EFFECTIVE TEACHER PROFESSIONAL DEVELOPMENT USING TECHNOLOGY

Technology-Based Strategies from across the Globe to Enhance Teaching Practices

A Guidance Note

© Freepik

WORLD BANK GROUP

Table of Contents

Acknowledgments

Abbreviations

2-G	second-generation (cellular network)
ABRA	A Balanced Reading Approach for Children and Designed to Achieve Best Results for All
AV	audio-visual
CIB	Culinary Institute of Barcelona
CoP	communities of practice
COVID	Coronavirus disease
ECE	early childhood education
EdTech	education technology
EIA	English in Action
ELLN	early language, literacy, and numeracy
FCV	fragility, conflict, and violence
FGD	focus group discussion
FIRE	Forum for International Research in Education
GPS	global positioning system
HELA	Hybrid Education, Learning, and Assessment
HIC	high-income country
IBE-UNESCO	International Bureau of Education (UNESCO)
ICT	information and communications technology
K-12	kindergarten to 12th grade
LED	light-emitting diode
LMICs	low- and middle-income countries
LMS	learning management system
LTRR	limited resource teacher training
M&E	lonitoring and evaluation
MMS	lultimedia messaging service
MOOC	lassive open online course
MoEYS	Ministry of Education, Youth and Sports (Cambodia)
NBER	National Bureau of Economic Research
n.d.	no date
OER	open education resource
PL	pedagogical Leader
PRIMR	Primary Math and Reading Initiative (Kenya)
RCT	randomized controlled trial
RTI	Research Triangle Institute
RTP	Radio Teaching Program (Sierra Leone)
SBL	scenario-based learning
SD	secure digital
SMS	short message service
SSA	Sub-Saharan Africa
T4T	Technology for Teaching
TESS	Teacher Education through School-Based Support
TESSA	Teacher Education in Sub-Saharan Africa
TPD	teacher professional development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund

About Technology for Teaching (T4T)

Technology for Teaching (T4T) is the World Bank's program to assist countries implement effective, scalable teacher professional development (TPD) programs that use low- and high-technology solutions to train and support teachers/Pedagogical Leaders (PLs). T4T provides practical tools to policymakers and practitioners for designing and implementing operationally feasible tech-based TPD in their contexts, thus contributing to build inclusive and resilient education systems.

T4T is part of a comprehensive set of tools and solutions offered by the World Bank to help countries enhance teaching and learning practices. Cutting across two principles of the Global Platform for Successful Teachers, T4T supports countries to *use technology effectively to provide high-quality professional development* while employing the EdTech principles. T4T builds on the foundation of the *Coach program*, which helps countries improve in-service TPD to accelerate learning.

T4T leverages the Coach and the EdTech Principles to outline how technology can be harnessed by governments to train and support teachers'/PLs at each of the three stages of the TPD experience: access, engage, and apply.

Overview

Education systems face the daunting task of delivering effective continuous professional development to teachers and educators. Delivering on this promise can be especially challenging in settings with resource and capacity constraints. Technology offers many solutions that, if used well and with a clear purpose, can support the delivery of effective teacher professional development. Evidence and operational experiences illustrate how systems can enhance TPD by leveraging technology throughout the learning experience across all three TPD stages: access, engage, and apply.

This Note presents common barriers that teachers/PLs face at each TPD stage and offers operationally feasible, tech-based mitigation strategies. These will enhance access to and engagement with TPD, will improve application of skills and knowledge in the classroom, and can be implemented in low-resource contexts. Drawing on emerging research and successful on-the-ground programs that support teachers/PLs from across the globe, this Note can be used by policymakers and practitioners to consider a range of options to address implementation barriers and scale up TPD programs using technology.

Section 1

Teacher Professional Development for a Changing World
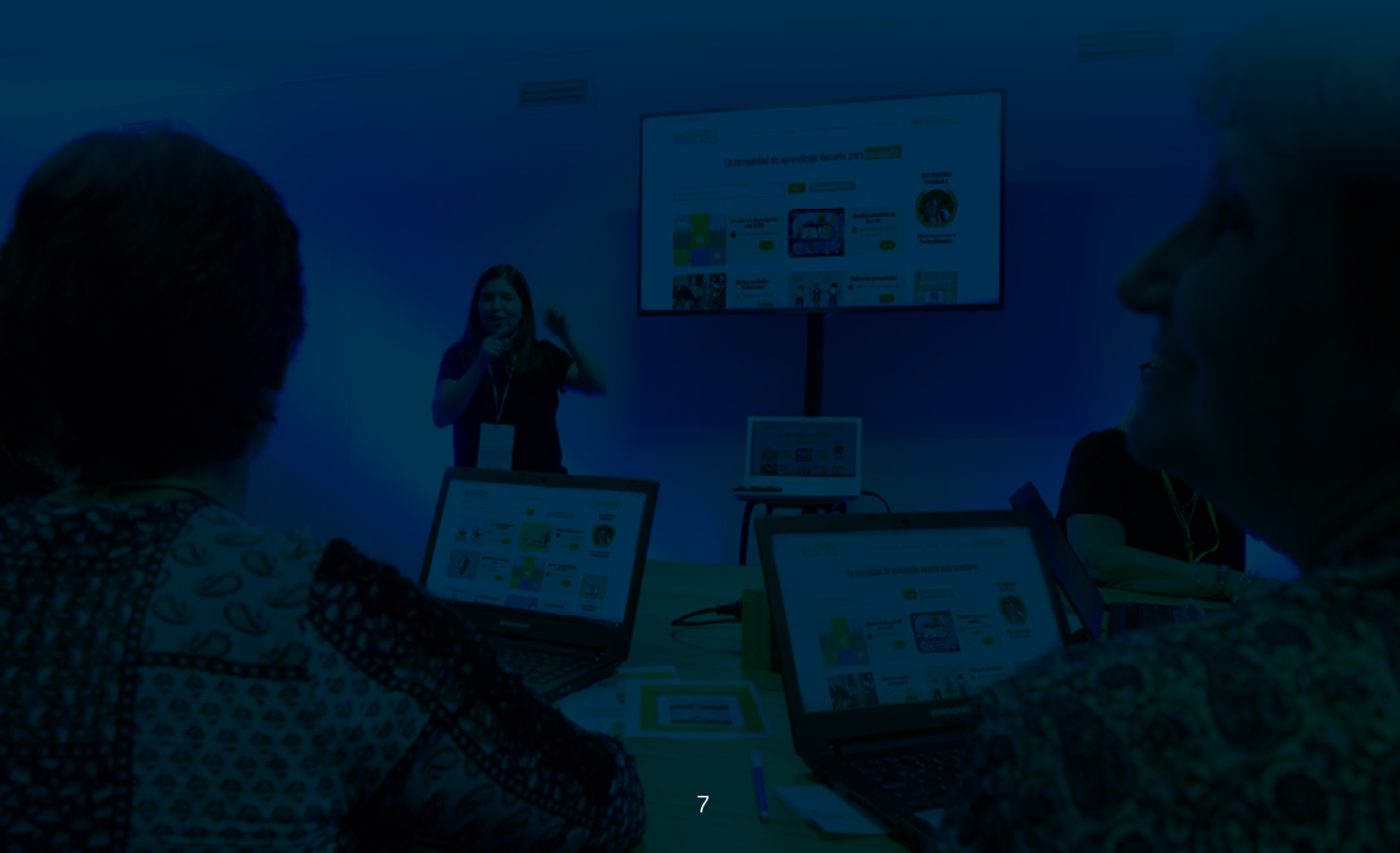
Teacher Professional Development for a Changing World

Evidence consistently illustrates the significant role that teachers' play in student learning. However, many teachers do not receive effective in-service professional development support and often teach without appropriate tools and/or resources. Teachers are the single most important school-based determinant of student learning (Hanushek 2011). Nevertheless, education systems tend to deliver teacher professional development that is ad-hoc, is not equitably accessible, and employs a one-size-fits-all approach that is theoretical and often irrelevant to teachers' needs (Popova and others 2018). Moreover, teachers often work in isolation in poorly resourced classrooms and schools, with limited support from peers and Pedagogical Leaders (PLs).[1] Under these conditions, many teachers struggle to apply effective teaching practices. Consequently, student learning is adversely affected.

The COVID-19 pandemic disrupted the normal operation of education systems and introduced a new reality of remote and/or blended learning for which millions of teachers were ill-equipped and unprepared (UNESCO, UNICEF, and World Bank 2020). Global experiences indicate that effective implementation of remote teaching strategies is a challenge due to main factors (Azevedo and others 2020). Quality remote instruction concerns not only hardware (technical infrastructure and connectivity), software (platforms), and content, but also teachers' preparedness and ability to continually engage with their students to facilitate learning (Munoz-Najar and others 2022). Maintaining engagement between teachers and students during the pandemic was challenging, thus likely exacerbating Learning Poverty,[2] which is estimated at 70 percent[3] of children in low- and middle-income countries (LMICs). Learning Poverty describes children cannot read or comprehend a simple text by age 10 (World Bank 2021a). This high rate illustrates that it is well-prepared and supported teachers who drive student learning, especially during a crisis (World Bank 2021b).

TPD enhances student learning by supporting and improving teachers' adoption of effective teaching and learning practices. As outlined by [the Coach principles](#), high-quality in-service TPD is characterized by providing tailored, focused, practical, and ongoing support that will enhance student-teacher interactions. These programs use data to tailor learning opportunities to align with teachers' needs. They are *practical*, enabling teachers to practice, reflect, and receive feedback, as opposed to theoretical programs in which teachers do not get a chance to practice new teaching strategies. These high-quality TPD programs are *focused* on mastering skills and knowledge by providing sufficient time to learn. Last, these programs offer *ongoing* support to teachers in the form of follow-up opportunities to practice new skills and knowledge.

When well integrated in the system, technology can facilitate high-quality TPD and lead to changes in teaching and learning outcomes. Delivering high-quality in-service TPD that improves teacher-student interactions is a challenge that education systems have struggled to address adequately, especially at scale (Béteille and Evans 2019). Decades of experience with traditional models of face-to-face training that takes teachers out of the classroom have not made the desired transformations in teaching practices that improve student learning (Popova and others 2018). Technology can help. With its unique attributes of connectivity, interactivity, multimedia, and data processing, technology can enhance the design and delivery of TPD, especially

---

1   Pedagogical Leader (PL) refers to any individual who provides ongoing support to teachers. This role most commonly is filled by a coach. However, individuals with a variety of backgrounds can fill the role of Pedagogical Leader, including specially trained master teachers, researchers, principals, pedagogical advisors, school support officers, and inspectors (Darling-Hammond, Hyler, and Garland 2017).
2   "Learning Poverty" means being unable to read and understand a simple text by age 10. The indicator, developed jointly by the World Bank and by UNESCO's Institute of Statistics, combines the share of primary-aged, out-of-school children who are schooling deprived and the share of pupils below a minimum proficiency in reading who are learning deprived (World Bank 2021a).
3   World Bank estimate after considering the effects of school closures during the COVID-19 pandemic (World Bank 2021b).

in low-resource or fragility, conflict, and violence (FCV) contexts. TPD programs need to leverage technology-based solutions, especially solutions that already are in the hands of teachers/PLs.

The introduction of technology in classrooms is not new. However, an understanding of ways in which technology can be leveraged to improve teaching practices can facilitate adapting to the changing world. This Note provides guidance to policymakers and practitioners on leveraging technology to train and support teachers/PLs at each stage of the TPD experience: access, engage, and apply. The Note presents common barriers teachers/PLs face at each stage and offers operationally feasible technology-based mitigation strategies that can be implemented in low-resource contexts. These mitigation strategies are illustrated through a series of case studies that draw from empirical evidence and on-the-ground practices. The strategies also highlight considerations for at-scale delivery of effective TPD programs.

Section 2
Methodology

Methodology

TPD encompasses all forms of continuing in-service education for teachers/PLs, including, but not limited to, trainings, workshops, coaching, peer-collaboration, and self-led learning. High-quality TPD can positively impact teaching practices in the classroom by directly influencing teacher-based outcomes such as content knowledge, digital skills, and pedagogical practices. Additionally, enhancing the delivery of TPD programs to cut costs, reach more teachers/PLs, and reduce dropouts from a program can indirectly influence teaching practices.

This Note is informed by a two-fold methodology to identify scalable and impactful tech-based solutions to facilitate TPD: (1) a review of global literature on tech-based TPD programs and (2) a collection of case studies from implementors currently operating in LMICs. By combining the strengths of both academic and practical approaches, this distinctive methodology captures the nuances of implementers' experiences while designing and implementing TPD programs.

The review adopted two definitions to differentiate between tech-based solutions that are advanced and those that are more suitable for contexts with limited resources, including infrastructure. These solutions are defined as:

High-tech
Characterized by access to consistent and high-speed Internet. Examples are smartphones or tablets, and applications enabling real-time or instant feedback.

Low-tech
Characterized by irregular/sporadic access to the Internet or no connectivity. Examples are traditional television and radio, landline phone calls, basic feature phones, and delivery of printed materials.

From December 2020 to March 2021, a review was conducted of global literature that details how technology can be used to facilitate in-service TPD in LMICs. This review includes peer-reviewed studies and working papers that evaluate interventions using technology to train and/or support K-12 teachers/PLs (appendix A).

To ensure that the Note draws out relevant details that may be missing from peer-reviewed papers, the review is complemented by case studies of programs currently being implemented in LMICs. These programs were sourced through a 100-day global campaign in which 435 TPD programs from 80 countries applied and were reviewed. Their reviews were based on use of technology to train and support K-12 teacher/PLs, resources required to implement the program, potential for impact on teaching and learning practices, and potential for scalability and replicability in low-resource contexts. From these 435 programs, **10 were selected as the T4T Champions** based their ability to effectively use low- and/or high-tech solutions to support teachers/PLs (box 1).

Box 1. T4T Champions

Section 3
How Can Technology Be Leveraged to Deliver TPD?

How Can Technology Be Leveraged to Deliver TPD?

Education systems can leverage technology to enhance teachers' or PLs' access to and engagement with TPD and improve their *application* of new skills and knowledge. Technology is part of a larger ecosystem that recruits, prepares, supports, manages, and motivates teachers (Global Platform for Successful Teachers). It will have no effect on teaching practices in isolation. When implementing tech-based TPD programs, it is crucial to consider the ecosystem in which teachers or PLs operate. This reflection involves anticipating the barriers to use and maintain technological solutions, defining a theory of change for how technology will mitigate these barriers, and considering contextual factors that will influence implementation.[4] This section highlights common implementation barriers that teachers/PLs face and, through the use of global case studies, provides guidance on leveraging technology's attributes to mitigate such barriers.

Technology's unique attributes can enhance TPD in a way that traditional TPD cannot. Technology's attributes of connectivity, interactivity, multi-media, and data processing facilitate at-scale and more frequent delivery of TPD (figure 1). Creating virtual spaces to co-create, interact instantly, and share resources is now more widespread than ever. The T4T Champions have used both low-tech solutions such as radio and high-tech solutions such as videoconferencing to expand their programs to new regions, connect teachers/PLs from across the globe, and use data to improve and adapt their TPD programs. Moreover, technology's attributes enhance the delivery of high-quality TPD. Data processing enables the provision of tailored support. Interactivity makes the professional development practical and relevant to teachers/PLs needs. Multi-media and connectivity facilitate ongoing support available anytime, anywhere, and help teachers/PLs to stay focused.

Implementing a context-specific, tech-based TPD program should be informed by the available technological infrastructure and the readiness of teachers/PLs and the school ecosystem. On-the-ground experiences show that lack of access to devices and connectivity are not insurmountable barriers to implement tech-based TPD programs. Rather, avoiding introducing technology in TPD programs as a "quick fix" to existing inefficiencies is the most crucial element for successful implementation. Three common pitfalls of a broad application of technology are (1) supplying hardware to classroom settings without considering the maintenance required, (2) introducing technology with which users are unfamiliar/untrained, and (3) introducing TPD content unsuitable for new contexts.

---

4   To support teachers' journey toward change, it is necessary to consider, first, the larger ecosystem: school climate, professional working conditions, and school leadership. Second, it is necessary to consider system-level constraints, for example, financial resources, administrative capacity, and technological infrastructure (such as access to electricity, devices, and connectivity). All these factors must be considered while implementing and scaling up effective TPD practices (section 4).

Figure 1. Attributes of Technology

Attributes of Technology	Applications of the Attributes of Technology
Connectivity Enables systems or computers (including servers, personal computers, and mobile phones) to exchange information.	**Support with the logistics of delivering TPD by:** • Reaching more teachers/PLs • Lowering costs
Interactivity Enables users to work together, influence one another, and respond to others' inputs, that is, communicate with one another.	**Share information by:** • Creating virtual spaces that facilitate instant exchanges • Enabling the creation, curation, and sharing of content that is interactive and appealing to adult learners **Facilitate connections and communications by:** • Creating virtual spaces for groups/teams to communicate • Increasing frequency of communication
Multi-media Implies the ability to communicate or express in more than one medium, such as text messages, phone calls, and videos.	**Automate processes by:** • Collecting and processing data in real time • Sending nudges and other reinforcement mechanisms • Personalizing content to user's needs
Data processing Implies the capability to collect, store, process, analyze, disseminate, and evaluate information.	

