All Children Reading–Philippines

EdTech Ecosystem Report: Philippines

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<td>artificial intelligence</td>
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<td>ALS</td>
<td>Alternative Learning System</td>
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<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
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<td>B2C</td>
<td>business to consumer</td>
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<td>B2G</td>
<td>business to government</td>
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<td>CHED</td>
<td>Commission on Higher Education</td>
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<td>CPD</td>
<td>continuing professional development</td>
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<td>DCP</td>
<td>DepEd computerization Program</td>
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<td>DepEd</td>
<td>Department of Education</td>
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<td>DICT</td>
<td>Department of Information and Communications Technology</td>
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<td>DOST</td>
<td>Department of Science and Technology</td>
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<td>EdTech</td>
<td>education technology</td>
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<td>ELLN</td>
<td>early language, literacy, and numeracy</td>
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<td>FIT-ED</td>
<td>Foundation for Information Technology Education and Development, Inc.</td>
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<td>GDP</td>
<td>gross domestic product</td>
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<td>ICT</td>
<td>information and communication technology</td>
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<td>ICTS</td>
<td>Information and Communication Technology Service</td>
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<td>K</td>
<td>kindergarten</td>
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<td>ISCOLE</td>
<td>Inter-School Computerized Operation Link Environment</td>
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<td>LGU</td>
<td>local government unit</td>
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<td>LRMDS</td>
<td>Learning Resource Management and Development System</td>
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<td>NEAP</td>
<td>National Educators Academy of the Philippines</td>
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<td>OER</td>
<td>open educational resources</td>
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<td>PhP</td>
<td>Philippine peso</td>
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<td>PISA</td>
<td>Programme for International Student Assessment</td>
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<td>PLDT</td>
<td>Philippine Long Distance Telephone Company</td>
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<td>Philippine Professional Standards for Teachers</td>
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<td>Philippine Regulatory Commission</td>
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<td>PTA</td>
<td>parent-teacher association</td>
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<td>SAMR</td>
<td>Substitution, Augmentation, Modification, Redefinition model of technology adoption</td>
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<td>SDO</td>
<td>Schools Division Office</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>SEI</td>
<td>Science Education Institute</td>
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<td>TECH4ED</td>
<td>Technology for Education, to gain Employment, train Entrepreneurs toward Economic Development</td>
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<td>TEI</td>
<td>teacher education institution</td>
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<td>TIMSS</td>
<td>Trends in International Mathematics and Science Study</td>
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<td>UNESCO</td>
<td>United Nations Educational, Scientific, and Cultural Organization</td>
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<td>United Nations Children’s Fund</td>
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About the authors

Patricia B. Arinto is a professor of e-learning and distance education at the University of the Philippines (UP) Open University and dean of the UP Visayas–Tacloban College. She was deputy principal investigator of the Research on Open Educational Resources for Development in the Global South project funded by the International Development Research Centre of Canada from 2013 to 2017, and team leader of the USAID-funded national assessment of the state of information and communication technology (ICT) in basic education in the Philippines in 2012.

Liezl F. Dunuan has over 13 years of experience in the field of ICT in education in the Philippines. From 2003 to 2015, she worked as a program manager with FIT-ED, handling different ICT in education programs by the foundation, in partnership with private companies such as the Coca-Cola Company and Intel Corporation. Part of her work with FIT-ED included setting up monitoring and evaluation systems for programs and research on the impact of ICT in education at different levels. She currently heads up programs in a local technology start-up company called Connected Women and writes features for a local online magazine.

Monalisa T. Sasing is a science education specialist at the National Institute for Science and Mathematics Education Development of UP. She worked with professional development programs encouraging the use of technology in the teaching of science and mathematics. She headed the development and implementation of the Intel® Teach Pedagogical Support System that was set up to provide instructional support to teachers trained on ICT integration under the Intel® Teach Program. She has been involved in several research activities related to assessment of teacher proficiency in science and math, use of technology in the classroom, and the influence of lesson study on teachers’ pedagogical content knowledge. She has also served as Philippines’ data entry manager for Trends in International Mathematics and Science Study (TIMSS) 2004 (Grade 4) and TIMSS Advanced 2008 and, recently, the international quality control monitor for the Philippines for TIMSS 2019.
**Executive Summary**

This report is an analysis of the education technology (EdTech) ecosystem in the Philippines. This report seeks to identify opportunities for EdTech alternatives to help the Philippines break away from the status quo in teaching and learning. It will contribute to ongoing policy review and curricular reforms intended to improve country-wide achievement in basic education. The information was gathered by a team of researchers from the Foundation for Information Technology Education and Development, Inc. (FIT-ED), and RTI over the course of four months in the second half of 2019. The study team interviewed over 50 key informants from government, civil society, and the private sector and visited schools, consulted relevant documents, and administered a large survey, all designed to answer the questions: what technology is being used in education, how is it being promoted and adopted, what are the effects, and how can good practices be scaled up? The result is the following ecosystem profile, based on the Scaling Equitable Education Technology (EdTech) Ecosystem Model published by Omidyar Network, now Imaginable Futures,¹ in 2019 (Omidyar Network, 2019a). The slices of the model that are larger indicate components that are particularly influential right now in the Philippines (Exhibit 1), notably:

- There are school-specific networking infrastructure initiatives for affordable, reliable school connectivity. [Enabling Infrastructure]
- Education curriculum and policy include expectations for basic technology literacy for all teachers and students. [Education Policy]
- Nongovernment coalitions and advocacy groups support quality EdTech scale-up. [Human Capacity].
- Mutually beneficial, cross-industry, public and private sector partnerships support access to, use of, and impact of EdTech products and services. [EdTech Supply and Business Models].

**Exhibit 1: EdTech ecosystem profile: Philippines**

The profile of EdTech use in the Philippines is one of strong government support for technology in education, but this support is largely articulated in the form of hardware provision to schools. The prevailing model of classroom integration is **learning about technology** (i.e., digital literacy to prepare for the information age workforce) or **teaching with technology** (i.e., digitizing lesson plans to move from chalkboard to projector), but not **learning with technology**.

Despite a notable absence over several decades of a broad vision and strategy for information and communication technology (ICT) in education (Vergel de Dios, 2016), there are many efforts by a range of

¹ See [https://www.imaginablefutures.com/](https://www.imaginablefutures.com/) for more information.
stakeholders, independently and in partnerships or coalitions, to create opportunities for children to use technology in school. Similarly, many organizations are involved in teacher training, but the content and focus of these trainings is not coordinated under the umbrella of a clear set of standards for what technology integration looks like and what teachers need to know and do to achieve that standard. At present, there is strong support for connecting last-mile schools and harnessing technology for out-of-school youth. Yet the focus remains hardware provision and improving internet connectivity or finding offline solutions for general digital pedagogy. There is not a large market for subject-specific EdTech software or personalized learning applications. There is a growing market for content management systems, and content repositories with curriculum-aligned resources, but this commercial sector will have to compete—ideologically and financially—with the government’s own open educational resources (OER) movement. The Philippines Department of Education (DepEd) has launched the “Digital Rise” campaign that includes providing offline-accessible OER with every school computer delivery, along with training on how to create custom digital resources. Whether this Digital Rise is the new official vision and strategy for ICT in education, and whether DepEd will be given the leadership and authority to coordinate EdTech across the country, remains to be seen.

As emphasized in the original Omidyar Network (2019a) report, there is no “right” EdTech ecosystem profile; each country will have a unique pathway on the journey to scale. However, it is likely that when all components are active and interacting in a complementary way toward the shared goal of scaling equitable access, then impact at scale will be reached sooner. Several recommendations emerge from this profile analysis that may move the country in the direction of a stronger EdTech ecosystem consistent with the ambitions of the national development plan Ambisyon Natin 2040 and the most recent DepEd strategic thrust: Sulong EduKalidad.

- EdTech needs a strong central vision and strategy, if not a dedicated coordinating body. This will help align inputs from a range of partners for more impact. The strategy, if created, will need to be communicated widely and endorsed from the highest levels of government and across departments outside of education.

- The vision and strategy must shift from learning about technology and teaching with technology to learning with technology. The distinction is about harnessing the unique attributes of technology for subject-specific learning, increasing time on task, and personalizing the learning process. This should apply in particular to subjects that are hardest to teach and where student achievement has shown the least growth using traditional methods.

- Continue to invest in champions within schools and division leadership who can serve as role models in the spread of effective EdTech, but also ensure that there are appropriate incentives and motivation for all teachers to develop their EdTech expertise as content developers, peer trainers, product reviewers, and policy advocates.

- Ensure that the Philippine Professional Standards for Teachers (PPST) include appropriate standards related to EdTech integration. The standards should clearly articulate degrees of technology integration using existing models, like the Substitution, Augmentation, Modification, Redefinition (SAMR) model of technology adoption, that push teachers towards more transformative use of technology for learning rather than simply digitizing teacher-driven lessons.

- Training investments should focus on transformative use of technology, including identifying needs, selecting products, integrating technology for personalized learning, and leveraging the attributes of technology to create new opportunities for higher-order thinking and increased time on task. Teachers should be incentivized to participate in training programs both formally and informally. Teachers should improve their own digital literacy by using technology in their work for administration,
reporting, communication, and other general tasks, improving through peer learning and school-based support rather than direct training.

- School leaders—school principals and IT coordinators—should be capacitated to take a lead role in building teaching capacity, setting expectations for technology use, supporting rapid-cycle evaluation of technology benefits, selecting products for use, and more. The guidelines and standards set at the central level should guide school leaders in setting and monitoring these expectations, as well as formal training programs that build EdTech leadership capacity.

- Improving marketing and distribution channels for both open educational resources and commercial products will help teachers find existing resources that meet their needs before embarking on new digital lesson development. Additionally, teachers who have invested in digital resources should have a channel for sharing these with other teachers after an efficient process of quality control. There are several options: add a new section to the current learning resources portal for interactive, digital resources; create a new portal for digital resources; or support an independent organization to manage a clearinghouse of products.

- More independent evaluation of what works, for whom, and under what circumstances needs to be coupled with efficient ways of communicating results and empowering teachers to act upon those findings.

A large survey of Division and School IT Coordinators and teachers completed for this study indicated that the goal of ICT integration for many division and school ICT coordinators is to make the work of teachers and staff easier and more efficient. Teachers additionally want EdTech that will improve student engagement. To meet these goals, communications and sharing of resources is critical, but there must be a balance between coordination and adding bureaucracy and extra effort. Strong central leadership can help define the goals and standards but must leave actual implementation to decentralized government and civil society actors. Ensuring that feedback loops back to the central level will help the leadership continue to monitor the strategy, initiate resource appeals to fill identified gaps, and communicate credible evidence of what works.

Introduction

About this Study

This study was prepared on behalf of the United States Agency for International Development (USAID), at the request of the Undersecretary for Administration (Alain Del Pascua) of the Philippines Department of Education (DepEd). This ecosystem analysis of information and communication technologies (ICT) in education in the Philippines is based on the Scaling Equitable Education Technology (EdTech) Ecosystem Model published by Omidyar Network, now known as Imaginable Futures, in 2019 (Omidyar Network, 2019a). The goal is to discover models of EdTech in use and understand what factors are driving—or preventing—scale-up of promising EdTech initiatives. Using the ecosystem model, we aim to identify the current interactions among ecosystem components and determine whether there are components or relationships that could benefit from strengthening, or whether the current enabling conditions are uniquely suitable to the Philippines context. As described in the Omidyar Network 2019 report “Scaling Access and Impact: Realizing the Power of EdTech”:

By adopting an ecosystem model, we are able to transition from a product-oriented approach designed to solve an individual user’s problem to a

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2 See https://www.imaginablefutures.com/ for more information.
systems-oriented approach that seeks to “enable the potential that is inside the ecosystem.” As such, strategic investment in ecosystem drivers, rather than restricting investments to individual products or actors, can ignite both local innovation and the networks and conditions needed to scale them. (p. 7)

In addition to creating this Philippines ecosystem profile, this report provides an in-depth look at specific, policy-relevant questions related to the components of the Equitable EdTech Ecosystem Model for the Philippines context. Four “Topic Briefs” were prepared as background:

- **EdTech supply and business models:** To support innovation and ensure equitable distribution of EdTech products and services, entrepreneurs (whether for-profit or nonprofit) need viable business models that produce consistent revenues, particularly in the early stages. These business models are sustained in a variety of ways—by consumer purchasing power, government procurement or grant programs, or private investment. *Philippines Topic Brief: Open Educational Resources and the Digital Resources Market.*

- **Enabling infrastructure:** There must be an ICT backbone sufficient to support the distribution and use of EdTech. This includes basic electricity, telecommunications infrastructure, and broadband internet access as well as certain networked administrative platforms and EdTech hardware access inside and outside of schools. *Philippines Topic Brief: Equitable Access and Reaching Last-Mile Schools.*

- **Education policy and strategy:** Scaling EdTech requires a clear vision and strategy that is articulated at the highest level of government and is backed by both durable legislation and equitable education financing. In addition, by setting standards for academic achievement, government incentivizes innovation at the school level, including with EdTech. *Philippines Topic Brief: EdTech Policy and Strategy over the Years.*

- **Human capacity:** Technology alone cannot solve the problem—a variety of stakeholders must collaborate to bring this vision to life. Key stakeholders include nongovernment coalitions, educators, and a range of transformational leaders at several levels of the system. *Philippines Topic Brief: Teacher Training in EdTech Integration.*

Additionally, Philippine researchers carried out case studies in two divisions where there are known examples of EdTech having grown to scale and been sustained over several years (*Annex 1*). Researchers consulted education stakeholders and observed EdTech in action to understand the key drivers of scale and use in the divisions. The simple, guiding research questions were: How did this EdTech program come to be? What has enabled it to expand and be sustained? What must other divisions do to replicate the positive impacts of the program?

Finally, a survey about ICT access and use in schools was distributed to division ICT coordinators who filled out the survey and also selected two elementary schools from their respective divisions to take the survey. From these schools the ICT coordinator and one teacher were invited to complete the survey. The response rate was 91.9% (or 205 out of 223 divisions). Of the target sample of 446 elementary schools and 446 elementary school teachers, 405 (90.8%) and 388 (87%), respectively, completed the survey. Some data from this survey are used in this report (Tinio and Pouzevara, 2019).

The division case studies, surveys, and broad ecosystem analyses that contributed to this report also resulted in several unique insights and recommendations, outlined in the

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3 Omidyar Network notes: A concept used in lean ecosystem development, a branch of Lean Startup, as described by Cicero in the Platform Design Toolkit. See Cicero Platform Design Toolkit: https://stories.platformdesigntoolkit.com/beyondcustomer-2acdf55b207d.
Conclusions and Recommendations section of this report, that DepEd and development partners may consider in an effort to improve learning outcomes through the use of EdTech.

**Why EdTech?**

Although introducing technology in basic education can be an *end in itself*—to prepare children with digital literacy for the 21st century workplace—EdTech can also be a *means to an end*. That end goal is improving learning outcomes in specific subject areas by transforming lesson delivery and interactivity in ways that traditional tools of the trade cannot. The basic premise is that if teachers continue to do what they have always done, they will always get the same results. The Philippines’ 2018 Program for International Student Assessment (PISA) results showed that the country was the lowest ranked participating country in reading, which leaves much room for improvement. However, decades of experience with integration of technology in education around the world has shown that simply providing technology is unlikely to have an effect on its own; what matters is how the technology is intentionally applied to the learning process. Computer-assisted learning, when deliberately applied to a specific subject matter, can have large effects on learning (Crawfurd & Hares, 2020). The question is not whether technology can make a difference, it is how best to align the hardware with the digital content or activities to the time and method of integration in the classroom. To navigate this question, Ruben Puentedura’s SAMR model (Substitution, Augmentation, Modification, Redefinition) of technology integration, which distinguishes different types of EdTech integration, from simple substitution to pedagogical transformation (see text box), is a useful frame (Puentedura, 2009, 2014).

### The SAMR Model

**Substitution:** Technology acts as a direct tool substitute, with no functional change. Examples: Teacher projects a digital version of notes that would have been written on the blackboard, a digitized textbook, computer-aided flash cards or quizzes for test preparation, learners write on a word processor rather than pen and paper.

**Augmentation:** Technology acts as a direct tool substitute, with functional improvement. Examples: A digital textbook that allows the reader access to definitions of words on click/touch, embedded multimedia resources visualize and contextualize concepts.

