MOBILE LEARNING IN LOW-RESOURCE COUNTRIES

January 2018

Efforts to improve literacy and learning in low-resource countries by using mobile devices have long been greeted with great fanfare. After decades of investment and hype, where do we stand? What have we learned? What has worked? Why? What hasn't? The prospect—even inevitability—of classrooms becoming mobile-dependent mandates a better understanding of what impact mobile devices are having on classrooms students. This paper summarizes knowledge to date, provides examples that illustrate trends, and suggests future directions for investment.

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Mobile Learning in Low-Resource Countries

Introduction

Two hundred fifty million children globally lack the basic literacy skills they need to build a healthy, economically secure life.[1] Moreover, we know that both learning to read and reading to learn require text for basic practice, information gathering, and critical thinking.

In low-resource countries, up to one-fifth of primary school students don't have a textbook or even shared access to one.[2] UNESCO reports that providing just one textbook to every student in sub-Saharan Africa would increase literacy scores by 5-20percent.[3] Building literacy for women is a critical need, as illiteracy rates of more than 60% worldwide among women have not changed in decades. Numerous studies have shown that literate mothers take better care of their own health and their children's, are more likely to enroll their children in school, and make positive decisions for their health.

For more than 30 years, textbook donation programs such as the International Book Bank, Books for Africa, and Books for Asia have sought to address this shortage of texts in low-resource countries across Asia and sub-Saharan Africa.[4] Because of the continued urgency of getting books to under-resourced countries as well as the power of technology to provide text, much attention of late has been directed away from hard copies and toward digital materials. Portability, continuous reduction in cost, growing availability, and a plethora of content surely make such materials attractive. Thousands of programs—from software pilots to countrywide laptop distribution—have rolled out over the past two decades. These initiatives, largely targeting young and middle grade levels, have been greeted with great fanfare and high expectations.

After all the investment and hype, where do we stand? What have we learned? What has worked? Why? What hasn't? The prospect—even inevitability—of classrooms becoming mobile-dependent mandates a better understanding of what impact mobile devices are having on students. This paper will summarize knowledge to date, provide examples that illustrate trends, and suggest future directions for investment.

Bird's Eye View: What General Trends Are Apparent?

Delivery of education via mobile devices builds on the experiences and results of textbook donation programs, which have been popular for more than 30 years. Moreover, studies have shown positive correlations between achievement test scores and the possession of textbooks.[5] Book-based initiatives continue to be important, as internet access is available to only 47 percent of the population, with notable geographic disparities. In Africa, only 7 percent of households are internet-connected, compared to 79 percent in Europe.[6] A Pew Research Center survey finds that 72 percent of the U.S. population owns smartphones, in contrast to 4 percent of the population in such low-resource countries as Ethiopia and Uganda, Pakistan, 11 percent; India, 17 percent; Kenya, 26 percent; Brazil 41 percent.[7] Those numbers are on track to grow by at least 10 percent in the coming few years. Cell phones now outnumber human beings by about 3.6 billion, and more than 1 billion people worldwide use tablets. [8]

As schools continue to launch digital learning programs, the realities and lessons of education innovation and reform often have been ignored. In their enthusiasm for doing good, educators,

international development agencies, and donors frequently have neglected the complexities of the school setting when introducing new elements or programs. Few if any reforms can succeed without accommodating their impact and imprint on student learning needs and styles, teaching, school culture and climate, and administrative practices. Thus, it has long been considered inadvisable to simply implement an exciting technology in a classroom without helping teachers understand how to maximize its use, teaching students about its capabilities, adapting materials to the local context, and engaging families and communities. Yet that has been the trend for nearly 20 years, as millions of computers, laptops, and tablet programs have been left at schools' doorsteps. [9]

Countries, mobile manufacturers, and utility corporations continually make improvements in hardware, software, and the power infrastructure, but basic issues of electricity supply, connectivity, battery life, charging, and usability remain significant obstacles. The essential foundation of reliable electricity still eludes as many as 1.2 billion people globally. More than 95 percent of those living without electricity are in sub-Saharan Africa and developing Asia, where education needs are the most severe, according to the International Energy Agency. Less than 10 percent of the population of Burundi, Chad, Liberia, Malawi, and South Sudan has electricity.[10]

Most low-resource countries are reckoning with some combination of political insecurity, economic instability, natural disasters, poverty, and war, which disrupts all aspects of education—technology-enhanced or not. The more developed a country is, the more traction any educational intervention is likely to have. As the Commonwealth of Learning's report on large-scale government laptop programs acknowledged, "countries with more developed and established educational systems seem to focus on creating strong policies, procedures and infrastructure for enhancing the educational process for students while also making use of various devices, not just tablets."[11]

Hundreds, maybe thousands, of studies of technology interventions in schools have shown pockets of success and clear signs of *potential*, but few studies are definitive, large, or rigorous enough to show which, if any, technology interventions are effective at improving learning, transferrable, and appropriate for scale. The dream of a technology-focused solution for learning has not yet been realized.

