smaller-size interventions conducted by NGOs, with impacts that governments are unlikely to achieve when implementing at national scale.

1.3 Taking implementation heterogeneity into account: the importance of uptake and dosage

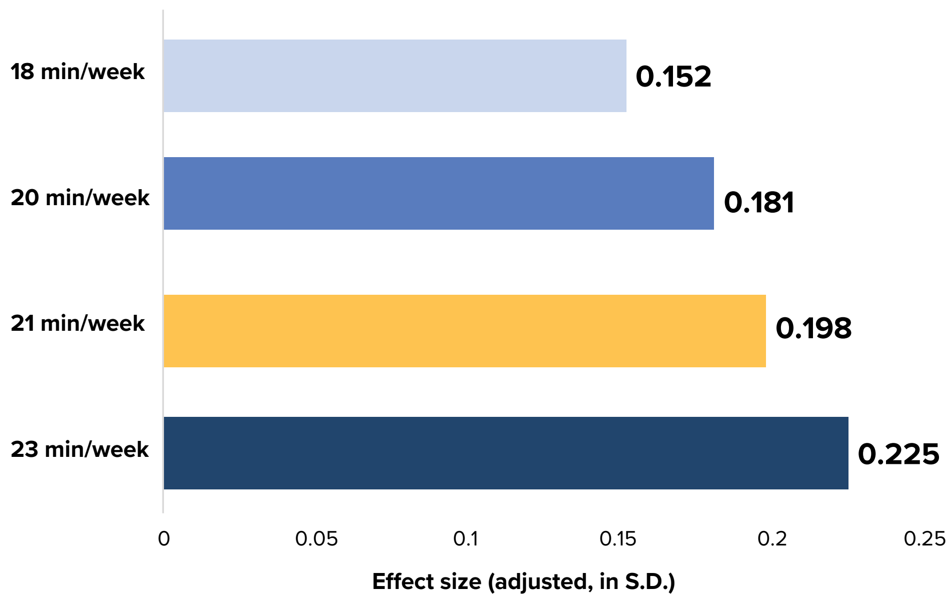
"Average effect sizes do not convey information on the extent to which students or teachers participated in the intervention. Average effect sizes also hide whether the intervention's magnitude of impact differed across students by their characteristics, which is crucial information for understanding whether a certain intervention increases or narrows the learning gap between students."

Heterogeneous effects (by uptake, dosage, student characteristics, etc.) also matter, but are rarely reported by both EAP or global studies. Average effect sizes which are most commonly reported do not convey information on the extent to which students or teachers participated in the intervention (uptake and dosage), particularly if their participation was less or more than what was specified in the study's protocol. Average effect sizes also hide whether the intervention's magnitude of impact differed across students by their characteristics (e.g., socio-economic status, baseline academic performance, gender, etc.), which is crucial information for understanding whether certain an intervention increases or narrows the learning gap between students.

Another EdTech intervention from the region illustrates the importance of uptake and dosage when considering the effect size of interventions (Ma et al., 2020). The average effect of this CAL intervention to support math learning in Taiwan, China, was zero, as compliance was low overall. However, there was significant improvement for the most active students in the treatment group, with impacts increasing as usage increased up to 23 minutes per week (Figure 5). Since many education interventions, including EdTech approaches, depend heavily on teacher adoption and integration, these issues of uptake and dosage are important to consider when thinking about average effect sizes. Reporting a "minimum dosage" required for impact in evaluations could be a helpful start.

The same pattern in variable impacts based on use also applies to non-tech interventions. The study conducted by Du et al. (2022) shows how the effect size on student standardized math scores varies depending on whether or not they comply with wearing eyeglasses at the endline. While providing subsidized eyeglasses improved the average test score of treatment students by 0.062 SD, the math scores of those who actually wore the eyeglasses increased by 0.918 SD. Unfortunately, many studies do not report the actual compliance and dosage of an intervention and generally only report the planned compliance and dosage. Thus, important information about why an intervention may or may not have an impact (i.e., is it because the intervention itself is not effective, or because students/teachers did not comply with it?) is often unavailable.

Figure 5 Impact of in-school CAL on math scores of grade 4 students in Taiwan, China, with different usage intensities

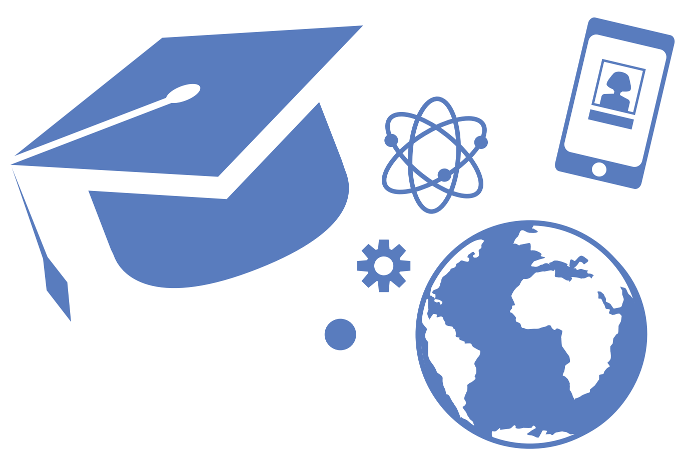


Source: Ma, Yue, Cody Abbey, Derek Hu, Oliver Lee, Weiting Hung, Xinwu Zhang, Chiayuan Chang, Chyi-In Wu, and Scott Rozelle. "The Impact of Computer Assisted Learning on Rural Taiwanese Children: Evidence from a Randomized Experiment." REAP Working Paper, 2020. https://fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/taiwan_o-cal_working_paper_2020oct.pdf.

Taking effect heterogeneity into account based on student characteristics. Along with considering uptake and dosage, a study by Ma et al. (2020) exemplifies the importance of assessing the heterogeneity in effect sizes across students with different characteristics (also known as heterogeneous effects), as well as the mechanisms behind those impacts (i.e., are these differences due to different dosage or simply because the intervention worked better for some students than others?). This information is often masked behind average effect sizes in studies, as noted in Vivalt, 2020, Evans & Yuan, 2022, and Pritchett & Sandefur, 2013. In the Ma et al. (2020) study, students with lower baseline math scores and male students were less likely to use the software, while teacher characteristics also influenced usage, among other variables.

As interventions grow larger and barriers to implementation increase, their potential to have differential impacts across students—in addition to the average effect size of the intervention—also grows larger. These startling findings shed light on the danger of a “one-size-fits-all” education program that compromises the interest of subgroups of participants for the overall positive impact. One study that had a strong degree of heterogeneity evaluated a preschool education intervention in rural Indonesia, and it found positive impacts on the developmental outcomes for poor children (0.20 SD) but negative effects on the developmental outcomes for non-poor children (-0.15 SD) (Brinkman et al., 2017). There are also examples of studies in which only the more privileged or high-performing students gained, while their worse-off peers did not have improved outcomes, such as one intervention in Kenya that provided textbooks to students (Glewwe et al., 2009). Besides this caveat, another important caution about basing decisions to implement certain interventions solely on average effect sizes is that, while an intervention may result in overall positive impacts for the primary target outcome (i.e., academic performance), it may also have negative externalities on other important outcomes. There is little available empirical evidence on this, but a gamified CAL platform in Chile had positive impacts on student learning in math (0.27 SD) but resulted in more severe symptoms of math anxiety and a lower desire among students to collaborate (Araya et al., 2019).

Several aspects deserve attention from researchers and policy makers in the field of EdTech to improve student learning. First and foremost, partnerships between NGOs, research institutions, and governments are crucial for leveraging the strengths of each implementor. These partnerships can start to address the challenges of scalability and effectiveness of EdTech for student learning. The technical expertise of NGOs and research partners, who often design and implement successful pilot programs, can be complemented at the initial design phase by government involvement. These partnership can help specify design approaches and costs that have the potential for future scale up. Second, future impact evaluations should report actual uptake and dosage of EdTech interventions. Implementers should use comparable measures to ensure comparability, and carefully measure compliance with the intervention protocol to improve insight into varying treatment impacts. Finally, there is a growing need to better understand the heterogeneity of effects. As interventions scale to broader populations, we should consider student characteristics such as socio-economic background, target outcomes, gender, disability etc. and the heterogeneous effects of different interventions on these subgroups. Future impact evaluations can be improved by including analyses of heterogeneity to inform more customized intervention designs, and a greater diversity of intervention programs to improve learning for all students and meet a broader range of student needs.



Section 2

What happened? Pre-pandemic learning inequalities and learning losses during the COVID-19 pandemic

2.1 Overview of the learning crisis before and during the COVID-19 pandemic

A learning crisis persists in middle-income countries (MICs) in the EAP region (Bridging the Learning Gap, World Bank, forthcoming). Multiple factors contribute to learning poverty, including lack of access to highly qualified and motivated teachers, inadequate school infrastructure including running water and electricity, and poorly designed academic curricula (Bau & Das, 2020; Chand et al., 2021; Duarte et al., 2011). Evidence from existing studies suggests substantial COVID-19-related learning losses across several MICs in the EAP region. For instance, researchers found a learning loss of 0.22 standard deviations (SD) in China during a seven-week school closure, which equates to over half a school year of learning loss (Patrinos et al., 2022). This is significantly higher than the average learning loss (0.17 SD) identified by a recent global systematic review from the World Bank (Patrinos et al., 2022). A recent World Bank report on learning loss in Cambodia found that student assessment scores declined by 42.8 points in Khmer and 56 points in math between 2016 and 2021, representing substantial losses of 8.4 and 11.3 percent, respectively (Bhatta et al., 2022). In Riau province, Indonesia, there was a 40 percent reduction in the number of Grade 2 and 3 students who could read and comprehend text in 2021 compared with 2018 (Molato-Gayares, 2022), while nationally, Grade 4 students in 2023

Photo: imageBROKER.com GmbH & Co. KG / Alamy Stock Photo

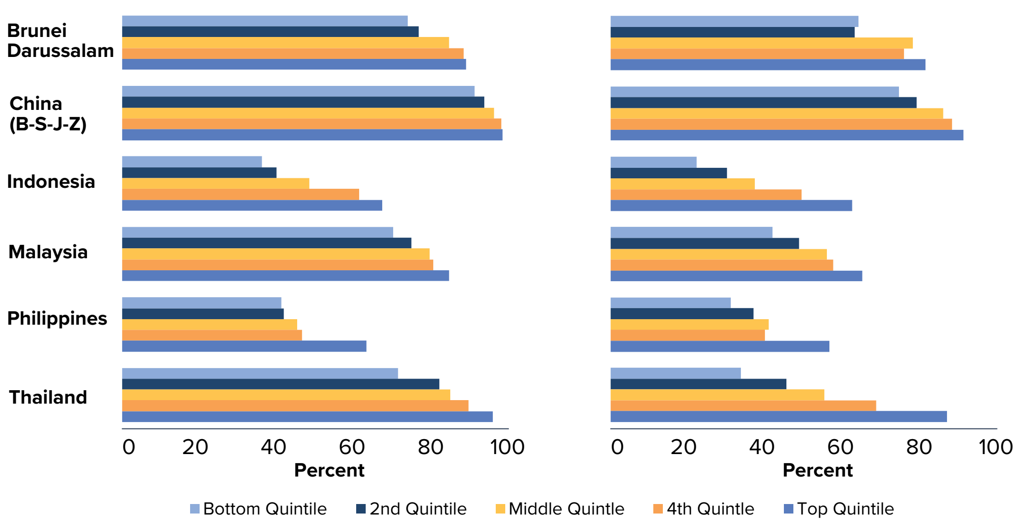
have lost 11.2 months equivalent of math skills and 10.8 months equivalent of language skills in comparison with Grade 4 students in 2019 (World Bank, forthcoming)

In response to the pandemic school closures, many EAP countries deployed EdTech to support student learning and to promote continued student engagement with schooling and retain students once schools reopened. However, striking disparities existed in students' access to technologies before the COVID-19 pandemic, especially among the poorest populations in low- and middle-income countries of EAP. In Indonesia, for example, less than 40 percent of the students from the bottom income group had access to an internet connection. Only around 20 percent of those from the bottom income group could access a computer that might be used for online learning (Figure 6).

Figure 6 Important inequalities existed pre-COVID-19 pandemic in student access to internet and computers

A. Percent of students that have access to an internet link, by income group

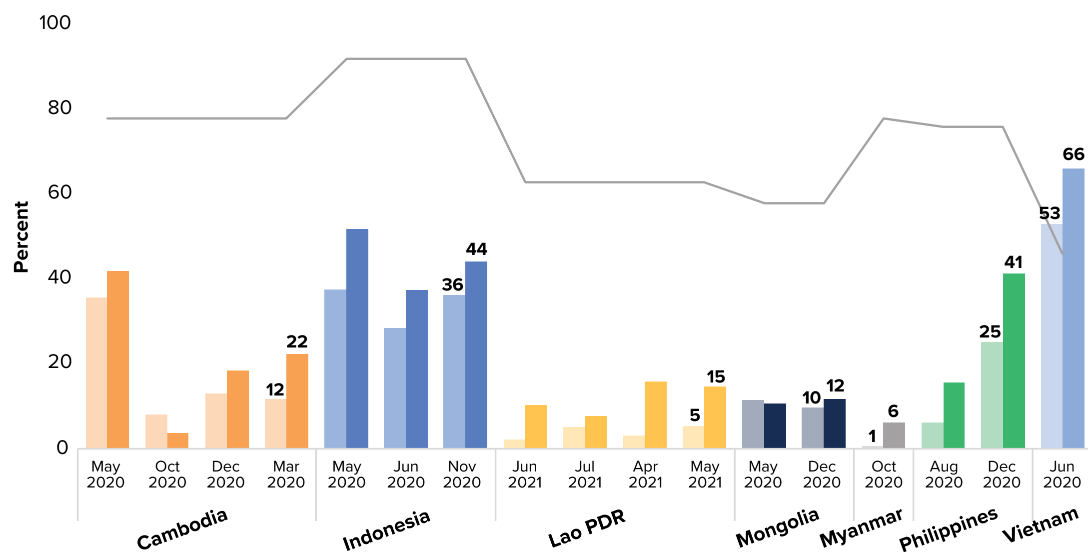
B. Percent of students that have access to a computer they can use for online learning, by income group



Source: World Bank staff calculations, using 2018 PISA data.

Low levels of engagement with learning during school closures overall were compounded by unequal access to EdTech. Surveyed EAP countries saw notable disparities between urban and rural regions in terms of the share of households with children participating in online or mobile learning (Figure 7). Vietnam was the only country where more than half of its students were engaged in remote learning, as 66 percent of urban and 53 percent of rural households reported their children's participation in online or mobile learning activities. Slightly less than half of the urban respondents in Indonesia (44 percent) and the Philippines (41 percent) reported engagement in online or mobile learning activities when schools were closed, whereas their rural counterparts had significantly lower usage (36 percent for rural Indonesia, 25 percent for rural Philippines). In particular, Lao PDR (15 percent urban, 5 percent rural), Mongolia (12 percent urban, 10 percent rural), and Myanmar (6 percent urban, 1 percent rural) exhibited extremely low levels of online or mobile learning for all students during survey rounds in 2020 and 2021, though urban levels of engagement were much higher. These findings suggest that in addition to high levels of learning loss overall, unequal access to technologies translates into higher learning loss for students from poorer socio-economic backgrounds.

