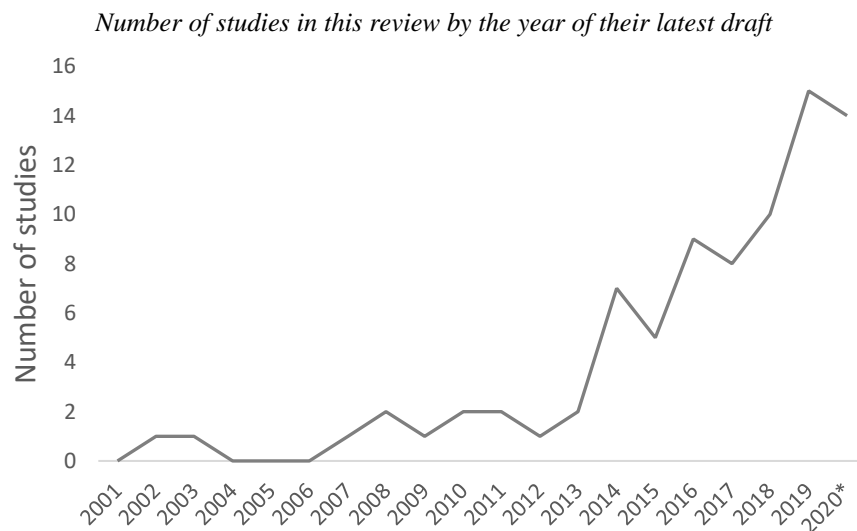


Online Appendix I: Further methodological considerations

1. Other study features which were not part of the inclusion and exclusion criteria

In the spirit of following Escueta et al. (2020) to be as inclusive of high-quality, relevant studies as possible, this review makes the explicit decision to not filter papers by any other criterion not mentioned above. Among the potential filtering criteria that did not play a role in the selection of the core studies, the time of publication is one of the most salient ones: there was no minimum year for the inclusion of a paper in the review, especially given that the oldest study found dates back to only 2002. Since not all studies have been published in an academic journal, the date for each study refers to either the date of publication in a peer-reviewed journal, or the date on the latest draft found for each study. The figure below provides a sense of the temporal distribution of studies: interestingly, the number has increased significantly since 2013, reaching 15 studies only for 2019. This time trend highlights the growing interest in the field of education in developing settings from researchers, and the further need for a compilation of all existing evidence to date.



* The 2020 value is as of September, 2020

Another feature which was not used to filter studies was the targeted outcomes and stakeholders. While 89% of all core studies either only targeted learning outcomes, or had it as one of its main outcomes of interests, there were other important outcomes studied, such as school enrollment, dropout rates, sexual health behaviors, and motivation. Similarly, the review was open to studies targeting all kinds of educational stakeholders. A vast majority of the interventions (83%) were

student-facing and targeted students in grades 1-12, but there were other groups studied included such pre-K students, university students, teachers, civil servants and parents.

Finally, the scale of the technology used did not play a role in the selection of the studies. The studied technology could be a large national rollout requiring large investments such as telesecundarias in Mexico (Navarro-Sola, 2019), or lower-touch text message interventions in Peru such as in Neilson et al. (2018a, 2018b). Similarly, there was no restriction on the sample size for the study, ranging from a few hundred observations like in Pitchford (2015), Mo et al. (2013), or Böhmer et al. (2014), to upwards of 100,000 in an experimental set up such as Neilson et al. (2018b) and almost 900,000 in a quasi-experimental setup (Navarro-Sola, 2019).

2. Search methods

The search for papers that make up the set of core studies was at the forefront of the evidence-gathering process for this review. The first round of searches was within repositories of peer-reviewed journals and databases such as EconLit, EconPapers, and Google Scholar, where multiple combinations of words related to the scope of this review¹ were searched. Furthermore, I looked for the same terms in the AEA Trial Registry for any trials that may have finished already. Next, I looked in the working paper repositories of well-known organizations that routinely produce education-related research as the World Bank, the Interamerican Development Bank, the EdTech Hub, NBER, the RISE Programme, Annenberg Institute, J-PAL, and IPA. I also used back- and forward tracing of citations from four highly cited and/or comprehensive papers: Muralidharan et al. (2019), Sampson et al. (2019), Escueta et al. (2020), Evans and Mendez Acosta (2020), and World Bank (2018). After identifying an initial set of papers through these methods, I forward-traced papers through the literature review sections of these papers, and the papers that they cite. I then backward-tracked, i.e. searched other papers that cited these studies, each of these papers through the Google Scholar feature for this process (“Cited by”). After completing this process, I iterated through the process of back- and forward-tracing papers until no additional papers were located. While there is no guarantee that all studies that meet the four main criteria are included in the set of core studies, great lengths were covered to ensure that the review was as extensive as possible.

¹ The actual terms searched were “EdTech”, “ed-tech”, “Ed Tech”, “Technology education”, “Technology in education”, “ICT in education”, “SMS education”, “Computers education”, “Laptops education”, “Technology instruction”, “Technology school” all by themselves, and then combining them with “developing countries”, “Latin America”, “Africa”, “Sub-Saharan Africa”, and “India”.

Online Appendix II: Non-comprehensive list of upcoming EdTech studies

Table A1: studies with a considerable EdTech component but for which there is no write up publicly available by the time this review was completed