**Modification:** Technology allows for significant task redesign. Examples: Learners construct a digital brochure incorporating self-generated photos, learners co-construct a mind-map to deconstruct a concept using a mapping tool on an accessible online workspace.

**Redefinition:** Technology allows for the creation of new tasks, previously inconceivable. Examples: Using Google Earth to explore the topography of a distant location; participation in global citizen science experiments and online collaborative learning; learners co-produce an animated instructional video demonstrating a scientific concept, including on-demand foreign language subtitles.

**What Is the Evidence?**

While SAMR is clearly a linear categorization of degrees of complexity and task integration of technology, it also implies a linear degree of impact or desirability. The global evidence base is still emerging as to whether or not this is the case, but for the purposes of the analysis and recommendations in this report, we prefer to emphasize that the hierarchy is really more about increasing levels of time on task and challenge to the learner. Technology may indeed allow for higher-order thinking tasks that were previously inconceivable (SAMR’s R), or it may simply make it easier for teachers to teach a lesson because they have an archive of digital lessons (SAMR’s S) that are quicker to project to the class, more legible, and can be shared among teachers to enable more time on task than previously possible. In this case, redefinition is neither automatically necessary nor better if there is already an effective blended lesson in use. When we refer to transformation, however, it is meant to emphasize that digitizing previously ineffective lesson plans, content, or delivery is unlikely
to change learning outcomes for the better. When current methods have not resulted in equitable achievement, it may be time to try new, technology-enhanced methods.

Transforming teaching through technology is about creating new opportunities for higher-order thinking and collaboration that were not previously available. As an example, one of the most common, powerful, and proven benefits of technology is the ability of computers to rapidly process large volumes of data and produce outputs or defined actions based on that analysis. From simple, drill-and-practice software in the earliest days of computer-assisted learning, the power of technology has evolved to include the use of algorithms to provide different learners with different input and sequences of learning and predict students at risk based on data. This new generation of computer-assisted learning is proving effective in places where it is used deliberately with appropriate contextual supports (for example, *Mindspark* in India [Ganimian, Muralidharan, & Singh, 2019]). With other advances in artificial intelligence (AI) and machine learning, “personalized learning” is taking on new levels of sophistication with the ability to recognize speech, process natural language, detect patterns in large sets of data, make predictions, and make decisions accordingly (see Annex 2 for more on AI). These features, however, are not universally and unequivocally “better”; they only add value if they are filling a specific challenge in each context, for example, the lack of native language speakers to teach second language acquisition.

The present study focused on technologies that can support early literacy and numeracy, consistent with USAID’s overall strategy. Although the division case studies and the focus of specific interviews were on apparently effective models of EdTech integration, this study did not objectively measure or verify claims of positive effects of the technology. Instead, the magnitude of demand as shown by uptake, use, and enthusiasm was the only indicator of effectiveness.

The following two exhibits originally published in “Scaling Access and Impact: Realizing the Power of EdTech” are referred to throughout this report and are reproduced here with permission (Omidyar Network, 2019a). Exhibit 2, the Equitable EdTech Ecosystem Model describes four broad categories and 16 components that were found in other cross-country research to have contributed to equitable scaling in those countries.

**Exhibit 2: The Equitable EdTech Ecosystem Model**

The ecosystem profiles generated from the original model—for China, Chile, Indonesia, and the United States—are all unique and emphasize that there is no one-size-fits-all approach.
to scaling EdTech. However, the authors hypothesize that stronger EdTech ecosystems, characterized by a balance of influence across different components of the model, will result in a more rapid transition from technology access to transformative impact, as shown in Exhibit 3. This study therefore also contributes to this growing knowledge base of how countries scale and sustain equitable EdTech.

Exhibit 3: The EdTech ecosystem change model

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The Philippines: Country Background

Society

The Philippines is an archipelago of just over 100 million people living across 7,600 islands in the Western Pacific. It has no international borders on land. It belongs to the Association of Southeast Asian Nations (ASEAN), and along with Singapore, Indonesia, Malaysia, and Thailand, it has one of the top five economies of the countries in the Association. It has seen steady growth above 5% gross domestic product (GDP) over the past decade and has been one of the fastest growing nations in the region (U.S. Central Intelligence Agency [CIA], n.d.; Republic of the Philippines, n.d.). Under the current president, Rodrigo Duterte, technology and infrastructure development are in the core agenda for economic growth. The United Nations Development Programme (UNDP) Human Development Index ranked the Philippines 106th out of 188 countries in 2019 (UNDP, n.d.). The World Bank projects that the Philippines will soon graduate to upper middle income status in the near future thanks, in part, to a competitive workforce particularly strong in the services sector (World Bank, 2019). The emphasis on human capital development through educational reforms and improvements was articulated in the Philippine Development Plan 2011–2016, and then through the 25-year long-term vision, “Ambisyon Natin 2040” (Executive Order No. 5, of 2016) signed by President Duterte in 2016. This ambitious plan aims to triple real per capita income and eradicate poverty and hunger.

“By 2040, the Philippines shall be a prosperous, predominantly middle-class society where no one is poor; our peoples shall live long, healthy lives, be smart and innovative, and live in a high-trust society.” — Executive Order No. 5, approving and adopting the 25-year long-term vision entitled, Ambisyon Natin 2040 as a guide for development planning.
Education System

The education system has been through two major reforms in the last decade: to expand basic education to 13 years of schooling and to introduce the use of the mother tongue as the medium of instruction in primary education. Specific programs and legislation promote inclusive and equitable access to basic education, including for marginalized populations; prioritize improving infrastructure and instruction for small and remote schools, known as “last-mile schools”; and mandate opportunities for out-of-school youth through the Alternative Learning System (ALS). The Enhanced Basic Education Act of 2012 (Republic Act No. 10533) and the Kindergarten Act of 2011 (Republic Act No. 10157) added senior high school (Grades 11 and 12), made kindergarten free and compulsory and established that children should learn in their mother tongue in early primary, with gradual transition to English and Filipino.

Although the basic education sector is well funded compared to others, and has seen growth in the last decade, government spending is still well below the Education For All recommendation of 4% to 6% of gross domestic product, at approximately 2.6% as of latest official (World Economic Forum, 2015). To support approximately 31,573 public primary and 16,327 public secondary schools,4 DepEd will receive an allocation of 521 billion Philippine pesos (PhP) in the proposed 2020 budget, which is 4% higher than in the previous year (Mateo, 2020). DepEd at the central level exerts considerable control over standards, expectations, curriculum, and materials, but education spending is decentralized at region and division levels. Consequently, schools have considerable freedom to implement special initiatives, methods, and tools for teaching and learning. Local government units (LGUs), local partnerships, and alumni often contribute to functioning and financing of schools. The “Special Education Fund” is a mandatory 1% allocation of every city’s real estate taxes to programs related to education (Vergel de Dios, 2016). The city government together with local school division officials meet and decide where these funds will be allocated. As a result, some urban or high-income areas may benefit from more resources than other schools in the same region because of the Special Education Fund.

About 35% of students of the estimated school-age population in the Philippines go on to higher education (United Nations Educational, Scientific and Cultural Organization [UIS], n.d.). A national achievement test is administered in Grades 6, 10, and 12, though it is not a requirement for graduation or university admissions. (Most universities use their own entrance exams in their admissions.) The Republic Act No. 10931, signed into law in 2017 by President Duterte, promotes universal access to tertiary education by providing free tuition and school fees for public institutions, and education subsidies, student loans, and other mechanisms to ensure access to tertiary education, especially for students from families with incomes in the lowest 20%. Across tertiary institutions, Education and Teacher Training is typically one of the highest enrollment disciplines, according to Commission on Higher Education (CHED) statistics, surpassed only by the Business and Administration and Related field (CHED, 2019).

Many universities have satellite campuses in different regions, and some have started offering online and distance learning. The University of the Philippines (UP) established the UP Open University (UPOU) in 1995, as an alternative to traditional classroom. It started offering fully accredited classes in 2001.

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4 The latest official figures on school numbers are from 2016–2017 (Philippine Statistics Authority, n.d.).
Infrastructure

The Philippines is an island nation in the Pacific’s “Ring of Fire,” the most volatile belt of active volcanos and earthquakes in the world. It also sits upon the Pacific typhoon belt, in the path of frequent tropical storms from the Pacific Ocean. These geographic vulnerabilities make connecting all citizens to basic infrastructure, including that which supports EdTech, a challenge. Nonetheless, the country has been characterized as having the fastest growing internet access in the world, with an increase from 36% penetration in 2012 to 60% in 2017 (see Exhibit 4, Timeline). It has also been called “the texting capital of the world” and the “social networking capital of the world” (GSMA Intelligence, 2014). However, according to sources cited in the National Broadband Plan, the Philippines falls behind other ASEAN countries in terms of affordability of internet services, internet penetration, and speed of services (Department of Information and Communications Technology [DICT], 2017).

Currently 44% of individuals have access to the internet but only 28% of households; 69% of internet users can access a 3G network or better, but users were connected to the Wi-Fi rather than cellular networks 44% of the time. In addition, 87% of the population owns mobile phone, and 55% a smartphone. According to the same report, Filipinos mainly use their phones for instant messaging, entertainment, e-banking, and e-commerce. Five major telecommunications operators cover 96% of the country’s landline telecommunications, while two major cellular carriers (out of six total) cover 75% of the market. The Philippine Long Distance Telephone Company (PLDT) dominates the market of internet service providers, alongside Globe, Digitel, and Bayantel. Mercalco is the largest supplier of electrification. Many of these companies are involved in partnerships supporting the education sector, described later in this report (DICT, 2017).

The regulatory environment for ICT development is managed by the DICT, which falls under the executive branch of the government. Its mission is to improve public access to the internet through provision of infrastructure through fiber optic and wireless means. Several active government frameworks and initiatives describe efforts to improve infrastructure, including the National Broadband Plan (2017), the National ICT Ecosystem Framework (2019), Philippine Digital Transformation Strategy 2022, and the e-Government Master Plan 2020. As a national government agency, DICT’s programs and projects are funded through the General Appropriations Act of the national budget. For 2019, the department’s total budget was at PhP 6.27 billion, of which around PhP 2 billion are allocated for capital outlays in ICT infrastructure and governance (Department of Budget and Management, 2019).

There is currently no universal access fund at present in the Philippines to support last-mile internet connectivity, although the government does have a priority program to improve last-mile schools (DepEd Memorandum 59, of 2019) and establishment of a universal access

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5 It is worth noting that DICT was officially created in 2016 (Republic Act No. 10844) after nearly two decades of reorganization and shifting of national ICT sector development policy and priorities from one agency to another. The original bill creating DICT was put forward in 2012. This is well documented in Vergel de Dios, 2016, and the gap in EdTech leadership has implications in the EdTech ecosystem, which will be revisited in the Conclusions section of the report.
service fund is a point in the National Broadband Plan. Another component of the National Broadband Plan is to develop a core network—the Philippine Integrated INFOstructure—for government agencies, including LGUs, public schools, state colleges and universities, public hospitals, and rural health centers. This ambition to improve broadband services is intended explicitly to benefit economic growth, specifically unified government service and improved opportunities for rural areas through distance learning, telehealth, and telecommuting.

In line with its mandate, DICT is implementing several programs that would directly impact EdTech use by DepEd and its schools. The first one is the Free Wi-Fi for All program, which aims to bring connectivity to all cities and municipalities in the country. The basic components of the program are setting up Wi-Fi access points in public places and setting up towers. DICT is working on a memorandum of understanding with DepEd to put the Wi-Fi infrastructure in DepEd facilities while waiting to learn the results of the public bidding and established presence of local service providers.

**Exhibit 4: Timeline of key EdTech milestones in the Philippines**

Education Technology in the Philippines

This section summarizes the state of EdTech in the Philippines, roughly along the categories of Access, Use, and Impact described by the Omidyar Network’s Ecosystem Change Model. It describes major initiatives, products, and processes that were uncovered by interviews, desk research, and a survey completed by 405 people (Tinio and Pouezevara, 2019). The examples are not exhaustive, and specific products or companies mentioned do not constitute an endorsement by the authors, but only an example of what is available.

**Scaling Access**

> Scaling access means there are EdTech products in the market, and users have the ability to adopt them because they have the technology (e.g., hardware, connectivity) to do so. – Omidyar Network, 2019b (p. 10)
Policy environment

The presence of policies and strategies that articulate goals for EdTech use, both in terms of improving computer literacy skills and using technology to improve teaching and learning of other subject areas or for non-academic skills development, can influence its adoption. In some countries, such as China, performance pressure to succeed at national standardized tests or high-stakes entrance or exit exams has fueled a market for digital tutoring apps.

In the Philippines, the basic education curriculum was revised in 2002 in an attempt to make learning more interdisciplinary, contextual, and authentic by promoting collaboration between students and teachers, and among students, as well as interaction with learning materials, including multimedia sources. A specific curricular recommendation was to use technology to access, process, and apply learning and use educational software for mathematics and science experiments. Subject teachers at all grade levels were encouraged to use technology for teaching, if available, to make learning interactive. This was a start in a shift from learning about computers (what passed for computer education) to learning with computers.

The current kindergarten to Grade 12 (K–12) curriculum that replaced the revised basic education curriculum (and implementation guidelines updated in 2019) shares the same underlying principles—to be learner-centered, relevant, and integrative. However, the goal of ICT integration is tied to the broader framework of 21st century learning: “The K to 12 graduate is...equipped with information, media and technology skills, learning and innovation skills, life and career skills, and communication skills necessary to tackle the challenges and take advantage of the opportunities of the 21st century” (DepEd Order 21, 2019, p. 6). Two significant curricular changes were enacted: (1) basic ICT skills are taught deliberately from Grades 4 to 6 instead of only in high school, and (2) an ICT specialization (comprising courses such as computer programming, animation, medical transcription, etc.) was introduced as an optional track in senior high school. ICT integration is still recommended as a medium for delivering curriculum content, although detailed guidance on ICT integration is expected to be part of an ICT framework “to be discussed in detail in a separate policy issuance” (DepEd Order 21, 2019, p. 17). At present there are national standardized tests that serve important purposes for education system monitoring and policy development, but there are no considerably high-stakes exams driving competition among youth or families for scarce educational opportunities.

Hardware

Although the vision for ICT integration is not yet completely articulated, a major strength of the Philippines EdTech ecosystem is strong central government support for scaling access to basic infrastructure, hardware, and software for teaching and learning for all students, whether they are in school or in the informal, alternative, learning system for out-of-school youth. ICT in education has been supported by school computerization efforts of the Department of Education since 1996, in a program that came to be known as the DepEd Computerization Program (DCP), (DepEd Order 78, 2010), followed by the DepEd Internet Connectivity Project (DICP) that started in 2009 (DepEd Order 50, 2009). Other government agency initiatives such as the Department of Trade and Industry’s Personal Computers for Public Schools project, the Commission on ICT’s iSchools Program, and various technology deployments of the Department of Science and Technology (DOST) have also contributed hardware and software (Vergel de Dios, 2016). At first, the government priority was to equip and connect high schools. DCP began reaching elementary schools in 2011 as high school penetration targets were reached. Funding for the DCP comes from the General Appropriations Act (i.e., the national budget), which is allocated every year by the government. It is part of the total budget allocated to DepEd, and year on year it has increased. In 2008, the budget was at PhP 78 million; by 2015 the amount had reached PhP 6 billion and 8.6 billion in 2018 (Laguda, 2016). The allocation amounts to approximately 2% or less of the agency’s total budget depending on the year. In
2018 the target was to reach 11,000 schools with 460,000 units. By 2022, DepEd aims to have one computer laboratory in every public school. Over time, the configuration of the DCP packages has changed according to needs and appropriateness of the technology for the location of the schools (for example, special needs of last-mile schools).

The DICP allocates a budget to the Schools Division Office (SDO) of PhP 4,000 per month or PhP 48,000 annually per school for internet connectivity. As of 2016, this budget is provided directly to schools as part of their Maintenance and Other Operating Expenses line item (DepEd, 2016). Additional funding for internet, hardware, and infrastructure also often comes from LGUs, alumni, parent-teacher associations (PTAs), private-sector partnerships, and other donations. Presently, the Digital Rise Program is an initiative to ensure that classrooms are provided with IT equipment through the DCP, combined with open educational resources (OER) and teacher training (more on Digital Rise in the following subsection Content).