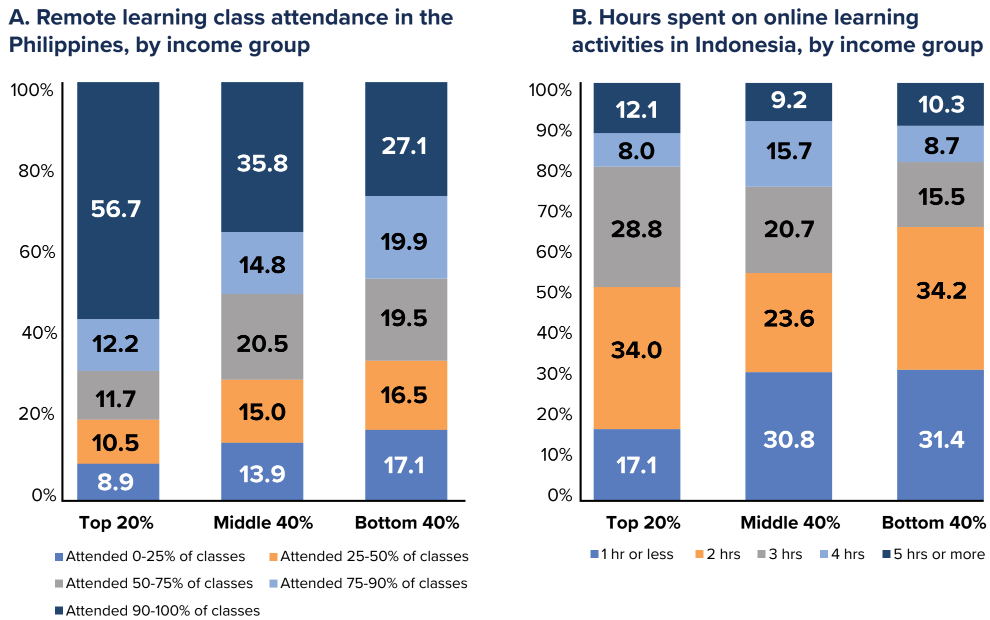
Figure 7 Percent of households with children engaged in online or mobile learning activities during weeks of COVID-19-related school closures, by country and sub-region



Source: World Bank staff calculations, based on HFPS data and UNICEF's "COVID-19 and School Closures" report.

Even for those who were able to access learning resources during school closures, the amount of time spent learning was much higher for children in wealthier households compared with children in lower-income households (Figure 8). In the Philippines, the number of children attending 90 percent or more of online classes was twice as high (56.7 percent) for children in the highest income level as in the lowest income level (27.1 percent). In Indonesia, children in lower-income households were more likely to engage in little or no online learning (31.4 percent) compared with those from households in the top 20 percent income tercile (17.1 percent). Only 17 percent of the wealthiest Indonesian children attended one hour or less of online learning, while more than 30 percent of children from the middle- and lowest-income households attended one hour or less per week.

Figure 8 Children in wealthier households were more likely to be engaged in online or mobile learning



Source: World Bank staff calculations, using HFPS data.

> *"The gap in remote learning participation and unequal dosage implies that, despite the efforts of governments, parents, teachers, and the private sector, inequity in student learning outcomes was exacerbated by the transition to online learning during COVID-19-related school closures."*

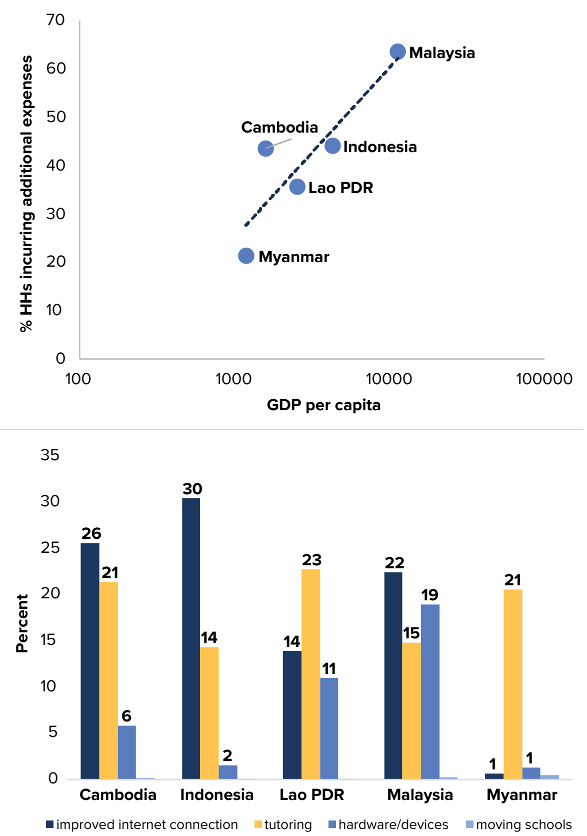
The gap in remote learning participation and unequal dosage (time spent on online learning) implies that, despite the efforts of governments, parents, teachers, and the private sector, inequity in student learning outcomes was exacerbated by the transition to online learning during COVID-19-related school closures. Following Yarrow et al. (2022), these mirror the findings from more extensively studied, high-income countries in other regions during COVID-19-related school closures, as a widening gap in learning outcomes emerged as a result of pre-existing inequalities in technology access and other forms of privileges (Clark et al., 2021; Donnelly & Patrinos, 2020; Dorn et al., 2020; Grewenig et al., 2020; Biswas et al., 2020). This global challenge is referred to as the "Matthew effect," whereby those who already enjoy wealth, education, and prior exposure to technology are most likely to benefit from new technologies (Trucano, 2013).

Disparities were also present in the strategies adopted by families in EAP countries to mitigate the learning losses of their children following school closures. According to HFPS data, households in wealthier developing countries (e.g., Malaysia, Indonesia) spent more on their children's education during school closures and were more likely to prioritize internet connectivity and device-related improvements. In contrast, households in poorer countries (e.g., Myanmar, Lao PDR) were more likely to spend on tutoring services compared with devices or internet connectivity (Figure 9). One reason for this is the pre-existing gap in network infrastructure across EAP countries. Recent data from the International Telecommunication Union (ITU) reveal that, as of 2021, only 1.66 percent of Burmese and 2.03 percent of Laotians were subscribed to fixed broadband services. Conversely, upper middle-income countries in the EAP region, such as Malaysia, had a broadband penetration rate nearly six times higher (11.12 percent) in the same year. In this regard, pre-existing disparities in internet infrastructure not only influenced household decisions on education expenditures, but also exacerbated the gap in access to online learning resources across countries with different income levels.[6]

Figure 9 On average, households in wealthier countries spent more on their children's education to compensate for school closures

A. Share of households incurring additional education expenditures vs. GDP per capita

B. Households incurring education expenditures due to school closures during the pandemic, by category



Source: World Bank staff calculations, using HFPS data. GDP per capita data are from OECD and World Bank national accounts data files, 2021.

6 Notably, Cambodia is an exception. ITU data show that only 2.03 percent of its populations had fixed broadband subscriptions, whereas 26 percent of its households spent more expenditures on improving internet connection during COVID. This is because fixed broadband services are not widely available in Cambodia. Based on pre-pandemic data from 2017, there were 117,049 fixed broadband subscriptions in Cambodia, accounting for just over 1 percent of total internet subscriptions in the country (UN-OHRLLS, 2017). At the same time, there were 18,572,973 mobile cellular subscriptions in Cambodia in 2017 (International Telecommunication Union (ITU), 2017). This indicates that mobile connectivity was a much more prevalent mode of internet access in Cambodia than fixed broadband, even prior to the pandemic.

For students from socio-economically disadvantaged backgrounds, reducing disparities in learning achievements can be supported by implementing more customized EdTech interventions, empowering these students to capitalize on EdTech and online education opportunities. To counter the tendency of EdTech to increase inequalities and enhance the effectiveness of EdTech interventions, researchers and implementors can consider supplementary measures tailored to the needs of communities that they intend to serve. In a COVID-19-related investigation in Nepal, researchers utilized mobile phone text and voice communications, and found positive impacts on mathematics learning for students belonging to the poorest households and with parents of low literacy level (Radhakrishnan et al., 2021).

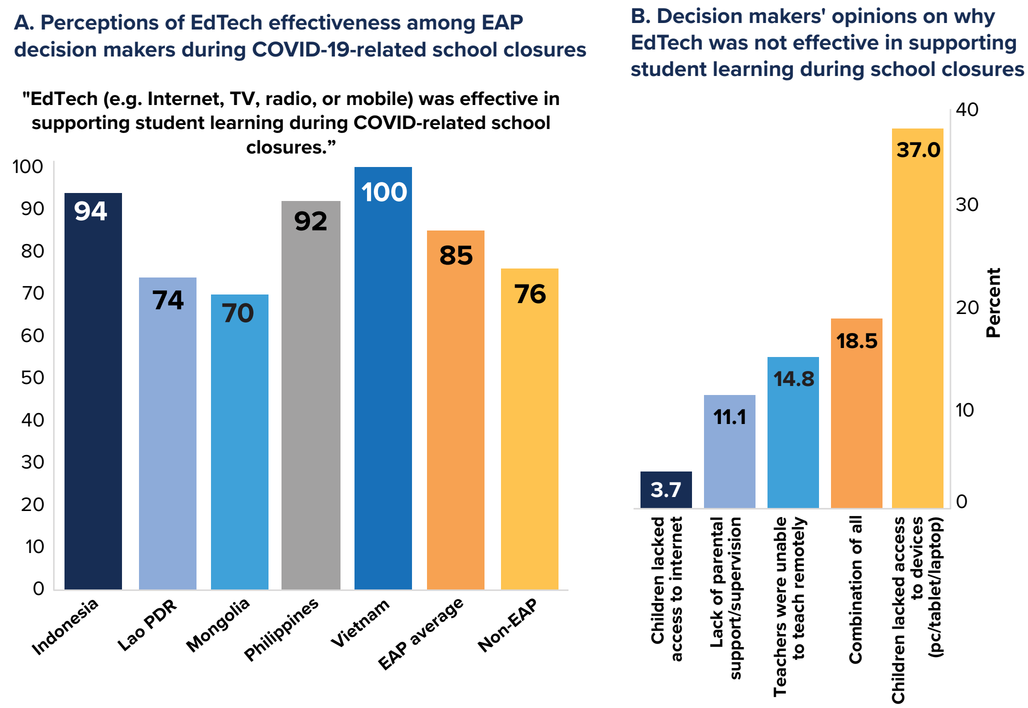
Another complementary measure was to provide more effective teacher training and orientation on different aspects of technology-enabled distance learning. Based on teacher survey in Cambodia, training on EdTech-based teaching skills was inadequate, with only about 43 percent of schools providing teacher training on teaching specific subjects using EdTech, and even smaller percentages on preparing classes for EdTech-based learning (Bhatta et al., 2022). More effective and targeted training on EdTech-specific teaching skills could have profound implications for teachers with limited prior use of ICT in teaching and learning contexts, and improve the effectiveness of distance learning in developing countries of EAP for the next crisis.

2.2 There is a "perception gap" between decision makers and the experience of students and families with EdTech

In addition to the expanding learning inequalities, we uncovered a discrepancy between the perceptions of decision makers in EAP and the public regarding the effectiveness of EdTech in online learning during the pandemic. In a survey conducted together with the Center for Global Development (CGD), on average, 51 percent of the decision makers at the ministries of education and finance in Indonesia, Lao PDR, Mongolia, the Philippines, and Vietnam acknowledged that EdTech did not benefit all children equally. However, the majority (85 percent) believed that EdTech was effective in supporting student learning during COVID-19-related school closures (Figure 10A).

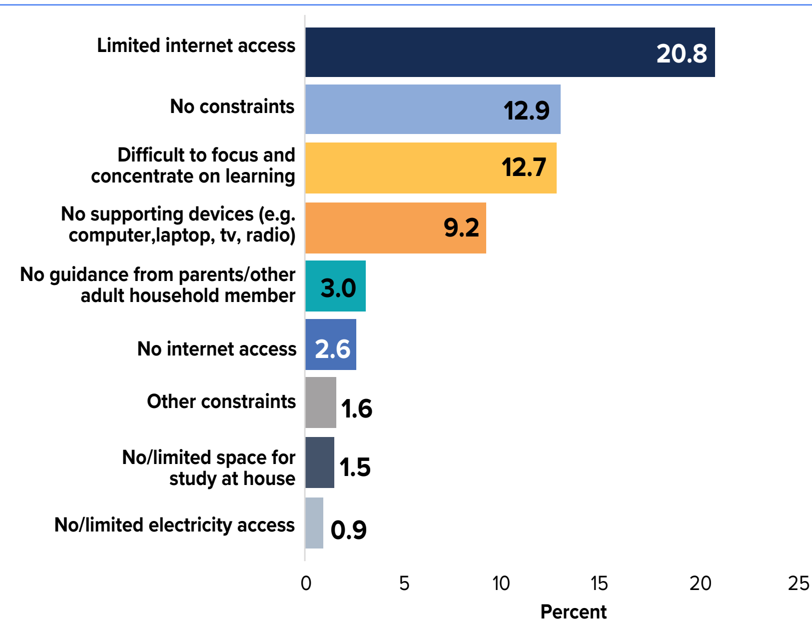
Among those who did not find EdTech effective, 37 percent cited a lack of access to electronic devices (PC/tablet/laptop) as the primary cause. This is consistent with the results from the HFPS surveys in the Philippines, where 18.9 percent of respondent households cited "lack of access to devices" as the number one barrier to learning during the COVID-19 pandemic. However, only 3.7 percent of the surveyed decision makers mentioned limited internet access as a primary reason for EdTech's ineffectiveness (Figure 10B), which contrasts with the HFPS results that indicate limited internet access is, in fact, a significant obstacle, for example in Indonesia (Figure 11).

Figure 10 Decision makers' opinion on whether or not EdTech was effective and the reasons for ineffective EdTech usage



Source: World Bank. Indonesia - High-Frequency Monitoring of COVID-19 Impacts 2020–2022, Rounds 7 (HIFY 2020–2022).

