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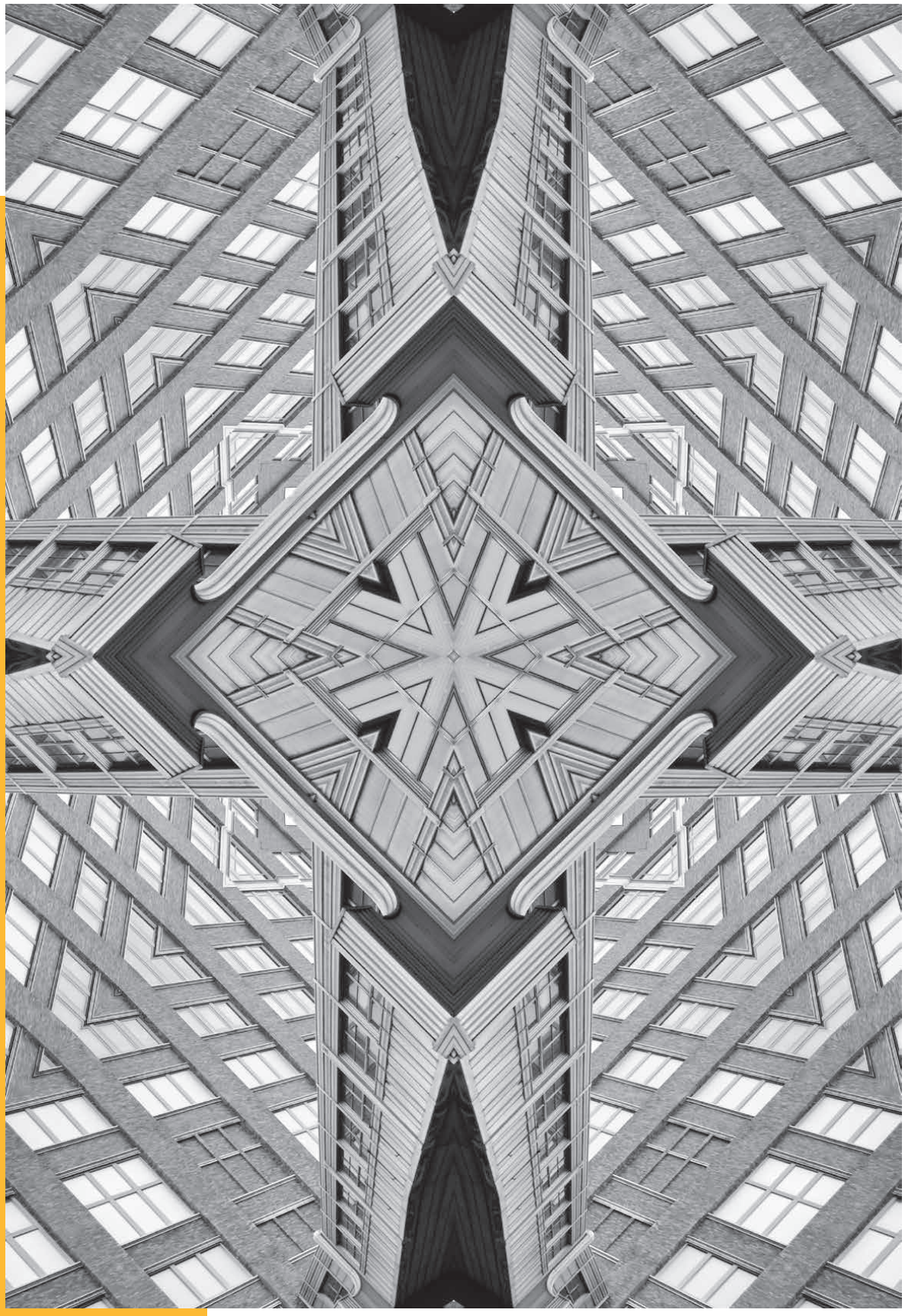

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Embedding Technology in Education: The Potential of India's Solutions in East Africa

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Abstract

India and the countries of Africa share common challenges in their education systems, among them, weak teacher capacities and lack of basic infrastructure. In India, technological interventions have been able to address some of the challenges at scale. Africa has met with less success in this regard, as governments prioritise the provision of hardware without addressing the systemic issues that hamper the adoption of such technologies. Current research on diffusion of technology for development focuses on creating an enabling environment for the private sector, and in particular, startups. This brief argues that in education, technology transfer should not just comprise the private sector but also the broader ecosystem (comprising of civil society organisations and education researchers) to enable the adoption of technology in a sustainable manner.