Source: Authors.

Section 3A. A Purposeful Application of Technology to Mitigate Barriers to TPD Delivery

The three stages of TPD—access, engage, and apply—provide an approach to identify barriers at each stage and the specific attributes of technology that can be leveraged to mitigate these barriers.[5] This approach ensures that technology is purposefully introduced in a program, guided by clear objectives to maximize its impact on teaching practices (World Bank 2020a). Figure 2 elaborates the T4T Approach, providing a high-level summary of leveraging tech-based solutions to mitigate common barriers that practitioners and policymakers face when designing and implementing TPD programs.[6] The remainder of this section uses case studies from evaluated programs and on-the-ground implementors to describe how tech-based solutions are leveraged to implement effective TPD.

---
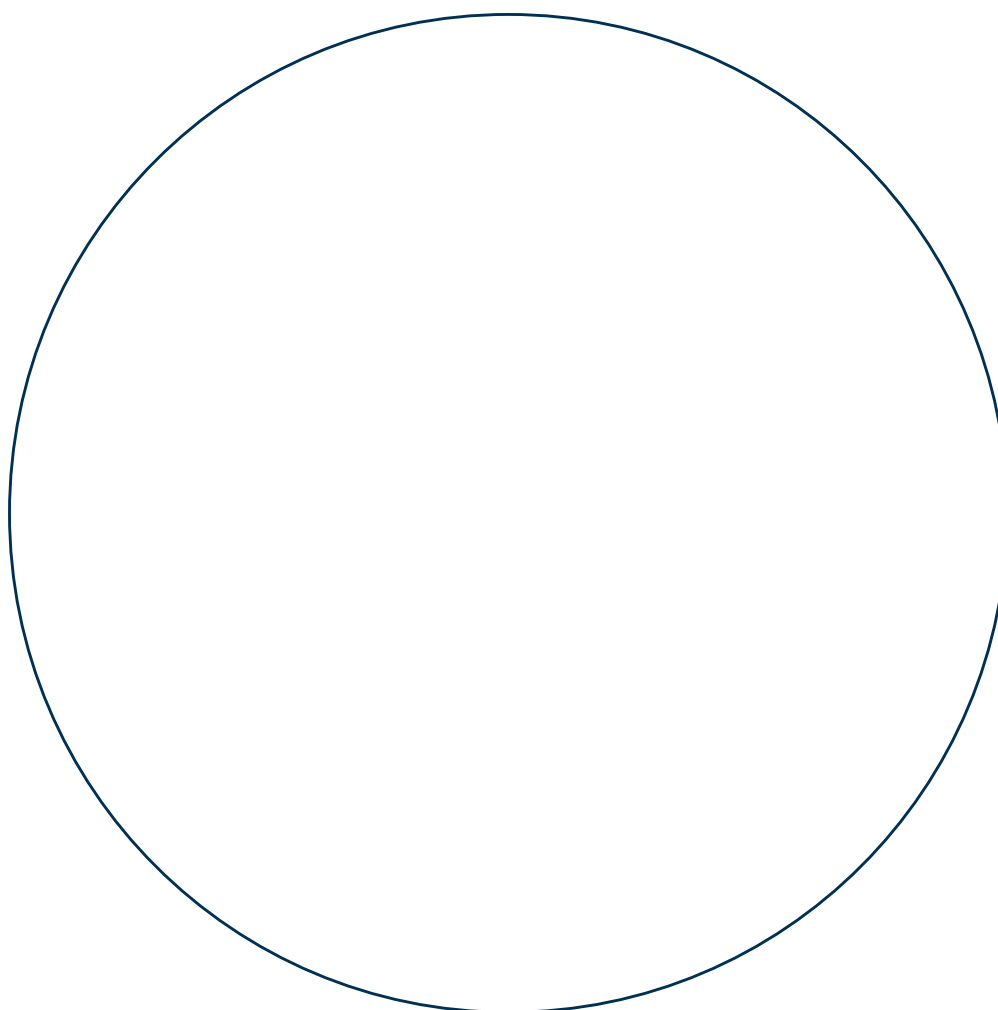
5   The three stages of TPD defined in this Note--access, engage, and apply--were developed by the authors based on literature on teachers'/PLs' professional learning needs and activities (Kwakman 2003; World Bank 2021d).
6   The T4T Approach does not include system-level and larger ecosystem-related barriers.

Figure 2. Technology for Teaching Approach by TPD Stages

Access to TPD
TPD opportunities frequently made available to teachers/PLs through a range of channels.

Barriers
- Limited access to TPD offerings
- Insufficient number and/or availability of skilled PLs
- Poor dissemination of TPD and/or TPD-related resources

Mitigation Strategies
- Provide teachers/PLs with access to professional development resources (self-led learning or assisted learning)
- Facilitate communication or enable interactions between teachers and PLs
- Communicate information on available learning opportunities and services
- Promote sharing of teacher-developed resources and pedagogical knowledge among teachers/PLs
- Identify and train local personnel

Engage with TPD
Being actively involved in available TPD opportunities; playing a role in the given opportunities to learn and enhance skills.

Barriers
- Misaligned with teachers'/PLs' professional needs
- Not designed in accordance with adult learning strategies; relies primarily on theory and lecture-based content
- Not relevant to teachers'/PLs' classroom realities

Mitigation Strategies
- Identify teachers'/PLs' professional learning needs and align TPD to them
- Diversify the delivery mechanism for TPD lessons
- Create opportunities for 'learning while doing'
- Create opportunities for modeling, deliberate practice, and feedback.
- Enhance teachers'/PLs' engagement with peers

Apply TPD Concepts
When back in their classrooms, teachers/PLs use the skills and knowledge acquired during their professional development.

Barriers
- Following TPD, low-quality and/or absent support for teachers/PLs
- Insufficient resources to implement skills and knowledge in the classroom
- Insufficient accountability mechanisms to ensure continued application of TPD concepts

Mitigation Strategies
- Continue engaging teachers/PLs between and after trainings
- Provide supplementary materials and tools for reference and guidance
- Monitor application of skills
- Remind teacher to continue applying new knowledge and skills

Attributes of technology: Connectivity · Interactivity · Multimedia · Data processing

Section 3A.1: Tech-based solutions to access TPD

A key bottleneck to effective delivery of TPD is that teachers/PLs have neither sufficient opportunities nor the range of modalities to access TPD. These obstacles are especially true for those at an economic disadvantage who work in low-resource/FCV contexts. Access to *TPD is defined as TPD opportunities* frequently made available to teachers/PLs through a range of channels. There exist many constraints to ensuring equitable and targeted access to TPD resources, peers, and pedagogical leaders.

Access Barrier #1
Limited access to TPD offerings

Mitigation Strategy 1.1
Provide teachers/PLs with access to professional development resources (self-led learning or assisted learning[7])

Attributes(s) of Technology:

 Connectivity   Multimedia

How
Technology's attributes of connectivity and multimedia enable TPD resources to reach a larger number of teachers/PLs and those in hard-to-reach geographies. To ensure access to high-quality TPD through technology, policymakers and practitioners must diversify the (1) format of resources (such as video and text messages) and (2) distributed channel of resources (such as radio and learning management system, or LMS).

Providing options to access TPD resources in the form, space, and time that are available to teachers/PLs facilitates timely and relevant training and support (**Case 1. Global School Leaders**). These options also enable users to conveniently review TPD lessons and use the lessons as reference points to continuously improve their teaching practices. It is best to start with channels and formats with which teachers/PLs are familiar (such as messaging platforms domesticated in a context). Then, if resources allow, education systems can develop and invest in dedicated platforms for teachers/PLs such as LMS (World Bank 2020b; World Bank Forthcoming a; World Bank Forthcoming b).

In low-resource contexts, open education resources (OERs)[8] can be powerful allies to enable teachers/PLs to make resources more accessible. OERs can be adapted and delivered via multiple channels including television, radio, SMS, and LMS. For example, Teacher Education in Sub-Saharan Africa (TESSA) leverages OERs adapted to 10 SSA country contexts and 4 languages to provide access to classroom activities (TESSA n.d.). However, to develop and maintain the platform, OERs require additional resources (technological, human). Teachers/PLs also are likely to need training to learn how to use these tech-based solutions (World Bank Forthcoming c).

---

7   Here, "assisted learning" implies supporting the learning and training of teachers/PLs via trainers, coaches, or peers; or via technology such as computers (computer-assisted learning).

8   Open educational resources (OERs) are "teaching, learning, and research materials in any medium--digital or otherwise--that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation, and redistribution by others with no or limited restrictions" (UNESCO 2021).

In addition to diversifying access options, technology facilitates context-specific approaches to deliver TPD. For instance, during the Ebola virus disease epidemic school closures, due to the low access to computers and televisions, Sierra Leone's Radio Teaching Program (RTP) used radio to deliver lessons to students and teachers (World Bank 2021c). During the COVID-19 pandemic, RTP was contextualized further to ensure equitable access to users who lacked connectivity. The program distributed manuals that teachers used to follow along with the RTP broadcasts on how to teach numeracy and literacy for emergency response content designed by teachers.

© Global School Leaders

🏆 **T4T Champion**

Case 1.
**Global School Leaders:
Diversifying and Contextualizing Delivery of Learning Content**

Global School Leaders, a nonprofit organization, provides principals with practical advice on how to guide teachers to facilitate remote instruction and learning. This goal is accomplished by diversifying both the content format and the distribution approach to suit a variety of contexts. The organization's School Leadership Program designs simple, easy-to-consume content that can be customized by local partners to ensure delivery using a range of channels. These include a web-based portal, WhatsApp, Facebook Messenger, and even Viber in places in which the other applications are not available.

The program quickly adapted to the COVID-19 pandemic by creating bite-sized learning modules, using both high- and low-tech channels to deliver materials and content distributed under the Creative Commons license, making it free and available to all. The modules covered topics such as creating remote and blended learning and teaching plans (see example here).

Users can access the content through phone and computers over the Internet. In low-resource contexts, the program also delivers lessons in hard copy followed by phone call support to users Similarly, where connectivity and devices are not widespread, coaching teachers and school leaders is conducted via group video calls (Zoom sessions) and through audio phone calls.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Global School Leaders is 1 of the 10 T4T Champions.

Mitigation Strategy 1.2
Promote sharing teacher-developed resources and pedagogical knowledge among teachers/PLs

Attributes(s) of Technology

Connectivity

How
Technology's attribute of connectivity enables creating virtual spaces that facilitate sharing resources with peers by reaching many teachers/PLs who do not share the same physical space and time. Promoting content developed by teachers/PLs can help bridge gaps in access to TPD resources (**Case 2. Experience from Kenya**). Specifically, in contexts in which the availability of content or pedagogical knowledge is limited, education systems can promote creating and sharing resources development by teachers/PLs themselves. For instance, in the Zataari refugee camp in Jordan, the community aspect of WhatsApp group chats provided teachers a space to learn from peers' experiences. Access to WhatsApp chats facilitated teachers'/PLs' discussions about challenges in teaching and their developing and sharing teaching materials and lesson plans (Motteram, Dawson, and Al-Masri 2020).

Teacher-/PL-developed resources may necessitate quality assurance prior to widespread dissemination. Technology does not allow for determining the quality of information distributed in the form of text messages and videos. However, technology does provide the space and an opportunity for users to discuss and critically evaluate the information being shared. Similar to the steep learning curve for using technology to teach and learn, training is required to evaluate the quality of resources. Another way to ensure quality checks is to involve a facilitator or moderator in the process of sharing resources among peers (**Case 3. Comunidad Atenea**).

Case 2.
Can Facebook Groups Enhance Continuing TPD? Evidence from Kenya

Technology provides teachers with more participatory professional development, especially in low-resource contexts. The 2018 analysis of a 2015 study of the interactions among 11,000 Kenyan teachers in a Facebook group showed that social media platforms can be an important avenue to teachers' continuous professional development. This avenue is especially crucial in low-resource contexts in which formal opportunities are not always available. The analysis of the virtual community's peer interactions revealed that the social media platform served as an informal, self-directed virtual professional development space for teachers. Teachers primarily discussed content knowledge (one-third of all posts). Topics included grammar, writing, listening, speaking, and literature. The platform also was used for "bonding" (27 percent of posts). This informal, teacher-led social media group enabled these teachers to create an online learning community to share ideas. In many low- and middle-income countries, avenues of continuous teacher professional development are limited. Domesticated social media platforms provide an accessible alternative to collaborate.

Source: Bett and Makewa 2018.
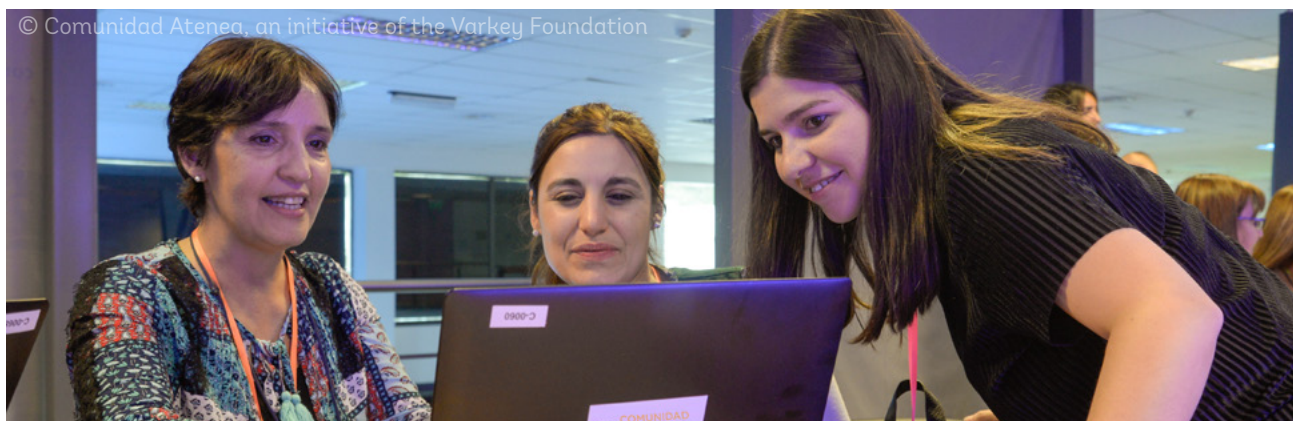
🏆 T4T Champion

COMUNIDAD atenea

Case 3.

Meeting Teachers Where They Are (Virtually): Learning from Comunidad Atenea's #AteneaExperiences

Comunidad Atenea operates in over 100 countries. It is a free and open-source social community that provides training opportunities and offers teachers a virtual space to share ideas, communicate, follow their peers through profile pages, and collaborate with them around a particular theme or concept. Focus group discussions (FGDs) with teachers and experts revealed that teachers in Latin America were innovating in their classrooms but not learning and sharing these teaching practices with their peers. Through week- and month-long training experiences, Comunidad Atenea provided a platform to share these innovations using mainstream social platforms such as WhatsApp, Zoom, and YouTube. The organization also shared the recordings with anyone who preferred to access the materials later. Teachers learned by collaborating with peers and receiving guidance from expert facilitators, especially on using day-to-day technology (such as TikTok) for pedagogical purposes.

These technologies enabled them to replicate strategies that peers are implementing in other classrooms in their country and beyond. For example, in 2020 Comnuidad Atenea facilitated teacher collaboration across Argentina, Chile, and Peru to create content to teach students about San Martín, a national hero in the region. More than 15,000 teachers from the Latin America Region are members of the platform. It is well known that creating spaces for teachers to connect in person is important. However, doing so comes with the limitations of sharing a physical space and time. Comunidad Atenea highlights the benefits of using technology to provide opportunities to more teachers, enabling them to share ideas across borders and at a time that is convenient to them.

Source: Information submitted during the application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Comunidad Atenea is 1 of the 10 T4T Champions.

Access Barrier #2
Insufficient number and/or availability of skilled PLs

Mitigation Strategy 2.1
Facilitate communication or enable interactions between teachers and PLs

Attributes(s) of Technology

Connectivity   Multimedia   Interactivity

How

Technology's attributes of connectivity, interactivity, and multimedia facilitate timely, more frequent, and ongoing communication among teachers and with PLs. Trainees can access trainers from other areas of their countries (Abrami and others 2016; Bruns, Costa, and Cunha 2017), or even abroad (Mendenhall and others 2018). They also can access experts who might have specific skills that local trainers do not possess. Additionally, using technology to access support reduces the time and cost required to meet by eliminating the need for travel. Technology also enables a limited number of experts to reach a large number of teachers/PLs through low-tech solutions such as text messages and audio phone calls, or high tech such as video conferencing.