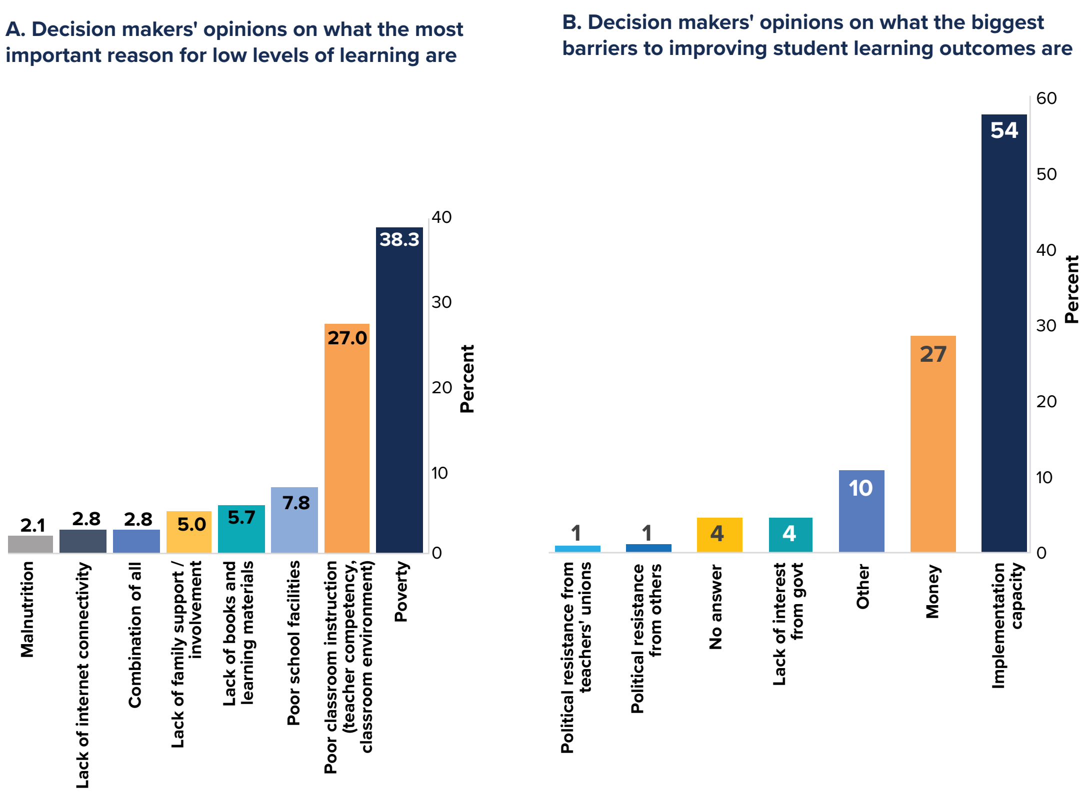
Figure 11 Percentage of respondents citing constraints faced in learning from home in Indonesia, from highest to lowest



Source: World Bank. Indonesia - High-Frequency Monitoring of COVID-19 Impacts 2020–2022, Rounds 7 (HIFY 2020–2022).

Other questions in the same survey reveal that only 2.8 percent of decision-makers in five developing countries of the EAP region identified internet connectivity as the primary reason for low learning levels (Figure 12). In contrast, over half of the respondents (54 percent) considered implementation capacity the most crucial factor in enhancing student academic outcomes (see Yarrow et al. for a detailed discussion). It may be that officials perceive connectivity as a necessary but not sufficient prerequisite for supporting learning.

Figure 12 Decision makers' opinions on the main driver and solution to improving low student learning outcomes are poverty and implementation capacity, respectively



Source: World Bank 2023, based on data collected together with the Center for Global Development (CGD).

We do not yet have enough information to clearly untangle the apparent contradictions between officials belief that EdTech was effective during the COVID-19-related school closures and available data that it wasn't effective in supporting learning for most students. Conclusions regarding the striking discrepancy between decision makers' views and the experiences of students and families point to a clear need for further study and effort to understand and eventually reconcile this substantial perception gap. Given the limited alternatives to tech-supported distance learning during pandemic-induced school closures, taking any action was often viewed as better than inaction, possibly creating a favorable impression for some decision-makers.

Section 3

Moving forward: How EdTech can support learning for all in EAP

Although large-scale evidence of student learning impacts from EdTech interventions by governments in MICs in the EAP region is limited, countries and families continue to invest in EdTech. This makes it essential to examine the evidence on how technology can be utilized to enhance learning outcomes for all students. Drawing from our global knowledge base, we propose several potential applications of technology to improve student academic outcomes in developing countries in the region and synthesize a range of EdTech adoption models in EAP for the consideration of relevant stakeholders.

Teachers are the primary actors to recover learning in the aftermath of the COVID-19 pandemic (see main EAP Education Flagship report for detailed discussion, Afkar et al., 2023). Going from a low-performing teacher to a high-performing teacher increases student learning dramatically. The effect has been measured from more than 0.2 SD in Ecuador to more than 0.9 SD in India—the equivalent of multiple years of business-as-usual schooling (Béteille & Evans, 2021). Technology is therefore most effective when it is used to enhance the ability of teachers to ensure that every student learns (World Bank, 2020). We therefore focus our recommendations on how EdTech can improve student learning through improved instruction that students receive in the classroom.

3.1 Recommendations

There are no specific EdTech approaches listed in the “Great Buys” or “Good Buys” of the Global Education Evidence Advisory Panel (World Bank,2023). The evidence is clear that investing in hardware like laptops, tablets and computers without complementary investments in connectivity and most importantly teacher training are unlikely to improve learning. At the same time, the distinction is becoming increasingly unclear between an “EdTech intervention” and an ed-

Photo: World Bank Flckr

ucation intervention that uses technology and interventions implemented in schools where technology is frequently used. The recommendations below are presented with the aim of helping decision makers select effective investments to support student learning, which will differ based on context, capacity and budget, as well as the specific learning focus of each program.

Recommendation 1: Consider using remote instruction, "the broadcast" or "dual teacher" model, where high-quality teachers are in short supply

Remote instruction (i.e., "the broadcast" or "dual teacher" model), including both pre-recorded and livestream approaches, has shown significant positive impacts on learning in several studies conducted in rural areas of MIC contexts where high-quality teachers are in short supply, including in Ghana (Johnston & Ksoll, 2017), India (Naik et al., 2020), Pakistan (Beg et al., 2019), Mexico (Borghesan & Vasey, 2021), China (Bianchi et al., 2022; Li et al., 2023), and Uruguay (British Council, n.d.). Four of these studies were implemented by governments, and five had treatment samples greater than 4,000 students (in fact, the studies in India, Mexico, and China were evaluations of interventions scaled up to thousands of schools and in Uruguay the study was part of a national program). It is important to note that, in contrast to the remote instruction that occurred during COVID-19-related school closures, these remote instruction interventions all took place in the classroom during the regular school day, and they involved the presence of a teacher in the classroom with the students in addition to the remote teacher (who transmits the pre-recorded or livestreamed lecture). Thus, in some contexts (particularly China), the term "dual-teacher model" has been used to refer to this novel form of instruction, though the term has normally been solely used to describe the livestream approach (He et al., 2020).

The interventions in Pakistan and Mexico are examples of the pre-recorded (or asynchronous) approach of this remote instructional model. In both of these interventions, students watched a recording of a well-trained teacher who delivers curriculum-aligned content tailored to the local context. The videos lasted for a portion of class time (about 10 to 15 minutes), while the remaining time involved instruction from the in-person teacher. The Pakistan intervention involved two days of in-service training to orient teachers on how to use this blended learning approach, while in the model used in Mexico, known as telesecundaria, the teachers also received a detailed teaching guide with step-by-step instructions for how to teach each class. The Mexican model is especially notable in that in these telesecundaria schools, all school subjects are taught in this way, and in-class teachers are often responsible for supervising classes in multiple subjects at a time.

The interventions in Ghana, India and Uruguay involved the livestream (or synchronous) approach to remote instruction, while the study in China included both livestream and pre-recorded approaches, in addition to other hardware inputs. Compared with the asynchronous interventions, these studies tended to replace a greater amount of the normal in-person classroom instruction with the remote instruction: for each class in the India study, students listened to 30 minutes of livestreamed lecture and then engaged in a 10-minute Q&A with the remote teacher (which replaced one-third of all normal class periods per week in students' main subjects). In the Ghana study, the livestreamed lectures were one hour in length for each class (replacing all classes in English and math). In the Uruguayan study, English lessons were delivered weekly to classrooms via video conference, while the local Uruguayan classroom teachers delivered the follow-up practice face-to-face.

Compared with other EdTech approaches, the use of this form of blended remote instruction, either synchronous or asynchronous, has real potential benefits. One is low-technology infrastructure requirements compared with some other EdTech interventions, as these interventions generally require one computer or tablet per teacher and therefore have higher student-to-computer ratios than some other EdTech interventions (Borghesan & Vasey, 2021). The pre-recorded approach might be particularly useful for rural areas with unstable internet connections. Although the synchronous models require moderate to high internet speeds to support the livestream, which in the Ghana and India studies were delivered through satellite technology (a satellite modem, solar panels) and projection equipment (a projector, webcam, etc.), the marginal cost of adding additional students to the intervention is still likely lower than interventions with high computer-to-student ratio requirements, such as computer-assisted learning. Another advantage is modest training requirements for classroom teachers compared with more complex forms of technology or education interventions with new content creation (Naik et al., 2020). Finally, classroom teachers' skills may improve through observation of the remote teacher (He et al., 2020; Zhang, 2020; Li et al., 2023). As demonstrated by Li et al. (2023), the indirect impact of remote instruction, which led to enhanced local teacher quality, resulted in a 0.343 SD increase in students' math scores. Similarly, in Uruguay's Plan Ceibal remote teaching program, local teachers participated in weekly coordination meetings with the remote teacher. During these meetings, the remote teacher would assist the Uruguayan classroom teacher in preparing the lessons and practicing the English content to be covered (British Council, n.d.). In addition, some scholars contend that the dual-teacher model can enable the classroom teacher to concentrate on more student-centered instruction, while the remote teacher focuses on delivering learning content to students (Johnston & Ksoll, 2017).

Recommendation 2: Explore more effective EdTech-supported teacher professional development with enhanced practicality, accessibility and teacher motivation

Similar to the dual-teacher model and other technologies to assist instruction, **virtual teacher training could allow teachers in low-resource settings to connect with expert instructors and receive long-term mentorship, but this approach requires further evaluation.** Distance professional development is a common interest where expert trainers are few and often located in different places than the teachers who need to be trained, but current evidence is mixed-to-negative.

Existing impact evaluations on teacher training programs have yielded mixed results. A recent synthesis of 170 studies in 40 LMICs found some evidence of the benefits of online teacher professional development for improving teachers' pedagogical practices, content knowledge, and motivation (Hennessy et al., 2022), though the review noted that very few studies have explored impacts on student learning outcomes. A study in Brazil involved a hybrid intervention consisting of several in-person classroom observations with feedback for teachers and Skype-mediated expert coaching sessions for pedagogical coordinators demonstrated small, positive improvements in Portuguese and math for Grade-10 students (0.05–0.09 SD) at a cost of US$2.40 per student per year (Bruns et al., 2018). In contrast, a virtual coaching intervention in South Africa that examined the impacts of virtual teacher training on student learning found their virtual professional development (PD) was less effective when compared with their in-person training and only marginally less expensive (Cilliers et al., 2021).

The quality and format of PD programs (such as the practicality and accessibility of training content), along with teacher motivation, serve as key determinants for the success of in-person PD initiatives (Loyalka et al., 2019; Popova et al., 2016), which likely is also necessary for online PD programs to succeed. Poorly designed training programs that do not align with teacher needs and interests are unlikely to improve teaching or learning. In this case, evidence from large-scale online teacher training in Indonesia during COVID-19-related school closures can provide us with further insights into ways that online teacher training could be improved at scale (Yarrow et al., 2022), including continuous mentorship on their implementation and opportunities to apply what they learned during PD sessions (see text box, below).

Teacher Training in Indonesia

A World Bank team mapped the eight largest private and public providers of online teacher training in Indonesia, covering 25 programs delivered in 2021. Most of the programs were short in duration and focused on digital literacy skills and how to implement remote learning by teachers for students. Training programs were mostly provided using online lectures, few provided individual coaching, while none provided opportunities for personalized teacher learning. In parallel, a nationally representative phone survey of 435 primary and junior secondary teachers spanning 30 provinces across Indonesia between February and March 2021 found that 44 percent of teachers participated in online learning during the pandemic, and that three-quarters of these teachers had never participated in online training prior to the pandemic. Many training participants reported challenges in implementing what they learned from online training. Most of the teachers who participated (88 percent) would like to continue receiving training online even after the pandemic ends. These results suggest that demand for online training is expected to persist post-pandemic, but more can be done to improve training quality.

Source: Yarrow, Noah; Khairina, Noviandri; Cilliers, Jacobus; Dini, Indah. 2022. The Digital Future of Teacher Training in Indonesia: What's Next?. World Bank.

One potential model could be to use blended teacher training and dual-teacher classroom programming together, though this has not yet been evaluated:

"The blended model" support for teacher training and classroom instruction

Online teacher training and dual-teacher classroom programming could be used together to enable students to receive higher-quality instruction from remote teachers and support classroom teachers to improve their own instruction. In the dual-teacher model, observing how remote teachers instruct could be part of classroom teachers' professional development, and other components (i.e., one-on-one training sessions over phone calls, in-person follow-up visits, online discussions with other teachers, etc.) could be integrated as teacher training. This blended model could be implemented differently based on the availability of resources in each context.

Options to implement these blended approaches to improving instruction (i.e., remote instruction and virtual teacher professional development), depending on the technological resources available in the given context include:

1. **High-tech:** If schools are already equipped with internet and/or satellite transmission infrastructure, or they are able to invest in such resources, then school administrators may consider using livestream to connect students with high-quality remote teachers, while one-on-one teacher professional development sessions could be partially conducted via video-conferencing platforms. In those contexts where it is feasible for teachers to record themselves teaching, video-based self-reflection, as well as virtual observation of lessons, can be a part of professional development support.

2. **Low-tech:** In low-resource settings where internet connections are not widely available, lessons could be recorded and then shared. Simultaneously, the classroom teacher can interact with a remote teacher in training sessions conducted over the phone blended with in-person visits. If the recorded lectures only take up a portion of the class period, teachers should ideally receive a structured lesson guide describing how to utilize the materials in conjunction with normal classroom activities. For remote teacher training sessions, a higher number of in-person teachers (trainees) could also be assigned to one mentor. SMS text messages and social media could be utilized to facilitate mentor-trainee communication and inter-peer learning among teachers (Jukes et al., 2017).

Recommendation 3: Don't use E-readers as an anchor for reading and learning programs

Having a library of hundreds or even thousands of textbooks and works of fiction at students' fingertips sounds like an educator's dream. When first introduced, it was hoped that digital books, "e-readers" and related tablet and mobile devices would help eradicate illiteracy around the world. **While helpful for learners with some disabilities, the available evidence suggests e-readers are less effective than high quality teacher training and regular textbooks and readers to support student learning.**

The available evidence indicates that e-readers are often less effective in improving student learning compared with paper technology, and may be more costly. One meta-analysis using 17 studies from high-income countries of children and adults found that "reading on paper was better than reading on screen in terms of reading comprehension" (Kong et al., 2018). Another meta-analysis of 54 studies of school children and undergraduates primarily in high-income countries by Delgado et al. (2018) tried to account for difficulties in comparing paper texts with digital texts, which include features such as hyperlinks, animations, or adaptive tests, which may have different effects on learning. They found advantages in paper-based books compared with digital reading, both in the case of time-constrained reading and when using narrative texts (Delgado et al., 2018). A review of recent studies also indicates that generally students retain, remember, and comprehend information more thoroughly when reading on paper than on a screen (Cohn, 2021), though we note the increasing ubiquity of screens in classrooms, particularly in higher income countries.