Researchers	Context	Project Title	Intervention	Source
Guilherme Lichand and Sharon Wolf	Côte d'Ivoire	Evaluating the Impact of Text and Audio Messages for Parents and Teachers in Côte d'Ivoire	Text and audio messages for parents either with or without messages to teachers to increase attendance in school.	https://www.poverty-action.org/study/evaluating-impact-text-and-audio-messages-parents-and-teachers-côte-d'ivoire
Emma Näslund-Hadley and Juan Manuel Hernandez Agramonte	Paraguay	The Effects of Interactive Radio Instruction for Science Education in Paraguay	Interactive audio instruction ("IRI") curriculum for early childhood education, particularly in science. Following success of similar project in Math.	https://www.poverty-action.org/study/effects-interactive-radio-instruction-science-education-paraguay
Juan Manuel Hernandez Agramonte and Mercedes Mateo-Berganza	Uruguay	The Impact of Text-Message Nudges on Preschool Attendance in Uruguay	Behaviorally-informed SMS messages to parents informing them of the importance of early childhood education to encourage preschool attendance.	https://www.poverty-action.org/study/impact-text-message-nudges-preschool-attendance-uruguay
Emma Näslund-Hadley, Juan Manuel Hernandez Agramonte, and Elena Arias Ortiz	Costa Rica	Using a Robot to Improve Young Children's Math and Programming Skills in Costa Rica	The Pensalo program introduces an intelligent robot named "Albert" that 4 and 5 year old students program by scanning a series of flash cards with instructions that use mathematical and numerical concepts.	https://www.poverty-action.org/study/using-robot-improve-young-children's-math-and-programming-skills-costa-rica
Emma Näslund-Hadley and Juan Manuel Hernandez Agramonte	Colombia	The Effects of a Multimedia Preschool STEM Education Program in Colombia	The program includes a web series, computer games, and interactive posters that teach children STEM-related concepts, and is facilitated by "community mothers through teaching guide, video tutorials, and a structured lesson plan on 4-5 year olds.	https://www.poverty-action.org/study/effects-multimedia-preschool-stem-education-program-colombia
Bruno Ferman, Lycia Lima, Flávio Riva	Brazil	The Impact of Automated Writing Evaluation on Learning and Access to College in Brazil	Evaluation of whether programs using natural language processing, and machine-learning algorithm to score and comment on essays can improve learning and increase access to college for secondary students in public schools in Brazil.	https://www.povertyactionlab.org/evaluation/impact-automated-writing-evaluation-learning-and-access-college-brazil
Bruno Crépon, Igor Asanov, Diego d'Andria, Thomas Astebro, Guido Buenstorf, Francisco Flores, Mona Mensmann, Mathis Schulte, David McKenzie	Ecuador	The impact of an online entrepreneurial mindset training for youth in Ecuador	Online-based psychology-based entrepreneurial mindset training paired with either negotiations skills or scientific skills training, and mentoring.	https://www.povertyactionlab.org/evaluation/impact-online-entrepreneurial-mindset-training-youth-ecuador
Adrienne Lucas, Sabrin Beg, and Samantha Sweeney	Pakistan	Screen Time: Tablets with Interactive Textbooks Did Not Increase Learning	Using an RCT among grade 6 students in Punjab, Pakistan, we tested the effect of providing tablets with interactive textbooks to students on their achievement in math and science. We found no evidence that the intervention	Information from the authors

			improved test scores 3 months after implementation.	
Alejandro Ganimian, Karthik Muralidharan, and Andy de Barros	India	Do Students Benefit from Personalized Learning? Experimental Evidence from India	Personalized instruction delivered by computer-assisted learning software. Comparison of software that provides only grade-appropriate activities, with fully and partially customized version of program, as well as a remedial version of it.	https://www.socialscien ceregistry.org/trials/2459/history/21859

Online Tables

Online Table 1: summary of studies included within the "Access to technology" category

Study	Intervention	Context	Target grade and outcomes	Sample	Findings	Cost
Angrist and Lavy (2002)	Program "Tomorrow-98". Target student-computer ratio of 10:1 in all schools. Additional teacher training to integrate computers to instruction. Program assignment at the school-level.	Israel	Grades 4 and 8. 122 schools, targeted at elementary and middle schools throughout Israel.	4,779 4th graders, 3,196 8th graders	Grade 4: -0.4 to -0.3 SD in Math, no effects in Hebrew. No effects in grade 8 across most models.	USD 3000 per computer, with 40 computers per school.
Bando et al. (2017)	Replacement of traditional textbooks with laptops. Randomization at school-level.	Honduras	Grades 3 and 6. 271 elementary schools throughout the country.	9,600	No effects.	Net cost of USD 48 per student, per year.
Barrera-Osorio and Linden (2009)	Program "Computadores para Educar". 15 computers per school to support children's language. 20-month long training for teachers. Randomization at school-level.	Colombia	Grades 3-9, 97 public schools with 80 or more students. Six school districts.	5,201	No effects.	Not specified.
Bet et al. (2014)	Propensity score matching groups with similar observable educational inputs but different intensity in computer access.	Peru	Grade 9, 202 schools.	4,897	No effects in math or language, 0.3 SD in digital skills.	Not specified.
Beuermann et al. (2015)	Program "One Laptop per Child". Four laptops, one per student, randomly distributed in each class for use at home. Each computer included applications such as educational games, programming environments, and an encyclopedia. Seven weekly training sessions. Randomization at the student-level within classes in treatment schools.	Peru	Grade 2, 28 schools, Public schools in Lima.	2,734	No effects on achievement level. Increased computer proficiency in treated students.	USD 188 per laptop.
Cardim et al. (2019)	Evaluation of "ProFuturo" intervention. The program includes the distribution of suitcases with tablets, a computer for the teacher and a projector. Randomization at the school-level.	Angola	Grades 4-6. 42 Catholic schools in Luanda.	2,460	No effects in learning, increased familiarity with technology.	Not specified.
Cristia et al. (2010)	ICT regional package including the lay-out of the electrical infrastructure, 10 computers and the installation of a network. These schools entered the Huascarán program and hence, they were assigned an innovation room coordinator, training and standard software. Additionally, the provision of internet access to these schools was prioritized.	Peru	Grades 7-11 (Grades 1-5 secondary school), 350 secondary schools.	18,049	No effects.	Not specified.
Cristia et al. (2017)	Program: "One Laptop per Child". Increased ratio of computers per student from 0.12 to 1.18 in treatment schools. 40-hour teacher training on how to use computers for pedagogical purposes. Randomization at school-level.	Peru	318 schools, 8 rural areas.	2,609	No effects.	USD 200 per laptop.
de Melo et al. (2014)	Program: "Plan Ceibal". One computer per pupil, with data detailing time of delivery of computer to individual, therefore allowing to use a continuous treatment variable (days of exposure). Leveraging different delivery dates, researchers use variation in delivery date across individuals within same school with fixed-effects at individual and school-level.	Uruguay	Grades 3-6, 90 primary schools, nationally.	2,057	No effects in math and reading.	USD 180 per laptop.
Habyarimana and Jack (2018)	A mobile money platform operated a "lock savings account", especially targeted at parents about to incur high educational costs.	Kenya	Parents of children half way into grade 7 (final year of primary). Parents from 337 primary schools in three counties.	4,020	Higher secondary school enrollment by 5-6 p.p. (ITT) or 18-24 p.p. (TOT). Total financial savings increased between three and four times. No effects on test scores.	Not specified, although the lock savings account earns a bonus 1% on top of the 2-5% APR (forfeited if savings are withdrawn beforehand).