The lessons of the highly hyped, expensive "One Laptop per Child," (OLPC) initiative (see below) still resonate. Its delivery of 2 million laptops to 36 low-resource countries at a cost of almost half a billion dollars produced no discernible learning impact.[12] As a Department for International Development (DFID) report notes, "If new technologies are introduced without changing any of the other aspects, *nothing different is happening*."[13]

While UNESCO reports that mobile phone use alone, with its access to text, promotes literacy and learning, the research—although there are some important exceptions—tells us that technology *alone* cannot advance literacy and learning. Delivering *content* via technology is very different from delivering *learning*.[14] Many experts believe that the basic premise must change—from simply providing *tools,* toward identifying *learners' needs* and then deciding which strategies should be enlisted. That is, mobile devices are just one tool to deploy in improving literacy and numeracy in low-resource countries. They work best when schools have the following:

- Some infrastructure, both physical and logistical
- Relevant, language-appropriate content at the right knowledge level
- Teachers skilled in use of these tools in the classroom

- Use of interactive learning/teaching/child-centered methods
- Customization for each student

In early programs such as OLPC, the focus was not sufficiently directed at students. Teachers often saw themselves, rather than the pupils, as the primary laptop users. In contrast, recent interventions "focused on touch screen tablet technology used directly by pupils have shown promising results," particularly in math, notes one research team.[15],[16]

Technology author Kentaro Toyama makes a pointed observation: "If a private company is failing to make a profit, no one expects that new laptops will turn things around. Yet, that is exactly the logic of so many attempts to fix education with technology."[17]

A Closer Look at the Research: What Does(n't) It Tell Us?

Research regarding the benefits and challenges of using technology to bolster basic skills is voluminous, but limited, producing a mosaic of results and myriad qualifiers. As the Mobiles for Education Alliance (a consortium of USAID, World Bank, Inter-American Development Bank, UNICEF, and 15 others) reported in 2015, "a paucity of rigorous evaluations forces funding organizations and the public to rely on a general sense that technology may enhance learning, rather than solid evidence, when making decisions."[18] Said differently, it is often unexamined "common sense" rather than research, evidence, or even theory driving these efforts.

A major shortcoming in the research is lack of clarity about exactly what the technological intervention was meant to address, in what way, and how its precise contribution could be assessed. A 2015 study that identified 11 countries with large-scale national tablet initiatives noted that "none of the identified initiatives was supported by a rationale or evidence for why tablets in general would help achieve the articulated objectives, let alone be supported by the reasons for selecting a particular brand or type of tablet."[19]

Michael Trucano, a World Bank blogger who has followed mobile learning for decades, points to that weakness: "All too often, the related question being asked is not *'what challenges are we trying to solve, and what approaches and tools might best help us solve them?'*, but rather, *'we know what our technology "solution" is, can you please help us direct it at the right problems?'*"[20]

In many studies, little distinction is made between what literacy experts call "learning to read" and "reading to learn." It is broadly understood that a major transition from the former to the latter ideally comes by grade four. Thus, if the reading materials and teacher support are designed for young children, we can assume that these are "learning to read" efforts and support decoding through letter recognition, linguistic awareness, vocabulary development, and basic comprehension. If, however, the materials are to build content knowledge in science, social studies, or literature or to support workforce development, we can assume that these are "reading to learn" efforts.

Similarly, distinctions are rarely drawn between materials accessed from a cell phone or through a community library, for instance, or efforts tied to the school.

Some reports show that technology can be a benefit, but not in and of itself. A 2016 review of 216 programs reaching 16 million children across 52 low- and middle-income countries noted that technology hardware "may be necessary but not always sufficient for improving learning outcomes."[21]

A 2015 review by the Commonwealth of Learning, a Vancouver-based NGO, identified 11 large-scale government-sponsored tablet initiatives. Its conclusion: The majority of these initiatives have been driven by the tablet hype rather than by educational frameworks or research-based evidence.[22]

An earlier (2012) landscape review noted that little of the writing on the topic discusses impact: "Much of the documentation from the developing world is from implementation reports, conference sites and blogs and is descriptive and promotional, rather than analytic and evaluative; or, they are reports of university-led pilot projects that focus on implementation considerations, feasibility, and attitudes toward m-learning, but not learning outcomes."[23]

Potential Is Immense: Where Should We Focus?

New research appears every day that sheds further light on the potential of technology to transform learning.

For example, Mindspark, a computer-assisted learning program in India, offered customized learning (i.e., lessons were adapted for each student based on his or her achievement status and updated according to his or her patterns of error). A 2017 evaluation showed that, combined with teacher support, it produced significant improvement for scores in math and Hindi. The results were strong for both boys and girls, with the most gains among the weakest students. While cautioning that the program was small-scale (619 middle-grade students), short-term (90 days), and deployed in an after-school setting, the researchers see potential. "Our results suggest that well-designed, technology aided instructional programs can sharply improve productivity in delivering education," the researchers write. In addition, they highlight Mindspark's ability to engage students who are significantly far behind, a population that is historically difficult to reach. Their conclusion: "Better aligning curricula and standards with actual learning levels of students may be an essential reform for improving the effectiveness of the education system." [24]

In Uruguay, as in multiple other countries, the OLPC initiative did not improve learning. But Uruguay has used that foundation to persist. Once primary students (grades 4-6) had laptops that were connected to the internet, schools offered video-based English language lessons for both teachers and students. They added teacher training, inclusion with community members and agencies, and a monitoring and evaluation plan. The program produced a 72 percent gain in achievement test scores. The British Council, a primary sponsor, and others suggest that remote lessons have identical outcomes to face-to-face learning and that the methodology shows promise for other subjects.[25],[26]

Another powerful sign of the potential of technology in education is the eagerness of major corporations to invest. In 2016 Google launched a $50 million global program to support organizations that are using technology to help the millions of children who do not have basic math and reading skills, even after several years of school.