Research on e-readers in the context of MICs indicates that there are additional challenges. In Lagos, Nigeria, World Bank colleagues found that e-readers with material aligned with the curriculum led to increased student learning only in the absence of textbooks, while e-readers with non-curriculum reading material led to decreases in student learning in both reading and math (Habyarimana & Sabarwal, 2018). A study in Zambia found that girls in an e-reader treatment arm scored significantly better on two of three basic literacy assessments than girls in the control arm. The study noted that there was a general lack of access to paper books in these communities and that the treatment was not simply providing e-readers but also included a broader intervention package, which involved training and compensating adults to support and troubleshoot technical issues (such as replacing chargers that were burnt out) and which was necessary for the smooth functioning of the intervention. The comparison groups did not receive any reading material, printed or otherwise (Mensch et al., 2021). One would hope that e-readers and adult support would show better results than nothing at all!

Piper and colleagues, working on multiple interventions in Kenya, discovered that students using individual e-readers experienced smaller gains in oral reading frequency compared with those in the non-e-reader treatment groups. Cost-effectiveness was the lowest for the e-reader group, with the control group and the two other interventions involving paper-based books demonstrating significantly larger learning gains per dollar than the e-reader group (Piper et al., 2016). Lastly, a recent empirical study found no significant differences in reading comprehension and time spent on reading between groups using print text and those using iPads. Feedback from students in the treatment group suggested that they struggled with using in-app task components. They also found the reading platform to be unsupportive of their note-taking, reading, and highlighting behavior (Sheen & Luximon, 2021). These findings from outside the EAP context indicate that increased learning is connected to the content on the device, the supporting environment including basics such as electricity, whether there are printed materials available as an alternative, and the usability of e-readers, though this may improve with time as students become more adept at using them. To combat learning poverty in EAP, our attention should be on encouraging and supporting children's reading activities regardless of the medium of delivery, though caution should be exercised based on the above findings when contemplating an investment in e-readers.

Despite these negative findings, e-readers and other devices may be appropriate for some specific learning challenges. We have much more experience and evidence about paper-basEdTechnology than screen-basEdTechnology, and the technology is changing constantly. Technology has the ability to make text larger, or provide the same text in many different languages, which may be very helpful for certain learners and contexts. For students, e-books reduce the number of textbooks they have to carry to school and include attractive features. These features, such as user-friendly functions, engaging graphics, enlarged text size, and plug-in speakers, could promote student learning autonomy and encourage creativity (Embong et al., 2012). For teachers, e-books could also simplify the management process, as they allow concurrent monitoring of classroom activities by each student (Embong et al., 2012). Evidence from a recent study of fewer than 800 students in the Republic of Korea reported gains in learning (0.28 to 0.32 SD in social studies and science) associated with the introduction of digital textbooks as a supplement to other, printed material (Lee et al., 2022). The question education decision makers may ask, therefore, is less “do e-readers and digital textbooks work?” and more “what are the trade-offs in terms of costs and needs for support between a paper-based and a screen-based approach to improving a specific aspect of student learning?” The alignment of the content with the curriculum is essential, and there is great variety in the quality and features of digital texts, as well as printed texts. These need to be carefully considered for each context and learning goal before choosing a specific approach.

Recommendation 4: Develop and expand interventions using assistive technology for learners with disabilities

In 2022, the World Bank estimated that over 1 billion people have a disability (World Bank, 2022). About 80 percent of them live in developing countries, making them the world’s largest minority (World Health Organization, 2023). Of these, there are an estimated 41 million children with disabilities in EAP (UNICEF East Asia and Pacific, 2020), making the potential market for assistive technology very large. However, access lags far behind demand (World Bank, 2020), indicating a generalized market failure. Learners with disabilities are the most likely to be out of school and at high risk of dropout and tend to have lower levels of learning than their peers (UNICEF East Asia and Pacific, 2022). Meanwhile, assistive technology has the potential to integrate students in the classroom, facilitating interactions with same age peers and building recreational skills (Zilz & Pang, 2021). This is a missed opportunity both for the students themselves and the wider society and can be partially addressed with existing EdTech solutions.

Several challenges, however, need to be taken into consideration before implementing assistive technologies at scale. First, existing evidence on the effectiveness of assistive technology is limited. So far, services for vision and hearing-impaired students tend to be localized rather than national. They are often provided with support from NGOs and international donors to fill gaps in provision from national governments. Devices and software such as screen readers, speech-to-text tools, and hearing aids can help children learn and stay enrolled (WHO & UNICEF, 2022). Even in China, one of the high performers in this domain, schools for vision and hearing impaired students tend to work regionally, and do not report student learning outcomes (Yarrow et al., forthcoming). Second, recent reports on assistive technology have highlighted challenges such as inadequate funding, lack of access and expertise, and a lack of awareness among teachers, as well as among education decision makers more broadly. More than 90 percent of policy leaders interviewed in EAP agreed with the statement that children with disabilities deserved the same level of access to public schools, and that accommodations should be made to include them (CGD forthcoming; Yarrow et al., forthcoming). However, around 10 percent of respondents in multiple countries did not agree with these statements, indicating that even among people in leadership positions, the right of educational inclusion is not universally supported. These issues are hindering the development of learning technologies for students with disabilities. Furthermore, students may feel stigmatized and choose not to use these technologies, as existing technologies have been found not to align appropriately with the students’ needs (Khazanchi et al., 2022).

Moving forward, it would be helpful for governments and civil society to collaborate with the private sector and research community in the EAP region. Such partnerships can facilitate the adaptation, development, evaluation, and scaling-up of assistive education technology that caters to the needs of children with disabilities, particularly in low- and middle-income countries. Engaging with systemic changes is essential to ensure the effective use of these technologies in enhancing student learning outcomes. As noted above, the sector faces challenges such as insufficient information for producers and consumers, barriers to entry, and fragmentation both between and within countries. Promising strategies to address these issues include market shaping, policy development, and information sharing, which can support large-scale improvements in product offerings, service provision, personnel training, and policy for accessible, adaptable, and high-quality assistive technology (World Health Organization, 2022). Addressing current gaps in access and quality is crucial to avoid leaving millions of children with disabilities in the EAP region behind.

Recommendation 5: Explore and evaluate the use of AI-enabled interventions for the personalization of learning and empowerment of teachers

The potential of artificial intelligence (AI) in education has received much attention in recent years as the use of AI tools to support or enhance learning has grown (Holmes et al., 2019). AI proposes providing learners with access to high-quality personalized learning, in addition to facilitating new approaches to assessment and reducing teacher workload. At the same time, there are still many concerns about AI educational applications in terms of their efficacy, the tendency of some forms of AI to replace teachers, as well as other ethical challenges (Akgun & Greenhow, 2022). We provide an overview of potential opportunities for AI in education, while also highlighting some caveats regarding potential drawbacks and gaps where more research is needed.

One of the most common and long-standing applications of AI for improving student learning is intelligent tutoring systems (ITS). The way such systems work is by automatically adjusting learning activities, difficulty, and scaffolding content based on the student's learning level. They make adjustments using four integrated models (i) expert domain knowledge about the subject (the domain model); (ii) a diagnostic assessment of the student's current level (the student model); (iii) adaptive feedback and hints to assist student learning (the teaching model); and (iv) a user interface that facilitates communication between the user and the system (Mousavinasab et al., 2021; Sedlmeier, 2001). The system attempts to create an individualized learning pathway for the student that is continuously updated.

In contexts where teachers are overextended or otherwise have difficulty providing students with individualized instruction, these systems could potentially help aid teachers in personalizing the students' learning pathways and providing teachers with the data and time to better understand how to engage students in differentiated instruction. One recent intervention in the region, which is part of a global initiative called Hi-Tech Hi-Touch, uses an ITS to support educators in teaching foundational knowledge and enabling students to progress at their own speed, which helped teachers focus on individualized instruction and active learning experiences in the classroom (Education Commission, 2020). The report recommends that crucial factors to the model's early signs of success are having a dedicated ministry contact who supports the project, using the software to identify opportunities for teacher professional development, and establishing alignment between the software content and the national curriculum to increase buy-in.

In addition to ITS, AI can be used to automate clerical and administrative tasks to relieve teachers' non-teaching workloads. A recent estimate of the activity composition of teacher working hours in multiple countries found that less than half of teachers' workday involves directly interacting with students, with the majority of their time being dedicated to tasks such as preparation, evaluation and feedback, professional development, and administration (Cardona et al., 2023). By handling lower-level details, including scoring examinations and essays, teachers would have more time to dedicate to direct interactions with students. A further application of AI includes improving professional development approaches. New products can allow teachers to record their classroom interactions and use AI algorithms to provide them with data on the ratio between the time that students and teachers spend talking or between the types of discourse most often used during class time, as well as help them select specific segments of the video recordings to review with coaches (Jensen et al., 2020). A randomized experiment that evaluated an AI-powered classroom discourse analyzer tool that helps select video recording content for professional development sessions in Shanghai, China, found significant positive impacts on a sixth- and seventh-grade students math performance (0.24 SD) (Chen et al., 2020).

Despite the recent explosion in interest in applications of AI in education, there is still limited rigorous evidence on its effectiveness (UNESCO, 2021), especially when compared to EdTech that performs similar functions but does not employ AI technology (van Klaveren et al., 2017; Vanbecelaere et al., 2020). It is important for governments to pilot different technologies, comparing those powered by AI and to other options to understand what works best to cost-effectively support student learning.

Recommendation 6: Improve and expand research on EdTech for student learning

There are six ways EdTech pilots and evaluations can be improved:

1. Test at scale – more evaluations of EdTech should be conducted at scale. While small "pilot" evaluations can be tests of efficacy, they often give little information about impacts, costs and capacities required to implement for large numbers of students, teachers and schools.

2. Design for scale – where tests with large numbers of students and teachers are not possible due to funding or other constraints, design with scale in mind, for example by minimizing costs and simplifying implementation. If teachers can only implement the program with intense expert support, the impact on student learning is unlikely to be scalable with existing government capacity.

3. Report learning impacts by type of sub-population (gender, income, baseline learning level etc.) in addition to the average effect. This heterogeneity becomes increasingly important at scale, especially if some effects are negative or some types of learners benefit much more than others.

4. Report the number of participants in the total treatment group, as well as the sample used for the study. If the sample is part of a much larger program, it is helpful to know that the intervention is already working at scale.

5. Measure and report costs, including training costs. When governments consider different approaches to support student learning, it is helpful to know what they might cost to implement.

6. Measure uptake and dosage effects, and report them. Since variations in intervention compliance and intensity often lead to heterogeneity in learning impacts, future researchers and implementers should develop standard metrics for uptake and dosage for comparison across interventions and study contexts.

Photo: World Bank Flckr

Section 4

Conclusion

Future pathways of the EdTech industry in EAP: balancing public and private interests

In July 2021, the Central Committee of the Communist Party of China issued Decree No. 40, titled “Opinions on Further Reducing the Burden of Students’ Homework and Off-campus Training in Compulsory Education.” The stated objective of the reform was to achieve a “double reduction” in the areas of homework and out-of-school tutoring, while alleviating parents’ anxiety and promoting students’ all-round development and healthy growth. The regulation also stated that companies that engaged in “subject-based training” “will be uniformly registered as non-profit institutions,” and will not be listed on stock exchanges or have foreign investors.

Governments of other countries in the region have taken a more favorable stance toward for-profit EdTech, aimed more at supporting or at least crowding-in private sector initiatives. A scaled example from Indonesia is the relationship between EdTech startup Ruang Guru and 32 regional governments. The partnerships allow Ruang Guru to widely distribute vouchers sold to the Government for their product and also include a package of educational content, virtual classes, the online-based test platform, and teacher training. As a result of this strategy and substantial funding, Ruang Guru has held the predominant position in the Indonesian K-12 EdTech market for several years (Omidyar Network, 2019). Another example in Indonesia is Google Classroom. During the pandemic the ministry requested 26 million workspace accounts to be established for students within 24 hours as schools were being closed. Google Classroom completed setting up these accounts in March of 2020; however, recent analysis indicates that only around 10 million of these accounts were ever activated by students, and that account activations were mostly in urban areas (Author Interview). In Malaysia, the Ministry of Education has partnered with Google, Microsoft and Apple to form the DELIMa (Digital Education Learning Initiative Malaysia) initiative. The aim is to provide a range of e-learning applications and resources, harnessing a multi-technology ecosystem for greater accessibility, and averages 1.7 million active users monthly (Project ID, 2020). In Vietnam, Galaxy Education is piloting a dual-teacher approach for English language teaching in 100 schools, trying to provide high-quality language instruction to classrooms who otherwise would not have access to this level of subject expertise (Author interview, May 2022). In Cambodia, the government is supporting teachers to identify students with hearing and vision disabilities using a phone based app. The program then helps connect students to services so they remain in school and continue learning. (Yarrow et al., forthcoming). Lastly, the Republic of Korea presents an

Photo: World Bank Flckr

example of how public-private partnerships can enhance EdTech system resilience during public health crises. Capitalizing on the country's advanced ICT infrastructure, the Korean government rapidly expanded the capacity of its e-learning platforms to support students who experienced school closures during the COVID-19 pandemic. About 50,000 public learning resources were added to these e-learning platforms, with much of the free content becoming available through a joint effort between the Korean government and the private sector (Ministry of Education, 2020). The Korean government also proactively addressed the digital divide in collaboration with major telecommunications companies such as Samsung and LG. As of April 2020, national statistics indicate that 280,000 students rented digital devices free of charge, accounting for 5.3 percent of the total student population in the Republic of Korea (Ministry of Education, 2020).

In sum, the contrasting approaches to regulating and supporting EdTech between China and other countries in the EAP region underscore the diversity of strategies governments can adopt to address the challenges and opportunities arising from public health and other crises, including the learning crisis. The integration of technology in education is likely to persist and expand, as many educational institutions, governments, and other stakeholders have recognized its potential benefits, especially in making education systems more resilient. In countries such as Indonesia, for instance, a steep trajectory in internet penetration rates has coincided with the emergence of numerous EdTech startups, which offer a wide variety of products and services aimed at improving the experiences of various stakeholders over the past few years (World Bank, 2020).

While the worst stages of the COVID-19 pandemic have subsided for most countries in the region, the future remains uncertain. Without a resilient education system, teachers and students cannot unlock remote learning opportunities during times of crisis, leading to significant learning losses and risking widening the gap in academic outcomes across students with varying levels of access to technology. Although EdTech is often a source of increasing learning inequality, its potential to improve student learning outcomes hinges on addressing the current limitations and inequalities it exacerbates. As the role of EdTech expands with new AI applications, it becomes increasingly vital for policy makers and the private sector to collaborate in fostering investment, innovation, evaluation, and regulation of the EdTech ecosystem in the EAP region. By ensuring equitable access to internet connectivity and tailoring EdTech solutions to cater to students' diverse needs, we can unleash its potential to not only enhance academic performance but also bridge the gap in learning inequalities. Meanwhile, conducting more rigorous impact evaluations with larger intervention scales and higher impacts but lower implementation costs will enable us to better test the effectiveness of EdTech interventions. In this regard, the post-COVID-19 era presents a unique opportunity to build a more inclusive and effective educational landscape, with technology serving as a potential catalyst for meaningful and lasting change in the education systems of EAP countries.