Technology enables local trainers' skills to be complemented by the abilities of experts, thus mitigating a local shortage of high-quality PLs. However, this strategy should not be employed to completely replace face-to-face interactions (**Case 4. Experience from Bangladesh**). Moreover, training programs that tested replacing in-person or hybrid training schemes with exclusively virtual coaching did not have promising results (Cardim, Millán, and Vicente 2021). The Cardim and others research suggests that some element of face-to-face interaction is still required but that the doses of face-to-face interactions may vary in frequency.

Case 4.
Can Teacher-Trainer Communication Improve Teaching Practices? Experiences from Bangladesh

In 2007 a small TPD program targeting rural teachers in Bangladesh adapted a 2-week face-to-face program (that had required teachers to commute to 1 of the Teacher Training Colleges) into a blended learning model that was delivered over 6 weeks. The blended training model provided schools with mobile phones (phones often were kept with the head teacher) to enhance communication, motivation, and multimedia delivery. The hardware procured included one laptop (for use by the training coordinator to create electronic materials to send to the teachers, send messages, and search the Internet for learning resources), mobile handsets, and phone service.

Results from this experience indicate that mobile communication between trainers and trainees supported program implementation by enabling continuous communication. Mobile communication also offered a pathway for regular follow-up to ensure that trainees stayed on task. Having access to a mobile phone enabled communication in numerous formats, including audio conference calling among multiple sites, SMS, video and photo capture, and transfer of photos and videos through MMS. Interviews with participants reinforced the potential of TPD programs based on the combination of reduced distance training and available self-study materials. The study confirmed that participants strongly preferred engaging in the blended

model, which enabled them to stay in their homes and classrooms, over a fully face-to-face approach. Teachers cited the most basic use of the phone (one-on-one conversation between trainer and trainee) as the most important.

Given the desire to keep costs low and to use low-tech solutions to support teachers, Internet connection was not used. The program also included distribution of print-based learning materials, which supported low costs while reducing the need to transfer learning materials via phone.

Source: Pouezevara and Khan 2007.

Mitigation Strategy 2.2
Identify and train local personnel

Attributes(s) of Technology

 Connectivity

How
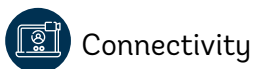
Technology's attribute of connectivity enables the design of a TPD program that leverages local talent to train teachers/PLs, especially in remote areas/FCV contexts. Providing high-quality TPD in hard-to-reach geographies is a challenge due to the unavailability of local experts to continuously support and train teachers/PLs. Practitioners have overcome this challenge and cut costs associated with traveling by identifying and training "champion" teachers/PLs, who in turn provide support to local teaches/PLs. These local "champions" are identified by programs based on their level of interest, empowerment, and skills to train others. They are trained by facilitators or expert coaches provided by the program to then impart these skills to local personnel and also to provide technical support when needed. Such TPD programs usually make remote technical support available and follow-up with the "champions" (Case 5. Penetes Educativos and Case 6. ProFuturo Digital Education).

© Puentes Educativos, a program by Fundación 99

🏆 **T4T Champion**   🌐 Puentes **Educativos**

Case 5.
A Whole-School Approach to Developing 21st Century Skills: Lessons from Puentes Educativos

Puentes Educativos, a TPD program established in 2009 by Fundación 99, strengthens rural communities by promoting collaborative pedagogical practices in and among schools. To facilitate changes in teaching practices among teachers in Chile, Guatemala, and Nicaragua, the program employs a blended model. This approach comprises in-person meet-ups and tech-based remote components for follow-up and feedback via audio phone calls, messaging apps, and videoconferencing. Encouraging participants to volunteer, within each partner school, Puentes Educativos identifies a strategic group consisting of 1 principal and 3 to 5 teachers. This group receives training and support from the program on active methodologies such as interactive groups; project-based learning; and debates through webinars, workshops, and coaching.

The program provides other local teachers in the school a space to learn and practice their skills. Teachers receive the program's topic-specific materials through radio and television broadcasts.

Other messaging apps also are available to them. Additionally, a pedagogical technical chief in each school helps the groups with activities such as modeling and reflective feedback. Through

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Puentes Educativos is 1 of the 10 T4T Champions.

© Profuturo

🏆 T4T Champion

ProFuturo

Case 6.

"Leading Teachers" Lead the Way through Profuturo's Digital Education Program

ProFuturo is a digital education program founded by Telefonica Foundation and "la Caixa" Foundation. ProFuturo promotes a cascade TPD model that leverages local talent to train and support teachers in nine countries across Africa, Asia, and Latin America. ProFuturo experts leverage available technology ranging from delivering printed material to providing servers, routers, and other devices as needed. The technology is used to train locally hired coaches through a blended model. These coaches in turn train other teachers, primarily in the pedagogical adoption of technology. After assessing local technological needs, ProFuturo contextualizes its TPD programs and co-designs them with the local implementing body (NGO, MoE). The training of local coaches facilitated by an LMS and digital resources is followed by identifying and training "Leading Teachers," who assume the role of coaches at the school level and promote communities of learning. Additionally, the program provides connectivity for coaches who upload teacher data during activities to facilitate feedback and M&E. Through technology, ProFuturo trainers in a different location are able to provide coaching and technical support to locally hired coaches during program implementation. Read experience here of a ProFuturo teacher and coach who transformed from not knowing how to use technology for teaching to training other teachers in digital skills.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: ProFuturo is 1 of the 10 T4T Champions.

Access Barrier #3
Poor dissemination of TPD and/or TPD-related resources

Mitigation Strategy 3.1
Communicate information on available learning opportunities and services

Attributes(s) of Technology

Connectivity   Multimedia

How

Technology's attributes of connectivity and multimedia enable dissemination of information to numerous teachers/PLs more frequently and at lower cost. Technology helps disseminate reminders or information that may influence decisions that teachers/PLs may make about their professional careers. Examples range from text messages with reminders to complete a MOOC module to interactive quizzes that enable teachers to decide whether they will benefit from a given opportunity. Teachers/PLs do not always have information on learning opportunities, especially those that may be self-led or available remotely. For instance, during the COVID-19 pandemic, a survey of teachers in Cambodia revealed that only 42 percent of teachers were aware of and had access to teacher in-service training to prepare for distance learning.[9] Evidence shows that making information readily available leads to positive behavioral changes. Increasing availability is an avenue that can be further explored as it relates to TPD (Escueta and others 2017; Dean, Morten, and Zinman 2012). To decide whether to access and attend TPD opportunities, teachers/PLs first must be informed of their availability (**Case 7. Experience from India**).

Automated solutions such as mass texting can be used to spread awareness about the availability of TPD opportunities, However, in more remote areas, low-tech solutions such as radio, television, and print in local media are still low-cost solutions that reach a wider audience. For instance, the Teacher Education through School-Based Support in India published articles in several local newspapers alerting readers to the course and its start dates (Wolfensen, Cross, and Henry 2017).

Case 7.

Can Text Messages Both Increase Awareness of Available Materials and Facilitate Student Learning? An Example from India

In the 2010s BridgeIT was a teacher-facilitated intervention implemented in several Asian countries. Through the program, teachers received mobile phones on which they could regularly access teaching materials, including videos and classroom activities, for classroom use.

A 2012 evaluation of the program in 86 Indian schools revealed that mobile phones also were used to send reminders to teachers on the availability of new material. Teachers were notified via text messages (SMS) of new videos, which they downloaded onto their phones using an open-source application. The study also indicated that teachers tended to use mobiles phones for TPD and classroom instruction more regularly than for computer-based content. Overall, the program (of which text messages was only a component) had positive results: increased student-centered instruction and student engagement, reduced absenteeism and, not surprisingly, higher student learning.

Source: Wennersten, Quraishy, and Velamuri 2015.

---

9 The statistic is reported based on a rapid needs assessment of the Cambodian education sector during the COVID-19 pandemic carried out by MoEYS and an Education Sector Working Group. The assessment interviewed 3,318 teachers (MoEYS 2021).

Section 3A.2: Tech-Based Solutions to Encourage Engagement in TPD

Even if professional development opportunities are available, teachers/PLs may not be able or willing to attend and engage with a given learning opportunity; or the given learning opportunities may not align with teachers'/PLs' classroom needs. Engagement with TPD is defined as *being actively involved in available TPD opportunities and playing a role in the given opportunities to learn and enhance skills.* Technology can be applied to the instructional design of a TPD opportunity, thus mitigating the negative outcomes of poor engagement in a TPD program. Such negative outcomes include poor acquisition of the knowledge delivered by the training and/or early dropout, resulting in limited or no changes in teachers'/PLs' classroom practices

Engagement Barrier #1
Misaligned with teachers'/PLs professional needs

Mitigation Strategy 1.1
Identify teachers'/PLs' professional learning needs and align TPD with them

Attributes(s) of Technology

Connectivity   Multimedia

How
Technology's attribute of data processing, that is, the collection and analysis of data in real time, improves TPD programs in a way that would not be possible without the automation of processes and personalization of programs. To enhance teachers'/PLs' engagement with available TPD opportunities and resources, it is important to align the design and content with their professional needs (**Case 8: Experience from India**). Analyzing diagnostic data on teachers'/PLs' classroom performance collected using classroom observation tools and needs assessments facilitated the design of TPD opportunities tailored to their needs. For instance, topics discussed during the refresher trainings as part of the Primary Math and Reading Initiative (PRIMR) in Kenya were designed to address issues observed and reported during implementation (Piper and Kwayumba 2014).

Technology makes it easier and faster to tailor TPD programs in three ways. First, technology provides tailored feedback using videos of teachers'/PLs' performance to be reviewed by coaches or peers. Second, technology improves a program using mobile phones or tablets to collect, record, and share data on users' performance (**Case 9. PerformEd**). Third, technology facilitates information management processes by leveraging software that stores and analyzes large amount of data quickly at lower cost; and eases the burden of manually analyzing teacher performance, which may be prone to errors and biases.

Case 8.
Leveraging Technology to Promote Teacher Engagement: A Snapshot from India

TESS-India (Teacher Education through School-Based Support-India) is an initiative that, among others, promotes large-scale massive open online courses (MOOCs) to transform teachers' pedagogical practices. By 2017 over 800,000 teachers in India had engaged with TESS programs. TESS' MOOC program is an interesting example of how data can be used to promote teacher engagement and enable policymakers to understand the results. Data from a program pilot were used to ensure that the course was designed to be contextually relevant in its content, length, and format.

In the TESS-India study, teachers participated in asynchronous, virtual interactions (though activities such as fora and peer-reviewed assignments), and in weekly or fortnightly in-person meetings with a local facilitator, especially for participants who had no access to devices or Internet. To inform the in-person session content, facilitators were provided with weekly information about teachers' engagement. Design and delivery of the MOOC was informed using data collected through surveys and interviews at the time of enrollment and at the end of the course. These data enabled researchers to understand the characteristics of the teachers and the factors associated with engagement with the course. The MOOC also encouraged peer-support. Almost all program participants (96 percent) provided feedback to their peers and reminded one another of deadlines by using messaging platforms such as WhatsApp. MOOCs are an effective means to engage with fellow participants while learning and deliver content to numerous teachers in a self-paced format.

Source: Wolfenden, Cross, and Henry 2017.

© PerformEd

🏆 T4T Champion

imagine education
ACCELERATING THE PRODUCTIVITY OF LEARNING

Case 9.
Enhancing a TPD Program by Using Data Every Step of the Way: Lessons from PerformEd's Implementation in Egypt

PerformEd is a "point of learning" platform developed by Imagine Education for teachers and school leaders. PerformEd is a foundational online course. Its baseline assessment identifies teachers' strengths and areas for development. This assessment leads to the creation of a personalized development plan with access to supporting resources, activities, and online fora.

The platform also provides ongoing recognition. Teachers can record their learning activities and attach evidence for progress, building a live, personalized portfolio of their actual, practical changes in pedagogical behaviors and attitudes. By informing conversations about personal development and good practices, the portfolio becomes the basis to elicit further support (via the platform) from peers, mentors, and managers, Teacher data collected by the platform also provides a snapshot for regional supervisors and national ministries of education both to illustrate the extent of change and practice occurring within communities and to inform future TPD planning.

PerformED's innovation arises from combining data collection and processing learning and assessment into one iterative feedback loop, by which assessments are continuously informing learning requirements. Technology makes it possible to leverage data in real time to support the professional development of teachers at the right levels.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: PerformEd is 1 of the 10 T4T Champions.

Engagement Barrier #2
Not informed by adult learning strategies; relying primarily on theory and lecture-based content

Mitigation Strategy 2.1
Diversify the delivery mechanism for TPD lessons

Attributes(s) of Technology

Connectivity   Multi-media   Data processing

How

Technology's attributes of data processing, multimedia, and interactivity enable creating, curating, and sharing resources that appeal to adult learners and are personalized to their needs. Technology can change the form of TPD content delivery by moving away from static information to more interactive, social, self-led, and/or game-based content (gamification, if supported in the given context). Depending on teachers'/PLs' professional needs, TPD practitioners can use technology to design more engaging content or more creatively share related pedagogical experiences. Examples include videos, infographics, and audio content (**Case 10. OneSky for all children**).

Interactive content can serve a second function by checking learners' understanding of content. Teachers in a TPD program in rural Nepal used video recorders to capture their classroom activities and lectures and their extracurricular activities such as cultural events. They later watched these videos (using CDs and/or laptops) to see their performances, self-assess their weaknesses, and make corrections (Pouezevara and Parajuli 2007).

A TPD program in Zambia focused on training teachers in literacy instruction in mother tongue languages and techniques to support struggling readers. The program encouraged teachers to complete quizzes and awarded them certificates upon completion of modules, thus incentivizing teachers to engage with the training content (School-to-School International 2017).

© OneSky

🏆 T4T Champion

OneSky
for all children

Case 10.

Lessons from Early Childhood: How OneSky for All Children Makes Its Digital Platform Attractive to Continuously Support Caregivers

OneSky for all children in Vietnam adopts a blended learning approach that includes in-person training and home visits. OneSky also created an online learning platform, 1BigFamily, to deliver early childhood development training to home-based childcare providers and caregivers. A local messaging platform in Vietnam (Zalo) and Zoom are used for communicating, training, and remote home visits and observations—adopted especially during the COVID-19 lockdowns when OneSky shifted its in-person elements to remote support.

The platform has a library of hundreds of digital resources The resources range from [animated responsive care videos](#), which model best practices in caregiver and child interactions, to articles by early development experts on homemade toy guides, local songs and stories, and vetted COVID-19 information for child health and development. The on-demand, interactive, and visual content enables caregivers of all educational levels to understand and immediately apply the concepts. The platform is accessed easily via a mobile application and a website portal. OneSky emphasizes the use of bite-sized, visually appealing resources, such as homemade toy guides in photo/pdf format, which are easily downloadable to caregivers' mobile phones.

The platform also offers a strong community of practice with a forum in which caregivers can reflect on learning from the training, seek support from their trainers and peers, share their own best practices through user-uploaded content, and work through challenging situations in their own daycares with peers. OneSky designed and continues to improve its platform to mimic commonly used social media platforms so that navigation of its platform will be intuitive for caregivers of varying digital literacy levels.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: OneSky for all children is 1 of the 10 T4T Champions.

Engagement Barrier #3
Not relevant to teachers'/PLs' classroom realities

Mitigation Strategy 3.1
Create opportunities for modeling, deliberate practice, and feedback

Attributes(s) of Technology

Multi-media

How
Technology's attribute of multimedia facilitates virtual spaces for collaboration and communication, making a TPD program practical and activity based. By demonstrating behavioral expectations and new instructional practices, modeling can help teachers/PLs visualize effective instruction and positively influence classroom practices. Teachers/PLs can use videos to document their own teaching practices and use these recordings to discuss approaches with peers or get feedback from PLs (Cilliers and others 2021; Jukes and others 2017). Videos also can be used to illustrate and analyze existing teaching practices from different classrooms (**Case 11. LeadNow!**) and countries (Shaheen and others 2013).

Modelling also can take the form of demonstrating videos and audios of self-study materials to expose teachers to new teaching strategies (Oakley, Scarparolo, and King 2018; Wennersten, Quraishy, and Velamuri 2015). Videos can be shared through phone-based applications, tablets, or online with a wide audience or with PLs, who then can offer feedback either in person or remotely. In sum, videos effectively showcase model behaviors, helping teachers/PLs review, reflect on, and ultimately improve their own practices (**Case 12. Experience from Zambia**).

🏆 T4T Champion

Case 11.

Using Scenario-Based Learning to Actively Engage Teachers: Leadnow! Shows How

LeadNow! developed in 2020 by Dignitas in Nairobi integrates scenario-based learning (SBL) to bring an active learning approach to TPD. Participants respond to interactive, realistic scenarios presented in text or animation format (example here) and accessed via a smart device to promote problem solving, decision-making and critical thinking. The teachers then are offered tailored feedback from more experienced colleagues (watch a school leader practice video here). The program aims to transform classroom teaching through reflective practice. Transformation is achieved by individual and group coaching, which is provided via available

technology ranging from SMS to video conferencing. Technology also is leveraged to convene the learning cohort from multiple locations. In-person school-based groups of 4-6 participants join a larger, multi-school virtual cohort in workshops and for reflection and feedback. As part of the professional development, bite-sized prompts including animations model new teaching strategies. Modules are delivered through Chabot in Messenger, an LMS, or WhatsApp. In low-connectivity areas, to access content, teachers and school leaders are grouped physically to share devices.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.