Two notable innovations supported by Google warrant a closer look. Targeted toward older children who already can read, the Rumie educational tablet is essentially a "library on a chip." It is low-cost, lightweight, updatable, trackable, and does not depend on an internet connection. Content can be adapted to age and learning level, tailored to local context, and continually updated. Purchased by NGOs and then delivered via in-country programs that already have local buy-in, Rumie is one of five Google prize winners for Canadian nonprofits. A seven-country evaluation in 2016 shows that students who

used the tablets had improved math and reading abilities and teachers experienced increased efficiency and ability.[27]

Since 2013 Google also has been funding Pratham Books to encourage reading. Through the Storyweaver initiative, it provides an open source platform to share and translate books. It launched in India, where as many as 30 languages are spoken. Now with books in 60 languages and the ability to post new stories, the platform integrates Google Translate, transliteration tools, and Google volunteers to improve the translation. The goal is to provide 200,000 titles for 500,000 users.

The tablet-focused, private Bridge International Academies—470 schools in five low-resource countries—was launched with funds from Mark Zuckerberg and Bill Gates, among others. The schools provide teachers with tablets to guide them through scripted lessons and track their own and their students' progress, adapting accordingly. A 2017 interim study covering a four-month period shows that Bridge K-2 students in Liberia are performing better across all literacy and numeracy metrics, reading faster and better, and solving basic math problems more quickly. The successes also are attributed to longer school days, teacher training and monitoring, standards aligned with learning, and the technology-enabled teacher program, as well as significantly higher expenditures per child.

"Any of these aspects could be implemented in traditional public schools, providing us with plausible models for improving all public schools across the country," notes George Kronnisanyon Werner, Liberia's Minister of Education. That said, the comparison government schools are plagued by lack of teachers and resources; critics suggest that almost any intervention would result in improved scores. A full impact study of Bridge is expected later in 2017.[28] These high-profile schools receive significant support from country governments, the U.S. and British governments, and the World Bank. They often generate controversy regarding privatization of schools and have come under fire in Uganda for low-quality work. While the cost may sound low—$54-$126 per year per student—school fees are often the first expense to be cut in struggling families' budgets.

Some studies effectively demonstrate the potential of digital technology, but are limited in scope. For example, Education Development Center, Inc., a global NGO, launched "Time to Learn" in Zambia, a suite of technology-enhanced training, coaching, and assessment tools for primary teachers to improve reading instruction. It produced significant increases in reading ability among both boys and girls, with strongest results in the areas where teachers were applying the tools and practices from their training. It also connected communities with services to counter the impact of poverty and HIV/AIDS on children's learning.[29]

Ideally the future will bring long-term investments that capitalize on the potential and bring the best programs to sustainable scale.

Ten Things We DO Know—Or DO We?

1. Use of technology in schools will only expand. Despite the partial, lukewarm, or inconclusive research results, enthusiasm for technology as a tool to improve education only grows. The potential is undeniable. Mobile devices have innate characteristics that seem to make them ideal learning tools—with math, devices offer computational sophistication; with literacy, devices offer access to libraries of

content, updateability, and capacity to integrate local content. When the devices are present, they seem to jumpstart a more interactive classroom dynamic, with small groups using the same device and producing more student-to-student and student-to-teacher interactions. Signs abound that young people are hungry for education and increasingly familiar with using mobile devices. Education is a priority for young people, as a multi-country study from Uganda, Morocco, Ghana, and Maharashtra in India shows: The only things more important are family and health. And 63 percent of the young people involved in the study believe they could learn using even the most basic of mobile devices. Still, one out of every five youths feels that there is a lack of learning services and information available to them. Fully 63 percent said they could see the potential to use their mobile for learning and accessing educational content. Youth in India were only slightly less enthusiastic, with 52 percent of young people saying that they could envision learning via their phones. Interestingly, 69 percent of Indian youth said the reason they do not have a phone is "no need," though just 10 percent of Moroccans felt the same. For many, mobile learning was seen as a way to get a new or better job (56 percent in Ghana and Uganda), learn a language (50 percent in India), and to read material or books (19 percent overall). [30]

Still, opposition persists. Many parents, teachers, and some students tend to view mobile technology as out of place in education and potentially harmful to students, or at best a distraction.[31] This is especially true in the Middle East and Africa, and particularly regarding girls. In Uganda, UNESCO reports that family disapproval is the reason more than a quarter (28 percent) of youth give for not owning a phone (27 percent in Morocco and 25 percent in India). Researchers studying mobile phone use in Ghana, Malawi, and South Africa in 2015 pointed out the downsides of mobiles in education. "Negative impacts included academic performance affected by disrupted classes, due not only to pupil practice, but also to teachers' calls; disruptions in adolescent sleep patterns associated with cheap night calls; time lost through prolonged sessions on social network sites; harassment and bullying; and increasingly widespread access to pornography."[32]

2. Context matters. Most educators will agree that any discussion of how to make an impact on education and learning must include the fundamentals: The inputs to a child's education are myriad and part of a complex and dynamic context. To be successful, any reform must engage the whole system.[33]

Technology doesn't drive progress; it simply amplifies and responds to existing affordances. As Kentaro Toyama writes in *The Atlantic*, "Technology's primary effect is to amplify human forces, so in education, technologies amplify whatever pedagogical capacity is already there."[34]

Mobile learning researcher Matthew Kam, now at Google, calls for improved understanding of learning and technology. "Only by developing a science of how people learn, with *and* without technology, can we understand how technology facilitates improved learning outcomes, and more importantly, those factors that enable these positive outcomes (or not) to be replicated in other contexts.[35]

The use of radio in schools may be instructive. Decades ago, when educators brought "interactive radio instruction" (broadcast lessons enhanced by teacher inputs) into schools, the radio was understood to be the conveyor, not the focus, of the intervention. Programs were in local language. The focus was the content and teacher training in interactive approaches. Radios were embedded in community life. These programs have consistently been shown to increase learning over time. [36]

The context can pave the way for success or failure. Research consistently indicates that mobile learning is most effective when embedded in ongoing technology-oriented activities, such as mixing sports

information with educational information. This might mean embedding short informational sections during half-time breaks in a football game listened to on a mobile.[37] In the United States at least, interventions that are imbedded in a comprehensive, sequenced plan, are more likely to succeed.[38] On the flip side, mobile learning has an uphill battle in the critically stressed climate of schools in low-resource countries with their high staff turnover, low budgets, poor attendance, and absent or unreliable electricity.