References

Abeberese, A.B., Kumler, T.J., & Linden, L.L. (2014). *Journal of Human Resources*, 49 (3) 611–633; DOI: https://doi.org/10.3368/jhr.49.3.611

Afkar, Rythia; Tara Beteille; Mary Breeding; Toby Linden; Andrew D. Mason; Aaditya Mattoo; Tobias Pfutze; Lars M. Sondergaard and Noah Yarrow. *Fixing the Foundation: Teachers and Basic Education in East Asia and Pacific*. Washington DC: World Bank Group

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics, 2*(3), 431–440. https://doi.org/10.1007/s43681-021-00096-7

Araya, R., Arias Ortiz, E., Bottan, N. L., & Cristia, J. (2019). *Does gamification in education work? Experimental evidence from Chile* (Working Paper IDB-WP-982). IDB Working Paper Series. https://doi.org/10.18235/0001777

Barrera-Osorio, F., & Filmer, D. (2016). Incentivizing Schooling for Learning: Evidence on the Impact of Alternative Targeting Approaches. *The Journal of Human Resources*, 51(2), 461–499. http://www.jstor.org/stable/24736029

Bau, N., & Das, J. (2020). Teacher Value Added in a Low-Income Country. *American Economic Journal: Economic Policy, 12*(1), 62–96. https://doi.org/10.1257/pol.20170243

Beg, S. A., Lucas, A. M., Halim, W., & Saif, U. (2019). *Beyond the Basics: Improving Post-Primary Content Delivery through Classroom Technology* (NBER Working Paper No. 25704, p. 42). http://www.nber.org/papers/w25704

Béteille, T., & Evans, D. K. (2021). *Successful Teachers, Successful Students: Recruiting and Supporting Society's Most Crucial Profession.* https://policycommons.net/artifacts/2445925/successful-teachers-successful-students/3467666/

Bhardwaj, Riaz; Yarrow, Noah; Cali, Massimiliano. 2020. *EdTech in Indonesia: Ready for Take-off?*. © World Bank, Washington, DC. Retrieved April 13, 2023, from https://openknowledge.worldbank.org/entities/publication/3290e918-2c89-5a90-899f-bba5941eb6ca

Bhatta, S. D., Katwal, S., Pfutze, T., Ros, V., Wong, Y. N., & No, F. (2022). *Learning Loss in Cambodia and the Use of EdTech during COVID-19.* http://hdl.handle.net/10986/38351

Bianchi, N., Lu, Y., & Song, H. (2022). *The effect of computer-assisted learning on students' long-term development. Journal of Development Economics, 158,* 102919. https://doi.org/10.1016/j.jdeveco.2022.102919

Biswas, Alok Kumar; Asaduzzaman, T. M.; Evans, David K.; Fehrler, Sebastian; Lnu, Deepika Ramachandran; Sabarwal, Shwetlena. (2020). *TV-Based Learning in Bangladesh: Is it Reaching Students?* [Text/HTML]. World Bank. Retrieved April 24, 2023, from https://documents.worldbank.org/en/publication/documents-reports/documentdetail/693481594961374723/TV-Based-Learning-in-Bangladesh-Is-it-Reaching-Students

British Council. (n.d.). Plan Ceibal—Remote Teaching into Uruguayan public schools. Retrieved June 13, 2023, from https://www.britishcouncil.uy/en/programmes/education/ceibal-en-ingles

Borghesan, E., & Vasey, G. (2021). *The Marginal Returns to Distance Education: Evidence from Mexico's Telesecundarias* (p. 68) [Working Paper]. https://gabriellevasey.github.io/MarginalReturns_BorghesanVasey.pdf

Brinkman, S. A., Hasan, A., Jung, H., Kinnell, A., & Pradhan, M. (2017). *The Impact of Expanding Access to Early Childhood Education Services in Rural Indonesia. Journal of Labor Economics, 35(S1),* S305–S335. https://doi.org/10.1086/691278

Cardona, M. A., Rodríguez, R. J., & Ishmael, K. (2023). *Artificial Intelligence and the Future of Teaching and Learning. U.S. Department of Education, Office of Educational Technology.* https://www2.ed.gov/documents/ai-report/ai-report.pdf

Central Committee of the Communist Party of China (2021), Decree No. 40, "Opinions on Further Reducing the Burden of Students' Homework and Off-campus Training in Compulsory Education. 中共中央办公厅 国务院办公厅印发《关于进一步减轻义务教育阶段学生作业负担和校外培训负担的意见》—中华人民共和国教育部政府门户网站, 2021). http://www.moe.gov.cn/jyb_xxgk/moe_1777/moe_1778/202107/t20210724_546576.html

Chand, S., Chaudhary, K., Prasad, A., & Chand, V. (2021). Perceived Causes of Students' Poor Performance in Mathematics: A Case Study at Ba and Tavua Secondary Schools. Frontiers in Applied Mathematics and Statistics, 7. https://www.frontiersin.org/articles/10.3389/fams.2021.614408

Chen, G., Chan, C. K. K., Chan, K. K. H., Clarke, S. N., & Resnick, L. B. (2020). Efficacy of video-based teacher professional development for increasing classroom discourse and student learning. *Journal of the Learning Sciences, 29*(4–5), 642–680. https://doi.org/10.1080/10508406.2020.1783269

Chen, X., Shi, Y., Yi, H., Zhang, L., Mo, D., Chu, J., Loyalka, P., & Rozelle, S. (2013). The Impact of a Senior High School Tuition Relief Program on Poor Junior High School Students in Rural China. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.2374361

Cilliers, J., Fleisch, B., Kotze, J., Mohohlwane, N., Taylor, S., & Thulare, T. (2021). *Can Virtual Replace In-person Coaching? Experimental Evidence on Teacher Professional Development and Student Learning.* RISE Programme. https://riseprogramme.org/publications/can-virtual-replace-person-coaching-experimental-evidence-teacher-professional

Clark, A. E., Nong, H., Zhu, H., & Zhu, R. (2021). Compensating for academic loss: Online learning and student performance during the COVID-19 pandemic. *China Economic Review, 68,* 101629. https://doi.org/10.1016/j.chieco.2021.101629

Cohn, J. (2021). *Skim, Dive, Surface: Teaching Digital Reading.* http://wvupressonline.com/node/865

Delgado, P., Vargas, C., Ackerman, R., & Salmerón, L. (2018). Don't throw away your printed books: A meta-analysis on the effects of reading media on reading comprehension. *Educational Research Review,* 25, 23–38. https://doi.org/10.1016/j.edurev.2018.09.003

Donnelly, R., & Patrinos, H. (2020, December 8). *Is the COVID-19 slide in education real?* https://blogs.worldbank.org/education/covid-19-slide-education-real

Dorn, E., Hancock, B., Sarakatsannis, J., & Viruleg, E. (2020). *COVID-19 and student learning in the United States: The hurt could last a lifetime.* Retrieved April 24, 2023, from https://www.mckinsey.com/~/media/McKinsey/Industries/Public%20and%20Social%20Sector/Our%20Insights/COVID-19%20and%20student%20learning%20in%20the%20United%20States%20The%20hurt%20could%20last%20a%20lifetime/COVID-19-and-student-learning-in-the-United-States-FINAL.pdf

Du, K., Wang, H., Ma, Y., Guan, H., & Rozelle, S. (2022). Effect of Eyeglasses on Student Academic Performance: What Matters? Evidence from a Randomized Controlled Trial in China. *International Journal of Environmental Research and Public Health, 19* (17), Article 17. https://doi.org/10.3390/ijerph191710923

Duarte, J., Garguilo, C., & Moreno, M. (2011). *School Infrastructure and Learning in Latin American Elementary Education: An Analysis Based on the SERCE.* https://www.researchgate.net/publication/254422066_School_Infrastructure_and_Learning_in_Latin_American_Elementary_Education_An_Analysis_Based_on_the_SERCE

Education Commission. (2020). High Touch High Tech Learning Vietnam *(Education Workforce Initiative: Country Report).* from https://educationcommission.org/wp-content/uploads/2020/07/2020-EC-Country-Report-Vietnam-ENG.pdf

Embong, A. M., Noor, A. M., Hashim, H. M., Ali, R. M., & Shaari, Z. H. (2012). E-Books as Textbooks in the Classroom. *Procedia - Social and Behavioral Sciences, 47,* 1802–1809. https://doi.org/10.1016/j.sbspro.2012.06.903

Evans, D. K., & Yuan, F. (2022). How Big Are Effect Sizes in International Education Studies? *Educational Evaluation and Policy Analysis, 44* (3), 532–540. https://doi.org/10.3102/01623737221079646

Filmer, D., & Schady, N. (2009). *School Enrollment, Selection and Test Scores* (No. 4998; Policy Research Working Paper). World Bank. https://openknowledge.worldbank.org/server/api/core/bitstreams/7f82d893-62e6-5a42-a710-b6ed16592329/content

Fuje, Habtamu; Tandon, Prateek, 2018. When do in-service teacher training and books improve student achievement? Experimental evidence from Mongolia 2018—Review of Development Economics—Wiley Online Library. Retrieved April 25, 2023, from https://onlinelibrary.wiley.com/doi/10.1111/rode.12387

Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). *Scores, Camera, Action? Incentivizing Teachers in Remote Areas.* Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035

Glewwe, P., Kremer, M., & Moulin, S. (2009). Many Children Left Behind? Textbooks and Test Scores in Kenya. *American Economic Journal: Applied Economics,* 1(1), 112–135. https://doi.org/10.1257/app.1.1.112

Grewenig, E., Lergetporer, P., Werner, K., Woessmann, L., & Zierow, L. (2020). *Covid-19 and Educational Inequality: How School Closures Affect Low- and High-Achieving Students.* Retrieved April 24, 2023, from https://www.cesifo.org/en/publications/2020/working-paper/covid-19-and-educational-inequality-how-school-closures-affect-low

Habyarimana, J., & Sabarwal, S. (2018). *Re-Kindling Learning.* World Bank Policy Research Working Paper. https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-8665

He, X., Yang, H. H., & Wu, S. (2020). Dual-Teaching Model: A Practical Approach for Students in Rural Areas. *2020 International Symposium on Educational Technology* (ISET), 193–195. https://doi.org/10.1109/ISET49818.2020.00049

Hennessy, S., D'Angelo, S., McIntyre, N., Koomar, S., Kreimeia, A., Cao, L., Brugha, M., & Zubairi, A. (2022). Technology Use for Teacher Professional Development in Low- and Middle-Income Countries: A systematic review. *Computers and Education Open, 3,* 100080. https://doi.org/10.1016/j.caeo.2022.100080

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence In Education: Promises and Implications for Teaching and Learning.* Center for Curriculum Redesign. https://curriculumredesign.org/wp-content/uploads/AIED-Book-Excerpt-CCR.pdf

Jensen, E., Dale, M., Donnelly, P. J., Stone, C., Kelly, S., Godley, A., & D'Mello, S. K. (2020). Toward Automated Feedback on Teacher Discourse to Enhance Teacher Learning. *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–13.* https://doi.org/10.1145/3313831.3376418

Johnston, J., & Ksoll, C. (2017). Effectiveness of Interactive Satellite-Transmitted Instruction: Experimental Evidence from Ghanaian Primary Schools. *CEPA Working Paper.* https://cepa.stanford.edu/content/effectiveness-interactive-satellite-transmitted-instruction-experimental-evidence-ghanaian-primary-schools

Khazanchi, Pankaj, and Rashmi Khazanchi. "*Role of Assistive Technology in Teaching Students With Disabilities in K-12 Classrooms.*" Technology-Supported Interventions for Students With Special Needs in the 21st Century. IGI Global, 2022. 149–176. https://www.igi-global.com/gateway/chapter/300026

Kleiman-Weiner, M., Luo, R., Zhang, L., Shi, Y., Medina, A., & Rozelle, S. (2013). Eggs versus chewable vitamins: Which intervention can increase nutrition and test scores in rural China? *China Economic Review, 24,* 165–176. https://doi.org/10.1016/j.chieco.2012.12.005

Kong, Y., Seo, Y. S., & Zhai, L. (2018). Comparison of reading performance on screen and on paper: A meta-analysis. *Computers & Education,* 123, 138–149. https://doi.org/10.1016/j.compedu.2018.05.005

Lee, S., Lee, J.-H., & Jeong, Y. (2022). The Effects of Digital Textbooks on Students' Academic Performance, Academic Interest, and Learning Skills. J*ournal of Marketing Research*. https://doi.org/10.1177/00222437221130712

Li, H., Liu, Z., Yang, F., & Yu, L. (2023). The Impact of Computer-Assisted Instruction on Student Performance: Evidence from the Dual-Teacher Program. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.4360827

Loyalka, P., Liu, C., Song, Y., Yi, H., Huang, X., Wei, J., Zhang, L., Shi, Y., Chu, J., & Rozelle, S. (2013). Can information and counseling help students from poor rural areas go to high school? Evidence from China. *Journal of Comparative Economics, 41* (4), 1012–1025. https://doi.org/10.1016/j.jce.2013.06.004

Loyalka, P., Popova, A., Li, G., & Shi, Z. (2019). Does Teacher Training Actually Work? Evidence from a Large-Scale Randomized Evaluation of a National Teacher Training Program. *American Economic Journal: Applied Economics, 11*(3), 128–154. https://doi.org/10.1257/app.20170226

Loyalka, P., Sylvia, S., Liu, C., Chu, J., & Shi, Y. (2019). Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. *Journal of Labor Economics, 37*(3), 621–662. https://doi.org/10.1086/702625

Ma, Y., Abbey, C., Hu, D., Lee, O., Hung, W., Zhang, X., Chang, C., Wu, C.-I., & Rozelle, S. (2020). *The Impact of Computer Assisted Learning on Rural Taiwanese Children: Evidence from a Randomized Experiment.* https://sccei.fsi.stanford.edu/publication/impact-computer-assisted-learning-rural-taiwanese-children-evidence-randomized

Macdonald, K. A. D., Brinkman, S. A., Jarvie, W., Machuca-Sierra, M., Mcdonall, K. A., Tapueluelu, S., & Thanh Vu, B. (2017). *Pedagogy versus School Readiness: The Impact of a Randomized Reading Instruction Intervention and Community-Based Playgroup Intervention on Early Grade Reading Outcomes in Tonga* (SSRN Scholarly Paper No. 2901756). Social Science Research Network. https://papers.ssrn.com/abstract=2901756

Mason, E. N., & Smith, R. A. (2020). *Tracking Intervention Dosage to Inform Instructional Decision Making*. Intervention in School and Clinic, 56(2), 92–98. https://doi.org/10.1177/1053451220914897

