Rapid Response Brief

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How does the use of technology in classrooms affect student learning?

Integrating technology into the educational curriculum is a development priority for many low- and middle-income countries, with the ultimate goals of improving education outcomes and reducing poverty. In the COVID-19 pandemic, the use of technology for learning has become increasingly important as countries try to navigate extended school closures and a widespread shift to remote learning. This brief presents evidence on the effects of computer assisted learning programs on education outcomes.

The findings are primarily drawn from a high-quality systematic review that draws together 18 studies evaluating 16 unique computer assisted learning programs implemented in East Asia and the Pacific, Latin America and the Caribbean, and South Asia. All programs included the use of computer technology to facilitate children's learning in an in-classroom setting. While none of the studies investigated remote learning, some of the lessons from the in-classroom use of technology may still be informative in the COVID-19 context.

Key Findings

- On average, it is not clear whether computer assisted learning programs improve learning outcomes (test scores) or access outcomes (such as enrollment or attendance).
- Effect sizes varied widely, and in some cases effects were negative and relatively large.
- Some interventions did significantly increase students' test scores, particularly those targeting math scores.
- Technological issues, insufficient teacher training, and a lack of integration into the existing curriculum may explain the lack of positive results in other cases.

Key Recommendations

- Quality of devices and internet connections should be assessed to minimize technological challenges.
- Computer assisted learning programs should incorporate comprehensive, sustained training for teachers.
- Programs delivered during school hours should be incorporated into the existing learning curriculum to ensure that they are not of lower quality than the lessons they plan to replace.

3ie International Initiative for Impact Evaluation

Australian Aid

Pambansang Pangasiwaan sa Kabuhayan at Pagpapaunlad
Republika ng Pilipinas

Background

Achieving universal access to high-quality education is a challenge in low- and middle-income countries, including the Philippines, where 22 percent of children did not complete basic education even before the pandemic. COVID 19 greatly exacerbated the situation wherein sudden closure of schools negatively impacted learning for more than 34 million children nationwide.

Leveraging technology for learning may improve education quality and increase access, particularly during COVID-19, when children are unable to physically go to school. In recent years, many countries have invested in computer assisted learning programs with the aims of improving learning outcomes and helping to reduce the rapidly growing digital divide.

Details of interventions

In the main International Initiative for Impact Evaluation (3ie) systematic review, all programs used computer technology to facilitate learning in in-school settings. These programs were implemented in primary and secondary schools, with a focus on grades 3, 5, 6 and 7.

Four studies each were conducted in China and Peru; 3 in India; and 3 each in Chile, Colombia, Costa Rica, Ecuador, Mexico, Nepal and Uruguay. Some focused on rural areas, others on urban areas, and a few included both.

While all programs shared the key element of using computers for learning, specific components of the programs varied, as described below:

- **Subject focus:** 13 programs focused on specific subjects – 9 targeted math, 2 targeted language arts (reading and writing) and 2 targeted both.
- **Curriculum:** 7 programs created a new curriculum, 3 provided a customized curriculum for each child and 9 used existing school curriculums.
- **Hardware/software:** Most programs provided new desktop computers or laptops, but a few relied on existing computers that were already available in program schools. Most programs provided specific learning software; 3 used basic computer software.
- **Teacher training/resources:** 14 of the programs were delivered by teachers, of which 11 provided teacher trainings varying in level of intensity. Nine programs also provided teacher resources.
- **In/out of school hours:** Learning took place during school hours for 8 of the programs, outside of school hours for 4 programs, and a combination for 6 programs.
- **Duration:** The duration of the programs varied significantly, from a couple of 40-minute sessions a week to 2 full school days weekly.
- **Additional components:** 4 programs included teacher monitoring, 2 provided technical support and free computer maintenance, and 2 incorporated parent engagement.

All studies but one reported on learning outcomes, including math test scores. Eleven also measured language arts outcomes such as reading or writing, and six reported composite test scores that combine multiple subjects. A couple of studies assessed access outcomes including enrollment, dropout, repetition and attendance rates.

Studies varied in the length of time between the intervention and the measurement of outcomes. One-third of studies measured effects after less than 12 months, one-third measured effects between 12 and 23 months after the program, and one-third measured effects more than 24 months after the program.

Philippines-specific findings were also drawn from a qualitative literature review on the barriers to educational technology integration among the Association of Southeast Asian Nation (ASEAN) member states.

Additional evidence is drawn from two other systematic reviews. McEwan (2014) includes 10 studies, most of which are also in the 3ie review. Escueta and colleagues (2017) includes 77 studies, most of which were conducted in high-income countries.