3. Devices alone cannot guarantee educational progress. A 2014 report on 83 studies, funded by DFID, concludes, "Edtech programmes should focus on enabling educational change, not delivering technology."[39] Findings from the 36-country OLPC delivery capture the same message: The effort produced no significant improvements in math and language test results for children who had the devices. A 2013 study in Uruguay concluded that there was no impact of the OLPC program on the test scores in reading and math and that the use of the laptops was mostly recreational, with only 4.1 percent of the laptops being used "all" or "most" days in 2012. "The absence of effect could be explained by the fact that the program did not involve compulsory teacher training and that laptops in class were mainly used to search for information on the internet," note the Uruguay researchers. [40] In Peru, however, some gains in cognitive ability were measured. The initiatives were continually limited by machine theft and disrepair, intermittent electricity, and poor internet connections.

4. Devices are catalysts for reading. Books and textbooks are still hard to find in the lowest-resource countries, and tablets and smartphones are increasingly supplying content.[41] The International Federation of Library Associations and Institutions vouches for the "motivational influence" of technology-delivered content and encourages educators to see it as a positive in promoting reading.[42]

In 2014 Nokia, UNESCO, and Worldreader joined forces to survey 4,000 mobile-phone users in Ethiopia, India, Kenya, Nigeria, Pakistan, and Zimbabwe about the use of their devices for reading. They found that people read more when they read on mobile devices and that young people like reading books on mobiles, both among those with negative and positive pre-existing attitudes toward reading. With the low cost and portability of mobile devices, adults report reading books and stories to children from mobile devices. (See below for distinctive findings about women readers.)

While noting that "deriving meaning from text is a deeply complex act that does not happen through exposure alone," the authors add, "It is a skill that needs to be taught and practiced, again and again and again. It is UNESCO's hope that mobile reading will be integrated into broader educational systems that teach people how to use text productively—from access to comprehension, and all the stages in between."[43]

Worldreader, founded in 2010 to use technology to deliver books and other content, works with a variety of governments, nonprofits, local agencies, and corporations, notably Amazon, which produces the Kindle tablet. Worldreader has distributed about 25,000 preloaded Kindles to 160,000 people in 12 sub-Saharan African countries. David Risher, founder of Worldreader, believes that providing reading materials is a profound start: "It really is the best way to get books into people's hands where the physical infrastructure isn't very good, the roads are bad, gas costs too much . . . but you can beam books through the cellphone network just like you can make a phone call—and that's really the thing that changes kids' lives." [44]

Worldreader's efforts are showing some impact on learning. In its first test, funded by the U.S. Agency for International Development at six schools in Ghana starting in 2010, the group found that primary-school students (grade 2) who used Kindles (at a cost of 50 cents each) increased their performance on standardized reading tests from about 13 percent to 16 percent. [45] The e-readers contained culturally and age appropriate reading materials in both local language and English. In a follow-on program, Worldreader conducted a randomized evaluation that showed students in the e-reader program more than doubled their comprehension score and improved in oral reading.

Africa Storybook, a nonprofit, provides open-license, age appropriate, local-language picture books to the youngest students and has begun experimenting with projecting books on screens and mobile delivery. It has succeeded in delivering volume and scope—more than 100 languages of often locally developed content using a wide array of partners. Books are available via a website and can be printed. According to implementing agency Saide, the program has collaborated with 30 partner organizations to implement in schools and libraries, integrate teacher education, and use websites, story donation, and story republishing. The project is in the pilot phase. [46]

5. Teachers matter. Strong content and skilled teachers lead to improved learning, whether they are using technology or not. Even with the growing sentiment that "teachers who can be replaced by a computer, should be," most countries' education models are grounded in pupil-teacher interaction. The goal of the majority of mobile reading programs is to supplement the established education program. DFID, the United Kingdom's international development agency, says, "Provision of ICT [information and communications technology] in schools is only the first step. For ICTs to become a tool for improving teaching and learning . . . they need to be supplemented by teacher professional development."[47] A Michigan State University study recommends a teacher training program that both uses and teaches with technologies, the establishment of a pedagogical foundation for e-learning to assist teachers in integrating it into their teaching, ongoing support for teachers, and means for educators to join a community of practice.[48]

Across the Philippines, the Text2Teach program combines improved pedagogy and instructional materials with training teachers to use technology to improve teaching and learning. Supported by Nokia, Pearson, International Youth Foundation, UN Development Programme, and Globe Telecom, the program has shown significant impact in improving the achievement rate (up 30-50 percent) and decreasing the dropout rate (down about 98 percent). "Key to the success of the program has been extensive teacher training for the use of the mobile technology to effectively and efficiently integrate the tool into their classroom practice."[49]

As Thomas Arnett of the Christensen Institute, a health and education think tank, writes, "The most powerful innovations for education in the developing world will likely come from blended-learning models that expand the reach and augment the effectiveness of the teaching force."[50]