Mensch, B. S., Haberland, N., Soler-Hampejsek, E., Digitale, J., Jackson-Hachonda, N., Chelwa, N., Nyirenda, P., Chuang, E., Polen, L., Psaki, S. R., Kayeyi, N., & Mbizvo, M. T. (2021). Effects of an e-reader intervention on literacy, numeracy and non-verbal reasoning among adolescent girls in Zambia: Evidence from a randomised controlled trial. *Journal of Development Effectiveness, 13*(3), 247–275. https://doi.org/10.1080/19439342.2021.1953566

Ministry of Foreign Affairs, Republic of Korea (2020). *Responding to COVID-19: Online Classes in Korea.* Retrieved March 31, 2023, from https://www.mofa.go.kr/eng/brd/m_22747/view.do?seq=15&srchFr=&amp%3bsrchTo=&amp%3bsrchWord=&amp%3bsr

Mo, D., Bai, Y., Shi, Y., Abbey, C., Zhang, L., Rozelle, S., & Loyalka, P. (2020). Institutions, implementation, and program effectiveness: Evidence from a randomized evaluation of computer-assisted learning in rural China. *Journal of Development Economics,* 146, 102487. https://doi.org/10.1016/j.jdeveco.2020.102487

Molato-Gayares, R. (2022). *How to Recover Learning Losses from COVID-19 School Closures in Asia and the Pacific* (Issue 217). Asian Development Bank. https://www.adb.org/publications/learning-losses-covid-19-school-closures

Mousavinasab, E., Zarifsanaiey, N., R. Niakan Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi Saeedi, M. (2021). Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments, 29*(1), 142–163. https://doi.org/10.1080/10494820.2018.1558257

Naik, G., Chitre, C., Bhalla, M., & Rajan, J. (2020). Impact of use of technology on student learning outcomes: Evidence from a large-scale experiment in India. *World Development, 127,* 104736. https://doi.org/10.1016/j.worlddev.2019.104736

Nie, J., Pang, X., Wang, L., Rozelle, S., & Sylvia, S. (2020). Seeing Is Believing: Experimental Evidence on the Impact of Eyeglasses on Academic Performance, Aspirations, and Dropout among Junior High School Students in Rural China. *Economic Development and Cultural Change, 68*(2), 335–355. https://doi.org/10.1086/700631

Omidyar Network. (2019). *Scaling Access and Impact Indonesia Report.* https://assets.imaginablefutures.com/media/documents/Scaling_Access_and_Impact_Indonesia_Report_vFinal_r.pdf

Patrinos, H. A., Vegas, E., & Carter-Rau, R. (2022). *An Analysis of COVID-19 Student Learning Loss.* https://doi.org/10.1596/1813-9450-10033

Piper, B., Zuilkowski, S. S., Kwayumba, D., & Strigel, C. (2016). Does technology improve reading outcomes? Comparing the effectiveness and cost-effectiveness of ICT interventions for early grade reading in Kenya. *International Journal of Educational Development, 49,* 204–214. https://doi.org/10.1016/j.ijedudev.2016.03.006

Popova, A., Evans, D. K., & Arancibia, V. (2016). *Training Teachers on the Job. World Bank Policy Research Working Paper.* https://openknowledge.worldbank.org/server/api/core/bitstreams/54a97576-f662-51c8-b702-e5a6be49f993/content

Pritchett, L., & Sandefur, J. (2013). *Context Matters for Size: Why External Validity Claims and Development Practice Don't Mix* (SSRN Scholarly Paper No. 2364580). https://doi.org/10.2139/ssrn.2364580

Project ID. *What is DELIMa? Malaysia's Rocketing Online Education.* (2020, July 14). https://project-id.org/blog/2020/7/13/what-is-delima-malaysias-rocketing-online-education

Radhakrishnan, K., Sabarwal, S., Sharma, U., Cullen, C., Crossley, C., Letsomo, T., & Angrist, N. (2021). Remote Learning: Evidence from Nepal during COVID-19. World Bank Policy Brief. https://www.researchgate.net/profile/Uttam-Sharma-4/publication/353549026_Remote_Learning_Evidence_from_Nepal_during_COVID-19/links/610279e91e95fe241a96945c/Remote-Learning-Evidence-from-Nepal-during-COVID-19.pdf

Schady, N., Holla, A., Sabarwal, S., Silva, J., & Yi Chang, A. (2023). *Collapse and Recovery: How the COVID-19 Pandemic Eroded Human Capital and What to Do about it.* World Bank. https://doi.org/10.1596/978-1-4648-1901-8

Sedlmeier, P. (2001). Intelligent Tutoring Systems. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 7674–7678). Pergamon. https://doi.org/10.1016/B0-08-043076-7/01618-1

Sheen, K. A., & Luximon, Y. (2021). Effect of in-app components, medium, and screen size of electronic textbooks on reading performance, behavior, and perception. *Displays, 66,* 101986. https://doi.org/10.1016/j.displa.2021.101986

Sylvia, S., Luo, R., Zhang, L., Shi, Y., Medina, A., & Rozelle, S. (2013). Do you get what you pay for with school-based health programs? Evidence from a child nutrition experiment in rural China. *Economics of Education Review, 37*, 1–12. https://doi.org/10.1016/j.econedurev.2013.07.003

Trucano, M. (2013). *The Matthew Effect in Educational Technology.* https://blogs.worldbank.org/edutech/matthew-effect-educational-technology

UNESCO (2021). AI and education: Guidance for policy-makers. Retrieved June 16, 2023, from https://unesdoc.unesco.org/ark:/48223/pf0000376709

UNICEF East Asia and Pacific. (n.d.). Education for Every Ability. Retrieved March 31, 2023, from https://www.unicef.org/eap/reports/education-every-ability

UNICEF East Asia and Pacific. (2020). *Regaining confidence after school closures.* Retrieved March 31, 2023, from https://www.unicef.org/eap/stories/regaining-confidence-after-school-closures

Van Klaveren, C., Vonk, S., & Cornelisz, I. (2017). The effect of adaptive versus static practicing on student learning—Evidence from a randomized field experiment. *Economics of Education Review, 58,* 175–187. https://doi.org/10.1016/j.econedurev.2017.04.003

Vanbecelaere, S., Van den Berghe, K., Cornillie, F., Sasanguie, D., Reynvoet, B., & Depaepe, F. (2020). The effectiveness of adaptive versus non-adaptive learning with digital educational games. *Journal of Computer Assisted Learning, 36*(4), 502–513. https://doi.org/10.1111/jcal.12416

Vivalt, E. (2020). How Much Can We Generalize From Impact Evaluations? *Journal of the European Economic Association, 18*(6), 3045–3089. https://doi.org/10.1093/jeea/jvaa019

WHO & UNICEF. (2022). *Global Report on Assistive Technology.* https://www.unicef.org/reports/global-report-assistive-technology

Wilichowski, T., & Cobo, C. (2021). Considering an adaptive learning system? A roadmap for policymakers. https://blogs.worldbank.org/education/considering-adaptive-learning-system-roadmap-policymakers

Wong, Ho Lun; Shi, Yaojiang; Luo, Renfu, Zhang, Linxiu and Rozelle, Scott (2014). *Improving the Health and Education of Elementary Schoolchildren in Rural China: Iron Supplementation Versus Nutritional Training for Parents: The Journal of Development Studies: Vol 50, No 4.* (n.d.). Retrieved April 25, 2023, from https://www.tandfonline.com/doi/abs/10.1080/00220388.2013.866223

World Bank. (2020). *Realizing the Future of Learning: From Learning Poverty to Learning For Everyone, Everywhere.* https://documents1.worldbank.org/curated/en/250981606928190510/pdf/Realizing-the-Future-of-Learning-From-Learning-Poverty-to-Learning-for-Everyone-Everywhere.pdf

World Bank. (2020). *Pivoting to Inclusion: Leveraging Lessons from the COVID-19 Crisis for Learners with Disabilities*. Retrieved March 31, 2023, from https://www.worldbank.org/en/topic/disability/publication/pivoting-to-inclusion-leveraging-lessons-from-the-c-ovid-19-crisis-for-learners-with-disabilities

World Bank. (2021). *Reimagining Human Connections: Technology and Innovation in Education at the World Bank*. Retrieved April 25, 2023, from https://documents.worldbank.org/en/publication/documents-reports/documentdetail/829491606860379513/reimagining-human-connections-technology-and-innovation-in-education-at-the-world-bank

World Bank. (2023) *Cost-Effective Approaches to Improve Global Learning*. Retrieved June 16, 2023, from https://thedocs.worldbank.org/en/doc/231d98251cf326922518be0cbe306fdc-0200022023/related/GEEAP-Report-Smart-Buys-2023-final.pdf

World Bank. (2023). *Disability Inclusion Overview*. Retrieved March 31, 2023, from https://www.worldbank.org/en/topic/disability

World Bank. (2023). *The Invisible Toll of COVID-19 on Learning.* https://documents1.worldbank.org/curated/en/099062323023530087/pdf/P179556020fd80030087730cbc843df07de.pdf

World Health Organization. (2022). *Global Report on Assistive Technology.* (n.d.). Retrieved March 31, 2023, from https://www.who.int/publications-detail-redirect/9789240049451

World Health Organization (2023). Disability. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/disability-and-health

Yarrow, N., Khairina, N., Cilliers, J., & Dini, I. (2022). *The Digital Future of Teacher Training in Indonesia.* http://hdl.handle.net/10986/37218

Yarrow, N., Pfutze, T., Yoo, J., & Kim, H. *EdTech in COVID Korea: Learning with Inequality* (World Bank Group Korea Office Innovation and Technology Notes). World Bank. https://thedocs.worldbank.org/en/doc/286e9d2e22dd4122f15249083ca84772-0200022022/original/EdTech-paper-4-29.pdf

Yarrow, N., Pynnonen, L., Song, C., Bhardwaj, R., & Spiezio, M. (forthcoming). *Unmet Needs: Use of Assistive Education Technologies to Support Children with Visual and Hearing Difficulties in the East Asia and Pacific Region.*

Yi, H., Song, Y., Liu, C., Huang, X., Zhang, L., Bai, Y., Ren, B., Shi, Y., Loyalka, P., Chu, J., & Rozelle, S. (2015). Giving kids a head start: The impact and mechanisms of early commitment of financial aid on poor students in rural China. *Journal of Development Economics, 113,* 1–15. https://doi.org/10.1016/j.jdeveco.2014.11.002

Zhang, L., Lai, F., Pang, X., Yi, H., & Rozelle, S. (2013). The impact of teacher training on teacher and student outcomes: Evidence from a randomised experiment in Beijing migrant schools. *Journal of Development Effectiveness, 5*(3), 339–358.

Zhang, S. (2020, October 27). GET2020. Breaking Down Dual–Teacher Model's Prospect Driven by National Distance Learning. JMDEDU. https://en.jmdedu.com/Article/542

Zilz, W., & Pang, Y. (2021). Application of assistive technology in inclusive classrooms. Disability and Rehabilitation: Assistive Technology, 16(7), 684–686. https://doi.org/10.1080/17483107.2019.1695963

Annex 1

Annex Table 1 List of Included Studies for Figure 1

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Sean et al. (2013)	Sean Sylvia, Renfu Luo, Linxiu Zhang, Yaojiang Shi, Alexis Medina, Scott Rozelle. 2013. Do you get what you pay for with school-based health programs? Evidence from a child nutrition experiment in rural China, Economics of Education Review, Volume 37, Pages 1–12, ISSN 0272-7757, https://doi.org/10.1016/j.econedurev.2013.07.003.	Non-tech	–0.11	0.16
Chen et al. (2010)	Xinxin Chen, Chengfang Liu, Linxiu Zhang, Yaojiang Shi, Scott Rozelle. 2010. Does taking one step back get you two steps forward? Grade retention and school performance in poor areas in rural China, International Journal of Educational Development, Volume 30, Issue 6, Pages 544–559, ISSN 0738-0593, https://doi.org/10.1016/j.ijedudev.2009.12.002.	Non-tech	–0.10	0.05
Loyalka et al. (2013)	Prashant Loyalka, Chengfang Liu, Yingquan Song, Hongmei Yi, Xiaoting Huang, Jianguo Wei, Linxiu Zhang, Yaojiang Shi, James Chu, Scott Rozelle. 2013. Can information and counseling help students from poor rural areas go to high school? Evidence from China, Journal of Comparative Economics, Volume 41, Issue 4, Pages 1012–1025, ISSN 0147-5967, https://doi.org/10.1016/j.jce.2013.06.004.	Non-tech	–0.07	0.09
Mo et al. (2020)	Mo, D., Bai, Y., Shi, Y., Abbey, C., Zhang, L., Rozelle, S., & Loyalka, P. (2020). Institutions, implementation, and program effectiveness: Evidence from a randomized evaluation of computer-assisted learning in rural China. Journal of Development Economics, 146, 102487. https://doi.org/10.1016/j.jdeveco.2020.102487.	EdTech	–0.07	0.14
Ma et al. (forthcoming)	Ma, Yue., Zhang, Markus., Rule, Andrew., Loyalka, Prashant., Wang, Min., Rozelle, Scott. (forthcoming). Adaptive versus Non-Adaptive Computer Assisted Learning: A Mixed-Methods Analysis in Rural China. REAP Working Paper.	EdTech	–0.05	0.07
Barrera-Osorio and Filmer (2015)	Felipe Barrera-Osorio and Deon Filmer. 2015. Incentivizing schooling for learning: Evidence on the impact of alternative targeting approaches. University of Wisconsin Press. DOI: https://doi.org/10.3368/jhr.51.2.0114-6118R1.	Non-tech	–0.04	0.16
Feng et al. (2021)	Feng et al. (2021). The Effectiveness of adaptive computer assisted learning in rural China. REAP Working Paper.	EdTech	–0.04	0.53
Ma et al. (forthcoming)	Ma, Yue., Zhang, Markus., Rule, Andrew., Loyalka, Prashant., Wang, Min., Rozelle, Scott. (forthcoming). Adaptive versus Non-Adaptive Computer Assisted Learning: A Mixed-Methods Analysis in Rural China. REAP Working Paper.	EdTech	–0.03	0.07