Habyarimana and Sabarwal (2018)	Provision of eReaders. Testing the marginal effects of eReaders with instructional material from the pure effect of endowing the student with an eReader. Four experimental groups: a pure control group, a group that only received an eReader with only non-curriculum reading material, a group that received an eReader with non-curriculum material and curriculum textbooks, and a fourth group with all of these previous features, plus supplementary curriculum-relevant material. Randomization performed at the student-level.	Nigeria	Grade 8. Lagos; students came from 214 schools.	497	Overall no significant effects of eReader. Students that received eReaders with curriculum materials and no access to textbooks has large, imprecise effects. eReaders without curriculum material led to a decline in in overall reading and math.	Cost of eReader is USD 80.
Kho et al. (2018)	Impact evaluation of internet access on student performance in the universe of public primary schools in Peru that initially acquired internet between 2007 and 2014. Leverages variation in cohorts impacted, and timing of rollout to schools.	Peru	Grade 2 provides test scores, but policy affected Grades 1-6. 5,903 public primary schools.	218,883	Initial math improvements of 0.042-0.076 SD, growing at a rate of 0.047 SD per year, reaching 0.29 SD 5 years after installation.	Not specified.
Malamud and Pop-Eleches (2011)	Program: "Euro 200 Program". USD 300 Voucher only valid to buy a home computer. Educational software needed to be installed separately, not always installed. Teacher training, 530 multimedia lessons on the use of computers for educational training.	Romania	Grades 1-12. Between 25,051 and 35,484 families received vouchers of program yearly between 2004 and 2008.	3,354	-0.44 SD math GPA, -0.56 SD in Romanian, -0.63 SD in English, higher scores in computer skills test by about 0.33 SD.	USD 300 per voucher plus management cost (not specified).
Malamud et al. (2019)	Three experimental arms: students that received computers with access to high-speed internet, students that received computers without access to high-speed internet, and a pure control group. Lotteries to give away 4 laptops within each class. Computers had standard software and some educational games. Randomization at student-level within classes in treatment schools.	Peru	Grades 3-5, 14 low-achieving public primary schools.	2,126	No effects in learning, cognitive and noncognitive skills. Free internet access led to improved computer and internet proficiency.	Not specified.
Mensch and Haberland (2018)	Program: GirlsRead! Three experimental branches: a pure control branch, a second branch with safe spaces for girls where mentors facilitate an empowerment-based life-skills curriculum and all the activities of the second branch, plus e-readers that girls keep for the duration of the program with approximately 100 books of varying reading levels primarily written by African authors. Randomization at school-level.	Zambia	Grade 6. 36 schools in three districts.	1,299	Reading scores 4.6 p.p. higher in e-reader arm. Three quarter of girls attended all community sessions. Only 2.4% of all e-readers were lost, stolen, or broken.	Not specified.
Meza-Cordero (2017)	Impact evaluation of One-Laptop-per-Child" intervention, using a difference-in-differences estimation strategy, as treatment was not randomly assigned.	Costa Rica	Grades 1-6. 34 schools.	3,174	Increase in time using a computer (to browse internet, do homework, read, and play), decrease of time spent doing homework and outdoor activities; no effects on learning.	USD 225 per student accounting for all costs, USD 209 per computer.
Mo et al. (2013)	Evaluation of One Laptop per Child policy. Randomization at individual-level.	China	Grade 3. 13 schools of migrant children in Beijing.	300	Effects in computer skills of 0.32 SD, 0.17 SD in math, no effects on language.	Not specified.
Navarro-Sola (2019)	Program: Expansion of Mexican Telesecundaria, or schools using televised lessons. The study exploits the staggered rollout of the policy from 1968 to present.	Mexico	Grades 7-9, 3,132 telesecundarias in 2,110 localities.	896,274	For every telesecundaria per 50 children, 10 more children enroll in secondary education, and 2 more pursue further education. Every year of education induced by telesecundaria, increased income by 17.6%.	USD 704 per student per year, including all administrative costs.
Piper et al. (2016)	Four experimental groups: base PRIMR program (early literacy program focused on teacher training, instructional support, and student	Kenya	Grade 2. 80 schools in Kisumu county.	1,580	All treatment arms had positive effects ranging from 0.17-0.29 SD in English, and 0.26-0.32 SD in Kiswahili.	Cost of tablet is USD 150, cost of eReader is USD 70. The cost of the

	learning materials at 1:1 ratio), PRIMR plus a tablet for the teacher to scaffold their instruction, PRIMR for pupils e-readers with age-appropriate textbooks, and a control group. Although there was randomization at the school-level, there were still imbalances in baseline characteristics, so authors prefer a difference-in-differences strategy.				The most effect arm was the basic PRIMR arm.	basic PRIMR program was USD 2.28 per pupil per subject per year.
Pitchford (2015)	Three experimental arms: math tablet intervention, non-math tablet control, and standard face-to-face practice. Intervention lasted 8 weeks, for 30-min per day. The math tablet intervention consisted of four different apps developed by onebillion ^o . Apps based on the National Primary Curriculum Randomization at individual level.	Malawi	Grades 1-3, One medium-sized urban primary school.	318	Positive, and statistically significant effects in math and language. Authors do not provide enough information to translate into SD units.	Not specified.
Seo (2017)	Program: GivePower school program. Six experimental groups: G1 schools received two 0.12 kWh solar home systems including lights and TVs ("facilities"); G2, solar facilities and English videos; G3, solar facilities and bilingual videos; G4, English videos only; G5, bilingual videos only; and control schools.	Tanzania	Grade 11, 164 schools in northern Tanzania. Schools are between the national median (57) and the mean (75) in terms of enrollment.	11,697	Impact of solar-facilities-enabled programs, averaged across video-provision status, to be 0.05 SD on secondary exit exam (across all subjects), and 2.8 p.p on passing rates.	USD 6.41 per student.
Yanguas (2020)	Analysis of long-term effects of "Plan Ceibal", or a one-laptop-per-child in Uruguay (whose short-term results are described in de Melo, et al., 2014). Study leverages cross-cohort variation and it is the first study with long-term, causal estimates of this kind of policy.	Uruguay	Adults exposed to one-laptop-per-child policy as children. All students in public primary and middle schools .	12,775	No effects on educational attainment as an adult. For college-goers, enrollment in the program led to lower likelihood of enrolling in science and technology majors.	Same as in de Melo (2014), et al. USD 180 per laptop.