Public-private partnerships

Predating the DICP, a public-private partnership was established to spread internet access to public secondary schools. Known as GILAS (Gearing-up Internet Literacy and Access to Students), this US$8.5 million effort was the result of a multi-sectoral consortium composed of corporations, nonprofit organizations, and government agencies. It provided internet access to 3,306 public secondary schools and trained 13,538 teachers and 542 principals (Vergel de Dios, 2016). Direct partnerships with large ICT companies such as Microsoft, Intel, and Facebook have also been instrumental in expanding access to basic hardware and computer literacy. When the one-laptop-per-child program came to the Philippines in 2011, it was part of a corporate social responsibility program supported by the company Procter & Gamble.

Microsoft partners directly with DepEd in the procurement and distribution of hardware and Microsoft software packages under the DCP. It also supports schools directly and has several programs such as the Microsoft Education Ambassadors, Microsoft Showcase Schools, and Education Summit (Microsoft Philippines Communications Team, 2017). Teachers can find global resources through the Microsoft Educator Community online portal. Microsoft trainings and platforms support integration of Microsoft products in teaching to gamify or organize content rather than specific subject-matter skills, although they emphasize the way that technology can be used for critical thinking, collaboration, and other student-centered or personalized methods.

One Meralco Foundation supports rural electrification through solar energy. According to Meralco reports, solar electrification has a positive effect on basic teaching and learning processes, such as attendance and time on task, because schools can operate when there are storms and teachers can remain on site for printing and other administrative tasks that previously required travelling to other cities. Solar electrification also opens the possibility of use of technology in teaching and learning in rural areas. An employee volunteer program has provided multimedia equipment to schools that receive the electrification program, amounting to about PhP 50,000 per school. These partnerships are facilitated through DepEd’s Adopt-a-School program.

The telecommunications company Smart Communications has been particularly supportive of last-mile schools. It partners with schools to provide technology in the form of “School-in-a-Bag” packages. The School-in-a-Bag is a portable digital classroom containing a laptop, LED TV, a hard drive, a smartphone, a pocket Wi-Fi, a solar panel, and five tablets for students that are preloaded with digital content. The digital resources include the mathematics courseware from the DOST Science Education Institute (SEI) (see below), financial literacy videos, custom-developed literacy apps (see text box), and storybooks from Adarna House. Another program, TechnoCart, is for schools with electricity that offer kindergarten. The mobile cart has one laptop, 20 tablets loaded with digital content like a
literacy app, a projector, a tablet for teacher, and a pocket Wi-Fi. According to the company’s website, the program encourages sponsors and partners that are interested in EdTech to donate a TechnoCart package for PhP 200,000, which also includes teacher training and monitoring and evaluation. Smart Communications relies on community partners to deploy these packages to public schools. For example, it partnered with the United Nations Children’s Fund (UNICEF) to provide 50 schools in Western Samar with school packages in May 2019. Before that, it distributed packages through its own foundation and in partnership with other donors such as Rotary Club, and even with its employee’s cooperative. Smart Communications also bundles the packages with a non-technology program called the Dynamic Learning Program from Central Visayan Institute Foundation. The program has around 1,400 learning activity sheets available at http://www.dlp.ph and there is an e-learning platform for the ALS. The learning sheets are meant to guide learners in independent self-study of a particular concept. There are also templates that can be localized, and a Dynamic Learning Program Ambassador is a trained teachers who helps other teachers and schools adopt the program. The Dynamic Learning Program was reported to have helped improve academic performance, with its biggest impact within the ALS population.

Another telecommunications company, Globe Telecommunications, has also been active in support of ICT integration. Early interventions included providing internet access and hardware. Based on learning from initial pilots, Globe Telecommunications created the Global Filipino School, beginning with an LGU in Bohol in 2012. It provided a package of services: infrastructure, internet access (wireless and wired), teacher training, and community mobilization. After two years, the company noticed observable differences in school performance. In 2014, it began to scale the project, which continued from 2015 to 2018, resulting in the establishment of one Global Filipino School in each division of DepEd. Each school was equipped with the latest technology, which changed year on year depending on what was available, relevant, and most appropriate in each case. Teachers received training on design thinking and 21st century learning.

Content

No amount of policy or hardware will change learning outcomes if there is no digital content or tools that can be applied to teaching and learning. There are several ways to approach content for EdTech; one is the application of standard productivity tools or general software to make learning interactive or student-driven (e.g., use Skype to connect to a virtual tutor or classroom exchange; create a quizzing game in PowerPoint to review lesson content). Another is to integrate pre-developed digital educational content designed to cover a specific content area (e.g., projecting videos of a historical event; showing a simulation of a scientific process; using computer-assisted learning software to practice math or reading skills). The former model depends largely on the instructional design capacity of the teacher to create and integrate technology in useful ways, whereas the latter model has the advantage that the instructional design work has already been done, and teachers can more quickly integrate subject-specific content into their lessons. Many countries in the Asia Pacific region, including China and Indonesia, are experiencing a billion-dollar boom in EdTech capital. Commercial software and platforms are being developed and marketed directly from business to consumers (known as B2C) or from business to government (B2G) (see Omidyar Network, 2019b and 2019c). This trend has not yet reached the Philippines, where only a handful of commercial EdTech companies have been identified, with the primary

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6 The Smart Communications web site is https://smart.com.ph/About/learnsmart/programs-projects/smart-technocart
7 Although this report uses both terms, “EdTech” and “ICT in Education,” synonymously if a distinction were to be made it would be that “ICT in Education” is when teachers digitize elements of lesson delivery themselves using available technology, but “EdTech” is deliberately designed, off-the-shelf, and ready to use, subject-specific digital applications integrated into the lessons.
market being private schools. However, there are many initiatives underway to expand access to and proficiency with basic productivity tools, activities, and subject-specific content developed by teachers themselves or through nonprofit community partnerships. Still, the current market for digital content is very fragmented, dominated by one-off trials, and there is no clear way for teachers to find and select the most appropriate interactive digital resources for their subject areas.

A survey of 405 elementary schools conducted for this study revealed that the most common digital resources used by schools are basic laptops or desktops and standard productivity tools, internet browsers, graphics software, and desktop publishing software. Nearly all respondents mentioned only Microsoft products and cited the DCP as the main enabler of access to any digital learning resources by providing hardware such as computers, laptops, television sets, projectors, and the internet connection on which they are used. Out of 366 school IT coordinators who answered the question, “To your knowledge, what is the most popular software program or digital learning resource in use at your school by teachers? Please describe,” 202 named only Microsoft products, 59 listed generic productivity tools (spreadsheet, word processing) without naming Microsoft, and 45 named Microsoft products along with other products. Tools apart from productivity tools that were cited include Kahoot, Plickers, and Wondershare Quiz Creator for quizzing and assessment; crossword puzzle generator; 4-D/augmented reality for science; Google Classroom and Google Drive for managing access to locally curated or locally developed resources; ZipGrade and the Geometer’s Sketchpad. Ten respondents in six different regions mentioned Quipper, a commercial content management system popular elsewhere in Asia, suggesting that there is B2C and B2G market for commercial software, although we do not know whether respondents used the free model or the subscription model. YouTube is also a popular source of videos, and many teachers share downloadable images like digital word or number flashcards on Facebook and WhatsApp groups.

Among content-specific educational apps, there are those that have been created through government partnerships and others that are created and distributed commercially through the private sector.

**Government sponsored, open resources**

Many respondents to the survey noted use of the centrally managed DepEd Learning Resource Portal also referred to as the Learning Resource Management and Development System (LRMDS), which is a repository of approved teaching materials and professional development resources that teachers can download and use in their K–12 classes. The portal contains primarily printable resources such as activity sheets, activity cards, lesson plans, learning modules, and teacher’s guides, and some media assets like illustrations, videos, audio, and photos that teachers may print or project with classroom technology. Some of the resources are developed and shared by teachers themselves but are published only after going through a strict quality assurance process beginning at the school, then the division, and then the regional level, where they will be uploaded by the LRMDS administrator. Resources are evaluated based on: (1) intellectual property rights (do they have the right to distribute the resource), (2) educational soundness (is it relevant to the curriculum and learning goal), (3) educational quality (is the content accurate, appropriate, and suitable for the context), and (4) technical review for digital offline resources (is the format accessible and functional) (DepEd, 2009). There is currently no similar, centrally managed repository for interactive educational software for computer-assisted learning, although certain commercial packages aim to curate and disseminate curriculum-aligned interactive learning resources. Some schools also have their own learning resources repository such as Google Drive. This may be used for storing other digital assets, contextualized resources for the local context, or teacher-made videos and PowerPoint presentations and daily learning logs that are appropriate for the local classroom but not relevant to share across the Philippines. Teachers also frequently access and share content from the internet through social media.
A major influence at present is DepEd’s **Digital Rise Program** and the **OER initiative**. In June 2019, the Office of the Undersecretary for Administration (OUA) of DepEd released an aide-memoire describing the OER initiative under the umbrella of the Digital Rise Program (OUA, DepEd, 2019, June 28). Digital Rise, itself, is an initiative not yet made into a law or policy, but strongly articulating a goal for developing information, media, and technology skills among teachers and learners and to achieve DepEd’s vision of the public school of the future. The OER aide-memoire notes the availability of a wide variety of OER in various learning areas, and especially OER in digital format that teachers can customize to fit specific learning needs and objectives and share with other teachers, thereby promoting teacher collaboration. The aide-memoire also presents OER as a strategy for addressing “challenges encountered by the public school system most specially the [last-mile schools] in terms of access to learning materials and skills to create or reuse contents.” This vision guides the two components of the OER project, namely, provision of an offline OER library for all schools and training of teachers in OER creation and use. The OER is closely linked to DCP in that resources are now loaded onto every DCP computer before delivery.

At the time of this writing, the offline OER library included more than 7,000 resources from the LRMDS; about 1,500 teaching resources from CHED’s Teach Together Program for senior high school; 20,000 interactive exercises from Khan Academy; and 5.8 million Wikipedia articles and other Wikimedia resources (including Wikivoyage, Wikispecies, Wiktionary, and Wiki for Schools and Business). The offline library is meant to be especially useful for last-mile schools located in remote areas with no internet connection. Although no reference is made to the term “OER” in LRMDS project reports, policies, and guidelines, the portal as a whole carries the Creative Commons BY-NC-SA8 license, which allows users to download, share, and adapt materials with attribution and for non-commercial purposes with no restrictions. On the other hand, it is accessible only to users with DepEd-provided login credentials, which means that the materials are not readily available to a global audience.

The teacher training component consists of workshops delivered around the country by staff of the Information and Communication Technology Service (ICTS) of DepEd. The workshop focuses on the creation of OER using free and open source authoring tools such as **CourseLab 2.4**, **WonderShare Quiz Creator**, and **Kolibri**. Unlike other training programs implemented by DepEd in which participants are handpicked by school heads and division and regional officials, OER workshop participants are recruited through open invitations. The workshops are usually held on weekends outside of school premises, participants bring their own laptops, and participation is voluntary. Those trained are expected to conduct one-on-one or small group training for their peers using the Learning Action Cells. Some become Core Leaders, organizing and facilitating workshops for large groups (ranging from 100 to 750 participants) in collaboration with LGUs and civic organizations.

The **DOST-SEI** has partnered with universities to create and distribute digital content as part of its mission to support DepEd by creating learning materials that teachers can use to better teach science and math. In collaboration with the UP National Institute for Science and Mathematics Education Development, DOST-SEI developed interactive courseware for Grade 1 to 6 mathematics. The courseware is free and distributed during education conferences, exhibitions, from the website of DOST-SEI, and through the **Google Play store**. DOST-SEI also maintains social media pages to help reach intended users with product updates. DOST-ICT is also involved in establishing ICT for technical education under the TECH4ED (Technology for Education, to gain Employment, train Entrepreneurs toward Economic Development) program. This project aims to establish up to 42,000 public technology access centers across the country where citizens can access e-government and e-health services, non-formal education and training, and e-employment, while creating

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8 Creative Commons Attribution—NonCommercial, ShareAlike, 2.0 Generic. See [www.creativecommons.org](http://www.creativecommons.org)
economic opportunity and promoting entrepreneurship. Centers are established through partnerships with local governments and businesses.

**Ateneo Laboratory for the Learning Sciences** also partnered with DOST-SEI and the CHED to develop four augmented reality, location-based games: *Igpaw Intramuros, Igpaw Loyola, Tuklas*, and *The Mind Museum ARventure*. Ateneo Lab also developed literacy games for Grades 4, 5, and 6 known as *Learning Likha* and *Ibigkas!*, which teach rhymes, synonyms, and antonyms (see text box below on literacy-specific EdTech). Raising awareness and sustained use of these products requires partnerships with DepEd. According to our interviews, strategies for distribution included involving teachers in the development process, conducting workshops through the Ateneo Center for Educational Development, and developing a teacher’s guide for classroom integration.

**Private and commercial content**

**Quipper** is an online learning management system. The international EdTech company operates in Indonesia, Japan, Mexico and the Philippines with content and instructional design tailored to each country’s needs and curriculum. Some of the resources are accessible for free, but paid upgrade licenses provide access to other features. In the Philippines, content is targeted at Grades 4 through 12, but most use is at the senior high school level. This is in part because when the new curriculum added grades 11 and 12, there was a dearth of education content for those grades, and Quipper was able to step in and provide locally relevant materials. Through the platform, teachers can send assignments such as quizzes or readings and they can monitor when children complete the tasks. Analytics help identify students in need and content areas where students struggle.

According to representatives, the number of partner schools in 2019 had grown by 17 times compared to its first year of service in 2015. The partner schools are a mix of public, private, urban, and rural schools that pay the subscription fee. An estimated 5 million users in total access either the free or paid version. **Edukasyon.ph** launched in 2015, is growing and has been successful attracting venture capital. The platform targets senior high school and university-level students with access to scholarships, online courses, and other resources, linking users with education and employment pathways. **Frontlearners** provides access to 3,500 K–12 curriculum-aligned resources and 20,000 quiz questions for e-learning access. The company cites more than 20,000 paying users, but the platform can also be accessed free, and claims to be in 60 public schools serving 60,000 learners (QBO, 2017).

Some schools also access EdTech through packages of hardware, content, and services delivered by private-sector partners. Although they operate on a much smaller scale, these partnerships allow for personalized and sustained support for technology integration. At present, such models are only operating in private schools where fees are generally passed on to the learners and their families. For example, **Phoenix Publishing House, Incorporated**, provides its client schools with hardware and a locally developed content management system known as *Aralinks* with pre-developed and curriculum-aligned content, assessments, and media assets that teachers can integrate into lessons. Students can access some digital learning resources at school or from home and teachers can also create their own digital resources, give quizzes, compute grades, and track students using the system. The hardware usually consists of a TV screen, a netbook for the teacher, and a set of either desktop or tablet computers for students, but a readiness assessment is used to customize for each school. In case of poor internet connection, Phoenix enables offline access through a school server. The company also provides school-based continuing professional development for teachers and school leaders focusing on both pedagogy and technology, and assigns an “integration facilitator”. Phoenix has also been supporting a program that trains students to code and trains teachers on basic computational thinking skills; the program has reached 13 campuses over the past two years. All of Phoenix’s

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9 Information on TECH4ED can be found at https://tech4edcenters.wordpress.com/ or https://dict.gov.ph/tech4ed/
programs have reached 300 private schools and a total of 10,000 teacher-users and 300,000 student-users. The cost is about PhP 1,500 per school year per student.

_Schoology_ is another commercial platform distributed in the Philippines by _Rex Publishing_ in partnership with private schools at a cost of PhP 3,500 per student. The cloud-based learning management system is mainly used to design and deliver instruction, access digital content from the Schoology community, and manage assessments and communication with parents. It is meant for in-school and at-home use, for students with access to the internet. Since the Schoology platform does not come with local content (not even the digitized versions of the textbooks Rex Publishing distributes to its client schools), Rex Publishing provided schools with a compilation of educational resources on CD. The company incentivizes teachers to use Schoology through a support program and by sending the top five teacher-users of Schoology to a conference Rex Publishing organizes for its clients.