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	–0.03	0.12
Kleiman-Weiner et al. (2013)	Max Kleiman-Weiner, Renfu Luo, Linxiu Zhang, Yaojiang Shi, Alexis Medina, Scott Rozelle. 2013. Eggs versus chewable vitamins: Which intervention can increase nutrition and test scores in rural China? China Economic Review, Volume 24, Pages 165–176, ISSN 1043-951X, https://doi.org/10.1016/j.chieco.2012.12.005.	Non-tech	–0.03	0.00
Yi et al. (2015)	Hongmei Yi, Yingquan Song, Chengfang Liu, Xiaoting Huang, Linxiu Zhang, Yunli Bai, Baoping Ren, Yaojiang Shi, Prashant Loyalka, James Chu, Scott Rozelle, 2015. Giving kids a head start: The impact and mechanisms of early commitment of financial aid on poor students in rural China, Journal of Development Economics, Volume 113, Pages 1–15, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2014.11.002.	Non-tech	–0.02	0.12
Loyalka et al. (2013)	Prashant Loyalka, Chengfang Liu, Yingquan Song, Hongmei Yi, Xiaoting Huang, Jianguo Wei, Linxiu Zhang, Yaojiang Shi, James Chu, Scott Rozelle. 2013. Can information and counseling help students from poor rural areas go to high school? Evidence from China, Journal of Comparative Economics, Volume 41, Issue 4, Pages 1012–1025, ISSN 0147-5967, https://doi.org/10.1016/j.jce.2013.06.004.	Non-tech	–0.01	0.09
Feng et al. (2021)	Feng et al. (2021). The Effectiveness of adaptive computer assisted learning in rural China. REAP Working Paper.	EdTech	0.00	0.49
Mo et al. (2016)	Mo,D., Bai, Yu., Boswell, Matthew., Rozelle, Scott. 2016. Evaluating the Effectiveness of Computers as Tutors in China, 3ie Impact Evaluation Report 41. New Delhi: International Initiative for Impact Evaluation (3ie).	EdTech	0.00	0.12
Filmer & Schady (2009)	Filmer, Deon, and Norbert Schady. “School Enrollment, Selection and Test Scores.” Policy Research Working Paper. World Bank, 2009. https://openknowledge.worldbank.org/bitstream/handle/10986/4190/WPS4998.pdf.	Non-tech	0.00	0.12
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.00	0.10
Filmer & Schady (2014)	Filmer, Deon, and Norbert Schady. 2014. The Medium-Term Effects of Scholarships in a Low-Income Country. Journal of Human Resources, Vol. 49, Issue. 3: page: 663–694. DOI: https://doi.org/10.3368/jhr.49.3.663.	Non-tech	0.01	0.11

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Mo et al. (2013)	Mo, Di, Swinnen, Johan, Zhang, Linxiu, Yi, Hongmei Qu, Qinghe, Boswell, Matthew, & Rozelle, Scott. (2013). Can one-to-one computing narrow the digital divide and the educational gap in China? The case of Beijing migrant schools. World Development 46: 14–29.	EdTech	0.01	0.24
Lai et al. (2015)	Lai, Fang, Luo, Renfu, Zhang, Linxiu, Huang, Xinzhe, & Rozelle, Scott (2015). Does computer-assisted learning improve learning outcomes? Evidence from a randomized experiment in migrant schools in Beijing. Economics of Education Review 47: 34–48.	EdTech	0.01	0.10
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.01	0.08
de Ree (2018)	Ree, Joppe de, Karthik Muralidharan, Menno Pradhan, and Halsey Rogers. "Double for Nothing? Experimental Evidence on an Unconditional Teacher Salary Increase in Indonesia*." The Quarterly Journal of Economics 133, no. 2 (May 1, 2018): 993–1039. https://doi.org/10.1093/qje/qjx040.	Non-tech	0.01	0.05
Ma et al. (2020b)	Ma, Yue, Cody Abbey, Derek Hu, Oliver Lee, Weiting Hung, Xinwu Zhang, Chiayuan Chang, Chyi-In Wu, and Scott Rozelle. "The Impact of Computer Assisted Learning on Rural Taiwanese Children: Evidence from a Randomized Experiment." REAP Working Paper, 2020. https://fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/taiwan_o-cal_working_paper_2020oct.pdf.	EdTech	0.02	0.12
Li et al. (2023)	Li, H., Liu, Z., Yang, F., & Yu, L. (2023). The Impact of Computer-Assisted Instruction on Student Performance: Evidence from the Du*al*-Teacher Program. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4360827.	EdTech	0.02	0.36
Wong et al. (2014)	Ho Lun Wong, Yaojiang Shi, Renfu Luo, Linxiu Zhang & Scott Rozelle. 2014. Improving the Health and Education of Elementary Schoolchildren in Rural China: Iron Supplementation Versus Nutritional Training for Parents, The Journal of Development Studies, 50:4, 502–519, DOI: https://doi.org/10.1080/00220388.2013.866223.	Non-tech	0.02	0.10
Filmer & Schady (2009)	Filmer, Deon, and Norbert Schady. "School Enrollment, Selection and Test Scores." Policy Research Working Paper. World Bank, 2009. https://openknowledge.worldbank.org/bitstream/handle/10986/4190/WPS4998.pdf.	Non-tech	0.02	0.12
Luo et al. (2012)	Renfu Luo, Yaojiang Shi, Linxiu Zhang, Chengfang Liu, Scott Rozelle, Brian Sharbono, Ai Yue, Qiran Zhao and Reynaldo Martorell. 2012. Nutrition and Educational Performance in Rural China's Elementary Schools: Results of a Randomized Control Trial in Shaanxi Province. Economic Development and Cultural Change, Vol. 60, No. 4 (July 2012), pp. 735–772.	Non-tech	0.02	0.07

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Yamauchi (2014)	FUTOSHI YAMAUCHI. 2014. An alternative estimate of school-based management impacts on students' achievements: evidence from the Philippines. Journal of Development Effectiveness, Vol. 6, No. 2, 97–110, http://dx.doi.org/10.1080/19439342.2014.906485.	Non-tech	0.03	0.14
Mo et al. (2014b)	Mo, Di, Renfu Luo, Chengfang Liu, Huiping Zhang, Linxiu Zhang, Alexis Medina, and Scott Rozelle. Text Messaging and Its Impacts on the Health and Education of the Poor: Evidence from a Field Experiment in Rural China. World Development 64 (December 1, 2014): 766–80. https://doi.org/10.1016/j.worlddev.2014.07.015.	EdTech	0.03	0.16
Mo et al. (2016)	Mo,D., Bai, Yu., Boswell, Matthew., Rozelle, Scott. 2016. Evaluating the Effectiveness of Computers as Tutors in China, 3ie Impact Evaluation Report 41. New Delhi: International Initiative for Impact Evaluation (3ie).	EdTech	0.03	0.10
Ma et al. (2020a)	Ma, Yue, Fairlie, Robert. W., Loyalka, Prashant, Rozelle, Scott, & National Bureau of Economic Research (2020). Isolating the "tech" from EdTech: Experimental evidence on computer assisted learning in China. NBER Working Paper No. 26953. National Bureau of Economic Research.	EdTech	0.03	0.08
Yi et al. (2018)	Yi, Hongmei, Di Mo, Huan Wang, Qiufeng Gao, Yaojiang Shi, Paiou Wu, Cody Abbey, and Scott Rozelle. "Do Resources Matter? Effects of an In-Class Library Project on Student Independent Reading Habits in Primary Schools in Rural China." Reading Research Quarterly 54, no. 3 (July 2019): 383–411. https://doi.org/10.1002/rrq.238.	Non-tech	0.03	0.84
Filmer & Schady (2014)	Filmer, Deon, and Norbert Schady. 2014. The Medium-Term Effects of Scholarships in a Low-Income Country. Journal of Human Resources, Vol. 49, Issue. 3: page: 663–694. DOI: https://doi.org/10.3368/jhr.49.3.663.	Non-tech	0.03	0.12
Luo et al. (2012)	Renfu Luo, Yaojiang Shi, Linxiu Zhang, Chengfang Liu, Scott Rozelle, Brian Sharbono, Ai Yue, Qiran Zhao and Reynaldo Martorell. 2012. Nutrition and Educational Performance in Rural China's Elementary Schools: Results of a Randomized Control Trial in Shaanxi Province. Economic Development and Cultural Change, Vol. 60, No. 4 (July 2012), pp. 735–772.	Non-tech	0.03	0.01
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.04	0.12
Bai et al. (2016)	Bai, Yu, Mo, Di, Zhang, Linxiu., Boswell, Matthew, & Rozelle, Scott. (2016). The impact of integrating ICT with teaching: Evidence from a randomized controlled trial in rural schools in China. Computers & Education 96, 1–14.	EdTech	0.05	0.08

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Macdonald et al. (2017)	Macdonald, Kevin Alan David, Sally Ann Brinkman, Wendy Jarvie, Myrna Machuca-Sierra, Kristen Andrew Mcdonall, Siosiana Tapueluelu, and Binh Thanh Vu. "Pedagogy versus School Readiness: The Impact of a Randomized Reading Instruction Intervention and Community-Based Playgroup Intervention on Early Grade Reading Outcomes in Tonga." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, January 18, 2017. https://papers.ssrn.com/abstract=2901756.	Non-tech	0.05	0.06
Sean et al. (2013)	Sean Sylvia, Renfu Luo, Linxiu Zhang, Yaojiang Shi, Alexis Medina, Scott Rozelle. 2013. Do you get what you pay for with school-based health programs? Evidence from a child nutrition experiment in rural China, Economics of Education Review, Volume 37, Pages 1–12, ISSN 0272-7757, https://doi.org/10.1016/j.econedurev.2013.07.003.	Non-tech	0.05	0.17
Hasan et al. (2019)	Hasan, Amer, Haeil Jung, Angela Kinnell, Amelia Maika, Nozomi Nakajima, and Menno Pradhan. "Understanding the Longer-Term Impact of Improving Access to Preschool Education in Rural Indonesia." Policy Research Working Paper. World Bank, 2019. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3490314.	Non-tech	0.05	0.12
Yamauchi (2014)	FUTOSHI YAMAUCHI. 2014. An alternative estimate of school-based management impacts on students' achievements: evidence from the Philippines. Journal of Development Effectiveness, Vol. 6, No. 2, 97–110, http://dx.doi.org/10.1080/19439342.2014.906485.	Non-tech	0.05	0.13
Yamauchi (2014)	FUTOSHI YAMAUCHI. 2014. An alternative estimate of school-based management impacts on students' achievements: evidence from the Philippines. Journal of Development Effectiveness, Vol. 6, No. 2, 97–110, http://dx.doi.org/10.1080/19439342.2014.906485.	Non-tech	0.06	0.12
Lai et al. (2016)	Lai, Fang, Zhang, Linxiu, Bai, Yu, Liu, Chengfang, Shi, Yaojiang, Chang, Fang, & Rozelle, Scott (2016). More is not always better: evidence from a randomised experiment of computer-assisted learning in rural minority schools in Qinghai. Journal of Development Effectiveness 8, no. 4: 449–472.	EdTech	0.06	0.18
Ma et al. (2020a)	Ma, Yue, Fairlie, Robert. W., Loyalka, Prashant, Rozelle, Scott, & National Bureau of Economic Research (2020). Isolating the "tech" from EdTech: Experimental evidence on computer assisted learning in China. NBER Working Paper No. 26953. National Bureau of Economic Research.	EdTech	0.06	0.08
Brinkman et al. (2017)	Brinkman, Sally Anne, Amer Hasan, Haeil Jung, Angela Kinnell, and Menno Pradhan. "The Impact of Expanding Access to Early Childhood Education Services in Rural Indonesia." Journal of Labor Economics 35, no. S1 (July 2017): S305–35. https://doi.org/10.1086/691278.	Non-tech	0.06	0.12

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Abeberese et al. (2014)	Ama Baafra Abeberese, Todd J. Kumler, Leigh L. Linden. 2014. Improving Reading Skills by Encouraging Children to Read in School: A Randomized Evaluation of the Sa Aklat Sisikat Reading Program in the Philippines. NBER Working Paper.	Non-tech	0.06	0.06
Yamauchi (2014)	FUTOSHI YAMAUCHI. 2014. An alternative estimate of school-based management impacts on students' achievements: evidence from the Philippines. Journal of Development Effectiveness, Vol. 6, No. 2, 97–110, http://dx.doi.org/10.1080/19439342.2014.906485.	Non-tech	0.07	0.14
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.07	0.09
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Non-tech	0.07	0.08
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.07	0.09
Mo et al. (2016)	Mo,D., Bai, Yu., Boswell, Matthew., Rozelle, Scott. 2016. Evaluating the Effectiveness of Computers as Tutors in China, 3ie Impact Evaluation Report 41. New Delhi: International Initiative for Impact Evaluation (3ie).	EdTech	0.08	0.08
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.08	0.13
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.08	0.12
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.08	0.11
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.08	0.10

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Blended	0.09	0.08
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Non-tech	0.09	0.08
Lai et al. (2016)	Lai, Fang, Zhang, Linxiu, Bai, Yu, Liu, Chengfang, Shi, Yaojiang, Chang, Fang, & Rozelle, Scott (2016). More is not always better: evidence from a randomised experiment of computer-assisted learning in rural minority schools in Qinghai. Journal of Development Effectiveness 8, no. 4: 449–472.	EdTech	0.10	0.14
Wong et al. (2014)	Ho Lun Wong, Yaojiang Shi, Renfu Luo, Linxiu Zhang & Scott Rozelle. 2014. Improving the Health and Education of Elementary Schoolchildren in Rural China: Iron Supplementation Versus Nutritional Training for Parents, The Journal of Development Studies, 50:4, 502–519, DOI: https://doi.org/10.1080/00220388.2013.866223.	Non-tech	0.10	0.10
Hasan et al. (2019)	Hasan, Amer, Haeil Jung, Angela Kinnell, Amelia Maika, Nozomi Nakajima, and Menno Pradhan. "Understanding the Longer-Term Impact of Improving Access to Preschool Education in Rural Indonesia." Policy Research Working Paper. World Bank, 2019. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3490314.	Non-tech	0.10	0.12
Li et al. (2023)	Li, H., Liu, Z., Yang, F., & Yu, L. (2023). The Impact of Computer-Assisted Instruction on Student Performance: Evidence from the Du*al*-Teacher Program. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4360827.	EdTech	0.10	0.28
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Blended	0.11	0.06
Lai et al. (2013)	Fang Lai , Linxiu Zhang , Xiao Hu , Qinghe Qu , Yaojiang Shi , Yajie Qiao ,Matthew Boswell, Scott Rozelle (2013) Computer assisted learning as extracurricular tutor? Evidence from a randomised experiment in rural boarding schools in Shaanxi, Journal of Development Effectiveness, 5:2, 208–231, DOI: https://doi.org/10.1080/19439342.2013.780089.	EdTech	0.12	0.12
Yang et al. (2013)	Yihua Yang, Linxiu Zhang, Junxia Zeng, Xiaopeng Pang, Fang Lai, Scott Rozelle, Computers and the academic performance of elementary school-aged girls in China's poor communities, Computers & Education, Volume 60, Issue 1, 2013, Pages 335–346, ISSN 0360-1315, https://doi.org/10.1016/j.compedu.2012.08.011.	EdTech	0.12	0.10