Notes: All randomized controlled trials indicate the level at which units were randomized. For the full coding and more detailed information on all the core studies included in the review, please see this online [document](#). The statistical significance of the findings stems from what each of the studies reports, and the alpha threshold for significance may vary by disciplinary approach of each paper. Abbreviations: "p.p.": percentage points, "SD": standard deviations.

Online Table 2: summary of studies included within the "Technology-enabled behavioral interventions" category

Study	Intervention	Context	Target grade and outcomes	Sample	Findings	Cost
Adelman et al. (2015)	Directors received a smartphone with a built-in system to allow school directors to send information about the school to a centralized server, including daily photographs of teachers to verify presence. School inspectors could then access the server in real time for efficient supervision.	Haiti	Teachers. 200 public and private primary schools.	2,260	No effects on test scores. The program did not improve management practices such as record keeping either. Low take-up.	Not specified.
Aker and Ksoll (2019)	Treatment consisted of a mobile phone monitoring program, where students, teachers and village chiefs were called on a weekly basis, over a six-week period. No phones or incentives were provided. 140 schools were assigned to an adult education program, and 20 to the pure control group. Among the 140 schools, half were assigned to monitoring. Randomization at village-level.	Niger	Adult learners. 160 villages, stratified by regional, and sub-regional administrative divisions.	1,776 individuals, 160 villages.	Monitoring increased reading by 0.14-0.30 SD, and math by 0.08-0.15 SD. Villages with no monitoring had no effects relative to the pure control villages.	Overall reported cost of mobile monitoring was USD 6.5 per village.
Berkhout et al. (2020)	Impact evaluation of the effect on test scores (implicitly on cheating) of switching to computer-based testing (CBT) for the high-stakes, national examination of junior secondary schools in Indonesia.	Indonesia	Grades 9 and 12. 50,124 junior secondary schools nationally.	353,190 students.	The introduction of computer-based testing (CBT) decreased scores by 0.40 SD, interpreted as a decrease in cheating. However, results become insignificant after two years of the introduction of CBT, suggesting that actual learning had to happen to compensate for the loss in test scores due to the curtailing of cheating.	Not specified.
Berlinski et al. (2016)	Program: "Parents up to date". High-frequency information about their selected child via text message (SMS messages). SMS texts contained specific information on attendance, behavior, and math test scores of each parent's child. Randomization at individual-level, along with share of students treated in each class.	Chile	Grades 4-8. 85 classes in metropolitan area.	1,447	0.08 SD in math after only 4 months. Probability of passing a grade increased by 2.8 percentage points. Increase probability of attending school for more than 85% of the time (threshold needed for grade progression) by more than 6.6 p.p.	Not specified. "Low-cost intervention".
Duflo et al. (2012)	Teacher attendance in treatment schools was monitored using cameras, and their salaries was linked to their attendance. Instructions for one student to take a picture of the teacher at the start and end of the work day. Cameras has tamper-proof date and time functions. Attendance was tracked for 30 months. Randomization at school-level.	India	Teachers. 113 single-teacher non-formal education centers/schools in rural villages of Rajasthan.	113 teachers. 2,230 students at baseline.	Teacher absenteeism fell by 21 percentage points, and test scores increased by 0.17 SD.	Not specified.
Dustan et al. (2019)	SMS campaign to increase civil servants' compliance with maintenance activities. Each SMS contains a fixed and a variable component. The fixed component includes the bureaucrat's first name and the deadline for task compliance. These fixed elements are rooted in behavioral insights. The variable component is the main behavioral lever, which could be a reminder/warning, social norm, monitoring, shaming, auditing threat, or a control condition. Randomization at school-level.	Peru	Civil servants in charge of a school maintenance program. 24,000 schools across Peru.	24,268	Increase of 3.86 p.p. in the probability of submitting an expense report by deadline, no evidence that the SMS campaign affected the quality of most of the infrastructure items.	Total cost of 57,860 SMS was USD 1,273, and the labor costs associated with the programming and sending of the SMS were USD 188 for the full campaign.
Gaduh et al. (2020)	Intervention had three different treatment arms. The first treatment arm provides a scorecard which evaluates the use of a government	Indonesia	Teachers. 270 mostly public schools in 5 districts.	3,832 students, 827 teachers.	Gains across all treatment arms; largest in treatment arm with camera: 0.18 SD in language, 0.20 SD in Math.	USD 40 per student.

	allowance. The second and third treatments added to the first treatment a pay-for-performance scheme that relied on included the first treatment. The second treatment added a camera with a timestamp which made the allowance dependent on teacher presence. The third treatment the payment of the allowance depended on the result of the scorecard. Randomization at school-level.				Camera treatment arm showed positive, imprecise estimates on teacher behavior, working at school, and teaching in class.	
John et al. (2016)	Impact evaluation of an electronic career guidance package for secondary schools, the e-Career Guidance System.	Nigeria	Grade 8, 2 public secondary schools in Akwa Ibom state.	60 students.	Positive effects in vocational and career outcomes. Not enough information to translate gains into SD units.	Not specified.
Neilson et al. (2018a)	Videos and infographics informing about the returns to education at different educational levels. Randomization at the school-level.	Peru	Grades 1-11, but learning outcomes only measured for Grade 8. 2,626 public schools in all department capitals across Peru, and 250 rural schools in Cusco and Arequipa.	Not specified.	Reduction of school dropout in urban areas (after second year of implementation, once take-up of treatment was higher) by 1.8 p.p., or 18.8% of the baseline; in rural areas the reduction was 7.2 p.p. or 50% of the baseline. Effects on math were 0.04 SD, and on reading were 0.03 SD.	At the scale of 25,000 students, authors estimate the cost would be USD 0.06 per student.
Neilson et al. (2018b)	Videos and infographics informing about the returns to education at different educational levels. Randomization was at the school-level, where 1524 schools were selected for treatment.	Dominican Republic	Grades 7-12, 2,469 public schools.	~120,000	Preliminary results show that the informative and persuasive videos both led to decreases in school dropout, and increases in standardized test scores.	Major costs were production and elaboration of the videos (\$104,000).
Riley (2017)	Students watched a film projection of "Queen of Katwe", a movie about a teenage girl from the slums of Kampala, Uganda striving to become a chess master, as a way to change students' beliefs about the importance of education. Randomization at the student-level.	Uganda	Grades 10 and 12, 13 secondary schools in urban Kampala.	1,446	0.11 SD in math for grade 10, 0.13 SD in math for grade 12; 9 percentage points more likely to continue enrolled in secondary school.	USD 5 per student.
Vakis and Farfan (2018)	SMS campaign with potentially useful information for teachers, such as reminders about deadlines, teacher benefits, motivational texts, and occupational wellness. No pure control group, as control group got at least two informative texts, and once on Teachers' day. The teacher's name was in some messages.	Peru	Teachers. 35,000 schools nationally, only teachers that registered for the program.	Experimental sample: 13145 teachers, rolled out nationally to 186,000 teachers.	3 p.p. increase in questions about job satisfaction and motivation. Likely underestimate, given that there was no pure control group.	Each SMS costs USD 0.03.