_Knowledge Channel Foundation, Incorporated_, is a non-profit organization that primarily airs videos as the _Knowledge Channel_ on television (ABS-CBN TV Plus and Sky Direct satellite TV) or streamed on its YouTube channel. Knowledge Channel has more than 1,500 educational episodes and over 1,000 multimedia resources available free its portable media library. According to the Foundation, it has reached 5 million Filipino learners and has connected more than 8,000 schools. Its most recent initiative is the _Basa Bilang_ Project to develop early reading and numeracy videos for Grades 1 to 3 for Filipino, English, and math based on DepEd-issued teacher’s guides. Its other programs, based on the new K–12 curriculum, include MathDali and AgriCOOLture, which are designed to impart a range of skills including media and technology literacy, learning and innovation, effective communication, and life and career skills. The Foundation also has a program to recognize educational institutions with innovative programs and projects related to transformative learning through its Excellence in Educational Transformation Awards.

Finally, though this list is not likely exhaustive, _FELTA_ is a private company that develops and markets instructional and learning materials with special focus on science, technology, engineering, and mathematics education. FELTA sells custom hardware such as 10 inch or 7 inch _Studybooks_ meant to be durable enough for students to use; a content distribution service, which is a school server and central content management system; digital and tactile science, technology, engineering, and math education resources; LEGO education packs; robotics and coding kits; and various multimedia resources. Schools purchase products independently, through LGUs or other private fundraising.

This study paid particular attention to education technologies in use for supporting basic education, especially primary school literacy and numeracy. The text box below summarizes some of the initiatives we found, but this compilation may not be exhaustive.

**Scaling Use**

_Progress toward EdTech use is considered observable when products show evidence of an active user base (such as subscriptions) and are facilitated for use in classrooms by trained educators, among others._ – Omidyar Network, 2019c, p. 12.

Relevant, easy-to-use curriculum and grade-aligned content is necessary for technology access to become technology use, for more than just digital literacy. However, just because schools have content does not mean they will use it. Policy, leadership, expectations, and training are drivers toward use of technology for teaching and learning. As described above, access to the potential of EdTech has been enabled by major efforts from the central government to provide every school with basic infrastructure, hardware, and, increasingly, content. However, teacher training is achieved much more through partnership initiatives. This and other means of spreading EdTech use are largely dependent on individual champions with special initiatives.
EdTech Tools for Literacy Improvement

**Basa Bilang** (Videos, Knowledge Channel, commercial)

In a pilot program in Grade 1 in Santa Rosa, teachers watch one video per day based on the DepEd-issued teacher's guide. The videos support the day’s reading lesson in Filipino, English, and math. Knowledge Channel also trains and mentors the teachers face-to-face and online. An experimental evaluation is in progress (through March 2020). There is a plan to expand the content to higher grades. Videos are distributed on air and online.

**Learning Likha** (Android App, Ateneo Lab for the Learning Sciences, free)

Two adventure-type games intended to help students notice important details when reading were created under this title. In the first game, the player helps the lead character, Likha, collect musical instruments by reading descriptions of the instruments and of and their locations. In the second game, the player helps Likha rescue animals and bring them to a sanctuary. Available free on Google Play Store (https://play.google.com/store/apps/developer?id=Ateneo+Laboratory+for+the+Learning+Sciences&hl=en).

**Ibigkas!** (Android App, Ateneo Lab for the Learning Sciences, free)

This is a drill-and-practice series for English and Filipino synonyms, antonyms, and rhymes and arithmetic. In single-player mode the player is given a target word, e.g., “small,” and is supposed to choose the answer—a synonym, antonym, or rhyme, depending on the game setting—from among the options. In multiplayer mode the target word only appears on one player's screen. That player has to say the word out loud (hence “ibigkas,” which means “to say out loud.”) The correct answer appears on only one of the players’ phones, who must tap it and the round continues. Available free on Google Play Store and the App Store (https://play.google.com/store/apps/developer?id=Ateneo+Laboratory+for+the+Learning+Sciences&hl=en).

**Dynamic Learning Program (DLP) Central Visyan Institute Foundation** has a blended learning model consisting of activity sheets for teachers and an e-learning platform specifically targeting out-of-school youth and Indigenous People. The website claims that with the DLP, “teachers can smoothly transition early tribal learners from their mother tongue to Filipino and English as medium for instruction in their major subjects.” The learning activity sheets are contextualized and indigenized to reflect the Indigenous People’s Education curriculum. This program has been used with the Smart Communications School-in-a-Bag initiative.

**Smart Communications mother-tongue literacy apps**

As part of the “School-in-a-Bag” program, Smart Communications has worked with DepEd, and a range of universities, nongovernmental organizations, and local community organizations to develop custom apps for teaching basic literacy and numeracy skills along with culture and stories from different regions. These apps include Katao for the Inabaknon language; Bahay Kubo for Filipino; Matigsalug for learning the alphabet, song, and dance of the Matigsalug tribe; Gnaré Blaan for basic literacy, culture, and folklore of the Blaan tribe; Kaaram for Waray language; Kaalam for Cebuano; Sanut Ilokano for Ilokano language; Singsing for Kapampangan; and Taallam and Tahderiyyah for Arabic language and Islamic values. These #LearnSmart apps may be downloaded from Google Play free (https://play.google.com/store/apps/developer?id=%23LearnSmart&hl=en).

**Vernacular** (Android App, USAID/Basa Pilipinas and DepEd, free)

This tablet-based Android application was developed by Educational Development Center and adapted to the Philippines under USAID/Basa Pilipinas. The application works offline and consists of a series of activities, games, and quizzes covering alphabet knowledge, phonemic awareness, spelling, vocabulary, and comprehension in English and Filipino (20 lessons each). It was piloted in the division of San Fernando, La Union, in 2017–2018, and results showed gains in reading skills after as little as 8 weeks’ use.

Other types of technologies more indirectly used in support of literacy learning include:

**Inter-School Computerized Operation Link Environment (ISCOLE):** An education management information system used for entering attendance, grades, and other information including literacy assessment data so that school administrators and teachers can better identify students with literacy difficulties who need intervention. ISCOLE runs on a school-wide network infrastructure and is meant to make administrative tasks less cumbersome for teachers and administrators alike.

**The DepEd OER program:** Encourages teachers to create and distribute audio-visual learning materials that can support reading, such as “click a letter, hear the sound of the letter”; create audio story books; or localize other standard DepEd curricular materials for the mother-tongue classroom.

**Early Language, Literacy, and Numeracy (ELLN) Digital:** A blended model of teacher professional development created by USAID, FIT-ED and DepEd, designed to orient teachers on methods for developing ELLN skills.

**Effective Literacy Instruction for Kindergarten to Grade 3:** An online teacher professional development module developed by USAID and SEAMEO-INNOTECH under Basa Pilipinas.
Teacher training for EdTech

In the early days of centralized provision of technology, neither the Personal Computers for Public Schools program nor DCP incorporated teacher training beyond the user training bundled by the hardware vendors. Instead, DepEd called on private-sector and civil society partners to support government computerization efforts by designing, implementing, and financing teacher professional development. As described in the previous section, a large share of teacher training happens when training and support are part of a package of services from a content or hardware provider. However, for schools receiving mainly hardware through the DCP, instituting an effective strategy for teacher training is a priority.

Training providers

The Intel® Teach Program was one such partnership under Personal Computers for Public Schools to train recipient schools by region. Intel® Teach began in the Philippines in the early 2000s as a one-time ICT literacy training that trained teachers in using Microsoft Office applications, email, and the internet and how to integrate them in teaching. It evolved into a broader program of ICT-supported inquiry- and project-based learning, coaching to support to teachers, technology planning for school leaders, rewards and recognition schemes for outstanding practitioners, and a variety of opportunities for collaboration among participants. Intel® Teach also trained faculty of teacher education institutions (TEIs) on how to deliver a technology integration course for preservice teachers, and several TEIs adopted the preservice curriculum. After over a decade of sustained large-scale, mostly face-to-face, teacher professional development activities, Intel’s program shifted to online learning, providing free access to courses on digital literacy skills, digital citizenship, project-based approaches, critical thinking, and digital collaboration. Intel eventually phased out its education programs in the Philippines in 2013.

For at least 13 years the PLDT Infotech Outreach Program was a partnership between UPOU and DICT that provided cascade-model training for teachers in digital literacy and 21st century skills. This was not limited to teacher training, though, and catered as well to out-of-school youth, senior citizens, and women via community technology centers. Like Intel, Microsoft began in the early 2000s in the Philippines with its Partners in Learning Program, offering similar face-to-face trainings in ICT literacy and ICT integration built around its products and services. Microsoft takes the approach of engaging with government leaders and policy makers to help them understand the value of technology adoption and works with the private sector as part of its corporate social responsibility programming. For example, if Microsoft provides the content and the training for basic technology use, Union Bank of the Philippines employees supplement the training with financial literacy. Microsoft has also engaged Ayala Foundation and SM company. By the 2010s, Microsoft’s programming in the Philippines, like Intel’s, transitioned from large-scale face-to-face trainings to community-building online and the cultivation of champions through the Education Ambassadors Program.

More recently, under Digital Rise and the OER program, DepEd began training teachers in 2019 through a combination of budget support and Microsoft support. Whereas a large and necessary part of this training is about basic functionality, part of the vision of OER is to train teachers to develop their own localized digital resources. Since May 2019, the OER team (mostly one staff member from ICTS) has trained approximately 10,000 teachers. The training covered how to use existing OER materials and develop localized e-learning resources using authoring tools. This is also done through partnerships and direct marketing to teachers who can volunteer to become EdTech leaders. ICT coordinators in every school are also trained as trainers so they can continue to build capacity in the school.

Smart Communications, in addition to the training provided with the technology packages described above, trained a total of 13,514 teachers in using ICT through its Smart Schools Program, which ran from 2004 to 2011. Similarly Globe Telecom provides ICT proficiency training to teachers through its Global Filipino School Program, along with the computers
and laboratory equipment that it donates to recipient schools. The training is conducted by Ayala Foundation’s Training Institute and aims to train teachers to deliver quality instruction and enhance the learning environment of students.

The Coalition for Better Education, a multisectoral and membership-based, nonprofit organization, partners with corporations such as Microsoft, Smart Communications, Globe, and Meralco and with TEIs like the University of Makati, University of San Jose Recoletos, and Cebu Normal University in training teachers. Catering mostly to public schools, Coalition for Better Education conducts teacher training on the effective use of ICT in class as well as trainings on AI and robotics. The Coalition’s teacher training on the effective use of ICT can be credited in the master’s program of partner TEIs. Teachers trained under this program must coach five other teachers on the effective use of technology (Microsoft Partners in Learning used a similar strategy). This coaching component helped sustain the program and included an online community using messenger to support teachers after training. As with Intel® Teach, training is done in the context of project-based learning using technology.

After more than a decade of equipping schools with the needed ICT infrastructure and capacitating teachers with ICT skills, USAID commissioned a survey of the state of ICT use in Philippine public secondary schools (Tinio, Rodrigo, & Mapa, 2012). The study used UNESCO’s “stages of adoption and use” model that promotes a SAMR-like hierarchy consisting of “emerging,” “applying,” “infusing,” and “transforming” stages (Anderson, 2010). Survey findings revealed that none of the 385 sampled schools reached the highest level of integration as defined by the framework (“transforming”), and only 11% were at the “infusing” stage. Most schools were at still at the “emerging” and “applying” stages. In the self-administered survey conducted for this report, among 387 elementary school teachers who responded, the top four ICT trainings received were related to the introduction to ICT (65%), use of productivity tools (61%), use of basic internet tools (51%), and training on using ICT for teaching and learning (35%).

Policy and guiding frameworks for teacher professional development

There is a lot that teachers need to know to effectively integrate technology, and there is not necessarily a global best practice concerning when, how, and for what duration teachers should be trained nor what the most important content is. Anecdotes abound—in the Philippines and elsewhere—about technology initiatives that failed because hardware was delivered before training, whereas others describe failed training when hardware was not yet available. Aligning teacher training with what is available, what the teacher needs, student needs, grade level, national curriculum, and other considerations is unlikely to be successful through central planning. On the other hand, with multiple, disparate, decentralized, and one-off trainings, the quality, comprehensiveness, and equity of teacher learning remain unknown. It is generally accepted that EdTech integration requires “Technological Pedagogical Content Knowledge [known as TPACK],” meaning you have to know about the technology, you have to know about the subject area content you are teaching, and you have to know how best to teach that content using technology. Guiding frameworks for teacher professional development in the Philippines—both general and EdTech specific—are evolving, and a recent restructuring has placed all responsibility for teacher professional learning under the National Educators Academy of the Philippines (NEAP).

DepEd Order No. 11 of 2019 on the NEAP transformation specifies teacher professional development be made more programmatic, relevant, and tied to the career development of teachers. NEAP has some existing professional development programs for teachers and school leaders that incorporate ICT integration. The Superintendents’ Leadership Program is a 12-module program, and 1 of the modules is on ICT integration in teaching and learning as well as in governance. Part of the training is the development of an ICT integration plan. The School Heads Development Program, on the other hand, is a 3-module program, and again,

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10 Information on TPACK is available at see http://www.tpack.org
part of the training is the development of an ICT integration plan for the school. In its transformation, NEAP will also utilize the Philippine Professional Standards for Teachers (PPST) that were adopted by DepEd in 2017 (DepEd Order No. 42, 2017) as it streamlines and plans the teacher professional development relevant to teachers' career growth. This will replace the UNESCO ICT Competency Standards for Teachers, which is the only other framework in use (discussed further below). All professional development programs developed must be aligned with the PPST to be considered one of the professional development offerings of NEAP. To implement this though, elaborations of the domains and strands of the PPST as they are applied in specific areas is necessary. For example, in terms of educational technology, the strand on Positive use of ICT under Content Knowledge and Pedagogy as well as the strand of the domain on Curriculum and Planning, which the PPST refer to as Teaching and learning resources including ICT, need elaborations. Similarly, the strand, Strategies for promoting literacy and numeracy, under the domain Content Knowledge and Pedagogy, has to have elaborations also. The PPST were formulated by the Philippine Normal University Research Center for Teacher Quality with funding from Australia’s Department of Foreign Affairs and Trade. The PPST are based on the national competency-based teacher standards CHED institutionalized in 2007. According to the Continuing Professional Development (CPD) Act of 2016 (Republic Act No. 10912, 2016) and Philippine Regulatory Commission (PRC) accreditation policy (PRC Resolution No. 11 of 2017), every teacher is required to complete 45 units (equivalent to one to two days of training in a year) of CPD within 3 years to renew the teacher identification.

Another related initiative is the institutionalization of the Results-Based Performance Management System, a nationwide information system that was set up to monitor teacher performance at all levels. The system has created incentives for teachers to undertake EdTech use in their classrooms. A specific classroom observation tool is used during the conduct of performance reviews of teachers, and one of the rubrics states that a teacher must demonstrate that they are able to “select, develop, organize, and use appropriate teaching and learning resources, including ICT, to address learning goals.” (Some schools also use a digital version of this classroom observation tool, which is another indirect way of infusing technology into education.)

Until the PPST, UNESCO had been a major influencer in determining and spreading curricular models through its ICT Competency Standards for Teachers. Through the CHED Policy Standards and Guidelines memoranda series of 2017, TEIs made use of the UNESCO ICT Competency Standards for Teachers to develop a two-part curriculum aligned with the standards but renamed as “Technology for Teaching and Learning 1 and 2.” Mindanao State University–Iligan Institute of Technology (MSU-IIT) is one of the TEIs that implemented the Technology for Teaching and Learning 1 and 2 courses. Mindanao State has also trained its faculty members and preservice teachers to use the free digital learning resources given by UNESCO. The university has its own online learning environment, called MOLE (or Mindanao State University–Iligan Institute of Technology Online Learning Environment), which runs in Moodle. UNESCO also provided TEIs, including MSU-IIT, with free digital learning resources and trained these TEIs on how to use them. UNESCO also collaborated with the University of the East in the conduct of the training on ICT for Active Learning. This work was mostly on a voluntary basis as there was no specific source of funding.