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Kleiman-Weiner et al. (2013)	Max Kleiman-Weiner, Renfu Luo, Linxiu Zhang, Yaojiang Shi, Alexis Medina, Scott Rozelle. 2013. Eggs versus chewable vitamins: Which intervention can increase nutrition and test scores in rural China? China Economic Review, Volume 24, Pages 165–176, ISSN 1043-951X, https://doi.org/10.1016/j.chieco.2012.12.005.	Non-tech	0.12	0.00
Zhang et al. (2013)	Linxiu Zhang, Fang Lai, Xiaopeng Pang, Hongmei Yi & Scott Rozelle (2013). The impact of teacher training on teacher and student outcomes: evidence from a randomised experiment in Beijing migrant schools, Journal of Development Effectiveness, 5:3, 339–358, DOI: https://doi.org/10.1080/19439342.2013.807862.	Non-tech	0.12	0.41
Yamauchi and Liu (2013)	FUTOSHI YAMAUCHI and YANYAN LIU. 2013. Impacts of an Early Stage Education Intervention on Students' Learning Achievement: Evidence from the Philippines. Journal of Development Studies, Vol. 49, No. 2, 208–222.	Non-tech	0.12	0.04
Brinkman et al. (2017)	Brinkman, Sally Anne, Amer Hasan, Haeil Jung, Angela Kinnell, and Menno Pradhan. 2017. "The Impact of Expanding Access to Early Childhood Education Services in Rural Indonesia." Journal of Labor Economics 35, no. S1: S305–35. https://doi.org/10.1086/691278.	Non-tech	0.13	0.14
Abeberese et al. (2014)	Ama Baafra Abeberese, Todd J. Kumler, Leigh L. Linden. 2014. Improving Reading Skills by Encouraging Children to Read in School: A Randomized Evaluation of the Sa Aklat Sisikat Reading Program in the Philippines. NBER Working Paper.	Non-tech	0.13	0.10
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.13	0.20
Mo et al. (2014b)	Mo, Di, Renfu Luo, Chengfang Liu, Huiping Zhang, Linxiu Zhang, Alexis Medina, and Scott Rozelle. Text Messaging and Its Impacts on the Health and Education of the Poor: Evidence from a Field Experiment in Rural China. World Development 64 (December 1, 2014): 766–80. https://doi.org/10.1016/j.worlddev.2014.07.015.	EdTech	0.14	0.14
Yang et al. (2013)	Yihua Yang, Linxiu Zhang, Junxia Zeng, Xiaopeng Pang, Fang Lai, Scott Rozelle, Computers and the academic performance of elementary school-aged girls in China's poor communities, Computers & Education, Volume 60, Issue 1, 2013, Pages 335–346, ISSN 0360-1315, https://doi.org/10.1016/j.compedu.2012.08.011.	EdTech	0.14	0.08
Nie et al. (2020)	Nie, J., Pang, X., Wang, L., Rozelle, S., & Sylvia, S. (2020). Seeing Is Believing: Experimental Evidence on the Impact of Eyeglasses on Academic Performance, Aspirations, and Dropout among Junior High School Students in Rural China. Economic Development and Cultural Change, 68(2), 335–355. https://doi.org/10.1086/700631.	Non-tech	0.14	0.15

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.15	0.13
Lai et al. (2015)	Lai, Fang, Luo, Renfu, Zhang, Linxiu, Huang, Xinzhe, & Rozelle, Scott (2015). Does computer-assisted learning improve learning outcomes? Evidence from a randomized experiment in migrant schools in Beijing. Economics of Education Review 47: 34–48.	EdTech	0.15	0.08
Mo et al. (2020)	Mo, Di, Bai, Yu, Shi, Yaojiang, Abbey, Cody, Zhang, Linxiu, Rozelle, Scott, & Loyalka, Prashant (2020). Institutions, implementation, and program effectiveness: Evidence from a randomized evaluation of computer-assisted learning in rural China. Journal of Development Economics 146: 102487.	EdTech	0.16	0.14
Mo et al. (2014a)	Mo, Di, Zhang, Linxiu, Luo, Renfu, Qu, Qinghe, Huang, Weiming, Wang, Jiafu, Qiao, Yajie, Boswell, Matthew, & Rozelle, Scott (2014). Integrating computer-assisted learning into a regular curriculum: Evidence from a randomised experiment in rural schools in Shaanxi. Journal of Development Effectiveness 6(3): 300–323.	EdTech	0.16	0.12
Loyalka et al. (2019)	Prashant Loyalka, Sean Sylvia, Chengfang Liu, James Chu, Yaojiang Shi. 2019. Pay by Design: Teacher Performance Pay Design and the Distribution of Student Achievement. Journal of Labor Economics, Vol. 37, Number 3. DOI: https://doi.org/10.1086/702625.	Non-tech	0.17	0.12
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Blended	0.17	0.08
Mo et al. (2013)	Mo, Di, Swinnen, Johan, Zhang, Linxiu, Yi, Hongmei Qu, Qinghe, Boswell, Matthew, & Rozelle, Scott. (2013). Can one-to-one computing narrow the digital divide and the educational gap in China? The case of Beijing migrant schools. World Development 46: 14–29.	EdTech	0.17	0.20
Fafchamps & Mo (2018)	Fafchamps, Marcel & Di Mo (2018). Peer effects in computer assisted learning: evidence from a randomized experiment. Experimental Economics 21: 355–382. https://doi.org/10.1007/s10683-017-9538-z.	EdTech	0.17	0.18
Barrera-Osorio and Filmer (2015)	Felipe Barrera-Osorio and Deon Filmer. 2015. Incentivizing schooling for learning: Evidence on the impact of alternative targeting approaches. University of Wisconsin Press. DOI: https://doi.org/10.3368/jhr.51.2.0114-6118R1.	Non-tech	0.17	0.18

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Zhang et al. (2013)	Linxiu Zhang, Fang Lai, Xiaopeng Pang, Hongmei Yi & Scott Rozelle (2013). The impact of teacher training on teacher and student outcomes: evidence from a randomised experiment in Beijing migrant schools, Journal of Development Effectiveness, 5:3, 339–358, DOI: https://doi.org/10.1080/19439342.2013.807862.	Non-tech	0.17	0.45
Mo et al. (2016)	Mo,D., Bai, Yu., Boswell, Matthew., Rozelle, Scott. 2016. Evaluating the Effectiveness of Computers as Tutors in China, 3ie Impact Evaluation Report 41. New Delhi: International Initiative for Impact Evaluation (3ie).	EdTech	0.18	0.12
Bianchi et al. (2022)	Nicola Bianchi, Yi Lu, Hong Song, The effect of computer-assisted learning on students' long-term development, Journal of Development Economics, Volume 158, 2022, 102919, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2022.102919.	EdTech	0.18	0.16
Yang et al. (2013)	Yihua Yang, Linxiu Zhang, Junxia Zeng, Xiaopeng Pang, Fang Lai, Scott Rozelle, Computers and the academic performance of elementary school-aged girls in China's poor communities, Computers & Education, Volume 60, Issue 1, 2013, Pages 335–346, ISSN 0360-1315, https://doi.org/10.1016/j.compedu.2012.08.011.	EdTech	0.19	0.14
Lai et al. (2016)	Lai, Fang, Zhang, Linxiu, Bai, Yu, Liu, Chengfang, Shi, Yaojiang, Chang, Fang, & Rozelle, Scott (2016). More is not always better: evidence from a randomised experiment of computer-assisted learning in rural minority schools in Qinghai. Journal of Development Effectiveness 8, no. 4: 449–472.	EdTech	0.19	0.12
Chen et al. (2013)	Chen, X., Shi, Y., Yi, H., Zhang, L., Mo, D., Chu, J., Loyalka, P., & Rozelle, S. (2013). The Impact of a Senior High School Tuition Relief Program on Poor Junior High School Students in Rural China. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2374361.	Non-tech	0.19	0.12
Gaduh et al. (2020)	Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. Research on Improving Systems of Education (RISE). https://doi.org/10.35489/BSG-RISE-WP_2020/035.	Blended	0.20	0.08
Tang et al. (2018)	Tang, Bin, Te-Tien Ting, Chyi-In Wu, Yue Ma, Di Mo, Wei-Ting Hung, and Scott Rozelle. "The Impact of Online Computer Assisted Learning at Home for Disadvantaged Children in Taiwan: Evidence from a Randomized Experiment." Sustainability 12, no. 23 (January 2020): 10092. https://doi.org/10.3390/su122310092.	EdTech	0.20	0.16
Lai et al. (2015)	Lai, Fang, Luo, Renfu, Zhang, Linxiu, Huang, Xinzhe, & Rozelle, Scott (2015). Does computer-assisted learning improve learning outcomes? Evidence from a randomized experiment in migrant schools in Beijing. Economics of Education Review 47: 34–48.	EdTech	0.20	0.14

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Fafchamps & Mo (2018)	Fafchamps, Marcel & Di Mo (2018). Peer effects in computer assisted learning: evidence from a randomized experiment. Experimental Economics 21: 355–382. https://doi.org/10.1007/s10683-017-9538-z.	EdTech	0.20	0.25
Lai et al. (2015)	Lai, Fang, Luo, Renfu, Zhang, Linxiu, Huang, Xinzhe, & Rozelle, Scott (2015). Does computer-assisted learning improve learning outcomes? Evidence from a randomized experiment in migrant schools in Beijing. Economics of Education Review 47: 34–48.	EdTech	0.22	0.14
Clark et al. (2021)	Clark, Andrew E., Nong, Huifu, Zhu, Hongjia, & Zhu, Rong. (2021). Compensating for academic loss: Online learning and student performance during the covid-19 pandemic. China Economic Review: 101629.	EdTech	0.22	0.02
Bianchi et al. (2022)	Nicola Bianchi, Yi Lu, Hong Song, The effect of computer-assisted learning on students' long-term development, Journal of Development Economics, Volume 158, 2022, 102919, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2022.102919.	EdTech	0.23	0.13
Lai et al. (2016)	Lai, Fang, Zhang, Linxiu, Bai, Yu, Liu, Chengfang, Shi, Yaojiang, Chang, Fang, & Rozelle, Scott (2016). More is not always better: evidence from a randomised experiment of computer-assisted learning in rural minority schools in Qinghai. Journal of Development Effectiveness 8, no. 4: 449–472.	EdTech	0.23	0.14
Chen et al. (2020)	Chen, G., Chan, C. K. K., Chan, K. K. H., Clarke, S. N., & Resnick, L. B. (2020). Efficacy of video-based teacher professional development for increasing classroom discourse and student learning. Journal of the Learning Sciences, 29(4–5), 642–680. https://doi.org/10.1080/10508406.2020.1783269.	Blended	0.24	0.03
Glewwe et al. (2016)	Paul Glewwe, Albert Park, Meng Zhao, 2016. A better vision for development: Eyeglasses and academic performance in rural primary schools in China, Journal of Development Economics, Volume 122, Pages 170–182, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2016.05.007.	Non-tech	0.26	0.22
Mo et al. (2015) combined	Mo, Di., Zhang, Linxiu, Wang, J., Huang, Wang, Shi, Yaojiang., Boswell, Matthew., & Rozelle, Scott. (2015). Persistence of learning gains from computer assisted learning: Experimental evidence from China. Journal of Computer Assisted Learning 31(6), 562–581.	EdTech	0.26	0.16
Glewwe et al. (2016)	Paul Glewwe, Albert Park, Meng Zhao, 2016. A better vision for development: Eyeglasses and academic performance in rural primary schools in China, Journal of Development Economics, Volume 122, Pages 170–182, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2016.05.007.	Non-tech	0.27	0.24

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Lee et al. (2023)	Lee, S., Lee, J.-H., & Jeong, Y. (2023). The Effects of Digital Textbooks on Students' Academic Performance, Academic Interest, and Learning Skills. Journal of Marketing Research, 0(0). https://doi.org/10.1177/00222437221130712.	EdTech	0.28	0.33
Macdonald et al. (2017)	Macdonald, Kevin Alan David, Sally Ann Brinkman, Wendy Jarvie, Myrna Machuca-Sierra, Kristen Andrew Mcdonall, Siosiana Tapueluelu, and Binh Thanh Vu. "Pedagogy versus School Readiness: The Impact of a Randomized Reading Instruction Intervention and Community-Based Playgroup Intervention on Early Grade Reading Outcomes in Tonga." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, January 18, 2017. https://papers.ssrn.com/abstract=2901756.	Non-tech	0.29	0.20
Lee et al. (2023)	Lee, S., Lee, J.-H., & Jeong, Y. (2023). The Effects of Digital Textbooks on Students' Academic Performance, Academic Interest, and Learning Skills. Journal of Marketing Research, 0(0). https://doi.org/10.1177/00222437221130712.	EdTech	0.32	0.37
Zhang et al. (2016)	Zhang, Yiyun, & Zhou, Xinlin. (2016). Building knowledge structures by testing helps children with mathematical learning difficulty. Journal of Learning Disabilities 49(2), 166–175.	EdTech	0.34	0.33
Glewwe et al. (2016)	Paul Glewwe, Albert Park, Meng Zhao, 2016. A better vision for development: Eyeglasses and academic performance in rural primary schools in China, Journal of Development Economics, Volume 122, Pages 170–182, ISSN 0304-3878, https://doi.org/10.1016/j.jdeveco.2016.05.007.	Non-tech	0.41	0.24
Bai et al. (2023)	Yu Bai, Bin Tang, Boya Wang, Di Mo, Linxiu Zhang, Scott Rozelle, Emma Auden, Blake Mandell, Impact of online computer assisted learning on education: Experimental evidence from economically vulnerable areas of China, Economics of Education Review, Volume 94, 2023, 102385, ISSN 0272-7757, https://doi.org/10.1016/j.econedurev.2023.102385.	EdTech	0.48	0.24
Habtamu and Prateek (2018)	Habtamu Fuje, Prateek Tandon. 2018. When do in-service teacher training and books improve student achievement? Experimental evidence from Mongolia. The World Bank Review of Development Economics. DOI: https://doi.org/10.1111/rode.12387.	Non-tech	0.62	0.00
Ito et al. (2019)	Ito, Hirotake, Keiko Kasai, Hiromu Nishiuchi, and Makiko Nakamuro. 2019. "Does Computer-Aided Instruction Improve Children's Cognitive and Non-Cognitive Skills?: Evidence from Cambodia." Discussion papers 19040. Research Institute of Economy, Trade and Industry (RIETI).	EdTech	0.68	0.19

Study	Citation	Intervention Mode	Effect size (adjusted, in S.D.)	95% Confidence Level
Ito et al. (2019)	Ito, Hirotake, Keiko Kasai, Hiromu Nishiuchi, and Makiko Nakamuro. 2019. "Does Computer-Aided Instruction Improve Children's Cognitive and Non-Cognitive Skills?: Evidence from Cambodia." Discussion papers 19040. Research Institute of Economy, Trade and Industry (RIETI).	EdTech	0.76	0.43
Du et al. (2022)	Du, K.; Wang, H.; Ma, Y.; Guan, H.; Rozelle, S.2022. Effect of Eyeglasses on Student Academic Performance: What Matters? Evidence from a Randomized Controlled Trial in China. Int. J. Environ. Res. Public Health 2022, 19, 10923. https://doi.org/10.3390/ijerph191710923.	Non-tech	0.92	0.67
Li et al. (2023)	Li, Haizheng and Liu, Zhiqiang and Yang, Fanzheng and Yu, Li. 2023. The Impact of Computer-Assisted Instruction on Student Performance: Evidence from the Du*al*-Teacher Program. IZA Discussion Paper No. 15944, Available at SSRN: https://ssrn.com/abstract=4360827 or http://dx.doi.org/10.2139/ssrn.4360827.	EdTech	0.98	0.28

Photo: World Bank Flckr