Findings

It is unclear whether computer-assisted learning programs are beneficial for improving learning (composite test scores, math scores and language arts scores) or access (enrollment, attendance, completion and dropout rates), based on the 18 studies included in the 3ie systematic review. While the overall average effects were small, the magnitude of individual study effects varied substantially and, in some cases, were negative. The results suggest that computer assisted learning may not be beneficial in all contexts, and it may even be harmful under certain conditions.

In all, results were mixed. The effect of computer assisted learning on math scores was evaluated in 17 studies. Three studies in India and Costa Rica showed negative effects; 6 studies in, Colombia, Nepal, Peru and Uruguay showed no effect; and 10 studies in Chile, China, Ecuador, India and Mexico identified positive effects. 13 studies assessed language arts test scores. 2 studies in Nepal and Peru found negative effects, 10 studies found no impact, and 1 study in China found a positive effect. Finally, 6 studies assessed the effects on composite test scores. One study in India found a negative effect; 3 in Colombia, Nepal and Peru found no significant effects; and 2 other programs in India found positive effects.

More positive results, especially with respect to math scores, were reported in the McEwan review. Among the studies it included, it found that computer assisted learning interventions yielded larger effects than other types of education programs, such as reduced class sizes or teacher incentives. However, it omitted some of the studies that found that computer assisted learning programs yielded negative effects.

A few studies in Colombia, Nepal and Peru looked at measures of access, including enrollment, attendance, completion and dropout rates, and found no significant effects on average. Nearly universal enrollment in primary education in Peru may help explain absence of an impact on enrollment. The ability to which computers can attract and motivate students may also be limited. One study found a substantial increase in the use of computers in the intervention group, but it did not appear to translate into changes in behavior, such as school attendance or completion.

The relatively large negative effects on learning outcomes observed in some studies are especially noteworthy. Technological issues such as damaged or dysfunctional equipment, lack of internet, and incompatible software negatively affected programs in Chile, Mexico, Nepal, Peru and Uruguay, according to the 3ie review's qualitative synthesis. Other studies highlighted insufficient training for teachers and a lack of integration of the technology into existing learning curriculums as potential explanations for the lack of positive effects.

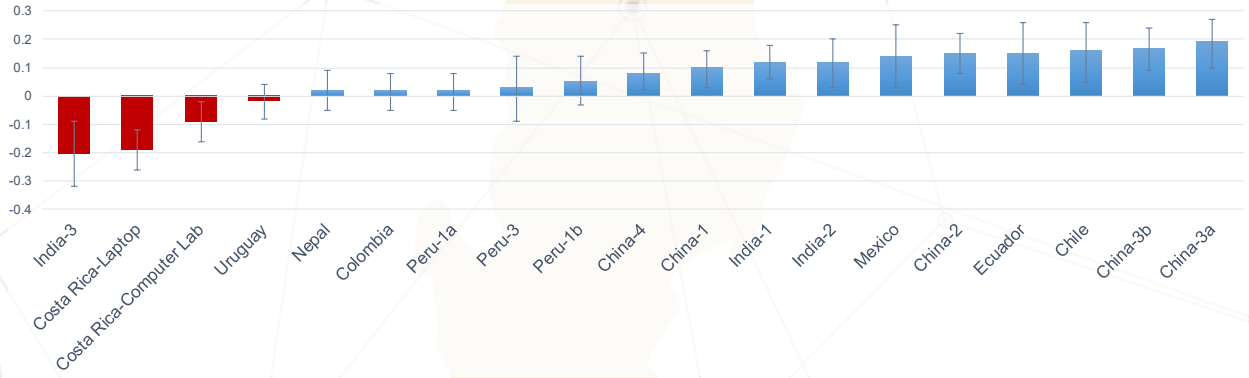
Another important factor was whether the program was offered instead of or in addition to regular school hours. In the Gyan Shala study in India, the in-school version of the program led to substantial negative effects on test scores while the out-of-school program appeared to benefit students substantially.

Qualitative findings from countries in South East Asia highlighted similar barriers to educational technology integration in classrooms, such as insufficient teacher preparation, slow internet connections, poor integration of computers into classroom learning, insufficient equipment maintenance and hardware incompatibility.

In the Philippines, barriers to optimal use of technology included teachers' fear of technology, the traditional mindset of school principals, inadequacy of facilities, lack of adequate maintenance of technology, dependence on the central government for financial investment and dependence on information communication technology service providers for software. The study highlighted a need for comprehensive and sustained in-service training for teachers and a systematic development program for education managers to help change the mindset of principals. Given the lack of technical staff for maintenance of computers or for technical support, the study's authors also suggested exploring lease arrangements as an alternative.