Notes: All randomized controlled trials indicate the level at which units were randomized. For the full coding and more detailed information on all the core studies included in the review, please see this online [document](#). The statistical significance of the findings stems from what each of the studies reports, and the alpha threshold for significance may vary by disciplinary approach of each paper. Abbreviations: "p.p.": percentage points, "SD": standard deviations.

Online Table 3: summary of studies included within the "Improvements to instruction" category

Study	Intervention	Context	Target grade and outcomes	Sample	Findings	Cost
Angrist et al. (2020)	Two low-technology interventions to substitute schooling during this period: SMS text messages with "problems of the week", and direct phone calls with instruction (15-20 minutes) plus the SMS. Randomization at the student-level.	Botswana	Grades 3-5. 103 schools across 9 out of 10 regions in Botswana.	4,550	0.16 SD in math from SMS intervention, and 0.29 SD in math from phone call intervention. Increased parental engagement.	USD 2.13 per child for only SMS intervention, and USD 14 per child in the phone and SMS intervention.
Beg et al. (2019)	Program: "eLearn". Program delivers expert math and science content through short videos with multimedia presentations, for four months of exposure. Curriculum tailored to local 8th grade curriculum. After each lecture, there would be multiple-choice review questions, a small tablet for teachers to project the material for their own review, and an LED screen installed in each classroom. Some teacher training on how to use the tablets was provided. 29 hours of content during regular class time. Randomization at school-level.	Pakistan	Grade 8. 100 schools in Punjab.	2,622	0.26 SD in Math, 0.26 in Science, 0.33 SD in combined score. Small increases in student and teacher attendance.	USD 15 per student with the inclusion of high fixed-costs at the scale of 100 schools, USD 9 was the marginal cost per student.
Berlinski and Busso (2017)	Program: testing a pedagogical intervention designed to give students a more active role in learning geometry, along with different technological complements. One pure control group and four treatment arms: 1) active learning, 2), active learning plus an interactive whiteboard, 3) active learning plus a computer lab, 4) active learning plus one computer per student. Randomization at the school-level.	Costa Rica	Grade 7. 85 schools.	18,000 students and 190 teachers. Sample was nationally representative.	Negative effects of -0.17 SD for active learning alone, and -0.25 SD for active learning plus technology. No treatment arm had positive effects. High take-up by teachers.	Not specified.
Bianchi et al. (2019)	Evaluation of government reform that connected high-quality teachers in urban areas with more than 100 million students in rural middle schools through satellite internet over four years. First difference in cohort, and second difference in geographic location, leveraging staggered implementation.	China	Middle schoolers, Rural schools in China.	4,479	0.18 SD in math 7-10 years later, 0.21 SD in Chinese. Share of people investing in informal education increased 9.8 p.p., earnings increased, increased likelihood of being in more analytical and less manual jobs, increased internet and computer usage.	Project served 100 million students, costing CNY 8.78 billion (USD 1.24 billion), or approximately USD 12.4 per student served.
Blimpo et al. (2020)	The program targets math and science instruction through incorporation of technology that enhances students' participation. The program provided computers for teachers, scripted lessons, and customized software; equipped classrooms with smart projectors (smartboards) and handheld devices (smart responders) that students can use to respond to teachers; as well as provided textbooks for students. Treatment also included "student responders", are battery-operated, wireless handheld devices that allow students to provide responses simultaneously, and allows teachers to monitor and track students' responses in real-time.	Gambia	Grade 12 (measured outcomes), program for grades 1-12, 24 schools across the Gambia	1044	0.54 SD on Math, 0.20 SD in English, increased probability of passing secondary exit exam by 15 p.p.	~USD 3,000 per classroom.
Böhmer et al. (2014)	After-school mathematics intervention aimed to fill knowledge gaps using computer-assisted learning (CAL). Khan Academy resources were used to teach basic numeracy. Each individual has full autonomy over which exercises they attempt. Gamefication is used to incentivize and engage the learners. Randomization at the individual-level.	South Africa	Grade 8. 9 schools in Western Cape circuit, which had to meet the criteria of good management and a working computer laboratory with an internet connection.	472	0.32 SD on basic numeracy questions, and 0.25 SD on core grade 8 curriculum questions.	Not specified.
Borzekowski (2018)	Showing of educational videos at school, part of the "Akili and Me"	Tanzania	Pre-school. 9 randomly selected	595	Positive effects across several fields of basic	Not specified.