**Leadership and champions**

Access and use are largely enabled by local champions and partnerships of the willing. This is the case for EdTech in classrooms, where official DCP hardware is often supplemented by donations from community partnerships, especially individual school alumni. The importance
of partnerships has been emphasized throughout the above sections, but the two case studies—Ilocos Norte and Sagay Divisions (see Annex 1)—illustrate concretely how strong leadership can make a difference in driving use of EdTech. For example, the Ilocos Norte case study is primarily about the division-wide scale-up of an offline content repository. However, during interviews for the case study, the researchers were told how important it is that the school heads take initiative. In Ilocos, those who prioritized ICT innovations in their schools could raise funds for equipment via fundraising activities, by talking to alumni, PTAs, and LGUs. This enabled them to raise funds for the hardware that allowed them to set up the ISCOLE education management information system. In Sagay, the important role of champions cascaded outward from a motivated school principal, to several teachers who took initiative, and then began to train others as a result of seeing positive benefits of ICT-assisted math lessons. From one school and one subject area, the model has expanded to the whole division and to other subject areas.

Scaling Impact

Finally, although EdTech products may be accessed and used at scale, scaling the impact of EdTech is a function of how EdTech is adapted for use in different ways by different populations. As such, the impact on learning is what must be ‘scaled’ rather than just product use. This is the hardest phase of scaling to demonstrate, but specific efforts to evaluate and communicate impact, redesign and adapt products for different audiences, and establish mechanisms for choosing the right products for the right purposes are indicators that EdTech will be more likely to have equitable impact. – Omidyar Network (2019c, p. 16)

Evaluation of effectiveness

At the both the division and regional levels, a systematic review of EdTech initiatives implemented at scale is lacking. Given the numerous pilot programs already conducted, local officials still seem to have a hard time answering the questions: what worked, what didn’t work, and why? Many key informants, whether schools or product developers, cited anecdotal evidence such as student engagement and teacher motivation as clear effects. In a survey of 205 division ICT coordinators, 41% said they never conducted impact evaluations of ICT, but 44% said they did at least once per year or more.

Several product developers and implementing organizations said the activities or products had been evaluated, but the authors of this report were not always able to access these evaluations firsthand. Some of the findings shared with us by interviewees include the following:

- Smart Communications evaluated the School-in-a-Bag program through the Philippines Normal University to understand its impact on students. The company found in participating schools that engagement among students increased, absenteeism decreased, and students were observed to be more independent learners. Factors that played a role in effective use of the technology were, naturally, the teacher, but also the presence of a resourceful school principal and an active PTA. Smart Communications concluded that the project was meeting its objectives.

- Globe Telecom shared that from its impact assessment of the Global Filipino Schools it found significant increases in teacher and student knowledge of how to use internet and basic software; students and teachers were more engaged and demonstrating “21st century learning skills,” including more progressive approaches to learning, such as collaboration and sharing.

- Knowledge Channel Foundation, Inc., has conducted several evaluation activities over the years including difference-in-differences studies isolating Knowledge
Channel viewing as a factor in improved test scores (compared to a non-viewing control group), increasing student attendance, and decreasing dropouts (Mapa, Briones, & Tardeo, 2008). Other studies found that videos helped improve learning outcomes and multimedia skills were improving.

- DOST-SEI has studied the effectiveness of the digital math resources in teaching. The researchers found that teachers and students appreciated the design, which conformed to established quality standards and motivated use. Moreover, they found statistically significant improvement in Grade 5 and 6 pupils based on pre- and post-tests of concepts (effect sizes ranged from .2 to .5 depending on the topic) (Lasallian Institute for Development and Educational Research [LIDER], 2014).

- UNDP plans to evaluate some of its programs in support of EdTech integration through an external evaluator. However, according to interviews, informal monitoring during implementation found that in Mindanao, it used to be the case that students did not like to go to school or were very late because of distances. Once their schools had technology, students started going to school and missing fewer classes; drawing apps help children get engaged and school climate improves because these rural schools feel valued and “seen.”

- The ELLN Digital blended learning program was evaluated in 2018. The external evaluators found that teachers found the digital course valuable and enjoyable. Pre- and post-tests detected a small but significant improvement in content and pedagogical knowledge. This gain was largest for teachers in rural schools, despite similar baseline scores. One challenge related to the digital format of the content is that it is standardized and therefore too easy for some or too complicated for others, and the evaluation recommended an adaptive model based on pre-test of strengths and needs. Some teachers did not have access to the necessary hardware (Oakley, King, & Scarparolo, 2018).

Several other evaluations are underway, including a process evaluation of the DCP, a process evaluation of the scale-up of ELLN, and the summative evaluation of the Technology Package for Student Learning and Empowerment Project (DOST-SEI), which used the mathematics courseware for Grades 1 to 6.

Therefore, there is an appetite for product evaluation and proactive engagement by EdTech providers to monitor effectiveness. For example, SEI assists teachers and undergraduate and graduate students who conduct research on the DOST courseware by lending them hardware (laptops and tablets) and providing installer copies of the product. This encourages more research studies and use of the DOST courseware. There are also some large fora for disseminating results, such as EdTech summits and the DepEd Cyber Expo, but these are one-day meetings and may not reach everyone who needs information.

**Nongovernment and advocacy organizations**

Moving toward impact through technology will depend on reaching teachers with the right products and the right implementation model; thus it is a function of both communication and capacity. Aligning EdTech for impact is a highly contextual effort that requires knowledge of local conditions and student and teacher needs. Therefore decentralized efforts and participation from local nongovernment organizations and coalitions can be very effective. The Philippines has many active partnership models in place for hardware and content distribution, many of which have been mentioned elsewhere in the report.

The **Coalition for Better Education** is an organization with the vision to enhance and improve the education system of the country. It promotes collaboration among sectors of education and other groups or organizations that advocate for education. It also provides some direct services such as teacher training and works through corporate social responsibility programs like the Microsoft Partners in Learning Program. Other partners
include Globe Telecom, Smart Communications, and Meralco, and education institutions of the University of Makati, University of San Jose Recoletos, and Cebu Normal University. A large proportion of their work is developing learning resources that teachers use in technology-enhanced learning. For example, with One Meralco Foundation, the Coalition created learning materials on energy and energy consumption.

South East Asian Ministers of Education Organization’s regional center for educational innovation and technology (SEAMEO-Innotech) is also active in designing and delivering digital learning and advocating in EdTech under its mandate to introduce innovations to teachers in the ASEAN countries. The extent to which these organizations communicate to the level of teachers, however, is not clear. Teachers tend to use social media such as Facebook to share resources and experiences, and now DepEd is also institutionalizing Facebook Workplace as a communication method.

FIT-ED (co-researcher for this ecosystem analysis) has been active for more than two decades in supporting policy development, teacher training, EdTech project implementation and evaluation. Its role as independent “connector” among multiple stakeholders has been a consistent source of historical knowledge about how technology is being integrated, what the challenges and successes have been, and how these can be addressed through the current state of the art. FIT-ED is currently part of the Teacher Professional Development at Scale Coalition and is supporting scale-up and evaluation of scale-up of teacher training for early literacy through the blended ELLN Digital program.

Another prominent organization, the Ayala Foundation, has been working in the field of education and technology. Some of the notable programs they have implemented alongside Globe Telecommunication include the Global Filipino Schools program and Text2Teach. The foundation is now distributing digital content on tablets in partnership with ProFuturo, a Spanish organization underwritten by Telefónica Foundation and “La Caixa” Banking Foundation. According to the Ayala Foundation website, the ProFuturo project has reached 126 schools, 1,562 teachers, and over 41,000 students. The foundation works with Division Offices in Region 4B (island provinces of Mindoro, Marinduque, Romblon, Palawan) on school selection and implementation. They have so far delivered technology packages in the form of a ‘suitcase’ to elementary schools. A suitcase includes a laptop server for the teacher, tablets for students, with content and a learning management system. Aside from EdTech programs, the foundation also focuses on quality elementary education through their Center of Excellence (CENTEX) in Public Elementary Education program.

The Philippine Business for Social Progress (PBSP) is another organization that recognized the need to push EdTech use in public schools. In 1994, they gathered a Consensus Group on Business and Education to discuss the state of science and technology education in the Philippines. As a result, they produced a “portfolio of project proposals” that support the establishment of computer laboratories and training centers for science and technology education.

Product Selection

Independent advocacy organizations could also be a part of these discussions to bridge information sharing between schools, private sector, the general public, and policy makers. They could also take on some of the more challenging aspects of scaling for impact such as acting as a clearinghouse for information on product effectiveness and advocating for policy actions in ways that support good practice. According to our survey of 205 division ICT coordinators, 33% said they choose products by following DepEd recommendations; 11% said they do not make purchases at all. The remainder of the cases were a mix between getting recommendations from funding partners and teachers directly, consulting with suppliers, and searching reviews on the internet. While most ICT officers indicated multiple sources of information, 47 (23%) only listed one source of information, most often DepEd.
Conclusion: Equitable EdTech in the Philippines

The combined findings from the interviews, surveys, and desk research provide a profile of the EdTech ecosystem in the Philippines. The profile, Exhibit 5, is a picture of the areas that are most active and influential in scaling effective practice (the larger slices), and the areas that are less active (the smaller slices). As emphasized in the original Omidyar Network (2019a) report, there is no “right” profile; each country will have a unique pathway on the journey to scale. However, it is likely that when all components are active and interacting in a complementary way toward the shared goal of scaling equitable access, then impact at scale will be reached sooner. The sections that follow describe in more detail some of the most influential factors and the areas that could be fostered through intentional activities.

Summary

Philippine schools benefit from strong and sustained government commitment to technology infrastructure, both general (electrification, internet penetration) and school-specific (computers, school connectivity). Some rural areas still suffer from poor general infrastructure, but government and private-sector partnerships exist to deliberately target these last-mile schools with appropriate packages.

The supply of EdTech is dominated by general computer hardware and productivity tools, but very few EdTech entrepreneurs create custom content for the education market. Of the educational apps available, most are created through pilot initiatives, grants, or teachers themselves, but lack an efficient distribution channel. There is, at the time of this report, no central repository for interactive digital learning tools (distinct from digital resources provided by DepEd through the LRMDS, although DepEd ICTS has plans to create such a repository). There is also a tradition of tight central control on content and methods, and some schools wait for directives before implementing EdTech.

On the other hand, where technology is being adopted and scaled it is at school and division levels, as the result of strong leadership and initiative by visionary thinkers with support from LGUs, school alumni, parents, and local businesses. The government is encouraging creation of digital resources through its OER program, but there is no clear guidance for when to create resources versus when to find something already made and how to find, share, and evaluate the content. Policies toward EdTech are in a continual state of evolution, and there are multiple agencies with some measure of involvement in the sector. The current Secretary of Education has articulated clear ambitions for improving 21st century skills, and digital literacy is the most prominent, stated objective in the curriculum and teaching standards. As such, most evidence of EdTech use is about general ICT skills development or using standard productivity tools to digitize lesson delivery. Digital Rise is the newest articulation of the government’s ambitions, but it is unclear how directive this is as a policy.
Teachers are being trained through a combination of central DepEd support, local initiatives, and partnerships, but the goals and objectives of the training are not necessarily tied to a common objective. As access approaches nationwide scale, and teachers become proficient in basic digital literacy and use of productivity tools for lesson delivery, a shift toward high-impact, specific uses of technology for content learning—particularly those that are currently difficult to teach, and could benefit most from multimedia reinforcement and personalization of instructional time—should become the focus.

**Key Ecosystem Drivers**

The most prominent themes in the interviews that point to drivers of equitable EdTech, outside of the fact that there has to be infrastructure, were capacity building, public-private partnerships, and visionary leadership. These show as the largest bars in the gray (Human Capacity), green (Education Policy), and blue (EdTech Supply) categories, respectively. The following sections describe each of the major ecosystem categories, with particular explanation of these influential factors (indicated with an arrow in the accompanying image).

**EdTech supply**

Public and private sector partnerships was the strongest component in this category. The private sector is involved in creating content and delivering packages of support. Community partnerships, corporate social responsibility, LGUs, and alumni support to schools also play an important role in the spread of access, use, and impact (Exhibit 6). In a few cases we heard about schools partnering with universities, but mostly universities have been involved in content creation, research and development, or support for the drafting of framework documents. This study identified very few private, commercial sources of education content created in the Philippines for Filipino learners. Those that are able to create a sustainable business model are catering to the higher grades and subject areas. There is a lot of available content (in English), from international suppliers. However, there is a tension between what the central office provides (the bulk of instructional materials and content) and what supplemental and other materials divisions and schools are allowed to buy themselves using national budget allocations. Although divisions and schools can raise external funds to buy any compliant purchases, the reality is that there is no guidance from DepEd on what digital content to invest in, and the survey results showed that many divisions rely on this advice.

Partnership can mean a lot of different things; there are very few partnership models that are not mutually beneficial. Even when individuals or companies donate time or materials there is usually some kind of direct return on that investment for them. In the Philippines context, where there was very little private-sector entrepreneurship in EdTech, there was very little to say about "EdTech business models," per se (Component 1.1). However, even centrally led efforts to distribute free and open resources need to have a model that is financially...
sustainable and mutually beneficial for both the recipient and the distributor. Thinking of partnerships in terms of a business model may help to take a proactive approach in involving different partners in supporting scale-up of free and open educational resources by offering incentives such as the opportunity to grow their business, promote their services, gain new competencies, or reach new markets. This kind of social entrepreneurship can be supportive of EdTech use. The Philippines is not yet seeing the kind of growth in EdTech supply and demand that has reached other countries in the Asia Pacific region, particularly China and Indonesia (see Omidyar Network, 2019b and 2019c). This may be due to the culture of central control of content.

**Enabling infrastructure**

The challenge of connecting all parts of a country like the Philippines—consisting of thousands of islands in the path of many potential destructive forces—cannot be overemphasized. Many government initiatives are underway to get rural communities connected and to find solutions for last-mile schools. Indonesia provides an example of a country with a similar geographic context, but as of 2011 95% of schools had access to some form of internet connectivity (Butcher & Bodrogini, 2016). The Philippines is also close to approaching scale of electrification and computer provision, but still far from reaching scale for internet connectivity; according to the Philippines Statistics Authority, 89% of elementary schools were connected to electricity, and 78% had computers, but only 26% had internet service as of 2016 (San Buenaventura, 2019). The DCP has been a major influence in spreading access to EdTech’s potential; now this must be combined with other ecosystem components to make sure that potential is acted upon (Exhibit 7).

Interestingly, although the Philippines has high personal device penetration, including smartphones with access to data and widespread social media use (similar to other countries like China and Indonesia), that particular characteristic has not been influential in the same way for spreading use and impact of EdTech. In China and Indonesia, there is a much more widespread use of personal devices to access direct-to-consumer EdTech independently, outside of school (B2C). In the Philippines, the influence of personal devices seems to be limited to teachers and schools being able to connect to one another to access free downloadables, tools, and ideas. It is likely that families use personal devices outside of school to access learning resources on YouTube or other non-education specific platforms (e.g., videos of songs or rhymes), but this was not an aspect reviewed in depth for this study.

**Education policy and strategy**

Providing, scaling, and sustaining EdTech infrastructure and training have been influenced by a national curriculum with stated expectations for basic technology literacy (Exhibit 8). Gradually standards have evolved from applying the expectations only in middle and high school (Grades 7–10 and then Grades 11–12 when they were added in the curriculum
reform), to introducing them in elementary school (Grades 1–6) starting in 2011. At all levels, teachers are now encouraged to use ICT across subject areas to make lessons more engaging, but the expectations for teacher competency or curricular integration are interspersed throughout various agency documents and not strictly monitored or enforced. There are not, as in other countries like China, high-stakes exams or considerable performance pressure on either schools or parents to adopt technology as a disruptive and transformative way of gaining an edge, although this may be an influence in private schools as a differentiator.

Beyond equipping schools with technology and basic digital literacy, no strong goal for how technology can and should be used in schools has been articulated. A series of ICT in education frameworks or master plans have been drafted but never formally adopted by the government as policy, with wide distribution (Vergel de Dios, 2016). At present, there is a small group of visionary leaders in DepEd who have formulated the ambitions for a “Digital Rise,” including leveraging OER for more widespread and transformative use of technology. There are plans to draft an ICT framework, but whether or not this small group has a large enough voice to create a movement remains to be seen. The World Bank in its SABER ICT Policy framework includes as one critical theme, in addition to a shared vision and thorough planning, that there be a clear line of authority and accountability of a lead implementation agency (Trucano, 2016). Currently DepEd’s ICTS acts as a lead agency, but it is also tasked with basic support and maintenance of information systems within DepEd, while a partnerships office manages private sector and donor inputs along with relevant bureaus (such as the Bureau of Curriculum Delivery or Bureau of Learning Resources). Still other government departments such as DOST and DICT are also active in curriculum and technology planning with schools. Thus the element of one lead voice seems to be a persistent weakness in the EdTech ecosystem, since it was already raised as a concern in a 2016 World Bank report (Vergel de Dios, 2016).