That said, the results of Sugata Mitra's "hole in the wall" experiments in India's rural slums raise provocative questions about the fundamental role of the teacher. His experiment embedded computers in kiosks, invited children to figure out how they work, and then invited them to answer very complex questions without any supervision. Working without teachers, children quickly mastered the devices, (which they had never seen before), discovered internet browsing, and answered all questions the

experiment posed. A core finding of that work is that youngsters' successes emerged from interactive group work, not solo use.[51]

6. Funding models work against long-term impact. The typical funding model for mobile technology in schools is sporadic, short-term, and externally sourced, which makes it nearly impossible to achieve sustained impact. As UNESCO notes, "The majority of mobile learning projects in AME [Africa and the Middle East] were initiated by individuals or organizations backed by private corporations or donor agencies. These supply-side initiatives generally follow a predictable trajectory: an initial injection of funds and resources enables the project to be launched in a pilot phase; partnerships are established with additional stakeholders; monitoring and evaluation is occasionally included; project reports are produced, sometimes with recommendations for scaling up; promotional materials are distributed that suggest the pilot was successful; and after the pilot phase ends, resources are usually not available to sustain the project."[52] As the National Academy of Sciences says, it often takes a while to get the "recipe" right, and the cook needs to taste the meal and tweak it.[53] This requires time, pilots, repeated iterations, and ongoing measurement . . . and the funding to do it.[54]

Additionally, many studies identify a "novelty" effect at play. "Some critics will warn that it is only the novelty of the technology that has an impact on motivation and time on task, and thus learning gains cannot be attributed to the software or instructional approach. In such a situation, the novelty effect can be expected to wear off quickly, leaving students and teachers in the same instructional situation they were in earlier."[55]

One India study in 2002-2004 showed that having computers in class produced improvements in math knowledge and performance, but results dropped off after the study.[56] Research from the United States illustrates the frustration of incremental improvements. "Although overall effects seem to be positive, no single technology program produced consistent results."[57]

7. Content matters. Content, whether delivered via multimedia, print, lecture, radio, or other means, forms the heart of education. "Effective programs have clear curriculum focus, use of relevant curriculum materials, a focus on teacher development and pedagogy, and evaluation mechanisms that go beyond outputs," notes a DFID report.[58] Locally developed local-language content that is age appropriate and aligned with education goals is the gold standard. With their potential to be continually updated and refreshed, mobiles show great potential as we gain the ability to provide personalized content to meet students' specific needs.

8. National policies for integrating technology into education are necessary. Policies that support the use of mobile learning have not yet become commonplace, and without them programs come and go without connecting to the larger education infrastructure or strategy. In its Education Strategy 2014-2021, UNESCO prioritizes this point, noting that, "in most countries, policy challenges with regard to teaching quality, learning outcomes, school dropout, gender equality, socio-economic inequality and transition from school to work are inadequately addressed."[59]

Policy improvements, however, are not quick fixes—they usually depend on an interlocked set of improvements.[60] In a five-country (Jordan, Namibia, Rwanda, Singapore, and Uruguay) analysis of what constitutes a successful national ICT policy, UNESCO identified the essential ingredients: alignment with national goals, alignment with other education goals, use of ICT as a lever for changing other

components of the education system, incremental implementation over the long term, monitoring and evaluation components, professional development for teachers, financial support, and connection to the private sector.[61] For example, policies that eliminated school fees across Malawi produced enrollment surges, but no plan existed to hire more teachers, build more facilities, or provide next-level education, diminishing the impact of the fee change.[62] Similarly, national policies to decentralize education, like the ones Argentina imposed at the secondary level, had varying results depending on the quality of management at the district level. In well-managed districts, decentralization improved education; in poorly managed districts, the opposite was true.[63]

9. Gender matters. Many researchers have unearthed differences between men's and women's access to and use of mobile devices. Across 20 nations, men are more likely than women to use the internet, according to a 2016 Pew Research Center report.[64] While male users of mobiles for reading greatly outnumber women, there are signs that once women start reading on their phones, they are more engaged, read more, and read to their children. [65] In fact, UNESCO's seven-country study found that as use of mobile devices increases, "the gender balance tilts to a female majority for the most active readers across countries. Among the top 2,000 active readers, over 59 per cent are female; among the top 1,000 active readers, 72 per cent are female; and among the top 100 active readers, 80 per cent are female."[66] In South Asia, 72 percent of women are without a mobile phone; in sub-Saharan Africa, 64 percent; and in East Asia and Pacific, 54 percent.[67] A seven-country study (Ethiopia, Ghana, India, Kenya, Nigeria, Pakistan, and Zimbabwe) of reading on mobiles showed that male readers outnumber females, largely a function of phone ownership. Looking more closely, when women do read on mobile, they read significantly more than men—207 minutes a month versus 33 minutes. [68]

A "complex set of socio-economic and cultural factors" negatively affect women's ownership of phones, notes the GSMA, a mobile phone industry association. "Without targeted intervention from the mobile industry, policy makers and other stakeholders, the gender gap in ownership and usage is unlikely to close naturally on its own."[69] Noting that the industry stands to gain $170 billion in the next five years with increased female ownership, the association also notes that "substantial socio-economic benefits" would accrue.

10. Affordability matters. Phones are still out of reach for many. In Ghana, 24 percent of young people say that cost is the reason they don't own one (the number is 13 percent in India, 20 percent in Morocco, and 21 percent in Uganda). As one Ghanaian NGO told the GSMA Development Fund, "One of the key factors in getting uptake of services is to look at the pricing strategy and people's willingness to pay. Remember that students have no income. The economics are tricky in these low-income countries."[70] Even where phones are donated, service fees are too much for many who live in low-resource countries.