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Introduction

In the last few decades, developing countries like India and those in Africa have made strides in improving access to education, resulting in increased enrolment of many first-generation learners. However, a significant proportion of these enrolees, lacking in instructional support, eventually fall behind curriculum.[1] This, along with teacher shortages[a] and poor teaching quality, ultimately leads to low learning levels;[2] indeed, within the same grades, experts find a notable degree of heterogeneity in learning levels.[3] Current patterns of education spending and methods of instruction in these countries are unable to bridge the gap between student learning levels, and the levels of curriculum, instruction and pedagogy.[4] This paper analyses persistent challenges in education in India and East Africa, and the role that technology can play in bridging the gaps in learning and teaching at scale.

In particular, technology-aided instruction is showing potential. In India, for example, Mindspark by Educational Initiatives, currently used by 350,000 learners in government schools across India, displayed 200-250 percent gains in learning outcomes in students in a randomised control trial.[5] Such a promise, coupled with rapid digital adoption across the country, has led to the emergence of a vibrant EdTech sector (Education Technology, or ET)[b] that ranks third in

a Kenya's Teacher's Service Commission (TSC) estimates an overall shortage of 96, 345 teachers — 38,054 at the primary level and 58,291 at the post primary school level. This was also highlighted in Uwezo Kenya's 2016 assessment. TSC estimates that by 2023, shortages are expected to increase to 84,478 for secondary schools and 34,941 for primary schools. Source: National Education Strategic Sector Plan 2018-2022, Ministry of Education, Republic of Kenya. https://www.education.go.ke/images/NESSP/NESSP-2018-2022.pdf

Similarly, according to the 2019 educations statistics of Tanzania, the country had a Pupil to Teacher Ratio (PTR) of 58:1 and a pupil–qualified teacher ratio (PTQR of 59:1) in government primary schools (which make up 96 percent of total primary schools) and a PTR of 54:1 and PTQR of 55:1 in all primary schools. This is below the recommended level of 45:1. Source: https://www.tamisemi.go.tz/storage/app/media/uploaded-files/13-summaryprimaryschoolsptr-2019.pdf and Uwezo (2019): Are Our Children Learning? Uwezo Tanzania Learning Assessment Report, 2019, Dar es Salaam, Twaweza East Africa, https://www.twaweza.org/uploads/files/Tanzania%20Report%20FINAL3%202019%2013-12-2019%20Print%20Ready+zm.pdf

b EdTech or Education Technology refers to the practice of using modern technology tools to implement innovative educational approaches for student learning and classroom teaching – with the aim of improving inclusion or providing engaging or individualised learning experiences. EdTech can be implemented at various levels of education and could take different forms, including:

- Tele-education to deliver lessons for students in remote areas. This could involve the use of projectors in classrooms that have pre-loaded content or could be linked to satellite systems for relaying live classes.
- The use of computers and tablets in schools to augment classroom learning and teaching. Interactive and gamified content are used to improve student retention levels and enthusiasm.
- Online courses offered by universities across the world that are available for anyone across the globe to enroll. They often cater to the tertiary sector providing professionals or young graduates a flexible way of building new skills and advance careers. They can be accessed through web or mobile applications.