The importance of policy is not necessarily that it be prescriptive and centrally regulate strict implementation, but rather that it acts to guide, prioritize, and also attract resource investments in a high-impact way based on those priorities. ICT policy and strategy must also be driven at the same time from the bottom up, with visionary local leaders on the frontlines (see next section) testing and scaling innovations based on experience. Researchers have put forward suggestions for “future-ready” EdTech policies (Zagami et al., 2018) that more deliberately plan for a changing infrastructure and technology environment. Expanding on earlier frameworks, these types of EdTech policies stress co-creation and contextualization of policy efforts in the day-to-day experience of relevant communities, situating EdTech visions alongside broader sector goals, such as the Sustainable Development Goals, and embracing technology advances or realities (e.g., computational support systems, big data, machine learning, AI, or social media) not only proactively, but also as an opportunity to use technology to support policy development and renewals.
Regarding the latter, this might include using technology to engage stakeholders, to create insights, and to provide platforms for critique and contribution, that would promote co-creation and transparency as well as address inequalities. The current administration has shown signs of this kind of forward-thinking policy and strategy, but it remains to be seen if it is premature to leapfrog to integrating sophisticated technology like AI when basic computer-assisted learning has hardly become a norm.

**Human capacity**

Quotations from key informants praise the role of local visionary leaders perhaps more than any other single driving factor (Exhibit 9). Sometimes these passionate visionaries are teachers themselves:

“My passion to teach children not in the traditional way is what motivates me to develop ICT integrated lesson plans. Since the response of the learners and positive response from my colleagues, school heads, and supervisors I have become more motivated to improve my work,” said a respondent in a focus group of digital learning resource developers. Others spoke of the intrinsic motivation that spreads innovation: “the most important [factor] is the continued intrinsic motivation in teachers.” “We cannot deny that there are really negative thinkers; I believe we could start with those who have already the fire… from simple gathering of these dried twigs, there are the people I believe we could spread fire, so that’s my strategy.”

The two division case studies presented in Annex 1 also emphasize how visionary and committed division leaders have particular power to scale EdTech practices. Most often the key informants mentioned the role of the principal:

- “The principal is a big factor in the successful use of ICT because the principal serves as an anchor. It pays to have a resourceful principal. There has to be skin in the game for everything.”
- “If I could only do one thing, it would be training school heads.”
- “A barrier to scaling is if the principal does not understand.”
- “Factors that helped create successful conditions for effective use of these resources in these schools are persistence, training of teachers, and convinced principals.”
- “School leadership is crucial. Even if you use the bottom-up approach, without support from the principals, the program will most likely not succeed. Initiative of school leaders to also source out funds is important for sustaining ICT use.”
- “Attendance or participation of school principals in the training programs is critical for success… Success rate is higher if there is really somebody who is focused on their development—there is continuous support.”
“School leaders can create the time and space for that mentoring and support to happen.”

Yet the reliance on visionary leaders creates the challenge of sustainability if that individual leaves. In the Philippines, division superintendents and principals have limits on the duration of their assignment so there are necessarily changes in staffing that may affect special initiatives. The NEAP professional development framework now includes ICT integration in the School Heads Development Program in recognition that instructional leadership covers pedagogy and ICT integration is part of pedagogy. Strong and skilled leadership can also create a sense of duty and intrinsic motivation, but in the Philippines there may be too much emphasis on scaling through motivated teachers alone, particularly given the emphasis on teacher-developed lessons and the spread of the OER training program under Digital Rise.

Capacity building is also a theme that came up repeatedly as a need, a barrier, and a driver of EdTech adoption and scaling. In the Philippines, a lot of capacity building is provided to teachers by a range of stakeholders, but it seems to be never enough, especially as priority shifts from digital literacy, to digitization of lesson delivery, to digital transformation of learning. Programs such as the Dynamic Learning Program Ambassadors or Microsoft Education Ambassadors build on a model of diffusion of EdTech through strong leaders who demonstrate good practice and take it upon themselves to encourage others. This model operates somewhere between a direct training and coaching role and an indirect model of good practice to emulate. Similarly, DepEd also has a LRMDMS coordinator whose duties and responsibilities include smooth communication and implementation of the policies and guidelines related to the use of LRMDMS; provision of technical assistance to teachers in the development, production, and storage of learning resources; distribution and utilization of learning resources in the school and/or divisions; and organization of the LRMDMS development team, composed of creative writers, illustrators, artists, animators, a quality assurance team, or learning resource evaluators. If this role could extend to EdTech resources, or be replicated in the division ICT coordinators, it might advance the impactful use of EdTech in schools. Integrated models of EdTech provision along with training and support (such as the model of Phoenix Aralinks, described earlier) are likely to have the most impact and sustainability because of the sustained and contextualized monitoring and support to schools by someone who does not already have teaching or administrative responsibilities. The challenge to DepEd is how to replicate this kind of holistic model within the limits of public funding; this cannot be done through centralized control and will have to allow for devolving responsibility to divisions and schools along with partnerships.

Multi-partner arrangements have supported access to hardware, software, and training by bringing partners together with specific areas of expertise, interest, and financing capability. This is exemplified by the example of Text2Teach, a long-running (2003 – 2014) alliance of multiple organizations supporting an innovative method for digital content distribution. Although this program had been a model of EdTech scaling for many years because of the strong collaboration among partners, each partner also brought their own interests and needs and when those interests changed (in this case, particularly when Nokia ceased being a major player and the K-12 curriculum was reformed) the program was not sustained. More recently, such partnerships are apparent in the efforts to provide School-in-a-Bag or other custom technology packages to rural areas. Local funding for school priorities through the LGU, alumni, or other local businesses are also supporting access to EdTech and training opportunities. In one case, UNDP relies on 3,000 community-based citizen monitors to help document and account for technology deliveries in difficult to reach areas. Will these multistakeholder partnerships be sustained and integrated as ‘business as usual’, or will they be a short-term input only? This is largely dependent upon decisions made by local or central government.
Conclusions and Recommendations

A challenge to EdTech integration anywhere is finding the right balance between central guidance and vision while allowing the market to fuel innovation naturally without ultimately resulting in fractured and incoherent activities. This is why an ecosystems approach emphasizes embracing and encouraging interactions between different parts of the system, rather than assuming that there is any central locus of control. Policy direction is particularly important for setting measurable goals and standards, followed up by measurement and accountability, but local levels allowed freedom are where real innovation and impact happen. Between the two there must be efficient, reliable, and credible sources of communication and evaluation of model practices to inspire and emulate. The ecosystems approach also helps identify these tensions in the system and use them as opportunities for planning strategic investments that strengthen the drivers and connectors in the ecosystem rather than just development of isolated products and activities.

Exhibit 10, below, shows just one example of how different ecosystem components work together in support of the main goal of EdTech use by teachers and students. Looking at where certain interactions are weak or actual inputs are absent may provide ecosystem influencers with ideas for high-impact investments.

Exhibit 10: Interactions between ecosystem components

The broad conclusions and recommendations derive from some of these interactions, especially leadership, training, product development and selection (supply and demand).

Leadership

Vision and strategy. A World Bank report (Vergel de Dios, 2016) has already written a comprehensive analysis of the fractured leadership evident and lack of ICT in education strategy in the Philippines prior to 2012. The same report also presented options, with pros and cons, of various alternative solutions, including creating a national coordinating mechanism for EdTech. The report pointed out three relevant lessons from the Philippines experience that remain pertinent today (Vergel de Dios, 2016, p. 13):

- ICT in education planning and implementation benefit from coordination and a holistic approach. A national ICT in education agency can help with this.
National ICT in education vision and standards can help align activities of various actors—especially in the absence of related policy guidance or a national coordinating agency.

Government must strike a healthy balance between encouraging institutions to support ICT in education efforts while helping to ensure a general coherence between such efforts.

Thus the central government—not just DepEd—needs to articulate a position on where it expects to position the leadership for a strategy, implementation, and monitoring of basic education technology integration. Maybe DepEd is the right place to do this, maybe within the existing ICTS office. But how this group interacts with DICT, DOST, CHED, and other institutions across the ecosystem model is critical. Similarly, if Digital Rise is the current strategic framework for ICT in education, it needs a much stronger dissemination plan and endorsement from higher levels of government and other departments.

The World Bank report, similar to this study, also found that a range of loosely formed organizations, coalitions, and initiatives and partnerships among DepEd and other stakeholders are already providing a range of important services even in the absence of a national strategy or coordinating body. Yet continuing to streamline and capture the impact of these supply-driven partnerships would allow DepEd to divert scarce public resources to the gaps that are not otherwise being filled. Partnership should, however, be a loose agreement that allows divisions and schools freedom to choose and implement, but within the broad values and frameworks defined by DepEd. The DepEd Adopt-a-School program is one example of this kind of flexible framework that enables local private-sector participation in school activities in exchange for tax incentives. Technology hardware and support seems to be a popular activity in school “adoption,” but encouraging partners to invest in other aspects of the ecosystem, such as evaluation, training, content development, and maintenance support might accelerate the transformative impact of technology.

Intrinsic versus extrinsic motivation for EdTech implementation. Statements from key informants and survey respondents in this study revealed how positive role models and intrinsic motivation have been very successful at spreading EdTech use. There are also programs that provide extrinsic rewards in different forms (which often help to spark intrinsic motivation) like points, badges, public recognition, or conference participation. When teachers have their work showcased to other teachers during workshops, learning action cells, and in-service training, it encourages them as well as others to do the same. While intrinsic motivation is certainly important, it is risky to assume that every teacher will have it. Intrinsic motivation must be cultivated, sometimes through external incentives as well. The diffusion of innovations theory (Rogers, 2003) suggests that motivation can spread when some individuals demonstrate use and impact from an innovation. Other teacher professional development experts such as Guskey (2002) suggest that individuals must act first, then see results; it is when they observe positive effects from their behavior that they change their motivation and attitudes and sustain behavior change. This is where policy, expectations, and rewards generated from higher levels can make a difference—by motivating teachers to take that first action.

Training

External incentive for training. Some institutions (SEAMEO-Innotech and Coalition for Better Education, for example) have managed to award official continuing professional development credits for the EdTech training they deliver. This strategy, if scaled up by DepEd, is mutually beneficial since it removes some of the training burden on the central office, but also ensures that these third-party trainings align with and are recognized by DepEd. With the new role of NEAP in delivering and monitoring teachers’ competency development, teachers should continue to get credit for a range of professional development opportunities. On the other hand, DepEd should be careful that tight central control of
training does not prevent teachers from accessing opportunities that would improve their teaching and technology. This makes it very important that advocacy organizations ensure that the PPST include appropriate standards related to EdTech integration.

**Training design.** Another tension of sorts is whether money is best diverted to training teachers or school heads who cascade down the training to schools. There are advantages and disadvantages to both, but in the context of the Philippines there may be a significant advantage to training school leaders. This study found that school principals seem to have a particularly strong influence in motivating teachers to enact technology integration. Training school leaders in digital literacy and using administrative software can also be one way to increase motivation and sustain infrastructure investments so that instructional use can continue to grow. Training school leaders on pedagogical integration can help ensure continuity and monitoring of teachers in their efforts to integrate technology. For teacher training, there appears to be a solid grasp of general technology use—television, internet access, productivity software like Microsoft PowerPoint, and other general tools to digitize traditional lesson plans. Major investments should now focus on subject-specific technology integration that is more explicit about matching the attributes of technology with the content area. Teachers should be encouraged to use technology for the subjects that are currently most difficult to teach using traditional methods, rather than to digitize lesson plans that already work well. Or, alternatively, teachers should be urged to use technology to create learning stations (see the Ilocos Norte case study) that allow children to work independently in one station while they provide personalized attention in another station.

Teachers surveyed for research contributing to this study expressed a desire, in the next 3 years, to receive trainings related to the use of advanced internet tools and platforms such as blogs, wikis, social media, and Google docs (56%); multimedia creation (54%); programming (50%); and using subject-specific software (49%). Many of them (55%) also want to know how to use ICT to better engage students in learning. This is also the topmost need identified by ICT division coordinators and expressed by most of the school ICT coordinators (56%) included in our survey. Teachers who do need more skills in general technology functionality should be encouraged to learn these skills through learning by doing (e.g., being required to fill out reports on the computer), independent learning, peer groups, or school or cluster-based activities that are based on clearly identified needs.

**Setting standards and rubrics for ICT integration.** Training should also incorporate concrete examples of how ICT integration goes beyond transferring chalk and blackboard to PowerPoint or converting a live lesson to a video-recorded one. Descriptive performance standards and technology integration rubrics issued at the central level can also guide LGUs and partnerships in areas of support that go beyond providing hardware and productivity tools. Many schools depend on LGUs for funds that meet unique needs and interests. Knowing that these unique interests contribute to a nationally sanctioned activity or framework could make it easier for these LGUs to approve EdTech funding requests.

**Supply and demand**

**OER versus off-the-shelf software.** Although the National Broadband Plan aims to support demand through local content generation supported by policy and regulatory means, in the education sector, this ambition is limited by the strict centralized control of the curriculum and education content of DepEd. Combined with low performance pressure (i.e., to pass high stakes exams, or to get into the best universities) of the kind that might drive consumer investment, entrepreneurial investment in EdTech is limited especially in local languages. The current market is very supply driven, with schools generally accepting what the central or division offices provide for them, and that decision is often made by suppliers who market directly to division leadership. To reach impactful EdTech integration there must be more opportunities for demand-driven ICT integration; that is, teachers identifying subject areas where they need support, being able to find technology resources that fill that gap, and having funds to purchase existing software or otherwise having an easy way to find free and
open resources that meet their needs. As one division DepEd official mentioned: “One of the things we need to focus on as support to teachers is really sit and look at the curriculum and plan where, and how, they will integrate technology in the classroom. From their curriculum planning, we go down to the tasks—where now do you put in technology, and if it needs to be in partnership with other subject areas.”

This statement reflects other known, global recommendations that technology should be integrated for specific purposes—particularly in those subject areas that already lack teaching resources, those that are hardest to teach, or those that benefit most from attributes of technology—rather than haphazardly for every subject area. Production of new OER and digital resources should be done based on measured areas of need and added value. DepEd should consider issuing procedural principles for creation, use, and dissemination of OER, along with expectations for use, that leave room for exploring other commercial products.

In any case, DepEd will have to resolve the tension or find an acceptable balance between encouraging teacher-developed materials and allowing commercial product use in public schools. There is no way to know whether commercial products are necessarily of higher quality than teacher-developed ones without doing more research into the materials, but certainly the opportunity cost of teacher-developed materials must be considered, if there are off-the-shelf products that meet the same needs. The OER movement has both advantages and disadvantages, and while it is in a nascent stage it is an opportune time to devise strategies for quality control, efficiency, and incentives for creation, dissemination, and use. Many apparently effective products for literacy, numeracy, and science education have been created for Filipino learners, but these are not widely scaled to all schools. The reality is that a product that generates no revenue leaves no room for dissemination and support. Additionally, many good products exist that may relieve teachers of some of the burden of creating their own digital resources, but a government policy that uniquely promotes OER may disincentivize use of many practical, effective, and affordable tools while encouraging teachers to invest time in creating duplicate resources that might be of lesser quality.

Our survey indicated that the goal of ICT integration for many division and school ICT coordinators is to make the work of teachers and administrative easier and more efficient. Therefore government policy can help distinguish the comparative advantages and goals of commercial or professionally developed, but free (as in the case of DOST-SEI products) EdTech versus teacher-generated and shared OER. There are certainly instances where OER makes most sense or has alternative objectives for teachers and students, just as there are certainly subject areas where it is more efficient to select and distribute off-the-shelf resources. For some subject areas, it may make more sense to curate and disseminate off-the-shelf packages, and for others, teacher-developed content is more appropriate. This may be the case, for example, with English language learning content for which there are thousands of products available. For local language and cultural subject matter there is only what Filipino teachers create. However, there should be incentives to create and distribute local content, particularly if it is of high quality. Teachers should get credit (by name) within the resource, and perhaps schemes to reward teachers either financially or through professional credits after a certain volume of shared resources can be developed. Right now the process of creating, quality control, and sharing is a disincentive since it is very resource-intensive and many months go by before the developed resource is online.