Now What? Where to Invest Over the Next 5-10 Years?

Development aid for education has been declining over the past several years, and may continue to do so. Yet the need persists. New players are needed, says the Brookings Institution, which calls for increased private investment in education in low-resource countries: "The private sector, who have most to gain (or lose) from weak education systems compounded by demographic shifts, should engage

more fully in solving this education crisis through a combination of funding and capability." Brookings notes that "corporate giving to global health is 16 times what it is to global education."[71]

Where would investments be most fruitful?

More Sophisticated Research

To effectively respond to the pressing need to improve education in low-resource countries, innovators and their supporters need a more sophisticated understanding of how people learn with and without technology as well as knowledge about what has and has not been achieved already to avoid repetition of mistakes or duplication of effort. Many experts and organizations are joining the movement to get serious about research. USAID and its partners in the Mobiles for Education Alliance issued a call in 2016 for increased funding for "research concerning the use of education technology in the developing world to support learning gains in schools," noting that "ministries of education are faced with a lack of evidence about which innovations actually yield education outcomes."[72]

Surrounding issues must be examined as well. "To better understand the efficacy of using touch screen tablet technology to raise pupil learning outcomes, research is needed that focuses not only on pupil learning outcomes, but also on critical aspects of implementation, such as teachers' use of and attitudes toward tablet technology and the embedding of tablet technology within the country's education system," according to the 2016 Mobiles for Education Alliance report. [73] Continued teacher training and long-term financial support would be essential to maintain these results, others note. [74]

Continued Rigorous Analysis

Continual analysis and sharing of best and most promising practices will advance our understanding of how/when technology is relevant for teaching and learning. Trucano, among others, bemoans the loss of intelligence in reports that are never published, translated, or shared among interested professionals. This may include exploring the experiences of the more highly resourced countries.[75] By developing a more sophisticated understanding of which if any of those lessons apply to low-resource countries, we may be able to accelerate progress.

Mechanical and Utility Improvements

Significant progress has been made in broadening the availability of electricity and internet. Hundreds of millions have gained electricity in the last 20 years, especially in China and India, largely in urban areas. The major investments underway by electricity companies, donors, lenders, and governments must continue, such as the 2017 opening of Africa's largest windfarm at Lake Turkana and the 2016 operationalization of the world's largest solar plant in Morocco.

Higher-Quality, Diversified, and More Targeted Content

Mobile devices' versatility, storage capacity, and ease of updating make them ideal containers for content. Continued growth in locally developed, relevant content in local languages is a necessity. Interestingly, GSMA, the mobile operators' industry association, calls upon its members to take the lead here. In a report on the importance of local content, GSMA notes, "For emerging markets in particular, mobile operators are well placed to effect change given their network assets, local presence and increasing involvement with entrepreneurial hubs, and trusted relationship with consumers."[76] While the report was not discussing educational content, the point applies.

Teacher Training

As EdTech innovator Wayan Vota notes, "Tablets are good, content is better, and teachers are the best educational ICT investment."[77] Far too many schools have too few and/or underprepared teachers, and low teacher pay and attendance plague many low-resource countries. Not only are more teachers needed, but better-trained teachers. The presence of technology often serves to jumpstart more interactive approaches in class, and the more engaged and skilled a teacher, the more he or she can contribute to the success of mobile innovations. "Teacher training and continued, on-going, relevant professional development for teachers are essential if benefits from investments in ICTs are to be maximized," writes World Bank's Trucano. Without it, he adds, technology can potentially improve the performance of highly-skilled teachers while overwhelming less-skilled teachers.

Teachers are on the frontlines of the infusion of technology into schools. "The mass introduction of devices directly into the hands of students can be very disruptive—and teachers will need to be supported as they manage their way through," adds Trucano.[78]

Promising Programs Brought to Scale

The role of donors is not only to supply financial support. Well-informed donors "can help policy makers answer some basic questions before they choose to adopt new gadgets," notes Devex, a media platform for global development. "For instance, donors can help policy makers clarify their objectives, what content and technology they already have in place, and how the impacts of new technology could be measured."[79] With donors insisting on applying lessons learned, scale becomes more possible.

The Mobiles for Education Alliance, which coordinates and connects players in the private, government, foundation, research, and donor realms, could play a transformative role.

Broader Application of Technology in Schools

This paper has focused on the use of technology among students and teachers for learning. But the entire school ecosystem is primed for technological tools for management, training, storage of materials, and record keeping. "Educational ICTs also offer the possibility of game-changing improvements to school governance, curricular reform, and teachers in the education systems. Among other efficiencies, the introduction of ICT could lower the cost of implementing student learning assessments and better link the results to both teacher development and the allocation of education resources."[80]

Conclusion

In 1989, "futurist" educators wrote on a then-esoteric question: What impact will the introduction of instructional technologies—still far off in the future—make on education? Their conclusion was prescient: "Advances occur only insofar as they are accepted, understood, and used by teachers."[81] That truth is at the heart of all subsequent findings about the use of technology in schools. Technology isn't a substitute for teaching, and it isn't an asset in itself. It is instead a supplement to what educators worldwide know works: a holistic approach to teaching and learning that positions teachers to engage with the right tool at the right time with the student who needs it. With that, mobile learning can succeed anywhere.