Note: LeadNow! by Dignitas is 1 of the 10 T4T Champions.

Case 12.
Technology in Zambia Can Help Teachers Reflect on Practice

Several Sub-Saharan African countries implemented the OER4School program, which was developed by the former Centre for Commonwealth Education at the University of Cambridge. The program was designed carefully based on two principles: (1) effective TPD must focus on student learning, and (2) teachers should engage collectively in active reflection about their own beliefs and pedagogical practices. The program uses technology to facilitate teachers' reflections and discussions about their practices. Specifically, videos filmed in Sub-Saharan African classrooms include examples of teacher-student interactions. This mechanism is at the core of the program. Footage of unknown teachers working in situations familiar to viewers undertaking TPD sparks collective discussions about the effectiveness and challenges related to practices observed in the videos.

In a 2012 implementation of this program in Zambia, teachers of grades 4-6 engaged in a year-long program of weekly sessions that covered interactive teaching principles, whole-class dialogue, group work, and inquiry-based learning. The program funded computers for teacher labs and classroom use. Results were positive. Teachers reported improvements in their own pedagogical practices, which resulted in increased student engagement and learning. The authors state, "In our programme, the role of video was a central external stimulus for [engaging in] reflection and inquiry… . …the technology is what enabled the evidence-based practice (reflection) to take place."

Source: Hennessy, Haßler, and Hofmann 2016.

Engagement Barrier #3
Not relevant to teachers'/PLs' classroom realities

Mitigation Strategy 3.2
Create opportunities for "learning while doing"

Attributes(s) of Technology

Connectivity   Multi-media

How

Technology's attributes of connectivity and multimedia enable teachers/PLs to teach, learn from their teaching, and reflect--all without taking them out of their classrooms. Traditional TPD (without technology) involves taking teachers/PLs out of the classroom for the duration of the training sessions (several days to weeks) and sends them to a different physical space. In contrast, leveraging technology makes it possible to train teachers/PLs inside their classrooms while teaching, and/or makes resources available that they can consult at their own time and convenience. Tech-based solutions include coaches remotely observing teachers, recording teaching practices, and availability of experts to virtually supplement the classroom teachers. With these aids, teachers can learn-teach-reflect-apply-revise-teach-learn in cycles, that is, "learn while doing" (**Case 13. Experience from Bangladesh**). Programs that leverage access to remote experts to complement full-time teachers in a classroom are an effective means for local teachers to learn while teaching, especially in low-resource contexts whose experts-student ratio is low. A program in India combined computers, broadband connectivity, and conventional satellite technology to deliver classes taught by expert teachers in a central location using multimedia teaching aids. Local teachers used these tele-education classes to update their knowledge and teaching techniques and to revise concepts of newly introduced topics—all during their regular classes (Naik and others 2020).

Case 13.
Using Classroom Observation Snapshots to Increase Instruction Time: Experience from Brazil

Throughout 2015, the government of the Northeast state of Ceará, Brazil implemented an experimental program to promote better techniques for student engagement and classroom management—all through in-class observations without taking teachers out of their classrooms. "Learning while doing" was operationalized in the program through a "classroom snapshot" methodology whereby quantitative data was generated on the interactions between teachers and students. Observations consisting of a 15-second scan of the classroom were conducted at 10 different moments in every class. These observations then were coded in four categories: instruction, classroom management, teacher off-task, and students off-task. Classroom observations were recorded while the teacher was teaching in the presence of an observer. The expert coaching advice received by classroom observers from a central team based in São Paulo was based on the recorded observations and feedback. This approach was instrumental in strengthening the feedback that teachers received.

In 2015 a randomized controlled trial study was done. It indicated that through the four components of the program—observation bulletins, face-to-face orientation sessions, Skype interactions with the training team, and self-help materials—teachers increased instructional time by 15 minutes every day. Time spent on classroom management and time off-task decreased. Consistent with the goals of the program, the use of questions in classroom teaching increased.

Source: Bruns, Costa, and Cunha 2017.

Mitigation Strategy 3.2
Enhance teachers'/PLs' engagement with peers and enable exchanges with other teachers/PLs

Attributes(s) of Technology

Connectivity   Interactivity

How
Technology's attributes of connectivity and interactivity facilitate virtual spaces in which teachers can exchange ideas and resources with their peers and PLs, during and after the TPD programs. The literature on teacher training emphasizes that effective TPD programs usually promote peer collaboration as a means to encourage teacher engagement in learning (Desimone 2009; Darling-Hammond, Hyler, and Gardner 2017). Technology enhances peer collaboration's frequency and reach (**Case 14. Teach2030**). Engagement with peers through technology can take on simple forms such as creating text messaging groups (**Case 15. Experience from Jordan**) composed of teachers/PLs from the same school or district taking part in a training program (Motteram, Dawson, and Al-Masri 2020; Nedungadi, Mulki, and Raman 2018) or through web-based platforms that connect trainees from different regions or even countries (Wolfenden, Cross, and Henry 2017). Evidence suggests that when teachers/PLs engage in peer interaction, it boosts their interest and, ultimately, engagement in training activities. Especially for programs implemented in contexts in which teachers/PLs have access (and the skills) to use mobile phones and data, promoting mechanisms for their increased collaboration can be a cost-effective way to influence teachers/PLs value the program more. Peer collaboration and communication through technology enhance access to experts and trainers locally and abroad (sec. 3A.1). Peer collaboration and communication also are essential components of a strategy to enable teachers/PLs to discuss what they have learned during the TPD programs and to ensure ongoing support and learning.

© Teach 2030

🏆 T4T Champion

Case 14.

Teach2030 Takes a Blended Learning Approach to Facilitate Teacher Collaboration

Teach2030 has been accessed by teachers in over 40 countries as it strives to develop cultures of peer-to-peer learning. The program adopts a blended learning approach. Smartphones enable teachers to participate in digital courses and complete activities. Learning is consolidated through establishing a routine in-school, face-to-face session that brings together teachers to reflect on TPD-supported learning and classroom implementation experiences. This learning community is echoed online, with communities of practice (CoPs) that connect teachers virtually within and across countries. The online CoPs provide the potential for global, more frequent, and rapid communication, which would be difficult to facilitate in the absence of technology. The program promotes the "little-and-often" approach to TPD by ensuring that teachers who work in underserved and low-connectivity settings can access relevant materials (courses use less than 50MB data each).

Sharing relevant content is further supported via social media (Facebook groups, YouTube) and messaging platforms (WhatsApp), as well as by the regular delivery of virtual workshops (co-presented by Teach2030 team and in-country teachers and Teach2030 Ambassadors—watch highlights here). Teachers' learning communities increase engagement with the content and make projects more sustainable. TPD can be delivered with a suite of technological tools: any device, data, and a place for teachers to meet to discuss their classroom practices and what they're learning from the courses. Adopting a multipronged approach enables ongoing engagement and follow-up.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Teach2030 is 1 of the 10 T4T Champions.

Case 15.

Technology in the Toughest Places: WhatsApp Connects Teachers in One of Jordan's Syrian Refugee Camps Interactions on a WhatsApp group of Syrian

Interactions on a WhatsApp group of Syrian English teachers working in a Zaatari refugee camp in Jordan were analyzed to reveal that this messaging platform can be an important avenue for peer-learning, especially in contexts affected by fragility, conflict, and violence (FCV). Analysis of texted discussions revealed that 45 percent of messages exchanged among teachers dealt with materials used, pedagogical practices, and training opportunities. Teachers also used the group to discuss other topics relevant to teaching in FCV settings, such as logistics of accessing the camp, issues with technology, and social interactions. The messaging group was used to share resources and ideas and follow up after in-person trainings. Teachers benefited from having a moderator: someone who continuously sent messages and promoted discussion among teachers. Social media platforms that teachers in FCV contexts use regularly for their personal use also can be a reliable source of ongoing exchange of ideas and professional development, especially in settings in which in-person meetings are halted due to conflicts.

Source: Motteram, Dawson, and Al-Masri 2020.

Section 3A.3: Tech-based solutions to encourage application of TPD skills or knowledge in the classroom

Although teachers/PLs may access and engage in available TPD opportunities, they may not have the necessary support and resources to retain the content and incorporate skills learned in their professional practice. Application is defined as *teachers/PLs using the skills and knowledge acquired during their professional development when back in their classrooms.* Without ongoing support and deliberate practice, teachers/PLs may not be able to use their newly acquired skills in the classroom, thus resorting to old ways of teaching and interacting with students, rendering the TPD opportunities inefficacious.

Application Barrier #1
Low-quality and/or absent support for teachers/PLs following TPD

Mitigation Strategy 1.1
Continue engaging teachers/PLs between and after trainings

Attributes(s) of Technology

Connectivity   Interactivity

How
Technology's attributes of connectivity and interactivity enable continuous and timely communication among teachers and with PLs, and at their own convenience. Encourage teachers'/PLs' ongoing development and practice between or after trainings, enabling them to test and implement in the classroom what they learned during the professional development activities. Encouragement can be facilitated through engagement with PLs or among teachers using phone calls, text messages, and virtual or in-person meetings, depending on context and availability of technology (Cilliers and others 2021; Shaheen and others 2013; Motteram, Dawson and Al-Masri 2020).

Technology can aid communication between trainings (**Case 16. Experience from Madagascar**) so that it is timely (given when teachers/PLs are actually practicing new skills) and relevant (responding to actions teachers/PLs are taking in their classroom). PLs can connect with teachers and offer light-touch, but highly valuable, individualized remote support by responding to teachers' questions, sharing intermittent tips and teaching techniques, offering short reminders of teachers' goals and messages of encouragement, requesting teachers to share short video clips of their teaching, examples of student work, and/or brief audio reflections on their progress (World Bank 2021d).

Case 16.
From Connection to Community: Mobile Teacher Training in Madagascar

A project in Madagascar involving 456 teachers in 2012 and 2013 had the goal of improving teachers' pedagogical skills and knowledge of French, the language of instruction. The project was designed as a hybrid training model: teachers gathered together in person every 3 months for a 3-day training session, and every month with a smaller group of teachers who lived in nearby villages. Notably, teachers used mobile phones to engage in activities such as daily quizzes and interactions with peers and tutors.

A 2021 study of the program used mobile phone records to analyze interactions among teachers. The study showed that teacher participants established professional and personal connections that remained active once the program formally ended. Interviews and classroom observations confirmed that the program managed to influence teachers' pedagogical practices. Moreover, the phone communications teachers had with their peers and tutors during and after the training period often were related to pedagogical practices. Teachers reported that they exchanged good practices on how to conduct a lesson with their former co-participants. Phone records and interviews with teachers corroborate these findings. This kind of program also has the potential benefit of creating a community not only of teachers but also of tutors, whose connections also were enhanced during and after the program. Tutors indicated that mobile phones facilitated quicker reach to teachers.

Source: Lautz-Cauzanet and Bruillard 2021.

Mitigation Strategy 1.2
Remind teachers/PLs to continue applying new knowledge and skills

Attributes(s) of Technology

Connectivity   Data processing

How
Technology's attributes of connectivity and interactivity can be leveraged to reinforce teachers/PLs, as individuals while reaching a wider audience. A common strategy TPD programs use to follow up with teachers/PLs is to periodically send them reminders using SMS or through other platforms or providing them with avenues to stay in touch with the coaches/PLs who can support them in implementing practices in the classroom (**Case 17. Experience from Kenya**). These messages serve multiple purposes. The messages can nudge teachers/PLs to test and apply skills developed during training sessions in class, enhance communication between teachers and PLs, create a constant space for teachers/PLs to discuss challenges in the classroom, provide teachers/PLs with actionable recommendations about pedagogical practices that they can implement or materials that they can use, and simply make them aware of the availability of new training materials and content (Slade and others 2018; Wennersten, Quraishy and Velamuri 2015). These practices contribute to make TPD an ongoing process. When using behavioral nudges, evidence suggests that, to elicit better behavioral responses, content should be simple and focused, as opposed to general. Nudging should be neutral in nature and not use punitive language (World Bank 2015) because the aim is only to point individuals to a particular choice. Connecting teachers with peers and PLs can encourage them to test and experiment with classroom-based initiatives. These ongoing connections make applying the skills an iterative process and give teachers/PLs a supportive space in which to learn, share, receive feedback, and improve their practices (Cilliers and others 2021; Shaheen and others 2013).

Case 17.
Using Text Messages to Improve Literacy Instruction in Kenya

Kenya's Health and Literacy Intervention aimed at supporting primary school teachers by providing them with semi-scripted lesson plans, delivering in-person training sessions before and during the program, and sending weekly text messages to teachers with instructional tips and encouragement for them to implement lessons plans. Teachers also received mobile credit every week, facilitating their response to text messages. This is an example of a program in which technology was used to provide nudging to help teachers apply concepts regularly in the classroom, enable two-way communication among teachers and their coaches, and lower the cost of in-person coaching.

In an RCT, researchers found that the program had positive effects related to teachers' classroom practices, children's literacy abilities, and student dropout. Even though the study did not isolate the impact of text messages from other elements of the program, teachers reported that these messages were good sources of teaching ideas, helped create a sense of community, and served as an ongoing mechanism for the program to collect feedback about the intervention. This mechanism contributed to teachers' constant engagement with the program. On average, teachers' response rate to weekly messages was very high (87 percent in Year 1 and 84 percent in Year 2 of the intervention). The messages also contributed to make the program cost effective: the costs involved in the messaging strategy were not high, and the program had positive results. SMS support accounted for ~20 percent of the total intervention cost, and the authors claim that the key to ensure low costs was the use of text messages to support teachers.

Source: Jukes and others 2017.

Application Barrier #2
Insufficient resources to implement skills and knowledge in the classroom

Mitigation Strategy 2.1
Provide supplementary materials and tools for reference and guidance

Attribute(s) of Technology

Connectivity   Interactivity

How
Technology's attributes of connectivity and interactivity enable sharing and distribution of supplementary resources more frequently, at a lower cost, and to more teachers/PLs. Resources for reference, practice, and reinforcement of knowledge and skills acquired during TPD programs are useful tools on which teachers/PLs can draw to implement new pedagogical skills in the classroom (Case 18. Experience from Kenya, Case 19. Inspiring Teachers). Such implementation tools (or "job aids") can take the form of guidance notes with examples and tips, lesson plans, tutorial guides provided during or after a training, or as standalone learning and teaching materials.

For instance, as part of the PRIMR initiative, teachers in Kenya were given a tablet containing multimedia lesson plans, supplementary pedagogical aids, virtual letter flashcards, and the Papaya™ software application, which had audio capabilities to practice letter sounds (Piper and others 2015).

Case 18.
Using Educational Technology to Develop Early Literacy Skills in Sub-Saharan Africa

ABRA (A Balanced Reading Approach for Children and Designed to Achieve Best Results for All) is a well-known literacy education software that has been implemented and evaluated in several countries. One of these evaluations assessed a 2012 implementation in Kenya. ABRA was then a multimedia software that included content for students, teachers, and parents. For teachers, the program included professional development materials such as lesson plans, videos, printable materials, assessments, and a platform for teachers to share ideas and materials. In addition to access to the software, teachers received equipment to access it, teaching materials with classroom activities and job aids, access to weekly web conferences to discuss ABRA implementation, virtual tutorials to help teachers and students start using the tools appropriately and immediately, and other support from trained professionals. The small-scale Kenyan study detected positive effects on teachers' pedagogical practices and student learning, consistent with program impacts found in evaluations conducted in other countries. Engagement with ABRA made teachers more confident in using technology. All teachers reported being enthusiastic about using technology in their instruction.

Source: Abrami and others 2016.

© Inspiring Teachers

🏆 T4T Champion

Case 19.
Inspiring Teachers Provides Inspiration to Use Job Aids to Support Teachers through Access, Engagement, and Application of Skills and Practices

Inspiring Teachers is a global education nonprofit that started in 2011 with 5 teachers coaching local teachers in Uganda. Now across 11 countries, the Limited Resource Teacher Training (LTRR) program provides teachers, school leaders, and PLs a set of printed peer-coaching guides and materials to support training teachers to become peer-coaches. The guides structure the peer-coaching process as teams work through monthly cycles of peer observation, feedback,

and deliberate practice. The guides are supplemented by a companion app with video exemplars of instructional techniques in practice, giving teachers additional confidence to try new techniques in their own classrooms. Job aids also support program oversight. An app for field officers enables digital collection of teacher observation data. A data dashboard provides insights and reports to enable system leaders to make adaptive program management decisions based on program fidelity and classroom teaching insights. All these supplementary materials are provided to users in both digital and print forms. The materials reinforce the knowledge and skills learned by teachers in different contexts. A 2019 evaluation showed that LTRR improved self-assessed classroom management, use of instructional strategies, and teachers' beliefs that attempts at new skills pay off.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Inspiring Teachers is 1 of the 10 T4T Champions.