	series. "Alik and Me" is an animated series teaching school readiness skills, in both Kiswahili and English. The videos were contextually-relevant and sensitive. Randomization at the student-level.		schools in peri-urban areas of Morogoro.		numeracy and literacy. ~0.15 SD in English and 0.22 SD in counting.	
Borzekowski and Henry (2010)	Showing of "Jalan Sesama", a multimedia educational project, developed for Indonesian children. Television episodes presenting educational messages regarding literacy and numeracy, health and safety, social development, and environmental and cultural awareness. Randomization at the individual-level.	Indonesia	Children age 3-6. Children selected from remote areas which typically have poor reception of broadcast television three main locations (Munjul, Kota Dukuh, and Gunung Batu village) from the Munjul subdistrict.	160	0.12 SD in early cognitive skills or the low-exposure group and 0.35 SD for the high-exposure group.	Not specified.
Borzekowski et al. (2019a)	Evaluation of the adaption and testing the Tanzanian-made program, Akili and Me (studied in Borzekowski), for children's viewing in Rwanda. Randomization at the student-level.	Rwanda	Pre-school to grade 2. Randomly-selected kindergartens and primary school in Gihara.	434	Statistically significant increases in math and language. Not enough information provided to reliably convert coefficients into SD units.	Not specified.
Borzekowski et al. (2019b)	Showing of Galli Galli Sim Sim, the Indian version of Sesame Street, 30 min of television five days a week for twelve weeks, varying how much Galli Galli Sim Sim versus other programming children watched. Randomization at the school-level.	India	Pre-school, 99 preschools in Lucknow, with children ages 3-7.	1,340	Overall literacy score reports effects between 0.24-0.37 SD, and numeracy scores effects of 0.15-0.20 SD.	Not specified.
Cilliers et al. (2020)	Three year follow up of Kotze et al. (2019).	South Africa	Grades 1-3, 180 public schools located in low-income rural communities in the Mpumalanga province.	2,684	After 3 years, the in-person coaching arm achieved improvements in oral language of 0.31 SD and reading proficiency of 0.13 SD. The in-person treatment arm achieved gains in oral language of 0.12 SD and no gains in reading proficiency. Furthermore, the virtual coaching induced a negative effect on home language literacy.	The cost per learner per year of the on-site program is USD 66, and the cost per learner per year of the virtual program was USD 51.
De Hoop et al. (2020a)	Evaluation of a "e-School 360" model, a multi-faceted program that integrates technology into education, provides ongoing teacher training and professional development, and includes community ownership.	Zambia	Grades 1-3. 64 schools across 3 rural districts in the Zambia's Eastern Province.	1,924	0.33 SD in reading, and 0.14 SD in math.	The cost of the program was USD 3 per month per student.
Gambari et al. (2016)	Video-based cooperative, competitive and individualized instructional strategies on the performance of senior secondary schools' students in geometry in Nigeria. The treatment involved identification of some difficult concepts in mathematics that were developed in simpler instructional module using video instruction platform. Randomization at the school-level.	Nigeria	Senior secondary students, 4 secondary schools in Minna.	120	Positive effects on all treatment arms, not enough information to translate into SD units.	Not specified.
Johnston and Ksoll (2017)	Broadcasting live instruction via satellite to rural primary school students. Classrooms in 70 randomly selected schools equipped with the technology required to connect to a studio in Accra. Randomization at school-level.	Ghana	Grades 2-4, 144 schools, districts of the Volta and Greater Accra regions; districts classified by Ghanaian government as "deprived".	4,545	0.23 SD in math, no effects in reading fluency overall, but gains in foundational skills (letter and word identification), no effects on classroom attendance nor time-on-task.	USD 22 per student, as authors estimate USD 100 per standard deviation gained. Estimate includes fixed-costs, which authors claim to be a large proportion of total costs.
Kotze et al. (2019)	Two different versions of coaching within a structured pedagogic program, the conventional form of one-on-one	South Africa	Grades 1-3. 180 public schools located in low-	3,227	Not enough information to convert point estimates into SD units. However,	The per-student costs of the on-site coaching and the

	on-site instructional coaching, and virtual coaching, which involves using a tablet, cellular phone calls, and daily text messaging.		income rural communities in the Mpumalanga province.		researchers find that "students from the two intervention groups performed consistently better than the control students" on most numeracy and literacy tasks.	virtual coaching models do not differ dramatically, and are US\$48 and US\$43, respectively, per year.
Lehrer et al. (2019)	Evaluation of "Sankoré" equipment, which consisted of classroom provision of interactive whiteboards.	Senegal	Grades 1-2. 173 initially surveyed schools in Dakar, Diourbel, Kaolack, Thiès, and Fatick.	14,713	0.186 SD in math.	Not specified.
Näslund-Hadley et al. (2014)	Program: "Tikichuela". Intervention consists of interactive audio segments that cover the entire preschool math curriculum. Since Paraguayan classrooms tend to be bilingual, the audio and written materials use a combination of Spanish and Guaraní. Audio lessons were implemented four days a week, with one day set aside to review what had been learned during the week. This extra day gave teachers flexibility to review topics that, according to their observation, the children needed more practice or assistance in addressing. The average duration of each class was 60 minutes. Randomization at the school-level.	Paraguay	Pre-school. 265 schools in department of Cordillera	2,907	0.16 SD in math.	Not specified.
Naik et al. (2016)	Technology-assisted teaching to replace one-third of in-school instructional time. Intervention combines computers and broadband connectivity with more conventional satellite technology to deliver classes taught by expert teachers at a central location using multimedia teaching aids. These lectures cover the standard syllabus prescribed for all schools in the state by the State Department of Education.	India	Grades 5-10. 1,823 rural, public schools across 18 districts in Karnataka. Data collection performed only in sub-sample of 105 treatment schools, and 98 comparison schools.	14,084	0.1-0.2 SD in math, 0.2-0.3 SD in science, 0.2-0.4 in English.	USD 1.7 per student per year.
Wennersten et al. (2015)	Program: BridgeIT. Teachers of Standard 5 and 6 English and Science classes were notified of the availability of new videos via text messages (SMS), which they downloaded onto their phones using an open-source application and showed, with suggested activities, to students on a TV screen using a TV-out cable. Participation was not randomized, it was simply rolled out in certain schools first, chosen by funders and implementers.	India	Grades 5 and 6, 86 schools in Andhra Pradesh and Tamil Nadu.	3,327	0.36 SD in English in both states. 0.98 in Science in Andhra Pradesh. Science gains not reported for TN.	USD 10.50 per student.
Wolf et al. (2018)	Three experimental arms: teacher training, teacher training plus parental-awareness meetings, and controls. The programs incorporated workshops and in-classroom coaching for teachers. The technology portion was the video-based discussion groups for parents. Randomization at the school-level.	Ghana	Teachers in public and private kindergartens in the Greater Accra Region, 240 schools.	444 teachers, and 3345 children.	Treatment arm with parental intervention has effects of ~-0.14 SD in overall school readiness, ~-0.09 SD in math, ~-0.08 in literacy. The branch without parental intervention had slightly higher, statistically significant effects. Parental meetings had no effect no the effectiveness of the teacher training.	Not specified.

Notes: All randomized controlled trials indicate the level at which units were randomized. For the full coding and more detailed information on all the core studies included in the review, please see this online [document](#). The statistical significance of the findings stems from what each of the studies reports, and the alpha threshold for significance may vary by disciplinary approach of each paper. Abbreviations: "p.p.": percentage points, "SD": standard deviations.