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the world, after the US and China, in terms of overall funding. The sector is home to some 4,450 ET startups as of 2020.[6]

In East Africa — a region which faces similar challenges in education systems — technology efforts have not had the desired effects on learning outcomes and teaching quality at scale. Domestic EdTech innovators have found it difficult to build effective products due to infrastructural barriers and lack of government support.[7] ET and technology-aided learning efforts by governments (through donor support and development partners) have been primarily viewed through the prism of providing hardware, without addressing the wide range of obstacles that impede the effective adoption of technology in education. These issues include providing contextualised and interactive digital content, developing teacher capacities, transforming teacher attitudes,[8] ensuring community buy-in,[9] and making technical support available at all times.[10]

This paper evaluates three technology-aided interventions that have shown some degree of success in certain parts of India: a) Hybrid Learning Programme by Pratham; b) Mindspark and Large Scale Education Programmes by Education Initiatives; and c) MDML (Multi- dimensional- multi- level) approach by Tide Learning. The paper finds that the success these tools have met so far in improving learning outcomes and enhancing teaching quality is driven not only by technological innovation. Rather, it is an outcome of interventions led by education researchers and civil society through extensive research and experimentation over several years. They have evolved from a larger 'ecosystem' that has allowed for close engagement between a vibrant civil society, education researchers, and technology innovators. This paper argues that these interventions, solving similar challenges, using varying degrees of technology could find relevance in East Africa.[c] After all, developing human capital through education and capacity building has been at the heart of India's development cooperation with Africa. India could expand it to the realms of primary and secondary education.[11]

c The paper focuses on three countries: Kenya, Rwanda, and Tanzania. Henceforth, when the paper refers to 'East Africa', it means these three.

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The paper does not look at the subject through the trade lens of market access and barriers for Indian education initiatives, but seeks to understand how the state of education, and in particular student learning levels, can be improved in East Africa through Indian technology-aided interventions. The paper is based on extensive research of secondary literature and government documents, augmented by interviews with stakeholders in East Africa and India. The paper highlights Kenya, Rwanda and Tanzania as they have a nascent K-12 ET sector and are better positioned in a continent whose markets are far from mature for ET products.[12] Through policies and programmes[13] in place and provision of infrastructure in public schools,[14] the focus countries have displayed the political will to integrate ET into education. They continue to invest in internet connectivity and rank in the top half amongst countries in Africa.[15]

Like in most developing economies, student enrolment rates in East Africa are increasing but learning levels remain inadequate. A considerable percentage of students in each of the three countries are unable to read basic texts or solve basic numeracy problems as determined by national curricula.[16] Furthermore, children from rural and poor households, and those who attend public schools[d] display far lower learning outcomes.[17] Shortage of teachers (especially in secondary school level) further exacerbates the challenges, as do low teacher capacities and poor teaching quality.

To be sure, East Africa has embraced ET, through both private sector innovation and government initiatives supported by donors. ET in the region, however, faces various hurdles and has yet to deliver on its promise at scale.

Infrastructural barriers

Both individual and household uptake of EdTech has been low for various reasons: a) unreliability and lack of availability of electricity supply and internet connectivity; b) lack of access to devices; and c) high costs of mobile and internet data.[18] (See Table 1) Majority of those accessing the internet use their mobile phones, with 2G being the dominant technology. The three countries rank in the bottom 16 percent, globally, in terms of affordability of internet data. Furthermore, households lack access to digital devices—a pattern that was revealed by the schooling-from-home measures instituted as a response to the COVID-19 pandemic. In Kenya, for example, only 20 percent of students are able to access their online school.[19]

> “Enrolment rates in East Africa are increasing but learning levels remain inadequate.”

Owing to such infrastructural barriers, ET with higher-tech features (interactive digital content) has witnessed minimal adoption. Indeed, the two most widely used EdTech products in the region are a TV show and an SMS-based learning app.

d They comprise majority of the population in these three countries.

Table 1

Population with access to electricity and internet, dominant mobile internet bandwidth, and cost of internet data

Country	% of population with access to electricity	Individuals using internet (% of population)	Dominant technology	Mobile–data-voice basket price as a percentage of Gross National Income Per Capita
Kenya	75	23	2G/EDGE	7.5
Rwanda	34.7	22	2G/EDGE	19.9
Tanzania	35.6	16	2G/EDGE	13.8

Source: Author's own, using various open sources.