Application Barrier #3
Insufficient accountability mechanisms to ensure continued application of TPD concepts

Mitigation Strategy 3.1
Monitor application of skills

Attribute(s) of Technology

Data processing

How
Technology's attribute of data processing facilitates using data to improve programs and teaching practices. Continued monitoring to support teacher performance is one way to encourage application of skills or knowledge acquired through TPD opportunities. Technology can aid in the collection, analysis, and sharing of information that can be used as part of the feedback process to teachers/PLs (**Case 20. Tu clase, tu país**). With this data, teachers/PLs can access their performance analytics, and PLs can use this data during feedback sessions to reinforce teachers' application of new practices. Data collection can be done by PLs, peers, or the teachers themselves to upload or share content to monitor their commitment toward application of new classroom skills (**Case 21. Experience from India**). With the availability of analytics, PLs can tailor their support to teachers based on progress, which is possible with the availability of timely performance data.
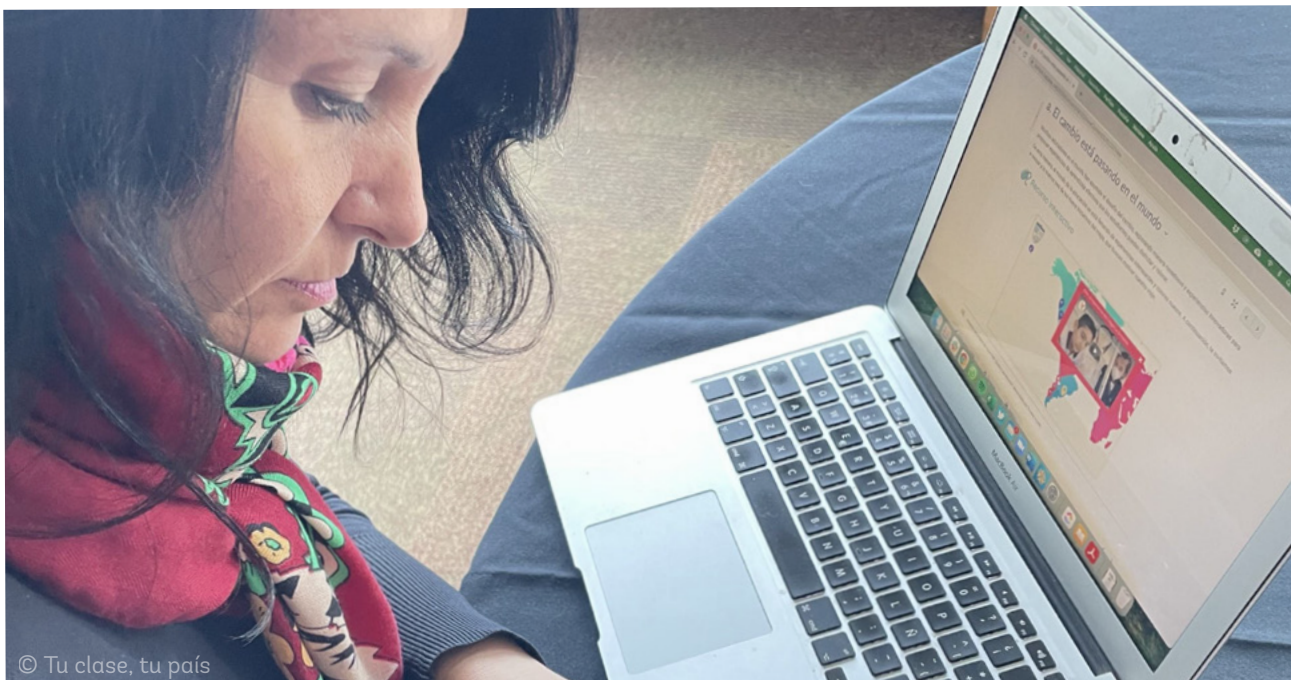
© Tu clase, tu país

🏆 T4T Champion

Case 20.

Using Data to Generate Feedback Loops, Encourage Practice of Skills: Tu clase, tu país

Tu clase, tu país, a non-profit organization operating across Latin America and the Caribbean, accompanies teachers as they change their practices through three continuous stages: information, reflection, and action, It is a learning strategy mirrored and monitored within an LMS. Each lesson uses a range of resources to propose micro-practices that a teacher can incorporate into her/his planning and lessons. The micro-practices are recorded by the teacher and shared with peers and tutors using the platform. Through an online community software, teachers and tutors reflect together by providing feedback to each other on what has been learned and what needs to be improved before the practice is returned to the classroom.

The practice of reflection is both self-evaluation and co-evaluation, with teachers working in collaboration with their learning community peers and tutors. Reporting functionalities within the LMS provide data that can be used for both personal and organizational growth. The functionalities both support the teachers' own learning experiences and provide educational systems with opportunities to receive data that will improve the supply of training trajectories for teachers. The system has both individual and organization feedback loops. Monitoring supports quality learning and retention. As a result of the monitoring and 24/7 support from certified tutors, more than 82 percent of the teachers finish the courses they take.

Source: Information submitted during application stage of the Teachers for a Changing World, interviews with program team after selection, and information updated on the HundrED webpage.
Note: Tu clase, tu país is 1 of the 10 T4T Champions.

Case 21.
Using WhatsApp to Reduce Teacher Absenteeism in Rural India

A study published in 2018 evaluated implementation of an Indian program, AmritaRITE (Rural India Tablet Education). The program used 2G-enabled tablets to monitor and support teachers, with the ultimate goal of reducing teacher and student absenteeism and improving learning. The program provided teachers with tablets that had WhatsApp and a few other applications pre-installed. Teachers were expected to participate in group interactions and send daily attendance reports and time-stamped photos of themselves and students in classrooms. Teachers also uploaded photos and records of what was taught in class to keep a track of their accomplishments. They also were were requested to submit periodic reports about students' performance. The program gave monetary incentives to teachers who regularly sent daily reports. The WhatsApp groups also served as a locus for interaction with peers and a PL, who provided teachers with lessons plans, instructional videos, and feedback on teaching practices. This model promoted peer learning, increased teacher attendance, adherence to planned activities, and accountability.

Source: Nedungadi, Mulki, and Raman 2018.

Section 4
Delivering At-Scale TPD Using Tech-Based Solutions

Delivering At-Scale TPD Using Tech-Based Solutions

Scalability is takes time, resources, and coordination at multiple levels of a system. Scalability is determined by the institution's capacity to leverage preexisting knowledge and experience that is applied under real-world conditions to reach more teachers/PLs. Scalability entails planning clearly what will be scaled (TPD program components), for whom and how, and clear articulation of the goals and expected results. Policymakers and practitioners who design and/or implement at-scale TPD programs must carefully consider trade-offs among costs, resource limitations, and contextualization of TPD programs for large-scale delivery, while trying to maintain the quality of a program.

To implement effective TPD programs at scale, it is important to distinguish between program components that are replicable and those that are contextual. Both are critical. Replicable components such as providing one-to-one support or group support are program design elements that have proven to work within certain parameters such as effective trainers and specific trainer-teacher ratios. Contextual components such as level of digital proficiency and incentives that positively impact teachers'/PLs' participation should be adapted to local needs because such nuances are critical to achieve the desired change in teaching practices at scale.

Policymakers must introduce technology in a TPD program with a clear purpose after considering the available needs, barriers, and resources in a particular context (**section 3**). Section 4 identifies key considerations when scaling effective TPD practices that use technology.

Key Considerations When Scaling Up TPD

1. Design with the user in mind

Consider the end-users' professional needs and how to design TPD and technology to align with these needs. Alignment requires determining the program's intended learning objective(s) and assessing contextual needs to adapt to learning ecosystems.

» *Consider the availability of minimal levels of ICT infrastructure and resources.* Education systems can work with the government counterparts in information technology (IT) and with the private sector to address connectivity challenges for students and teachers. Using a whole-of-government and multistakeholder approach, policymakers can engage the broader ecosystem, for example, telecom companies, publishers, local EdTech startups, radio, and TV stations, to build partnerships with local and global EdTech providers (World Bank 2021c).

» *Assess the learning ecosystem* in which teachers/PLs operate to inform the design of a flexible contextualized program. For instance, when scaling up nationally, sociocultural, geographic, and linguistic differences even within a country will influence the extent to which a program is adopted by its target audience. Thus, a contextualized approach and flexibility to adapt at the school level within an overall national framework are necessary.

» *Assess professional development needs and digital skills* of target users to inform scale-up decisions and to ensure sustainable results. Using diagnostic assessment tools to identify teachers'/PLs' learning needs and digital skills enable program implementors to tailor TPD delivery channels and content

» *Establish intended learning objective(s) of the TPD program* and an implementation plan for how the tech-based solution will help achieve these learning objectives. Set time-bound scaling goals with measurable results that are monitored over time. The T4T Approach outlined in **section 3** helps implementors determine existing barriers at each stage of the TPD process and identify potential tech-based solutions to enhance teaching practices.

» *Design measures to boost willingness and skills of teachers/PLs to adopt the tech-based solutions.* Even if teachers/PLs use phones in their personal lives, using these devices for professional development can be very different. Providing resources to help teachers/PLs build confidence in using technology and familiarizing them with its uses and benefits in communicating with and teaching students is essential to ensure adoption.

For example, Teach2030's Become a Digital Learner course is designed for teachers/PLs to learn how to use their smartphones to support their professional development. Programs should be careful not to underestimate the learning curve of using technologies that might be considered very basic in other contexts (Pouezevara and Kahn 2007). When introducing a tech-based TPD activity, understanding the baseline level of digital skills of teachers/PLs and using technology that is domesticated can be a great starting point. Moreover, it is essential to address teachers' negative emotions and beliefs because they are a motivational barrier to engagement in TPD and/or adoption of technology (box 2).

Box 2. Behavior Change and Teacher Professional Development

To achieve enhanced classroom teaching, teachers have to be willing to change their current routines, behaviors, perception, or habits. Accepting that there is room for professional improvement can be difficult if individuals are not motivated or aware of the benefits that can result from changes in their behaviors. For example, teachers' negative perceptions about their own abilities, or misplaced confidence about their capacity, could prevent them from fully engaging in TPD and learning (Sabarwal, Kacker, and Habyarimana 2018). Even more so, if teachers' existing beliefs or mindsets are at odds with the assumptions that underpin the TPD program, they could result in a mismatch between the program's intended change (behavioral or pedagogical outcome) and what is applied or manifested in the classroom (Brinkmann 2016; Munby 1984; Smylie 1988). Designing TPD programs that diagnose and address insights from behavioral economics can help address motivational or behavioral barriers to engagement in TPD and/or adoption of technology.

Source: Quota and Bhatia 2022.
Note: For details on addressing motivational barriers to behavioral change in the TPD journey, refer to "Motivating Changes in Teaching Practices Guidance Note," which is part of the suite of Coach Tools and Resources.

2. Estimate costs for a program to ensure sustainability

The costs of delivering a tech-based TPD program will vary by program components, technology used, resources available, and costs to acquire and maintain these resources. One way to estimate the cost of development and implementation of a program is the minimum input approach: (1) determine the components required to deliver the TPD program, that is, the program activities and associated minimum inputs required to implement each activity, (2) determine the dose or frequency of each of these activities, and (3) calculate the associated costs for the program implementation over a given period.

» *Consider available low-cost solutions.* A review of costs associated with common types of tech-based TPD methods (extracted from published articles on tech-based TPD programs) revealed that Coaching (for example, observation, feedback, conference calls with PLs) and *Digital Resources for Teaching* (for example, teaching software and audio-visual materials) are among the highest cost TPD methods. Providing Instructional tips and strategies (such as via SMS) are among the lowest cost methods. The review followed a component-based approximation accounting for inputs such as time (salaries), logistics (travel), technological devices (phones, laptops, tablets), data bundles and device maintenance, and development of learning materials (Cobo and others 2022).

» *Consider the costs of maintaining technology.* Specifically for interventions that rely on distributing technological equipment to teachers/PLs, i((t is essential to plan and budget for timely and adequate maintenance. Planning and budgeting include ensuring that the chosen technology can be replaced locally and a support team is available to handle glitches and provide technical assistance (Blimpo and others 2020). Local school districts likely will not have adequate teams to provide technical assistance (TA) to procured program equipment. As a result, in some cases, this equipment could be broken for several months (Lehrer, Mawoyo, and Mbaye 2019). Damaged equipment could contribute to limit engagement of teachers/PLs during TPD activities, delaying implementation and leading to a waste of valuable resources, including time.

3. Measure as you go and monitor implementation

Implementing at scale requires careful consideration of the impacts, or intended impacts, that a program has on the desired teaching and learning outcomes. Information that measures impact, especially the isolated impacts of technology or of other specific components of a program, may not always be readily available. For programs that already are being implemented, practitioners may consider employing nimble evaluations, which are rapid, low-cost impact evaluations especially useful in LMICs (Guide on M&E of TPD Program). Alternately, when designing a context-need-specific program, design with scale in mind and include opportunities for monitoring and evaluation (M&E). Through this process, practitioners (1) will gain a better understating of how the TPD program, or program design, led to behavioral changes that resulted in improved teaching practices so (2) can ensure that these program components are implemented, or replicated, at scale with fidelity.

» *Consider evidence strength.* Even though an intervention had positive impacts in one context does not mean that this success will translate to similar results in another context. Prior to implementing at scale, careful piloting and testing of interventions should be done. During this testing and iterating, the non-negotiable project components that determine how an intervention is changing behaviors should be identified with the intention of replicating or scaling up.

» **Measure project components** (such as dosage of TPD, teachers' time on task) throughout implementation to inform scalability decisions. Determining the non-negotiable and adaptable components of the program involves capturing nuances of implementation that will help isolate the technology's impact on the change in teaching practices.

» **Monitor implementation fidelity.** Monitor fidelity of implementation and review and revise program components to constantly adapt to the context and evolving needs. Collecting and analyzing data at each implementation stage will inform adaptations that enhance the program's relevance and generate more opportunities to design an impactful and personalized TPD experience. TPD programs that use technology often falter on implementation fidelity when they (1) are complex in design, (2) use new technologies that are not easily taken up by teachers/PLs, and/or (3) otherwise engender poor ownership and engagement from key stakeholders. Successful program designs include room for teachers to adapt a prescribed program to fit their needs. In other words, ensuring that the program delivers results as intended requires the flexibility to enable teachers/PLs to improvise.

Section 5
What Are the Main Takeaways?

What Are the Main Takeaways?

Technology can support the delivery of TPD by enhancing access to and engagement with learning opportunities, and application of new knowledge and skills in the classroom. Evidence-based mitigation strategies presented in this Guidance Note offer policymakers and practitioners a range of options to address implementation barriers at each stage of the TPD experience: access, engage, and apply. A key takeaway is that human connection is essential. Thus, replacing face-to-face with fully virtual interactions will not necessarily lead to positive results. This section summarizes top tips for implementation at each of the three stages of TPD.

1. Access

While lack of access to high-tech-based-TPD can be a barrier, it also is an opportunity to innovate with the flexibility and inclusiveness that low-tech solutions can offer. In fact, using a combination of technologies to deliver TPD can provide higher levels of flexibility for a diverse target group, thus broadening these teachers' opportunities to access professional learning. The ability to take advantage of the flexible solutions that technology offers will be determined by the specificities of the context in which the TPD occurs (for example, access to infrastructure, connectivity, or devices, as well as the proficiencies of targeted teachers/PLs to use different kinds of technologies). As illustrated in the cases studies in section 3, there is no right or wrong technology. Rather, the choice of which technology to leverage is context dependent and tied to the intended purpose(s) of introducing technology.

Top Tips to Promote Access

» Make professional development available to teachers/PLs anytime, anywhere; start with the channels of distribution and formats with which they are familiar.

» Promote learning communities but also involve a facilitator or moderator to promote quality checks in the process of sharing resources among peers.

» Leverage and train local talent.

» Make information about available offerings readily and easily accessible. Doing so can go a long way in increasing uptake.

2. Engage

Teachers are at the center of the learning experience. Technology can facilitate more frequent opportunities for teachers to communicate, observe, and model practices using devices or resources that are part of their daily routines. The technology chosen to support teachers' needs should consider the characteristics and the voices of teachers/PLs. Teachers'/PLs' perceptions about technology, their experience using it, and their digital skills can be critical factors to consider when using technology to facilitate TPD opportunities. Designing strategies to regularly collect and analyze teachers' engagement in the learning process (not solely a satisfaction survey at the end of the process) also is critical to track up-take and to adjust the program during implementation. When possible, planning for synchronous and asynchronous feedback from teachers and instructors will be extremely useful. Sharing the results of the feedback with the teacher community also will strengthen teachers' feeling of ownership in taking up the new technologies.

Top Tips to Promote Engagement

» Collect and use data to continuously inform improvements in programs and policies to suit teachers'/PLs' changing needs.