Packaging products and services has shown to be an effective way of expanding and sustaining EdTech use in the Philippines and elsewhere. Another way to package products and services to make teaching easier is to design “programs of learning” that package resources and implementation models together for a specific curricular goal. This is the kind of role that either a deliberate central agency dedicated to EdTech integration or civil society partnerships could take on. This will be increasingly important as there are more OER for teachers to contend with. When there is too much choice for teachers, they risk being
overwhelmed and making wrong or ineffective choices. The Omidyar Network country report for the United States (2019d) gave the example of civil society initiatives that served to curate OER for teachers. Such organizations also relieve the central DepEd of the burden of quality control that is currently creating a backlog in getting resources into the LRMDS and a disincentive to try to create and share (so ultimately, schools and divisions maintain a separate repository, or they simply share resources they find on the internet, which may or may not be open).

**Communication and sharing evidence.** DepEd is aware that there is no research division that captures evidence in EdTech use. ICTS (the department responsible for executing the DCP) is developing a monitoring, evaluation, and learning framework for ICT-assisted teaching. The goal is that central replenishment of hardware will occur only after schools produce evidence of training and use. A permanent repository of evidence, which ensures teachers can access it when needed, would help scale the right EdTech equitably. If the market for educational apps grows, including multimedia resources developed by teachers, it will be important for schools to be able to find and choose resources based on some kind of criteria for quality or evidence of effectiveness. Also, learning from these efforts must feed back into policy and strategy at the central level. The present study cannot conclude that this is not happening, but there do seem to be multiple and varied efforts through different partnerships. At minimum, the DCP computers that are being delivered, and associated training, should include copies of the various interactive courseware that has been developed by different partners.

Right now common practice for finding digital resources, apart from following central and division-level directives, is to get recommendations from other teachers through one of many social media networks. DepEd intends to develop an OER website similar to LRMDS that would allow teachers to find quality-assured OER. In doing so, DepEd should recognize lessons learned from the implementation of LRMDS and ensure that the quality assurance process is efficient and the website user-friendly. More inter-agency sharing and internal/external collaboration with DepEd is needed to spread access to digital learning resources. There are several opportunities sponsored by DepEd (“CyberExpo”), DOST (“science and technology week”), and external parties (“EduTech Philippines”). These large trade fairs could be coupled with a smaller policy working group or technical committee meeting to establish updated lists and recommendations based on evidence from formal evaluations, action research, and teacher recommendations. Civil society and the private sector should also be able to play a role in evaluating and spreading access to these digital learning resources. The evidence clearinghouse could be part of the OER website or LRMDS, or a separate, independent evidence clearinghouse.

**Privacy, security, and information management.** This study did not specifically set out to investigate issues of privacy and security in EdTech implementation, and those issues did not come up as a priority; however, there were examples of EdTech use (such as learning management information systems that keep student data and share with parents) that seem to warrant concern. A deeper look at privacy, security, and general information management will be important, particularly if the government plans to move forward with any AI-enabled activities.

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References


Annex 1: Case Studies

Ilocos Norte Case Study – Use of RACHEL (Remote Access Community Hotspot for Education and Learning)

Exploration

Schools Division Superintendent Vilma Eda was assigned to Ilocos Norte Division in April 2017, and immediately prioritized getting information and communications technology (ICT) innovations to work for the division’s 372 elementary and 54 secondary schools. One of the first things she did was reassign technical teachers from the classrooms to work in the Schools Division Office (SDO). “There was no one in the division who can do what he does,” Eda says of Kenneth Tabios, one of the reassigned teachers who became division ICT coordinator in July 2017. He was joined a few months later by Engineer Almadin Domingo, an IT officer who was previously assigned to Laoag City Division.

Eda introduced the RACHEL (Remote Access Community Hotspot for Education and Learning), which she had been using since 2015 in her previous assignment in Batac City. RACHEL is a package of content that can be accessed through a small Raspberry Pi server. The server stores the digital materials and websites offline and then acts as an intranet for devices at the school level. In Batac, SDO initially partnered with Mariano Marcos State University to configure the RACHEL devices, but eventually the SDO personnel learned to do it themselves and save time.
School Division Superintendent Vilma Eda turned over Raspberry Pi devices to school heads in Ilocos Norte (Photo Courtesy of SDO Ilocos Norte)

In Ilocos Norte, the SDO first distributed the Raspberry Pi devices to areas with large indigenous populations and multi-grade schools since such schools are usually located in remote areas and would thus benefit from this technology the most. As the division acquired more Raspberry Pi devices for use in the schools, the SDO also learned of challenges. For example, the ports would break after repeated plugging in; the SD card was too small (128G cards are required because the RACHEL content increased to 100G); only 10 tablets could connect to the server device. By February 2018, the SDO realized that it was not necessary to buy the Raspberry Pi server devices to access the RACHEL offline repository of resources, and that installing the RACHEL system into existing laptops is actually more advantageous.

Scale-up

At the time of the case study (September 2019) the division reported configuring a total of 449 laptops, so each school in the division had one to two laptops on which RACHEL was already installed. Teachers also opted to install RACHEL on their personal laptops and use their own devices for their classes. With RACHEL, teachers had access to international open education resources such as those from Khan Academy, classical literature, textbooks, and other reference materials offline. The division also added locally made, contextualized instructional materials for elementary teachers using mother tongues.

The division formed a learning resource team in charge of contextualizing the RACHEL interface for the division. That included searching for open educational resources (OER) that could be included in the interface. Aldrin Paguirigan, for example, wrote to ABS-CBN, a local television station, regarding educational videos that could be shared with the teachers. Thus, their RACHEL ultimately included Knowledge Channel Foundation, Inc., videos; Department of Science and Technology (DOST) courseware for science and math; and educational games. Other content materials, such as those written in mother tongues and appropriate for early grade learners, were actually teacher-made and submitted to the division for quality assessment or evaluation and inclusion into the RACHEL. Teachers continued to digitize existing learning materials for uploading and inclusion in RACHEL.

"Prior to RACHEL, it was very hard to get learning materials. Now, you can easily access RACHEL and get your own materials," said an elementary school teacher who teaches in F. Camaquin Integrated School located in Vintar, a mountainous district in the division. Teacher-made slide presentations, or curated videos and other instructional materials, were uploaded to teachers' RACHELs so that they could be presented in class.

Selected teachers underwent a one-day training on the use of RACHEL in May 2019, prior to the distribution of RACHEL on laptops. The division could not train all 4,000+ teachers, but those who were trained were responsible for sharing what they learned in the training with the other teachers in the schools via school-based learning action cells, which were scheduled weekly.

Impacts

Trained teachers were adept at customizing their own modules within RACHEL. "We are trying to provide RACHEL in accordance to the subject they are teaching. This way, you won’t be storing things you won’t be needing (in your device) in your class," said Tabios. One Grade 6 science teacher who was observed for this case study presented her lesson for the day through a song and an informative video she chose, which she uploaded into RACHEL. She then connected her device to the TV monitor in her class so everyone could see and hear the presentation. After discussion, she asked her students to work on varied group tasks as a way to assess their understanding of the lesson. Each small group had at least one member with a smart phone connected to RACHEL, through which they accessed
the content for their specific class. Groups then submitted their outputs (e.g., student-made videos, student-accomplished worksheets, student-made posters, etc.) to her via RACHEL.

"I usually ask students to submit outputs via RACHEL so I can check it at my most convenient time. As long as I have my laptop, I can access their outputs and grade them. I don't have to bring heavy papers home," she said.

Another way teachers used RACHEL was through station rotation. A class would be divided into three groups. There would be a teacher-led station where a small group worked directly with the teacher; an ICT-based/tech station where another small group worked using ICT devices—they would be asked to watch videos or work on an interactive material or a teacher-made PowerPoint (offline or online); and the last station was an independent station where students worked on their own. Station rotations worked in schools where there were limited hardware devices, since only a few students at a time worked with devices.

Having instructional materials available for students offline was another benefit of having RACHEL, as mentioned by Tabios, himself a former high school teacher: "As we know, not all students read or write at the same pace. Having the material on your device allows you to read and reread the text as long and as many times as you want. This is a way to customize learning for the students."

Another thing that made a difference in this division was an able in-house technical team, which the superintendent put together by pulling people from the field into the division office. An advantage of having an in-house team is that technical support and follow-up are easily done. Projects set up by third parties usually die out after a while because they become static. It becomes costly to procure third-party services for improvements, which is not a problem if done internally. In this case, the in-house team could listen to feedback from users and continuously improve the existing innovations at no extra cost to the SDO.

Looking forward

Another major ICT project that Superintendent Eda worked on was setting up 21st Century Learning Environment Models (CLEMs). These are modern classrooms equipped with various devices that are not standard Department of Education Computerization Program (DCP) hardware: interactive whiteboard, 3D printer, a laptop caddy with 25 laptops, a visualizer/document camera, virtual reality goggles, digital microscopes, and computer kiosks with learning modules for science and math already installed (DOST courseware), among other things. The specifications for the CLEM were from DOST, and each CLEM cost about PhP 3.5 million. Superintendent Eda personally lobbied for the CLEM by talking
to the local government unit; she convinced the mayor to use the Special Education Fund for this purpose, even though it was earlier earmarked for something else. “The municipality of Burgos has planned to put up 21st century classrooms every year until all schools are modernized,” Eda stated in a press release.

Superintendent Eda was with the division for a little over 2 years and initiated and supported a number of ICT innovations for the division. She believed that one of the key ingredients for successful innovations is establishing the integrity of the SDO to get the buy-in of stakeholders such as the local government officials. At the school level, meanwhile, school heads and administrators played a critical role in facilitating and sustaining innovations by earning the valuable support of parents and alumni.

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This case study was prepared by Anne Tang-Choi under a subcontract issued to the Foundation for Information Technology Education and Development, Philippines, based on interviews with the officials and staff, and class observations of the Department of Education Schools Division of Region 1, September 2019.

**Sagay Case Study – Collaborative lesson development of digital math resources**

*Exploration*

From 2009 to 2015, Alma Mirasol was principal of Bato National High School (BNHS) in Sagay Division of Negros Occidental Province. In 2014, in support of the kindergarten to Grade 12 (K–12) curriculum, Principal Mirasol began to develop a school information and communication technology (ICT) strategic plan. First, she tried to identify teachers with the potential to develop ICT-assisted lesson plans. Florabelle Carandang, a Grade 10 math teacher, was trying to produce ICT-assisted lesson plans by substituting print resources with digitized material, but was frustrated by her lack of ICT skills. To address this gap, she reached out to the three school ICT coordinators to provide her with ICT-created objects (e.g., PowerPoint presentations, effects, transitions) to include in her lessons. When Carandang delivered her ICT-assisted lessons in class, she noticed that it was easier to keep the students’ attention focused. Students also participated more, which encouraged her to continue creating more materials.

With the continued help of the ICT coordinators, Carandang gained confidence in ICT-assisted lesson development and started to share her work with other math teachers. One teacher, Lesser Loc, also started to develop his own materials. Bringing his own set of skills, the two helped each other continue to develop and improve their ICT-assisted lesson plans. In order to motivate other teachers, Principal Mirasol invited BNHS teachers to join her in observing Carandang’s classes. These teachers were interested in observing the change in her classroom, and subsequently Carandang was assigned to deliver a session on ICT-assisted lesson plan development during an in-service training event in July 2017.

After the training, Principal Mirasol directed all BNHS math teachers to select at least two competencies each for ICT-assisted lesson development and delivery within a grading period. Each teacher was responsible for developing lessons covering those selected competencies. The math teachers were tasked as a group to ensure that there would be no duplication of the competencies taken on by each one. Mirasol then brought together the mathematics teachers for a workshop that culminated in a showcase of the completed ICT-
assisted lesson plans. Lessons were demonstrated during the workshop, and participants were given the opportunity to evaluate and critique the lessons and give suggestions on how to enhance and improve them.

“At first, only Florabelle and Lesser worked to develop lesson plans,” Mirasol said. “They started with designing lessons covering two mathematics competencies. They later completed ICT-assisted lesson plans for 16 math competencies for Grade 6 (out of a total of 89) and 16 math competencies for Grade 10 (out of a total of 50). Then five more teachers (mostly from the elementary level) started developing ICT-assisted lesson plans.” According to Principal Mirasol, it took the teachers three full days to develop an ICT-assisted lesson plan covering 1 competency. By school year 2015–2016, 6 BNHS math teachers and 10 elementary teachers were utilizing ICT-assisted lesson plans in their classes. According to Mirasol, the teachers wanted to change students’ attitude towards math from “difficult” to “fun”. The teachers believed that the students would have an authentic learning experience through ICT-assisted lesson plans.

Division Scale-Up

Mirasol was promoted to Division Educational Supervisor for Mathematics in 2015, and she moved to scale up the initiative for ICT-assisted lesson development and delivery started at BNHS. She said, “I will look at every district, for teachers who are potential development partners like Florabelle and Lesser, with the same passion and with the skills to come up with ICT-assisted lessons.” Mirasol worked with Jonah Uypico, the ICT officer of Sagay Division, to launch ICT-assisted lesson plan development in all 56 schools in the division.

Before a division-wide training workshop for mathematics teachers, Uypico provided training for individuals in the division who were able to lay out documents for publication. The training included how to use Adobe® Photoshop® and how to localize existing material, including understanding intellectual property guidelines. Mirasol and Uypico also coordinated with the division Learning Resource Management and Development System (LRMDS) team to work on publishing the completed lesson plans on the DepEd portal, for easy access. By the time of this case study the division had 16 lesson developers who produced 16 ICT-assisted lesson plans targeting the 8 competencies for elementary level math and 8 competencies for high school level math. The lesson plans were approved for division-wide use and have been submitted to the region for next level quality assurance checking.

The Sagay Division mathematics teachers and ICT coordinators worked effectively together. The task of developing of ICT-assisted lesson plans gave them the opportunity to bring their knowledge and skills together to explore something outside their experience, and for which they had no previous training or guidance. The program expanded to include mathematics teachers from Grades 4, 5, and 9. In 2019, 21 lessons for Grade 4, 21 lessons for Grade 5, 8 lessons for Grade 8, and 8 lessons for Grade 9 mathematics were produced. The program expanded to social studies (Araling Panlipunan) lessons in August 2019.
To support scale up and sustainability through improved infrastructure, the division partnered with the local government unit (LGU) for the provision of smart TVs for all schools, and Sagay Central Incorporated (a sugar milling and sugar growing company) provided an infrastructure package for the division worth PhP 2 million. The division also encouraged all schools to include provision for ICT infrastructure support in their plans with local stakeholders (e.g., alumni associations). One alumni association donated 50 computer units. Nonetheless, reliable access to the internet remains a challenge for most schools in Sagay.

As part of the division ICT-assisted lesson plan development initiative, the LRMDS unit conducted a workshop on quality assurance for the selected teachers and ICT expert lesson developers. The DepEd quality assurance process is a lengthy one because it goes through several levels of approval (division, region, central) and as a result, a lesson plan may take 6 months to go online. Carandang and Loc’s 16 ICT-assisted lesson plans targeting 16 competencies for both Grade 6 and Grade 10 math produced in August 2015 had not received approval for publication as of September 2019. While waiting for publication approval, the division distributed offline softcopies of the ICT-assisted lesson plans to all mathematics teachers in Sagay, for their immediate use.

Impact

In 2015, Mirasol asked for action research to document and evaluate how this innovation impacted teaching and learning. Research published in August 2015 indicated improvement in student performance based on pre- and post-test results, with high mean percentile score results in every test given after each ICT-assisted lesson. There was also an increase and improvement in quality of student participation. However, according to the SAMR model for education technology adoption (Substitution, Augmentation, Modification, Redefinition), most of the teachers developing and using ICT-assisted lessons in Sagay continued to be at the Substitution level. But there were some—including Carandang—who were already starting to integrate the Augmentation level. As an example, Loc used a satellite image of Barangay Lopez Jaena to project as a 3D map for a series of lessons on geometry. Alfie Silva gave his students access to Geometer’s Sketchpad®, an interactive program for exploring Euclidean geometry, algebra, calculus, and more.