Online Table 4: summary of all studies included within the "Self-led learning" category

Study	Intervention	Context	Target grade and outcomes	Sample	Findings	Cost
Abrami et al. (2016)	Interactive, multimedia literacy software for 90 minutes per week, for 13 weeks. Randomization at the class-level.	Kenya	Grade 2. 12 classes.	429	Gains in certain areas such as reading comprehension and listening skills. Not enough condensed information to translate into gains in SD.	Not specified.
Araya et al. (2019)	Program: "ConectaIdeas", two weekly, 90-minute sessions in a computer lab where students solve math exercises. Software can create individual and group competitions. Competitions were intra- and inter-schools. Software shows each student how many exercises have been completed, and compares it with class average. Personalized "ads" are shown regularly to motivate students. Randomization at the class-level.	Chile	Grades 4, in 24 schools. Public schools in Chile attended by socioeconomically disadvantaged students who also significantly lagged in math achievement.	1,089	0.27 SD in math, no effect in language. Increased students' preference to use technology for math learning, promoted the idea that studying can raise intelligence. Increased math anxiety and reduced willingness to collaborate in groups.	USD 150 per student cost, 5% increase in public expenditure per primary student in Chile
Bai et al. (2016)	Computer-assisted complement to English class. Comparison between "computed assisted instruction" (CAI; program integrated with curriculum), "computer assisted learning" (CAL; not integrated into teacher's instruction), and a pure control group. The integrated program included three parts: a curriculum, a lesson-by-lesson English Teaching Plan, and a set of instructions on teacher responsibilities. English teachers in CAL and CAI were also compensated with 80 USD per semester. Randomization at school-level.	China	Grade 5 in 127 schools. Rural schools in Haidong Prefecture in Qinghai Province.	6,304	No effects of pooled test for CAI/CAL, effects of 0.07 SD for CAI when tested separately. Suggestive evidence that CAL did help higher performers.	Not specified.
Banerjee et al. (2007)	Program: Pratham-developed program during year 1, program developed by Media-Pro during year 2. Two hours per week during or before/after school, with two children per computer. Software linked to Gujarat's curriculum, focusing on basic skills. Software changes the question difficulty by ability. Randomization at the school-level.	India	Grade 4. 110 schools. Mumbai and Vadodara.	~5,500	0.35 SD in math for year 1; 0.48 SD in math for year 2. Math effects persisted one year after leaving intervention. No effect on language either year. No effect on attendance.	USD 15 per student per year.
Bettinger et al. (2020)	Intervention tested computer-assisted learning program, with theoretical implications for estimation of educational production function. Three treatment arms: a base dosage CAL arm with ~20-25 minutes per week of math CAL and ~20-25 minutes of language CAL; a double-dosage CAL arm with ~40-50 minutes of math CAL and ~40-50 minutes of language CAL; and a control arm. The software is adaptive to each student's level. Randomization at the class-level.	Russia	Grade 3. 343 schools.	5,621	0.11-0.12 SD in math for base dosage, and similar results for the double-dosage-level arm. 0.06-0.07 in language for the base dosage arm, and no effects in language for the double-dosage arm. The differences between the two treatment arms are not statistically significant in either subject.	Not specified.
Brown et al. (2020)	Program evaluation of a digital game-based learning program ("Can't Wait to Learn").	Sudan	Children age 7-9. 8 villages in Sudan	221	Positive effects in math, Arabic, and psychological well-being. Not enough information provided to translate gains into SD units.	Not specified.
Büchel et al. (2020)	Comparison of relative effectiveness of computer-assisted learning (CAL) and traditional teaching. The first treatment arm is pure CAL, the second is CAL plus traditional teaching, and the control group is traditional classroom teaching. Each experimental arm consisted of 90 minutes of additional instruction per week. Randomization at the school class-level.	El Salvador	Grades 3-6. 198 school classes in Morazán across 29 schools.	3,197	0.21 SD from CAL, 0.24 SD of CAL plus supervisor (difference not statistically significant).	The cost per child is 44 USD for the traditional teaching arm, 43 USD for the CAL arm, and 56 USD for the CAL plus teacher.