In another review of 29 studies that mostly took place in developed countries and investigated a range of education outcomes, 20 found positive effects, 8 found no effects and only 1 found negative effects. Many of the positive effects were programs that only aimed to improve math scores. Many of the interventions' effect sizes compared favorably with other strategies to improve learning outcomes, such as reduced class sizes, longer school days and intensive face-to-face tutoring. Experimental literature from China and India also found positive impacts and emphasized the use of personalized instruction.

Math score change with computer assisted learning (3ie review)



Recommendations

Programs incorporating technology in the classroom should be implemented with careful consideration of program context and design. The quality of devices and internet accessibility should be assessed to minimize technological challenges that may cause more harm than good. In settings where the internet connection is unreliable, other approaches may be more suitable for improving learning. Providing technical support and free maintenance of devices may also help mitigate some of these challenges.

Programs should also include comprehensive and high-quality training for teachers on the delivery of computer assisted learning programs. These trainings should be offered on a regular basis to help sustain teachers' computer skills and technology use. Training should also be tailored to help address and respond to teacher-reported barriers to using technology in their classrooms.

Moreover, the timing of program delivery should be considered carefully. If programs delivered during school hours are of lower quality than the lessons they are replacing, they may harm children's learning outcomes by crowding out higher-quality lessons, a problem that doesn't arise with supplementary after-school programs. For this reason, special attention should be taken to ensure that programs delivered during school hours are of the same or higher quality than the pre-existing lessons. Incorporating programs into the existing learning curriculum, rather than establishing a new curriculum, may be one way to avoid harmful effects. Providing specific learning software may also help integrate technology more effectively into established lesson plans and educational objectives.

Evidence quality, strengths and limitations

The findings and recommendations included in this brief are primarily based on a high-quality 3ie systematic review that synthesizes evidence from 18 studies on computer assisted learning programs. The studies included in this review are all from low- and middle-income countries across East Asia and the Pacific, Latin America and the Caribbean, and South Asia. Moreover, all studies directly respond to the question of interest: Does the use of technology in classrooms affect student learning? In addition, the risk of bias was assessed and reported for all included studies. While most studies were categorized as low bias, high levels of bias were reported for a few; therefore, the results should be interpreted with some caution.

Findings are also drawn from two additional systematic reviews. The McEwan review includes many of the same studies as the 3ie review, but it omits some of the studies the 3ie review includes. The Escueta et al. review draws mostly from studies in developed countries, so its applicability to the Philippine context is not clear.

In the context of COVID-19, the primary limitation of the evidence is that it is based on in-school programs rather than contexts of distance learning.

Regional and Philippines-specific findings are based on a qualitative literature review of several individual studies conducted in South East Asia. These findings are useful for understanding some of the potential barriers to educational technology integration in the Philippines and nearby countries, but should not be treated as a comprehensive, systematic synthesis of evidence. Furthermore, findings from the Philippines were based primarily on a study conducted in 2001, so they should be interpreted with care.

About the Philippines Evidence Program

3ie's country evidence program in the Philippines is a tripartite partnership between the National Economic and Development Authority (NEDA), the country's independent economic development and planning agency as mandated by the Philippine constitution; the Department of Foreign Affairs and Trade of the Government of Australia; and 3ie. This decade-long partnership started in 2014, and it aims to build interest in and capacity for evidence-informed decision-making in the Philippines. Priority sectors are identified by the government, with 3ie providing technical oversight on evaluations assessing major governmental reforms and service delivery programs.

This rapid response brief is primarily based on the following systematic review

Snilstveit, B, Stevenson, J, Phillips, D, Vojtkova, M, Gallagher, E, Schmidt, T, Jobse, H, Geelen, M, Pastorello, M and Eyers, J, 2015. *Interventions for improving learning outcomes and access to education in low- and middle-income countries: a systematic review*, 3ie Systematic Review 24. London: International Initiative for Impact Evaluation (3ie).

More information, including a brief summary of the systematic review, is available here: https://www.3ieimpact.org/evidence-hub/publications/systematic-reviews/interventions-improving-learning-outcomes-and-access

Additional findings are based on the following papers:

Dotong, C, De Castro, E, Dolot, J and Prenda, MT, 2016. Barriers for educational technology integration in contemporary classroom environment. *Asia Pacific Journal of Education, Arts and Sciences*, 3(2), pp.13–20.

Escueta, M, Quan, V, Nickow, AJ and Oreopoulos, P, 2017. Education technology: an evidence-based review, Working Paper 23744. Cambridge, MA: National Bureau of Economic Research.

McEwan, P, 2014. Improving learning in primary schools of developing countries: a meta-analysis of randomized experiments. *Review of Educational Research*, 85(3), pp.353–94.