Endnotes

[1] UNESCO. Reading in the Mobile Era. UNESCO. 2014.
[2] UNESCO. Education for People and Planet: Creating Sustainable Futures for All, Global Education Monitoring Report. UNESCO. 2016.
[3] UNESCO, 2014.
[4] Zell H. Publishing in Africa: Where Are We Now? *LOGOS*. 2008.
[5] Fredriksen BJ, Brar S, Trucano M. *Getting Textbooks to Every Child in Sub-Saharan Africa: Strategies for Addressing the High Cost and Low Availability Problem*. The World Bank. 2015.
[6] International Telecommunications Union. Measuring the Information Society Report. International Telecommunications Union. 2016.
[7] Poushter J. Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies. Pew Research Center. February 22, 2016. Retrieved from http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/.
[8] Statistica.com. Retrieved from https://www.statista.com/topics/841/tablets/. November 29, 2017.
[9] Trucano M. Big Educational Laptop and Tablet Projects—Ten Countries to Learn From. EduTech: A World Bank Blog. July 31, 2013.
[10] International Energy Agency. Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa. International Energy Agency. 2014.
[11] Tamim RM, Borokhovski E, Pickup D, Bernard RM. Large-Scale, Government-Supported Educational Tablet Initiatives. Commonwealth of Learning. 2015.
[12] Cristia JP, Ibarraran P, Cueto S, Santiago A, Severin E. Technology and Child Development: Evidence from the One Laptop per Child Program. IDB Working Paper Series No. IDB-WP-304. Inter-American Development Bank Department of Research and Chief Economist. February 2012.
[13] Power T. Educational Technology Topic Guide. Health & Education Advice & Resource Team. October 2014.
[14] UNESCO, 2014.
[15] Hubber PJ, Outhwaite LA, Chigeda A, McGrath S, Hodgen J, Pitchford NJ. Should Touch Screen Tablets Be Used to Improve Educational Outcomes in Primary School Children in Developing Countries? *Frontiers in Psychology*. 2016; 7:839. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4893577/.
[16] Habler B, Major L, Hennessy S. Tablet Use in Schools: A Critical Review of the Evidence for Learning Outcomes. *Journal of Computer Assisted Learning.* 2015; 32:139–156.
[17] Toyama K. Why Technology Alone Won't Fix Schools. *The Atlantic*. June 3, 2015.
[18] USAID. Evaluating the Impact of ICT4E Interventions Concept Note and Background Research. USAID. February 13, 2015.
[19] Tamim et al., 2015
[20] Trucano, 2013.
[21] Snilstveit B, Stevenson J, Menon R, Phillips D, Gallagher E, Geleen M, Jobse H, Schmidt T, Jimenez E. The Impact of Education Programmes on Learning and School Participation in Low- and Middle-Income Countries. International Initiative for Impact Evaluation. September 2016.
[22] Tamim et al., 2015.
[23] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Landscape Review Mobile Education for Numeracy. Evidence from interventions in low-income countries. 2014.

[24] Muralidharan K, Singh A, Ganimian AJ. Disrupting Education? Experimental Evidence on Technology-Aided Instruction in India. July 20, 2017. Retrieved from http://econweb.ucsd.edu/~kamurali/papers/Working%20Papers/Disrupting%20Education%20(Current%20WP).pdf.

[25] British Council. Remote In-Service Teacher Training for English. September 2017. Retrieved from https://www.britishcouncil.co/en/about/english-education-solutions/success-stories/remote-in-service-teacher-training-english.

[26] World Bank. September 2017. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTEDUCATION/0,,contentMDK:23704574~menuPK:282428~pagePK:64020865~piPK:51164185~theSitePK:282386,00.html.

[27] Moon C, Kavanagh A, Jeffrey J, Gebbels J, Korsgaard K. Social Entrepreneurship and Disruptive Innovation: Evaluating the Use of Rumie's Free Educational Software in Seven Developing Economies. European Conference on Innovation and Entrepreneurship. Academic Conferences International Limited. September 2016.

[28] Bridge International Academies. Learning in Liberia: Mid-Year Gains in Literacy and Numeracy. A Pilot Study on Bridge Partnership Schools for Liberia (PSL). 2017.

[29] USAID. Vernacular Evaluation Report: A Cost-Effectiveness Study of ICT in Zambian Community Schools. Undated.

[30] GSMA Development Fund. Shaping the Future—Realising the Potential of Informal Learning Through Mobile. 2012.

[31] Porter G, Hampshire K, Milner J, Munthali A, Robson E, DeLannoy A, Bango A, Gunguluza N, Mashiri M, Tanle A, Avane A. Mobile Phones and Education in Sub-Saharan Africa: From Youth Practice to Public Policy. *Journal of International Development.* 2016; 28:22–39. Wiley Online Library. June 11, 2015.

[32] Ibid.

[33] McEwan PJ. Improving Learning in Primary Schools of Developing Countries: A Meta-Analysis of Randomized Experiments. *Review of Educational Research*. September 2015; 85:353–394. Retrieved from http://academics.wellesley.edu/Economics/mcewan/PDF/meta.pdf.

[34] Toyama, 2015.

[35] Kam M. References on Mobile Learning. Blog entry retrieved from http://matthewkam.org/references-on-mobile-learning/. 2013.

[36] Anzalone S, Bosch A. Improving Educational Quality with Interactive Radio Instruction: A Toolkit for Policymakers and Planners. Africa Region Human Development Working Paper Series; No. 52; Africa Regional Educational Publications. The World Bank. 2005. Retrieved from http://documents.worldbank.org/curated/en/288791468035958279/Improving-educational-quality-with-interactive-radio-instruction-a-toolkit-for-policymakers-and-planners.

[37] GSMA Development Fund, 2012.

[38] Dicerbo K, Francisco A, Saxberg B, Uncapher M. Analysis: For Ed Tech that Actually Works, Embrace the Science of Learning. Blog entry retrieved from https://www.the74million.org/article/analysis-for-ed-tech-that-actually-works-embrace-the-science-of-learning. 2017.