» Incorporate frequent self-assessment quizzes or other forms of checks to enable teachers/PLs to meaningfully benefit from the professional development.

» Demonstrate behavioral expectations and new instructional methods as models to improve one's own teaching practices.

» Enable teachers/PLs to learn-teach-reflect-apply-revise-teach-learn in cycles and in their classrooms.

3. Apply

Tech-based solutions can ensure sustainability in delivering high-quality TPD throughout the learning experience by facilitating ongoing support and delivery of resources. While planning the implementation of the TPD, it is important to consider the enabling support mechanisms at every step of the learning experience (that is, before, during, and after program is delivered). Support mechanisms provide opportunities for teachers to receive additional guidance or assistance as needed. This support may include materials and resources on how to use technology, on learning content and application in digital settings, or any other knowledge pieces that may aid implementation fidelity and maintain quality application of learned skills when teachers are back in the classroom. The supporting mechanisms can be enabled by a local pedagogical leader or a facilitator. The mechanisms can be sustained by a help desk or other channel that regularly connects with teachers in person or remotely. Technology can be an effective tool for enabling remote support, monitoring teachers' needs and providing feedback (either one-to-one or at scale). Effective support provided during the TPD programs can increase effectiveness by early mitigation of problems.

Top Tips to Promote Application

» Offer light-touch but frequent feedback on teaching practices including tips on techniques, reminders of goals, and encouragement to stay motivated.

» Keep the behavioral nudges focused, short, frequent, and neutral as opposed to punitive.

» Encourage experimentation and discussions of the resulting learnings from the TPD.

» Provide tools to help apply learned skills in the classrooms such as tutorials on how to use technology, learning materials, lesson plans, and references.

When used well, technology can support enhanced access and engagement with TPD and application of new skills in the classroom. Well-integrated technologies can be multi-purpose and multi-context. At the same time, technologies are malleable so the combination of different tools for providing TPD offers higher levels of flexibility. That is why timely feedback can help mitigate problems or misalignments. In this way, practitioners can use the information to identify means for leveraging technology for new and/or existing professional development practices. The Note draws together emerging research from across the globe, shares successful case studies, and offers areas for consideration when scaling programs. It emphasizes that technology does not operate in isolation, rather it is one tool in a range of policy options that practitioners can leverage to enhance the delivery of TPD opportunities. Successful programs use technology with a clear purpose in-mind, adapt application to the local context, and rigorously and systematically use data to learn and adjust program design (Hawkins and others 2021). Last, the Note emphasizes the need for the global community to continue documenting innovative TPD practices, especially in low-resources contexts, and share their experiences with users around the world.

© Diana Styvanley / World Bank

© TESS India

© OER4Schools
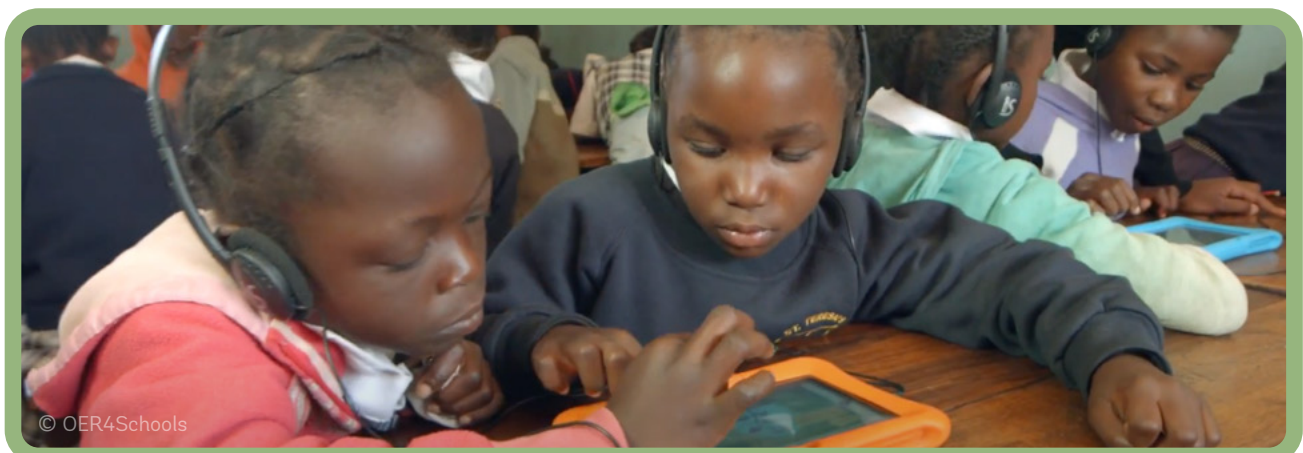
Appendixes

Appendix A. Detailed Methodology

A Systematic Rapid Review of Empirical Evidence

From December 2020-March 2021, our team conducted a review of existing evidence that detailed how technology could be used to facilitate in-service TPD in LMICs. The review included studies that showed how technology was applied across broader professional development needs. Other activities and external factors that influenced teachers'/PLs' willingness, student learning outcomes, and home environment were not within the scope of the review. A key challenge was the limited number of peer-reviewed empirical studies that focused on isolating the impact of technology on change in teaching practices. [10]

Methodology

This Note takes into account the results of the 2021-22 review of in-service TPD programs for LMICs intended to influence (1) ***Practices:*** Teacher-based outcomes such as content knowledge, digital skills, pedagogical practices; and/or (2) ***Processes:*** Mechanisms that make the programs and/or teachers/PLs more effective by reducing costs, reaching more teachers/PLs, and reducing drop-out of teachers/PLs from a program.
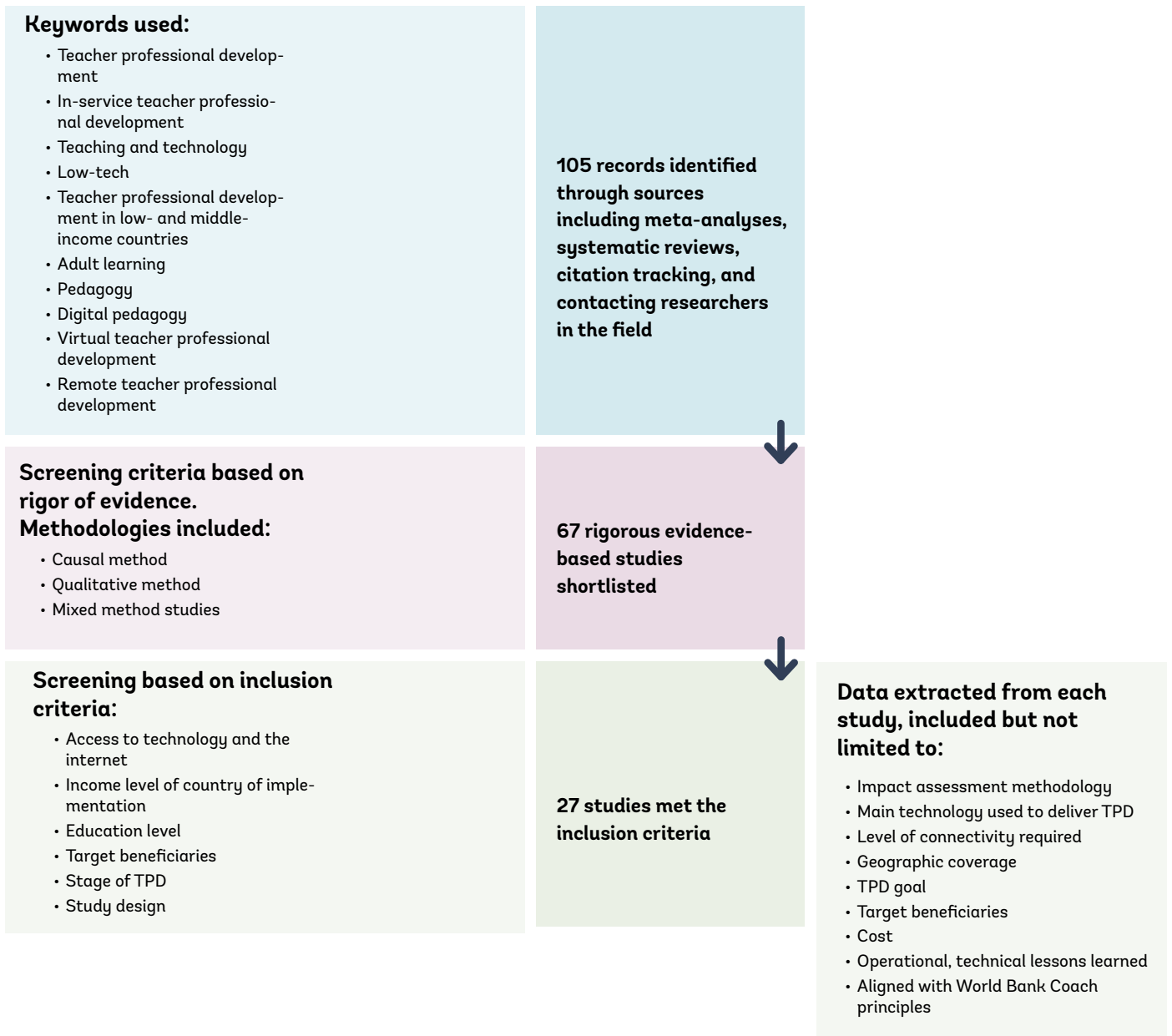
The two-fold methodology to identify scalable and impactful tech-based solutions to facilitate TPD in LMICs comprised a (1) review of global literature on tech-based TPD programs and (2) gloal crowdsourcing contest.

The methodology for the 2021-22 review (figure A.1) was as follows:

1. **Search** for relevant studies using meta-analyses, systematic reviews, citation tracking, and contacting researchers in the field, yielding over 100 studies. The keywords used were teacher professional development, in-service teacher professional development, teaching and technology, low-tech, teacher professional development in low- and middle- income countries, adult learning, pedagogy, digital pedagogy, virtual teacher professional development, and remote teacher professional development. Of these, 67 studies were evidence based (and published as working papers or in peer-reviewed journals). The remainder were anecdotal reports with non-rigorous analyses.

2. **Screen** the 67 shortlisted studies using the inclusion criteria below. Screening resulted in 27 studies, which were made part of the Evidence Matrix. See T4T Evidence Matrix for a summary of the 27 studies.

3. **Extract** methodology of assessing impact, main technology used to deliver TPD, geographic coverage of the intervention, TPD goal or outcome and target beneficiaries of the intervention, and implementation cost (where available). Researchers were contacted to gather details not explicitly stated in the published or working papers.

4. **Judge** how much confidence to place in the findings of each study. Each study was evaluated for methodological quality and relevance to teacher-based outcomes.

5. **Summarize** the findings of each study, grouped by the broad topics of policy challenge, TPD outcome, and technology used.

---

10 Additionally, the research approach was "subject agnostic." In other words, we did not differentiate between the technology used when the goal was teacher knowledge vs. when the goal was attitude or skills. Similarly, we did not differentiate between the technology used when the content was subject specific (for example, mathematics, science) vs. when it was pedagogy related (for example, grouping, continuous assessment). However, as the literature and experience base grow, we may find that technology is more suited to certain kinds of content improvement than to others.

Figure A.1 Review of Global Literature

Keywords used:
- Teacher professional development
- In-service teacher professional development
- Teaching and technology
- Low-tech
- Teacher professional development in low- and middle-income countries
- Adult learning
- Pedagogy
- Digital pedagogy
- Virtual teacher professional development
- Remote teacher professional development

105 records identified through sources including meta-analyses, systematic reviews, citation tracking, and contacting researchers in the field

Screening criteria based on rigor of evidence. Methodologies included:
- Causal method
- Qualitative method
- Mixed method studies

67 rigorous evidence-based studies shortlisted

Screening based on inclusion criteria:
- Access to technology and the internet
- Income level of country of implementation
- Education level
- Target beneficiaries
- Stage of TPD
- Study design

27 studies met the inclusion criteria

Data extracted from each study, included but not limited to:
- Impact assessment methodology
- Main technology used to deliver TPD
- Level of connectivity required
- Geographic coverage
- TPD goal
- Target beneficiaries
- Cost
- Operational, technical lessons learned
- Aligned with World Bank Coach principles

Inclusion Criteria for Selecting Studies

The studies in the T4T Evidence Matrix were selected according to the inclusion criteria listed in table A.1.

Table A.1 Evidence Matrix

Selection Criteria		Included	Excluded
Technology	Access to technology and the internet	Interventions that operate in contexts with low or irregular connectivity. Interventions that operate in contexts with high connectivity (for example, online learning platform, video streaming) are given secondary priority.	Interventions that do not use any form of technology to train and/or support teachers /PLs.
Context	Income level of country of implementation (as per World Bank country classification by income)	Low-income, low-middle-income, and upper-middle-income countries (LMICs).	High-income countries (HICs).
	Education level	K-12.	ECE, Higher Education.
Design	Target beneficiaries	Interventions that 1. Use technology to deliver training and/or support to teachers and PLs. 2. Use technology to improve student learning outcomes and provide training and/or support to teachers/PLs and report the impact on teacher-based outcomes.	Interventions that include the use of technology only for students.
	Stage of TPD	Interventions for in-service TPD.	Interventions for pre-service TPD.
	Study design	Interventions in which a quantitative estimate of the impact is given (experimental/quasi-experimental). Interventions with observational studies are given secondary priority.	Interventions that are not evaluated or have only published self-evaluated reports.

Global Crowdsourcing Campaign: Teachers for a Changing World Global Campaign

Objective: To identify and promote impactful and scalable solutions that support teachers' professional development.

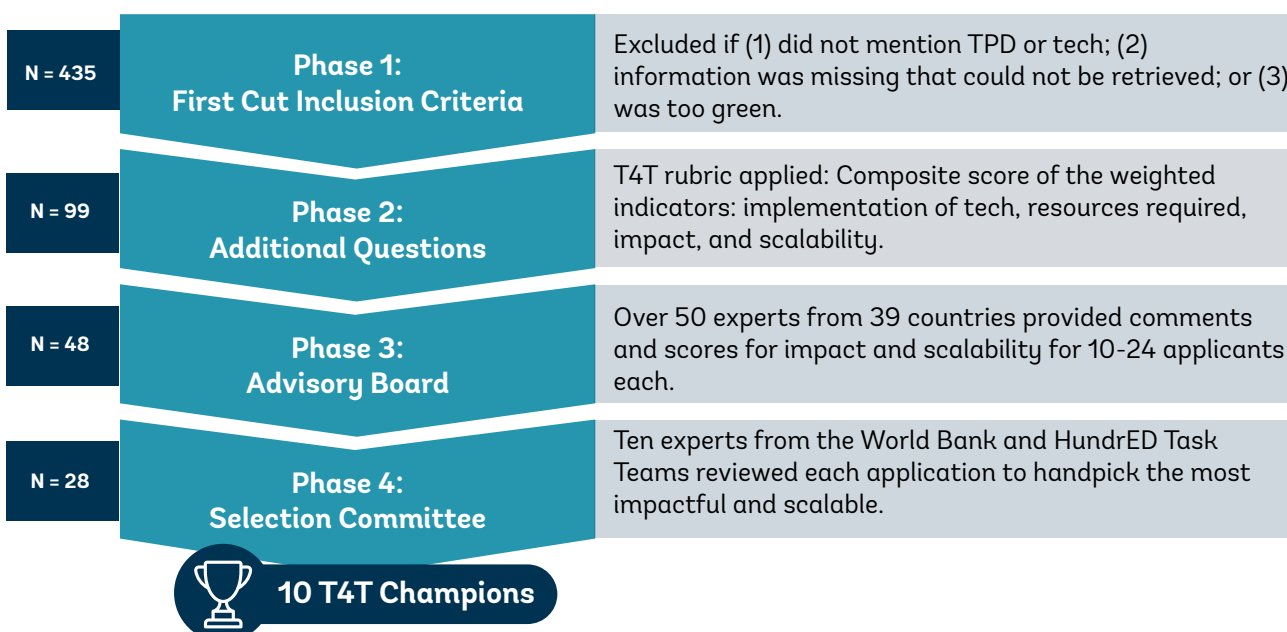*Outcome:* 435 innovations from 80 countries around the world were submitted to the Spotlight[11] between December 2020 and March 2021. The contest accepted applications in 5 languages: English (76 percent), Spanish (14.5 percent), Arabic (5.6 percent), Portuguese (2.7 percent), and French (1.1 percent). The applications came from 6 regions: South America (25.8 percent), Africa (21.8 percent), Asia (21.5 percent), North America (15.7 percent), Europe (12.6 percent), and Oceania (2.5 percent). Ten Champions were identified based on their impact and potential to scale. To learn more about the Champions and the Campaign, go to World Bank Technology for Teaching Brief, HundrED Spotlight 2021: Teachers for a Changing World.

Four-Phase Selection Process

The Campaign's goal was to identify and share leading tech-based solutions that train and improve teaching practices so that teachers/PLs can thrive in their classrooms. The selection process had four phases (figure A.2).