Teachers said they were encouraged to sustain their work as ICT-assisted lesson developers when other teachers showed appreciation for their efforts. “Something that you consider as your own, and knowing that many teachers benefited from it, gives me a strong feeling of motivation and inspired me to do even more ICT-assisted plans and even do something better,” said Loc. Silva said he was inspired by the work of Carandang and Loc. He tried the ready-made ICT-assisted lesson plan in his class and was encouraged to create his own. “Para sa bata, para sa bayan (We work for the child, for the nation)” is the teachers’ rallying call. “I find it enjoyable [ICT-assisted lesson development], and it eases my work. It gives me a feeling of fulfillment and satisfaction when my pupils enjoy our mathematics class while learning,” said Grade 6 math teacher Roy Bersales.

Looking ahead

Looking ahead, Mirasol said there was a need for continuous teacher training in content, pedagogy, and technology use as well as greater investment in infrastructure and technical support. Similarly, Uypico noted that “Most teachers don’t know the levels of ICT integration in teaching and learning. They think that transferring chalk-and-blackboard content to a [PowerPoint] is already ICT integration. It is not.” Mirasol planned to provide teacher incentives such as scholarships for advanced studies, attending international conferences, and awarding productivity points for consistent, high-quality performance as incentives.

This case study was prepared by Eddelyn Gupeteo under a subcontract issued to the Foundation for Information Technology Education and Development, Philippines, based on interviews with the officials and staff, and class observations of the Department of Education Schools Division of Sagay City within the period September 29 to October 3, 2019.
Annex 2: Artificial Intelligence in Education

**What is AI?**

Although the intelligent computing power of information and communications technology (ICT) has been applied to education (known simply as “EdTech” or “ICT in Education”) for decades, advances in technology made possible through machine learning and big data analytics are providing new ways of simulating tasks previously done only by humans. Artificial intelligence (AI)-enabled educational tools continue to grow in scope and sophistication as companies harness AI in their product offerings for an increasingly receptive market. Government departments of education and public and private school systems, as well as individual students and their families, are eager to understand the potential of AI in education.

There is no single consensus definition on AI in education, but rather, the technologies can be understood through a continuum of sophistication and functionality: intelligent tutoring systems (ITS), virtual learning environments and learning management systems, conversational agents, and smart classrooms. The key difference between AI-enabled education and traditional computer-assisted instruction (CAI), which has been in use for decades, is that it is enabled by machine learning. That is, CAI already operates using human-programmed algorithms to execute commands based on input faster and more accurately than humans. However, AI-enabled learning systems get smarter with use, essentially self-updating algorithms automatically based on larger and larger datasets. Another application of machine learning techniques is mining data to identify clusters, patterns, or features that are meaningful predictors of an outcome but that human analytics have not been able to identify a priori.

In fact, AI as a term has been used for at least 60 years to describe technologies that perform human functions, including the ability to diagnose a situation and act upon it based on rapid data processing power. Until recently, AI remained a specialized field of study, but the recent explosion of “Big Data” combined with more affordable access to computing power has made it possible to harness AI for commercial and social uses while at the same time, transforming and expanding machine intelligence with those data. Therefore, modern AI has entered the mainstream consciousness because of much more advanced machine learning techniques and sophisticated functions such as natural language processing, shallow text processing, facial recognition, and gesture and emotive interpretation, which are increasingly used in everyday commercial products thanks to the volumes of data made available through the internet. As one Microsoft commentator explains, AI “is not merely ‘digitization’ of existing resources or teaching practices. Instead it is adding a new layer of value by delivering data-driven insights and tools to enable access to learning that simply could not be achieved without the power of the intelligent cloud” (Microsoft, 2018).

**The hope of AI for education**

AI-enabled education is the application of machine learning algorithms to content development, facilitated classroom instruction, and tutoring at the individual student level. The consensus in the education community at a global level is that AI cannot and should not replace teachers, but rather that the technology can be used to augment the teaching experience and more quickly enable highly personalized learning for students. AI can complement the teaching experience by freeing teachers from certain routine administrative tasks such as attendance taking and grading, or by creating opportunities for periods of self-directed learning by students. This can enable teachers to better focus their time and efforts on higher priority tasks such as teaching creative thinking, communications, and problem solving (or those requiring social and emotional intelligence, which machines have yet to replicate).
The extent to which emerging technology, and specifically AI, is adopted and applied to education around the world, is impacted by a host of factors. These factors include the level of development in a particular country, access to financial and technological resources, as well as the willingness of the respective countries’ political leadership to embrace emerging and disruptive technologies. Nevertheless, the degree to which AI is starting to feature in classrooms around the world is growing, evidenced by the growing awareness in developed and developing countries alike that the future of the workplace is, and will be, invariably shaped by AI.

An international conference on AI and education took place in Beijing, China, May 16–19, 2019, resulting in the "Beijing Consensus on Artificial Intelligence and Education." The United Nations Educational, Scientific, and Cultural Organization (UNESCO) reports (2019) that the consensus recommends that governments:

- "Plan AI in education policies in response to the opportunities and challenges AI technologies bring, from a whole-government, multi-stakeholder, and inter-sectoral approach, that also allow for setting up local strategic priorities to achieve Sustainable Development Goal (SDG) 4 targets."
- Support the development of new models enabled by AI technologies for delivering education and training where the benefits clearly outweigh the risks, and use AI tools to offer lifelong learning systems that enable personalized learning anytime, anywhere, for anyone.
- Consider the use of relevant data where appropriate to drive the development of evidence-based policy planning.
- Ensure AI technologies are used to empower teachers rather than replace them and develop appropriate capacity-building programs for teachers to work alongside AI systems.
- Prepare the next generation of the existing workforce with the values and skills for life and work most relevant in the AI era.
- Promote equitable and inclusive use of AI irrespective of disability, social or economic status, ethnic or cultural background, or geographical location, with a strong emphasis on gender equality, as well as ensure ethical, transparent, and auditable uses of educational data."

The Beijing Consensus followed the Qingdao Declaration adopted in 2015 on leveraging ICT to achieve SDG 4, which stated that emerging technologies must be harnessed to strengthen education systems, access to education for all, quality and effective learning, and equitable and more efficient service provision. In between simple EdTech and advanced AI on the spectrum of technology-enabled learning, “Smart classrooms” use technology to rethink traditional classrooms. What this means for kindergarten to Grade 12 (K–12) classrooms is a focus on collaboration, interactive lessons, and technology-enabled learning spaces (such as e-devices, charging stations, etc.). Smart classrooms can be equipped with one or a combination of the following “intelligent” technologies: interactive whiteboards, bring your own device (BYOD) programs for individualized learning, augmented reality (AR) and virtual reality (VR), and makerspaces (simulated coding with tactile objects). These may or may not use AI as a core feature.

**Application of AI in education**

Many school systems are taking advantage of AI by implementing smart learning management systems (education platforms for teachers, parents, and administrators) or ITS that deliver personalized education content through a host of learning applications on e-devices. These systems step up the previous EdTech functions through modern AI tools.
The following examples show the evolution from traditional EdTech to modern AI-enabled education in two common cases:

- First, traditional EdTech has long provided the possibility to access learning opportunities online and engage in collaborative learning using asynchronous discussion boards or synchronous chats. Now, certain AI features such as automatically graded quizzes or adaptive calendars that set deadlines and push notification replace certain routine tasks for instructors and students, allowing them to focus more on the content. Traditional collaborative online activities may now be further enhanced by using natural language processing to translate discussions, allowing participants to contribute to a discussion by speaking rather than typing, summarizing for teachers the content of discussions, and identifying patterns of student progress.

- Similarly, traditional computer-assisted learning (digital and interactive content, quizzes, games, simulations, and more) can now be enhanced through the power of advanced learning analytics to guide learners through more efficient learning paths based on demonstrated strengths and weaknesses and then find patterns in student learning trajectories that can help revise curricula for all. Where computing power had previously been harnessed for efficient grading of multiple choice quizzes, modern AI-enabled computing can now grade written essay questions.

Therefore, AI provides new directions in the use of ICT for education, but it is not necessarily a requirement for improvement, nor will it overcome larger weaknesses in basic education delivery. If schools have been unable to implement traditional EdTech effectively, then it is unlikely that AI-enabled EdTech will have an impact. According to one source: “The key to AI success is specificity. It is crucial to define key needs AI tools can meet and shortcomings it can address. This is especially true for K–12 institutions faced with limited time and budgets” (Bonderud, 2019). This can be understood as defining needs and shortcomings in traditional teaching content and methods that AI tools can meet better than any current option. AI applications can perform a wide range of intelligent behaviors: optimization (e.g., supply chains); pattern recognition and detection (e.g., facial recognition, fraud detection); prediction and hypothesis testing (e.g., predicting disease outbreaks); and natural language processing (e.g., machine translation, spam filtering) (International Development Research Centre, 2018). The Philippines National ICT Ecosystem Framework, developed by the Department of Information and Communication Technology (DICT), recognizes that AI can be harnessed for positive economic and social growth, or it can also be harmful and it recommends: “Therefore, policy and regulatory frameworks need to balance between enabling innovation while protecting privacy and security, in order to ensure that the AI applications are inclusive and fair” (DICT, 2019, p. 31).

**AI for Education Management**

The potential of AI is perhaps best realized through its application to Big Data analytics. Education systems have large amounts of data that simply cannot be efficiently processed by humans. AI can be applied to combining analyzing and finding patterns in multiple data sources and using that insight to improve the efficiency of decision-making. IBM Watson Education and Google are both entering this market with systems to support AI for decision-making. Challenges to making this work effectively include the quality and completeness of the data that go in and the ability to protect personal information.

Other AI systems support education delivery by acting as a virtual assistant to teachers or school administrators to grading activities, handling routine and repetitive paperwork, dealing with logistics-related matters, or personnel issues. AI systems can make contact with
parents for reminders and address other routine matters, giving
teachers more time to focus on things that require a personal touch with
the students.

**Intelligent Tutoring Systems**

ITS are **adaptive, personalized learning** for students. Unlike previous
forms of adaptive quizzes that select increasingly harder questions
based on prior input within the limits of a previously defined decision
tree, AI-enabled virtual tutors deliver content and engage students in
dialogue, answer questions, and provide feedback in unique and
previously undefined ways. This may include advanced speech and
writing recognition as well as automated question generation. Metrics
can be shared with teachers, administrators, and parents. Many types
of ITS exist that can help children advance their learning with feedback
in the absence of a teacher. In fact, this was the premise of the Global
Learning XPRIZE that was recently awarded to innovators who
developed “scalable solutions to enable children to teach themselves
basic reading, writing, and arithmetic within 15 months,” as
demonstrated through a pilot in Tanzania. The winning solution has
also been used in Malawi (Language Magazine, 2019). Google Bolo is
also a speech-based reading tutor that can process and respond to
unique verbal inputs, offline as well as online. Information on Google

Adaptive learning is embedded in **computer adaptive assessments**
that adjust the difficulty of successive questions based on a student’s
answer pattern. ALEKS®, Assessment and Learning Knowledge
Spaces, is an example of an AI assessment system. ALEKS, from the
publisher McGraw-Hill, uses adaptive questioning to understand
individual learners’ progress. ALEKS then delivers customized course
content on topical gaps as identified.

**Autonomous conversational agents** can answer questions from
students, provide assistance with learning or assignment tasks, and
reinforce concepts with additional materials that can help reinforce the
curriculum. Voice assistants such as Amazon Alexa, Google Home,
Apple Siri, and Microsoft Cortana may provide an opportunity to interact
with educational material outside of the classroom, particularly for
learners with low literacy or physical impairments. Voice assistants are
particularly useful for language learning. The French Ministry of
Education plans to introduce voice assistants in elementary school
English lessons to compensate for the poor pronunciation of non-native
teachers (Hue, 2019).

**Virtual Learning Environments and Learning Management Systems**

A virtual learning environment (VLE) is essentially an online classroom.
VLEs can include virtual or human facilitators, and they can also be
“blended”, meaning traditional classrooms that integrate AI. Learning
management systems are, similarly, online platforms used to
administer content, document and track learners’ progress, and
manage administrative reporting and parental engagement. Alo7
(“Hello World”) is a Chinese online learning platform. Alo7 provides
English language tutoring to over 15 million students in China (Hao, 2019). Small groups of learners are instructed through video conference by live English tutors abroad while they follow along with paired workbooks. This is combined with the Alo7 platform that uses smart speech recognition algorithms to refine individual student’s pronunciation and has recently incorporated face and video analysis to the platform to gage the student’s interest level and mood as they learn. Information on Alo7 is available at https://tutor.alo7.com/.

Another type of virtual solution based on automatic speech recognition, and machine translator is the Presentation Translator, a free PowerPoint plug-in, that provides real-time subtitling (same language transcript or different language) that can support learners with special needs, and the possibility to interact with keyboard or voice commands, providing options for remote access for out-of-school students. The Seeing AI app translates a picture taken with the smartphone into a description of the scene, which can be used by visually impaired students to integrate into the classroom or extracurricular activities. Finally, Microsoft products such as Office Lens® and Immersive Reader® allow learners to take a photo of text and have this converted into machine readable text, or larger print for particular learning needs (Microsoft, 2018).

Squirrel AI Learning claims to be China’s largest AI-driven adaptive education provider. Combining face-to-face and virtual education, Squirrel AI has built independent learning centers where students are provided with highly individualized learning content. They are shown videos by highly trained and effective teachers, provided with content notes, connected with virtual tutors, and assessed to determine what scaffolding might be missing for a particular concept. If there is a question that the AI bot cannot address, human tutors at the center are available to guide students. Squirrel AI’s internal evaluations have found that Squirrel AI tutoring improved student scores over traditional, human teaching.

When AI is applied to traditional learning management systems (platforms to store and retrieve course content, readings, quizzes, etc.), it can analyze and find patterns in multiple sources of data, helping teachers identify struggling students and intervene before it is too late. Brightspace Insights is one such platform (Loeffler, 2018). Learning management systems can support teachers to take attendance, record grades, track student performance, build lesson plans, and ensure curricular standards compliance. Over time, the predictive analytics can understand the chances of success for students based on engagement time, page views, and more. This insight is then harnessed by the teacher to adapt the content delivery. **Intelligent agents** can be programmed to spot these patterns and send notifications to the teacher and student.

**Robots and AI Hardware**

Edu-robots

Although examples of actual AI edu-robots are rare, they do exist. Avatarion is a Swiss company that builds *Avatar Kids*, robots with full video and audio connections that simulate physical presence for children who cannot be in class due to illness or other reasons. A tablet controls the robot’s movements, speech, and raising the robot’s hand to

**Intelligent agents**
ask questions, speaking through a connected microphone and speaker, and send images. Cloud-based AI analytics monitor the interactions to provide feedback to the developers. Information on Avatar Kids is available at [http://www.avatarkids.ch/fr/home.html](http://www.avatarkids.ch/fr/home.html).

In 60 Chinese kindergarten classrooms, Keeko, a 2-foot tall AI robot, is being piloted. Keeko is a teacher’s assistant that engages children, answers questions, tells stories, and works with children through logic games (AFP & Pinkston, 2018). An AI-enabled edurobot is used to teach science classes daily to 300 Grade 7–9 learners in Bengaluru, India, at the Indus International School (Balaji, 2019). The robots resemble humans and are able to answer questions. Although 4,000 students are enrolled across the Indus Schools, it is unclear how many schools use the robots.

The Swedish company Lexplore is harnessing AI and eye-tracking software to help teachers determine elementary school reading levels and diagnose dyslexia. In as little as 30 seconds, Lexplore determines a student’s reading ability by tracking eye movements as the child silently reads a passage. Machine learning algorithms have been taught to recognize patterns in eye movement to quickly and objectively determine a child’s reading level. Information on Lexplore is available at [https://www.lexplore.com/](https://www.lexplore.com/).

A number of classrooms are on the cutting edge of smart classrooms. Two initiatives in China are experimenting with brain-wave trackers and facial recognition technology (Moon, 2019; Wall Street Journal, 2019). One school in China has installed AI cameras in classrooms to monitor students’ expressions with the goal of tracking engagement and attentiveness. Student metrics are shared with teachers to adjust their teaching. Attendance is also taken by the facial recognition cameras. Another initiative in China is using brain-wave technology to monitor student’s concentration levels. Live analytics are fed to the teacher as they teach; reports and classroom rankings are shared with parents.

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