Carrillo et al. (2011)	Program: "Personalized Complementary and Interconnected Learning (APCI) program". Computer-aided instruction in mathematics and language, 3 hours per week during school. Personalized curriculum based on screening test; fixed after screening test. Randomization at the school-level.	Ecuador	Grade 5. 16 schools. Public schools in Guayaquil.	1,061	0.30 SD in math, and no effect on language. Larger gains for students at the top of the achievement distribution.	Not specified.
Chong et al. (2020)	Mandatory six-month Internet-based sexual education course. Randomization at the school*classroom level (to allow for analyses of spillovers).	Colombia	Grades 9. 138 classes across 69 junior high schools in 21 Colombian cities.	4,599	0.4 SD increase in knowledge about sexual education, 0.2 SD in attitudes, and 55% increase in likelihood of redeeming vouchers for condoms.	USD 14.7 per student per semester.
De Hoop et al. (2020b)	Program evaluation of a digital game-based learning program ("Can't Wait to Learn").	Jordan	Grades 1-3. 35 schools within Zarqa Governorate.	709	No effects in math, Arabic, and psychological well-being.	Not specified.
Derksen et al. (2020)	Evaluation of program providing access to Wikipedia. Randomization at the student-level.	Malawi	Grades 8-10. 4 government boarding schools.	1508	Gains in English of 0.103 SD.	USD 4 per student.
Freeman and Hawkins (2017)	Evaluation of "Evoke", a game-based interactive environment. Evoke is a project-based learning module, using storytelling, virtual games, and social networks, which connects students with their peers and mentors. Randomization at the class-level.	Colombia	University students, two thirds being between 18-22 years old. Recruitment in 14 university classes.	297	Gains in "21st century and socioemotional skills". Authors do not provide enough information to translate gains into standard deviation units.	Not specified.
He et al. (2008)	Two interventions, only one of which involves an EdTech intervention. This intervention consists of a "PicTalk" machine, which is designed to be used by a single student who with the help of a stylus, can point to pictures and hear the word pronounced. Learner could choose topics, and within each topic, what words to point to. The other, non-EdTech, intervention consisted of sets of flashcards designed to cover the same competencies as the PicTalk machine. Randomization at the school-level.	India	Grades 1-5. 97 schools in Thane Municipal School District, and 242 schools in Mangaon sub-district government schools.	15,062 students across all years, all schools.	0.25-0.35 SD, depending on specification. Stronger students benefit more from the more self-paced machine-based implementation.	USD 20.46 per student in Thane, and USD 11.20 per student in Mangaon (including costs of machines and material development).
Hirshleifer. (2016)	Treatment consists of a math software curriculum implemented in all classrooms of the intervention. The main research question focuses on whether incentivizing inputs (the completion of learning modules) is more effective than the incentivizing of outputs (a test at the end of each module). The incentives were small monetary rewards. Randomization at the treatment level using a partial rotation design.	India	Grades 4-6. 45 classrooms in Mumbai and Pune.	3,218	0.57 SD in math for the branch incentivizing the inputs, and 0.24 SD for the branch incentivizing outputs.	Maximum incentive was USD 2.65 per student (200 rupees of rewards).
Ito et al. (2019)	Treatment consisted of 20 30-minute classes when students were allowed to use an app-based computer-aided instruction instead of regular math classes. Adaptive learning with algorithm in response to the proficiency level of each individual. Randomization was at the class-level.	Cambodia	Grades 1-4. 5 public elementary schools near Phnom Penn.	1,636	0.56-0.67 SD in math scores, increases in subjective expectation of being able to attend tertiary education. No effects on motivation.	Not specified.
Jere-Folotiya et al. (2014)	Evaluation of computer-based literacy game. Randomization at the student-level.	Zambia	Grade 1. 42 government schools in Lusaka.	573	Positive effects in spelling. Not enough information to translate into SD units.	Not specified.
Lai et al. (2013)	Two 40-min mandatory sessions per week during lunch breaks or after school, teams of 2 children. Based on national curriculum. Reinforced material taught that week Program was remedial in nature. Randomization at the school-level.	China	Grade 3 and 5. 72 schools rural boarding schools in Shaanxi.	2,726	0.12 SD in math, no effects in language across both grades.	Not specified.
Lai et al. (2015)	Two 40-min mandatory sessions per week during lunch breaks or after school, teams of 2 children. Based on	China	Grade 3. 43 migrant schools in Beijing.	2,369	None in language, 0.15 SD in math, 0.31 points in 1-10	Not specified.

	national curriculum. Reinforced material taught that week Program was remedial in nature. Randomization at the school-level.				scale asking about whether child "likes school".	
Lai et al. (2016)	Two 40-min mandatory sessions per week during lunch breaks or after school, teams of 2 children. Based on national curriculum. Reinforced material taught that week Program was remedial in nature. Randomization at the school-level.	China	Grade 3. 57 rural schools in Qinghai.	6,865	0.15 SD in both math and language.	USD 7.6 per student.
Linden (2008)	Program: Gyan Shala Computer Assisted Learning program. Two children with one computer (split screen), two versions of the treatment. Version 1: one hour per during school, version 2: one hour per day after schools. Reinforces material taught that day. Randomization at the school-level.	India	Grades 2-3, 60 schools. Gyan Shala schools in Gujarat.	779	-0.57 SD in math as a substitute, and 0.28 SD in math as a complement.	USD 5.2 per student.
Lysenko et al. (2019)	Evaluation of computer-based literacy game.	Kenya	Grades 1-3. 48 classes	1,899	Positive effects in spelling. Not enough information to translate into SD units.	Not specified.
Ma et al. (2020)	Three experimental branches: 1) pure control group, 2) supplemental computer-assisted learning, 3) supplemental workbook. The program sessions were held once a week for 9 months. Randomization happened at the class-level.	China	Grades 4-6. 130 schools from 9 impoverish counties.	4,024	No effects of the pure technology portion of the intervention.	USD 18 per student.
Mo et al. (2014a)	Two 40-min mandatory sessions per week during lunch breaks or after school, teams of 2 children. Based on national curriculum. Reinforced material taught that week Program was remedial in nature. Randomization at the school-level.	China	Grade 3, and 5. 72 rural schools in Shaanxi.	4,757	0.17 SD in math.	USD 9,439 in total over one year.
Mo et al. (2014b)	Two 40-min mandatory sessions per week during lunch breaks or after school, teams of 2 children. Based on national curriculum. Reinforced material taught that week Program was remedial in nature. Randomization at the school-level.	China	Grade 3, and 5. 72 rural schools in Shaanxi.	2,741	0.25-0.26 SD in math.	USD 9,439 in total over one year.
Muralidharan et al. (2019)	Program: "Mindspark". Evaluation of after-school Mindspark centers, which scheduled 6 days of instruction per week, with 90 minutes per day, for 4,5 months. Half of each session was self-driven learning on Mindspark software, and the other half consisted of instructional support from a teaching assistant in groups of 12-15 students. Technology-led instructional program, software benchmarks the initial learning level of every student and dynamically personalize the material to match the level and rate of progress made by each student. Randomization at the student-level.	India	Grades 4-9. Students recruited from 5 public middle schools in Delhi.	619	0.37 SD in Math, 0.23 in Hindi.	USD 15 per student per month.
Pitchford et al. (2018)	Three experiments reported, testing the effectiveness of apps developed by onebillion [®] . Eighteen 30-min sessions on average across the 14-month study period. Note that treatment was not randomly selected, but rather the government chose one school per district to be treated, and researchers chose a similar comparison school. Hence, this is closer to PSM than to an RCT.	Malawi	Grades 1-2. 14 schools across seven education districts across Malawi.	1,217	Gains in math in the order of 0.19-0.62, depending on gender, and gains of 0.33-0.46 in reading. Girls benefited more from the intervention.	Not specified.
Rosas et al. (2002)	Introduction of educational video-games in the classroom. Students in the experimental group were exposed to an average of 30 hours over a three-month	Chile	Grades 1-2. Economically disadvantaged schools.	1,274	Positive, and statistically significant effects in math and language. Authors do not provide enough	Not specified. "Low-cost videogame".

	<p>period. The games had a self-regulation system that dynamically adapted the level of difficulty of the contents to the player's learning pace, presenting the player contents based on his or her level of knowledge. The games had a progressive and increasing level of difficulty, based on the presentation of antagonists and obstacles. According to the child's performance, the game provided feedback indicating if he or she chose the correct or incorrect answer.</p>				<p>information to translate into SD units.</p>	
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