The first phase, First Cut, narrowed the 435 innovations to 99 based on several first-cut exclusion factors and their relatability to the campaign's goals. In the second phase, Shortlist, each innovation provided additional materials that were thoroughly reviewed to evaluate their impact and scalability and reduced the number of innovations from 99 to 48. The third phase, Advisory Board, comprised external experts who provided additional comments and scores on each remaining innovation. Each innovation was viewed multiple times, narrowing the number from 48 to 28. In the final phase, Selection Committee, members from the World Bank and HundrED[12] collaborated to evaluate the remaining innovations and recommend 10 final contenders who had demonstrated excellence in their support, training, and improvement of teaching practices around the world.

Figure A.2 T4T's 4-Phase Selection Process

N = 435	**Phase 1: First Cut Inclusion Criteria**	Excluded if (1) did not mention TPD or tech; (2) information was missing that could not be retrieved; or (3) was too green.
N = 99	**Phase 2: Additional Questions**	T4T rubric applied: Composite score of the weighted indicators: implementation of tech, resources required, impact, and scalability.
N = 48	**Phase 3: Advisory Board**	Over 50 experts from 39 countries provided comments and scores for impact and scalability for 10-24 applicants each.
N = 28	**Phase 4: Selection Committee**	Ten experts from the World Bank and HundrED Task Teams reviewed each application to handpick the most impactful and scalable.

🏆 **10 T4T Champions**

---

11 Organized by the World Bank and HundrED, Spotlight is a focused collection of explorations of innovations in tech-based TPD.

12 HundrED.org is a global Finland-based not-for-profit organization that seeks and shares inspiring innovations in K-12 education. For more about the organization and their work, see https://hundred.org/en#c233c1c7.

1. First Cut Phase Inclusion Criteria

In the initial phase, Discovery, all 435 innovations went through the initial scan to confirm alignment with the campaign's selection criteria. Innovations were excluded if they did not (1) mention teacher or PL professional development, (2) have integrated technology, or (3) include any information in their applications, including title or contact. This information was obtained using the innovation page on the HundrED website. Based on the criteria, 144 innovations were retained. Those 144 innovations then underwent an additional review in this initial phase using their websites and documents provided. From this initial phase, of the 435 innovations submitted, 99 continued to the second round.

2. Shortlist Phase Inclusion Criteria

In phase 2, Shortlist, the applicants who had submitted the 99 innovations that were selected to move forward were contacted by the team to submit additional materials and information pertaining to their innovations. In this phase, applicants were asked 14 questions to clarify their innovations' impact, scalability, and their innovations' support for TPD. Applicants for only 85 of the 99 innovations provided responses. These responses were used to evaluate the innovations based on a weighted matrix that assessed the Spotlight's four major indicators: implementation of technology and of resources, impact, and scalability. Phase 2 culminated in 48 innovations being selected to move forward to the third phase. These innovations also were discussed in more detail with the internal team to decide which 48 of the 85 would move forward.

3. Advisory Board Phase Inclusion Criteria

In the third phase, Advisory Board, over 50 experts from 39 countries (see table B.1 for a list of members) were asked to participate in an evaluation series of the 48 applications. Each Advisory Board member reviewed between 10 and 24 innovations. The Advisory Board members scored each innovation on two dimensions: its impact and its scalability. Additionally, the members provided specific comments about each innovation that explained their evaluation and scores. The 48 shortlisted innovations were divided in 3 batches. The plots on the subfigures in figure A.3 represent a review of all the shortlisted innovations in this Spotlight. The composite score and the variance of each Advisory Board member's individual impact and scalability scores aided in finalizing the top 28 applications that would move to the final phase.

Figure A.3 Total of 865 Reviews Made by the Advisory Board

Batch 1	Batch 2	Batch 3
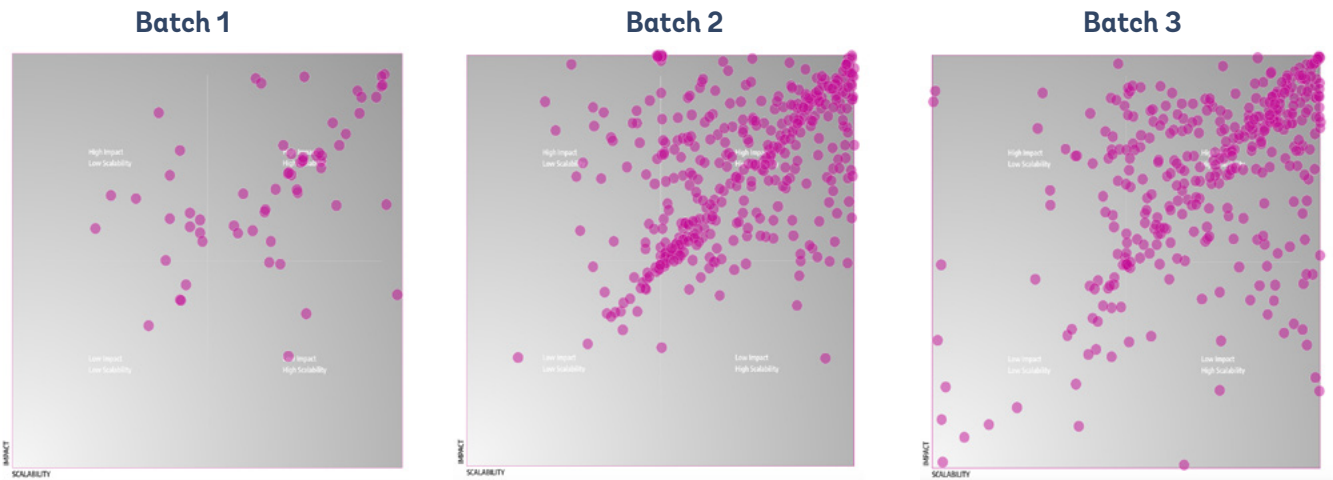
4. Selection Committee Inclusion Criteria

In the final phase, the Selection Committee team members (table B.2) from the World Bank and HundrED reviewed all 28 innovations and recommended the 10 innovations that they considered would be the most impactful and scalable when supporting TPD. In this fourth and final phase, each innovation was reviewed using its questionnaire responses, websites, and HundrED pages. As the final step, the internal team agreed the top 10 innovations.

Appendix B.

Table B.1 Advisory Board members

#	Name	Affiliation[a]
1	Alexander More	Sherborne Area Schools' Trust
2	Andrea Buffara	Escola Americana de Vitória; Gamut Education
3	Avis Beek	Wilfrid Laurier University
4	Betina Pizzuto	Unknown
5	Carlos Vargas	UNESCO
6	Lottie Dowling	Meg Languages
7	David Vidal	Aonia Educación
8	Dieu Nguyen	Wise Consulting
9	Dina Fajardo	Digital Education Futures Initiative, Entrepreneur Dexterity Club
10	Divine Kpe	Africa Education Watch
11	Esther Gacicio	World Bank Group
12	Fernando Oria	Mind The Gap
13	Francesc Balagué	Culinary Institute of Barcelona
14	Francisco Ruiz Pincetti	Fundación Forge
15	Gisela Flanigan	Sistema Global
16	Hannah Saks	International School of Lausanne
17	Hatice Kırmacı	Women Science Teachers
18	Helen Maffini	MindBE Education
19	Hicham Filali Zehri	Morocco Ministry of Education
20	Inaki Sanchez	World Bank Group
21	Isaac Patrick Biyaga Da Biyaga	Thenavigo
22	Jeff Holte	Liger Leadership Academy
23	Jinan Karameh Chaya	Entrepreneur Academy Lebanon
24	Jos Eussen	Maastricht University
25	Kevin Colleary	Graduate School of Education, Fordham University
26	Kristen Golomb	Propel Schools
27	Luciana Pölönen	Unknown
28	Marcela Arce	Center for Teacher Development
29	Maria Barron	World Bank Group
30	Mher Davtyan	University College London, Institute of Education
31	Nataliia Rzhevska	Pereiaslav-Khmelnytskyi Hryhorii Skovoroda State Pedagogical University
32	Nseobong Edem	Victorious International Schools, Okpok-Ikpa Okoyong
33	Panagiota Argyri	National Kapodistrian University of Athens
34	Paul Neira Del Ben	The Learning Factor
35	Peter Wallet	UNESCO (International Task Force on Teachers for Education 2030)
36	Quique Vergara Gasulla	Escola Virolai
37	Raquel Fernandez Jimenez	Fundació Tr@ms and Sant Gervasi School
38	Rebecca Gitomer	CareerVillage.org
39	Keith Gordon	Foundation for Global Children
40	Rijendra Thapa	Unknown
41	Roch Turner	Hamilton School District/University of Montana
42	Sagar Tandon	Indonesia Women Empowerment Fund
43	Sampo Forsström	University of Eastern Finland
44	Shien Zutshi	Unknown
45	Sabine Prechter	Friedrich-Alexander-University
46	Sonia Guerriero	UNESCO
47	Stephen Whitaker	Humanitree School
48	Tara Fagan	Museum of New Zealand Te Papa Tongarewa
49	Valerie Djioze-Gallet	UNESCO
50	Vanessa Wilkins	Future School Lab
51	Vince Siu	Press Start Academy

Note: a. The affiliations of Advisory Board members are provided by the member at the time of registration to participate. Some members chose to anonymize their affiliation, which are marked "Unknown."

Table B.2 Selection Committee Members

#	Name	Affiliation
1	Danny Gilliland	HundrED
2	Clara Garcia Millan	HundrED
3	Rakhi Nair	HundrED
4	Christopher Petrie	HundrED
5	Emma Cameron	World Bank Group
6	Cristóbal Cobo	World Bank Group
7	Robert Hawkins	World Bank Group
8	Aishwarya Patil	World Bank Group
9	Manal Quota	World Bank Group
10	Michael Trucano	World Bank Group
11	Tracy Wilichowski	World Bank Group

References

Abrami, Philip C., C. Anne Wade, Larysa Lysenko, Jonathon Marsh, and Anthony Gioko. 2016. "Using Educational Technology to Develop Early Literacy Skills in Sub-Saharan Africa." *Education and Information Technologies* 21 (4): 945-64. https://eric.ed.gov/?id=EJ1100503.

Agyei, Douglas Darko. 2020. "Integrating ICT into schools in Sub-Saharan Africa: from teachers' capacity building to classroom implementation." *Education and Information Technologies* 26, no. 1 (2021): 125-144. http://dx.doi.org/10.1007/s10639-020-10253-w

Azevedo, Joao P., Amer Hasan, Koen Goenko, Diana Goldemberg, and Aroob S Iqbal. 2020. "Learning Losses Due to COVID19 Could Add up to $10 Trillion." World Bank blogs. World Bank, Washington, DC. September 10. https://www.brookings.edu/blog/future-development/2020/07/30/learning-losses-due-to-covid-19-could-add-up-to-10-trillion/.

Barrera-Osorio, Felipe, and Leigh L. Linden. 2009. "The Use and Misuse of Computers in Education: Evidence from a Randomized Experiment in Colombia." World Bank Policy Research Working Paper 4836. World Bank, Washington, DC. https://dash.harvard.edu/handle/1/8140109.

Barron, Maria, Cristóbal Cobo, Iñaki Sanchez Ciarrusta, and Alberto Munoz-Najar. 2017. "What Is Hybrid Learning? How Can Countries Get It Right?" World Bank Blogs. World Bank, Washington, DC. April 27. https://blogs.worldbank.org/education/what-hybrid-learning-how-can-countries-get-it-right.

Beg, Sabrin A., Adrienne M. Lucas, Waqas Halim, and Umar Saif. 2019. "Beyond the Basics: Improving Post-Primary Content Delivery through Classroom Technology." NBER (National Bureau of Economic Research), Washington, DC. https://learningportal.iiep.unesco.org/en/library/beyond-the-basics-improving-post-primary-content-delivery-through-classroom-technology.

Berlinski, Samuel, and Matias Busso. 2015. "Challenges in Educational Reform: An Experiment on Active Learning in Mathematics." *Economics Letters* 156: 172-75. https://publications.iadb.org/en/challenges-educational-reform-experiment-active-learning-mathematics.

Beteille, Tara, and David K. Evans. 2019. "Successful Teachers, Successful Students: Recruiting and Supporting Society's Most Crucial Profession." World Bank Group, Washington, DC. https://documents1.worldbank.org/curated/en/235831548858735497/Successful-Teachers-Successful-Students-Recruiting-and-Supporting-Society-s-Most-Crucial-Profession.pdf.

Bett, Harry, and Lazarus Makewa. 2020. "Can Facebook Groups Enhance Continuing Professional Development of Teachers? Lessons from Kenya." Asia-Pacific Journal of Teacher Education 48 (2): 132-46. https://www.tandfonline.com/doi/abs/10.1080/1359866X.2018.1542662#:~:text=Besides%20being%20traditional%20in%20approach,to%20enhance%20teachers'%20professional%20development.

Bianchi, Nicola, Yi Lu, and Hong Song. 2020. "The Effect of Computer-Assisted Learning on Students' Long-Term Development" NBER (National Bureau of Economic Research), Washington, DC. https://www.nber.org/papers/w28180.

Blimpo, Moussa P., Ousman Gajigo, Solomon Owusu, Ryoko Tomita, and Yanbin Xu. 2020. "Technology in the Classroom and Learning in Secondary Schools." Policy Research Working Paper 9288. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/33983 License: CC BY 3.0 IGO.

Bold, Tessa, Deon Filmer, Gayle Martin, Ezequiel Molina, Christophe Rockmore, Brian Stacy, Jakob Svensson, and Waly Wane. 2017. "What Do Teachers Know and Do? Does It Matter? Evidence from Primary Schools in Africa." Policy Research Working Paper 7956. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/25964 License: CC BY 3.0 IGO.

Brinkmann, Suzana. 2016. "The Role of Teachers' Beliefs in the Implementation of Learner-Centred Education in India." PhD diss., UCL (University College London), London. https://discovery.ucl.ac.uk/id/eprint/1532842/.

Bruns, Barbara, Leandro Costa, and Nina Cunha. 2017. "Through the Looking Glass: Can Classroom Observation and Coaching Improve Teacher Performance in Brazil?" Policy Research Working Paper 8156. World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/27962 License: CC BY 3.0 IGO.

Cansoy, Ramazan. 2017. "Teachers' Professional Development: The Case of WhatsApp." Journal of Education and Learning 6 (4): 285-93. https://files.eric.ed.gov/fulltext/EJ1151679.pdf.

Carrillo, Paul E., Mercedes Onofa, and Juan Ponce. 2010. "Information Technology and Student Achievement: Evidence from a Randomized Experiment in Ecuador." IADB (Inter-American Development Bank), Washington, DC. https://publications.iadb.org/en/publication/10627/information-technology-and-student-achievement-evidence-randomized-experiment.

Cardim, Joana, Teresa Molina-Millán, and Pedro Vicente. 2021. "Can Technology Improve the Classroom Experience inPrimary Education? An African Experiment on a Worldwide Program." No. wp2101. Universidade Nova de Lisboa, Nova School of Business and Economics, NOVAFRICA. https://econpapers.repec.org/scripts/redir.pf?u=https%3A%2F%2Fnovafrica.org%2Fwp-content%2Fuploads%2F2021%2F01%2F2101.pdf;h=repec:unl:novafr:wp2101

Cilliers, Jacobus, Brahm Fleisch, Janeli Kotze, Nompumelelo Mohohlwane, Stephen Taylor, and Tshegofatso Thulare. 2021. "Can Virtual Replace In-Person Coaching? Experimental Evidence on Teacher Professional Development and Student Learning." RISE Working Paper Series 20/050. https://doi.org/10.35489/BSG-RISE-WP_2020/050.

Cobo, Cristóbal, and Iñaki Sanchez Ciarrusta. 2020. "Successful Examples of Scaling up Teaching and Learning in Response to COVID-19." World Bank Blogs (blog). World Bank, Washington, DC. April 22. https://blogs.worldbank.org/education/successful-examples-scaling-teaching-and-learning-response-covid-19.

Cobo, Cristobal, Manal Quota, Jayanti Bhatia, and Aishwarya Patil. 2022. "Technology for Teacher Professional Development Navigation Guide: A Summary of Methods." World Bank, Washington, DC. License: Creative Commons Attribution CC BY 4.0 IGO. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099600105272224265/p1742520dc51460ee0932c06175edf971ac

Darling-Hammond, Linda, Maria E. Hyler, and Madelyn Gardner. 2017. "Effective Teacher Professional Development." LPI (Learning Policy Institute). https://learningpolicyinstitute.org/product/effective-teacher-professional-development-report.

De Carvalho, Antunes, and Frederico Jose. 2022. "Learning Management Systems for Education: Knowledge Pack (English)." Washington DC: World Bank Group. http://documents.worldbank.org/curated/en/099117504132225905/P17425200744b2006097cd0363083f114b9.