[39] Power, 2014.

[40] deMelo G, Machado A, Miranda A. The Impact of a One Laptop per Child Program on Learning: Evidence from Uruguay. Banco de Mexico Working Papers; No. 2014-22. 2014.

[41] UNESCO, 2016.

[42] Doiron R. Using E-Books and E-Readers to Promote Reading in School Libraries: Lessons from the Field. World Library and Information Congress: 77th IFLA General Conference and Assembly. 2011.

[43] UNESCO, 2014.

[44] Quoted in Neary L. E-Readers Mark a New Chapter in the Developing World. National Public Radio. December 2, 2013.
[45] Worldreader. Ghana iREAD Study: 2012-2014 (iREAD2) Final Evaluation. November 2014. Retrieved from https://comms.worldreader.org/wp-content/uploads/2017/01/iREAD-Full.pdf?x80235.
[46] McIlwraith H, ed. Language Rich Africa—Policy Dialogue. The Cape Town Language and Development Conference: Looking Beyond 2015. British Council. 2014.
[47] Tikly L. Implementing Education Quality in Low Income Countries. UK Department for International Development. Edqual Final Report. 2011.
[48] Olson JM, Codde J, deMaagd K,Tarkelson E, Sinclair J, Yook S, Egidio R. An Analysis of e-Learning Impacts & Best Practices in Developing Countries with Reference to Secondary School Education in Tanzania. 2011. Retrieved from https://www.researchgate.net/publication/272682458_An_Analysis_of_e-Learning_Impacts_Best_Practices_in_Developing_Countries_With_Reference_to_Secondary_School_Education_in_Tanzania.
[49] Cristano Y. Text2Teach: What We've Learned from a Decade of Mobile Learning in Primary Schools in the Philippines. 2014. Retrieved from http://www.unesco.org/new/en/unesco/themes/icts/m4ed/unesco-mobile-learning-week-2014/symposium/breakout-sessions/text2teach/.
[50] Arnett T. The Economics of Educational Nonconsumption in the Developing World. 2015. Retrieved from https://www.christenseninstitute.org/blog/the-economics-of-educational-nonconsumption-in-the-developing-world/.
[51] Hole-in-the-Wall Education Project website.
Mitra S. The Child-Driven Education. TED Talk. 2010.
[52] UNESCO. Turning on Mobile Learning: Global Themes. UNESCO. 2012.
[53] Bransford JD, Brown AL, Cocking RR, eds. *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. Chapter 9: Technology to Support Learning. The National Academies Press. 2000. Retrieved from https://www.nap.edu/read/9853/chapter/13.
[54] Dicerbo et al., 2017.
[55] GSMA Development Fund, 2012.
[56] Banerjee A, Cole S, Duflo E, Linden L. Remedying Education: Evidence from Two Randomized Experiments in India. 2007. Retrieved from https://economics.mit.edu/files/9907.
[57] Strigel C, Pouezevara S. Mobile Learning and Numeracy: Filling Gaps and Expanding Opportunities for Early Grade Learning. RTI International. 2012.
[58] Power, 2014.
[59] UNESCO. Education Strategy 2014-2021. UNESCO. 2014.
[60] Tiongson ER. Analyzing the Distributional Impact of Reforms: A Practitioner's Guide to Trade, Monetary and Exchange Rate Policy, Utility Provision, Agriculture Markets, Land Policy, and Education, in *Education Policy Reforms in Analyzing the Distributional Impact of Reforms,* Coudouel A, Paternostro S, eds. The World Bank. 2005.
[61] UNESCO. Transforming Education: The Power of ICT Policies. UNESCO. 2011.
[62] The World Bank. Abolishing School Fees in Africa: Lessons from Ethiopia, Ghana, Kenya, Malawi, and Mozambique. 2009.
[63] Galiani S, Schargrodsky E. 2002. Evaluating the Impact of School Decentralization on Educational Quality. *Economía.* 2002; 2:275–314.
[64] Poushter, 2016.
[65] UNESCO, 2014.
[66] Ibid.

[67] GSMA Development Fund. Bridging the Gender Gap: Mobile Access and Usage in Low- and Middle-Income Countries. 2015.
[68] UNESCO, 2014.
[69] GSMA Development Fund, 2015.
[70] GSMA Development Fund. Accelerating Affordable Smartphone Ownership in Emerging Markets. 2017.
[71]Winthrop R, Bulloch G, Bhatt P, Wood A. Investment in Global Education: A Strategic Imperative for Business. Brookings Institution. 2013.
[72] Mobiles for Education Alliance. A Call to Action: Funding for the Evaluation of Educational Technology. 2016.
[73] Ibid.
[74] Hubber et al., 2016.
[75] Bransford et al., 2000.
[76] GSMA Intelligence. Local World—Content for the Next Wave of Growth. September 2014.
[77] Vota W. Tablets are Good, Content is Better, and Teaches are the Best Educational ICT Investment. Educational Technology Debate: Exploring ICT and Learning in Developing Countries. April 2011.
[78] Trucano M. Teachers, Teaching and ICTs. EduTech: A World Bank Blog on ICT Use in Education. Nov. 15, 2013.
[79] Tyson J. How to Get Education Technology Right. Devex. April 6, 2016.
[80] Tiwari G. How Can Educational ICT be Relevant to the Poorest of the Poor? Educational Technology Debate. April 2014.
[81] Farrell JP, Heyneman SP, eds. *Textbooks in the Developing World: Economic and Educational Choices*. Economic Development Institute of the World Bank. 1989.