De Hoop, Thomas, Hannah Ring, Garima Siwach, Paula Dias, Gelson Tembo, Victoria Rothbard, and Anaïs Toungui. 2020. "Impact of e-Learning Technology and Activity-Based Learning on Learning Outcomes: Experimental Evidence from Community Schools in Rural Zambia." Semantic Scholar. https://www.semanticscholar.org/paper/Impact-of-e-Learning-Technology-and-Activity-Based-Hoop-Ring/52f85acb57921619b72c3cfdebdab713a99ede58.

Desimone, Laura M. 2009. "Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures." Educational Researcher 38 (3): 181-99. https://journals.sagepub.com/doi/10.3102/0013189X08331140.

Escueta, Maya, Vincent Quan, Andre Joshua Nickow, and Philip Oreopoulos. 2017. "Education Technology: An Evidence-Based Review." NBER (National Bureau of Economic Research), Washington, DC. https://www.nber.org/papers/w23744.

Fandiño Parra, Yamith. 2012. "The Impact of ICT Training through Wikis on In-Service EFL Teachers: Changes in Beliefs, Attitudes, and Competencies." HOW Journal 19: 11-32. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2296142.

Freeman, Barbara, and Juliana Raigosa Montoya. 2022. "Teachers' Skills and Skills Frameworks for Remote and Blended Learning Knowledge Pack (English)." Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/099118004132238882/P1742520615db3006094220dcbb0af52257.

Gutierrez Bernal, Marcela, Mariama Wurie, and Mari Shojo. 2021. "Sierra Leone's Radio Teaching Programme: Challenges and Opportunities." World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/36453 License: CC BY 3.0 IGO.

Hanushek, Eric A. 2011. "Valuing Teachers: How Much Is a Good Teacher Worth?" Education Next 11 (3): 40-45. http://hanushek.stanford.edu/publications/valuing-teachers-how-much-good-teacher-worth.

Hartman, Joel L. 2008. "Moving Teaching and Learning with Technology from Adoption to Transformation." Educause Review 43 (6): 24-25. http://www.bu.edu/tech/files/2013/05/Moving-Teaching-from-Adoption-to-Transformation.pdf.

Hawkins, Robert J., Michael Trucano, Juan Cristóbal Cobo Romani, Alex Twinomugisha, Ciarrusta Sanchez, and Inaki Alejandro. 2021. "Reimagining Human Connections: Technology and Innovation in Education at the World Bank (English)." World Bank Group, Washington, DC. http://documents.worldbank.org/curated/en/829491606860379513/Reimagining-Human-Connections-Technology-and-Innovation-in-Education-at-the-World-Bank.

Hennessy, Sara, Bjoern Haßler, and Riikka Hofmann. 2016. "Pedagogic Change by Zambian Primary School Teachers Participating in the OER4Schools Professional Development Programme for One Year." Research Papers in Education 31(4): 399-427. https://www.tandfonline.com/doi/abs/10.1080/02671522.2015.1073343?journalCode=rred20.

IBE (International Bureau of Education). 2021. "Hybrid Education, Learning, and Assessment (HELA)." IBE-UNESCO (International Bureau of Education-UNESCO), Geneva. http://www.ibe.unesco.org/en/news/hybrid-education-learning-and-assessment-hela.

Johnston, Jamie, and Christopher Ksoll. 2017. "Effectiveness of Interactive Satellite-Transmitted Instruction: Experimental Evidence from Ghanaian Primary Schools. CEPA Working Paper No. 17-08." Stanford Center for Education Policy Analysis. https://cepa.stanford.edu/content/effectiveness-interactive-satellite-transmitted-instruction-experimental-evidence-ghanaian-primary-schools

Jukes, Matthew C.H., Elizabeth L. Turner, Margaret M. Dubeck, Katherine E. Halliday, Hellen N. Inyega, Sharon Wolf, Stephanie Simmons Zuilkowski, and Simon J. Brooker. 2017. "Improving Literacy Instruction in Kenya through Teacher Professional Development and Text Messages Support: A Cluster Randomized Trial." Journal of Research on Educational Effectiveness 10 (3): 449-81. https://www.researchgate.net/publication/306069139_Improving_Literacy_Instruction_in_Kenya_Through_Teacher_Professional_Development_and_Text_Messages_Support_A_Cluster_Randomized_Trial.

Kabilan, Muhammad Kamarul. 2016. "Using Facebook as an e-Portfolio in Enhancing Pre-Service

Teachers' Professional Development." *Australasian Journal of Educational Technology* 32 (1). https://doi.org/10.14742/ajet.2052.

Kafyulilo, Ayoub, Petra Fisser, and Joke Voogt. 2016. "Teacher Design in Teams as a Professional Development Arrangement for Developing Technology Integration Knowledge and Skills of Science Teachers in Tanzania." Education and Information Technologies 21 (2): 301-18. https://eric.ed.gov/?redir=http%3a%2f%2fdx.doi.org%2f10.1007%2fs10639-014-9321-0.

Karlan, Dean, Melanie Morten, and Jonathan Zinman. 2012. "A Personal Touch: Text Messaging for Loan Repayment w17952." NBER (National Bureau of Economic Research), Washington, DC. https://www.nber.org/papers/w17952.

Kwakman, Kitty. 2003. "Factors Affecting Teachers' Participation in Professional Learning Activities." Teaching and Teacher Education 19 (2): 149-70. https://doi.org/10.1016/S0742-051X(02)00101-4.

Lautz-Cauzanet, Eilean von, and Eric Bruillard. 2021. "From Connection to Community: A Medium-Term Contribution of a Mobile Teacher Training in Madagascar–The Genesis of a Social Network." In Fifth Networks in the Global World Conference, 285-305. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-030-64877-0_19.

Lehrer, Kim, Monica Mawoyo, and Samba Mbaye. 2019. "The Impacts of Interactive Smartboards on Learning Achievement in Senegalese Primary Schools." 3ie (International Initiative for Impact Evaluation), New Delhi. http://www.3ieimpact.org/sites/default/files/2019-01/GFR-PW2.14-NEPAD-Senegal-e-school.pdf.

Mendenhall, Mary, Makala Skinner, Sophia Collas, and Sarah French. 2018. "Expanding Teacher Support through Mobile Mentoring in Kakuma Refugee Camp: Benefits and Challenges." https://www.tc.columbia.edu/cice/pdf/02_M.-Mendenhall-Special-Issue-2018.pdf.

MoEYS (Ministry of Education, Youth and Sports) Cambodia, UNICEF, and Save the Children. 2021. "Cambodia COVID-19 Joint Education Needs Assessment." March. https://www.unicef.org/cambodia/media/4296/file/Cambodia%20COVID-19%20Joint%20Education%20Needs%20Assessment.pdf.

Mogos, Ariam. 2022. "Digital Teaching and Learning Knowledge Pack (English). Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/099120304132286876/P17425202703c80400872f014bab55254c3.

Morten, Melanie, Dean S. Karlan, and Jonathan Zinman. 2012. "A Personal Touch: Text Messaging for Loan Repayment," Center Discussion Papers 121867. Yale University, Economic Growth Center. 10.22004/ag.econ.121867. https://ideas.repec.org/p/ags/yaleeg/121867.html.

Motteram, Gary, Susan Dawson, and Nazmi Al-Masri. 2020. "WhatsApp-Supported Language Teacher Development: A Case Study in the Zataari Refugee Camp." *Education and Information Technologies* 25 (6): 5731-51. https://pubmed.ncbi.nlm.nih.gov/32837232/

Munby, Hugh. 1984. "A Qualitative Approach to the Study of a Teacher's Beliefs." *Journal of Research in Science Teaching* 21 (1): 27-38. https://doi.org/10.1002/tea.3660210104.

Munoz-Najar, Alberto, Alison Grace Gilberto Sanzana, Amer Hasan, Juan Cristóbal Cobo Romani, Joao Pedro Wagner De Azevedo, and Maryam Akmal. 2022. "Remote Learning during COVID-19: Lessons from Today, Principles for Tomorrow (English)." World Bank Group, Washington, DC. http://documents.worldbank.org/curated/en/160271637074230077/Remote-Learning-During-COVID-19-Lessons-from-Today-Principles-for-Tomorrow.

Naik, Gopal, Chetan Chitre, Manaswini Bhalla, and Jothsna Rajan. 2020. "Impact of Use of

Technology on Student Learning Outcomes: Evidence from a Large-Scale Experiment in India." World Development 127. https://doi.org/10.1016/j.worlddev.2019.104736.

Näslund-Hadley, Emma, Armando Loera Varela, and Katelyn Ann Hepworth. 2014. "What Goes on inside Latin American Math and Science Classrooms: A Video Study of Teaching Practices." Global Education Review 1 (3): 110-28. https://files.eric.ed.gov/fulltext/EJ1055189.pdf.

Nedungadi, Prema, Karunya Mulki, and Raghu Raman. 2018. "Improving Educational Outcomes and Reducing Absenteeism at Remote Villages with Mobile Technology and WhatsApp: Findings from Rural India." Education and Information Technologies 23 (1): 113-27. https://eric.ed.gov/?id=EJ1166549

Oakley, Grace, Gemma Scarparolo, and Ronnel King. 2018. "An Evaluation of ELLN Digital: Technology-Supported Teacher Professional Development on Early Language, Literacy, and Numeracy for K-3 Teachers." Foundation for Information Technology Education and Development. Quezon City, Philippines. http://dl4d.org/portfolio-items/elln-digital/.

Piper, Benjamin, and Dunston Kwayumba. 2014. "The Primary Math and Reading Initiative (PRIMR). Kisumu Information and Communication Technology (ICT) Intervention Endline Report." Research Triangle Institute (RTI), Research Triangle Park, NC. https://www.eddataglobal.org/countries/index.cfm?fuseaction=pubDetail&ID=664.

Piper, Benjamin, Evelyn Jepkemei, Dunston Kwayumba, and Kennedy Kibukho. 2015. "Kenya's ICT Policy in Practice: The Effectiveness of Tablets and E-Readers in Improving Student Outcomes." In FIRE (Forum for International Research in Education) 2 (1): 3-18. Lehigh University Library and Technology Services, Bethlehem, PA. https://www.researchgate.net/publication/329206518_Kenya's_ICT_Policy_in_Practice_The_Effectiveness_of_Tablets_and_E-readers_in_Improving_Student_Outcomes.

Piper, Benjamin, Joseph Destefano, Esther M. Kinyanjui, and Salome Ong'ele. 2018. "Scaling up Successfully: Lessons from Kenya's Tusome National Literacy Program." Journal of Educational Change 19 (3): 293-321. https://doi.org/10.1007/s10833-018-9325-4.

Popova, Anna, David K. Evans, Mary E. Breeding, and Violeta Arancibia. 2018. "Teacher Professional Development around the World: The Gap between Evidence and Practice." Policy Research Working Paper 8572. World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/30324 License: CC BY 3.0 IGO.

Pouezevara, Sarah Lucas, and Rubina Khan. 2007. "Learning Communities Enabled by Mobile Technology: A Case Study of School-Based, In-Service Secondary Teacher Training in Rural Bangladesh." Technical Assistance Final Report. Appendix 11 of the Final Report. In "Innovative Information and Communication Technology in Education and Its Potential for Reducing Poverty in the Asia and Pacific Region." Prepared by RTI International for ADB (Asian Development Bank), Metro Manila, Philippines. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.517.132&rep=rep1&type=pdf.

Pouezevara, Sarah Lucas, and B. Parajuli. 2007. 6. "Using Video Technology for Primary School Teacher Training in Rural Nepal." In "ICT and Teacher Education: A Collection of Case Studies from the Asia-Pacific Region," 62-73. UNESCO Bangkok. http://www.unescobkk.org/fileadmin/user_upload/ict/e-books/Teacher_Education_Case_Studies/Using_Video_Technology_for_Primary_School_Teacher_Training_in_Rural_Nepal.pdf.

Quota, Manal, and Jayanti Bhatia. 2022. "Motivating Changes in Teaching Practices: Technical Guidance Note." World Bank Blogs (blog). World Bank, Washington, DC. March 17. https://blogs.worldbank.org/education/designing-tpd-programs-overcome-motivational-barriers-10-strategies-0

Sabarwal, Shwetlena, Kanishka Kacker, and James Habyarimana. 2018. "Better Than Most: Teacher Beliefs about Effort and Ability in Uganda." Policy Research Working Paper 8440. World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/29846 License: CC BY 3.0 IGO.

School-to-School International. 2017. "GraphoGame Teacher Training Service: Evaluation Report." Agora Center, University of Jyväskylä, Finland. https://allchildrenreading.org/wp-content/uploads/2019/07/Agora-Center-Project-Evaluation.pdf.

Shaheen, Robina, Christopher Walsh, Tom Power, and Sonia Burton. 2013. "Assessing the Impact of Large-Scale Teacher Professional Development (TPD) in Bangladesh: English in Action (EIA)." In American Educational Research Association: 27 Apr-01 May. http://oro.open.ac.uk/38404/.

Slade, Timothy S., Scott Kipp, Stirling Cummings, and Kondwani Nyirongo. 2018. "Short Message Service (SMS)-Based Remote Support and Teacher Retention of Training Gains in Malawi," 131-68. In "Cultivating Dynamic Educators: Case Studies in Teacher Behavior Change in Africa and Asia," edited by Sarah Remington Pouezevara. RTI Press Book No. BK-0022-1809. RTI Press, Research Triangle Park, NC. https://doi.org/10.3768/rtipress.2018.bk.0022.1809.

Smylie, Mark A. 1988. "The Enhancement Function of Staff Development: Organizational and Psychological Antecedents to Individual Teacher Change." American Educational Research Journal 25 (1): 1-30. https://doi.org/10.3102/00028312025001001.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2021. "Open Educational Resources (OER)." Last accessed: Jan 13, 2021. https://www.unesco.org/en/communication-information/open-solutions/open-educational-resources

UNESCO (United Nations Education, Scientific, and Cultural Organization), UNICEF (United Nations Children's Fund), and the World Bank. 2020. "What Have We Learnt? Overview of Findings from a Survey of Ministries of Education on National Responses to COVID-19." UNESCO, UNICEF, and World Bank, Paris, New York, and Washington, DC. https://openknowledge.worldbank.org/handle/10986/34700 License: CC BY-SA 3.0 IGO.

Velázquez, Franzoni, Ana Lidia, María Cristina Cardenas Peralta, and José Ángel Mandujano Canto. 2020. "Lessons from the Training and Support of Teachers in the Development of Digital Skills: A Case Study of@prende 2.0." Digital Education Review 37: 154-71. https://files.eric.ed.gov/fulltext/EJ1301761.pdf.

Wennersten, Matthew, Zubeeda Banu Quraishy, and Malathi Velamuri. 2015. "Improving Student Learning via Mobile Phone Video Content: Evidence from the BridgeIT India Project." International Review of Education 61 (4): 503-28. https://eric.ed.gov/?redir=http%3a%2f%2fdx.doi.org%2f10.1007%2fs11159-015-9504-y.

Wilichowski, Tracy, and Gabrielle Arenge. 2021. "Facilitating Effective 1-1 Support: Technical Guidance Note." Coach Series, World Bank, Washington, DC. License: Creative Commons Attribution CC BY 4.0 IGO. http://documents.worldbank.org/curated/en/589311630358726963/Technical-Guidance-Note.

Wolfenden, Freda, Simon Cross, and Fiona Henry. 2017. "MOOC Adaptation and Translation to Improve Equity in Participation." Journal of Learning for Development 4 (2): 127-42. http://jl4d.org/index.php/ejl4d/article/view/209.

World Bank. 2015. World Development Report 2015: Mind, Society, and Behavior. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0342-0. License: Creative Commons Attribution CC BY 3.0 IGO. https://www.worldbank.org/content/dam/Worldbank/Publications/WDR/WDR%202015/WDR-2015-Full-Report.pdf

World Bank. 2020. "Remote Learning, Distance Education and Online Learning during the COVID19 Pandemic: A Resource List by the World Bank's EdTech Team." Last updated: April 10, 2020. https://documents1.worldbank.org/curated/en/964121585254860581/pdf/Remote-Learning-Distance-Education-and-Online-Learning-During-the-COVID19-Pandemic-A-Resource-List-by-the-World-Banks-Edtech-Team.pdf

World Bank. 2021a. "What Is Learning Poverty?" Updated: April 28, 2021. https://www.worldbank.org/en/topic/education/brief/what-is-learning-poverty

World Bank. 2021b. "World Bank: Pandemic Threatens to Drive Unprecedented Number of Children into Learning Poverty." https://www.worldbank.org/en/news/press-release/2021/10/29/world-bank-pandemic-threatens-to-drive-unprecedented-number-of-children-into-learning-poverty.

World Bank. 2021c. "Policy Actions for School Reopening and Learning Recovery." Last modified: May 5, 2021. https://www.worldbank.org/en/news/factsheet/2021/04/30/notes-on-school-reopening-and-learning-recovery

World Bank. 2021d. "Coach: Program Overview Document." Sept. https://thedocs.worldbank.org/en/doc/b455af6f955a971fd29157524f9d190a-0140052021/related/Coach-Program-Overview-Document.pdf

Links of interest