Bureaucratic Red Tape

Government buy-in is crucial for scaling and creating significant impact in the region.[20] Governments are the largest providers of education in the region, with majority of students enrolling in public education systems (See Table 2). Moreover, they also have the means[e] to provide ICT infrastructure in schools, which most individual households cannot afford. However, bureaucratic red tape and conflicts of interest prevent ET innovators from catering to public schools. In Kenya, for example, ET innovators — who are generally considered third parties — have had to wait an average two years to get their content approved by the Kenya Institute of Curriculum Development (KICD).[f] This acted as a

e Governmental means include budgets, as well as assistance from donors and development partners. The ICT infrastructure referred to here include devices, electricity, and internet connectivity.

f KICD "evaluates vets and approves the curricular and curriculum support materials for basic and tertiary education, as well as offering curriculum based consultancy services in basic and tertiary education and training." For more, visit: https://kicd.ac.ke/about-us/background-history/

huge barrier for private sector participation in EdTech. The process has been refined in recent years, and today it takes about four months to quality-assure third-party content.[21] The related challenge is that KICD produces content in collaboration with its own partners who are given contracts for installing content in devices of public schools. This leads to a conflict of interest with ET innovators for whom the biggest market is public schools.[22]

Table 2

Percentage of primary and secondary schools owned or aided by government in East Africa

Country	% of primary schools owned or aided by government	% of secondary schools owned or aided by government
Kenya	64	84.5
Rwanda	83.4	82
Tanzania	96	86.5

Source: Author's own, using various open sources.

ET innovators need government permissions to offer services and products to public schools. Governments often seek evidence on the efficacy of ET products to provide permissions. To generate evidence, ET innovators need access to classrooms and schools to pilot and test their products which, again, need government connections and support. This creates a "vicious cycle for ET entrepreneurs to scale and show results on the efficacy of their products. Development partners like the World Bank or UNICEF are not going to invest in someone who doesn't have proven results."[23]

While private ET innovators have yet to achieve scale, governments in East Africa have embarked on various ET initiatives through the support of development partners and donors.[24] These projects have provided infrastructure and hardware to enable public schools to adopt ET.

Governments in East Africa consider the procurement and provision of hardware as the Holy Grail and view the adoption of EdTech through an approach that prioritises hardware[25] over other elements.[26] This approach—coupled with expectations of quick results—has proven unsustainable, stifling the promise of ET in improving systemic challenges in education.

Indeed, hardware and technology provision is only part of a longer chain of equally important challenges:[27]

a) the **provision of interactive and contextualised digital content** that is compatible with local infrastructure capabilities

b) **implementation talent**: in which teacher training and capacity building is the most important, followed by availability of technical support

c) **engaging ET ecosystem and local communities** for design thinking and adoption, respectively, and transforming teachers' attitudes. These aspects play a crucial role in the success and sustainability of the adoption ET products and hitherto have been neglected by governments.

Digital Content and Platform Design

Digital content developed by education and curriculum development boards in Kenya, Rwanda and Tanzania[28] tend to be less interactive and engaging. Often they consist merely of digitisation of textbooks[29] or recorded lessons of teachers in classrooms.[30] As to the content procured by government through development partners, they often lack local context. This highlights the need for a strong local EdTech ecosystem in the region.[31]

Stakeholders are of the view that there is a need to improve and design content that is rich, interactive, aligned to local curricula and contextualised to local settings, sensitivities and culture.[32] Content contextualisation, in particular, is important to ensure children focus on learning. According to the founder of TIDE Learning,[g] "If students are needed to master a particular concept or solve a question through the use certain animation objects that are foreign to local cultures, students end up focusing on the 'new' object instead of actually learning."[33]

g TIDE Learning is an education organisation in India that has been working on Early Childhood and Primary Education for the last 10 years. They have pioneered an innovative, affordable and scalable pedagogical model that overhauls classrooms and current approaches to allow children learn at their own pace. See: https://tidelearning.com

The digital content developed should also be compatible with technological capacities of devices and ICT infrastructure in various regions.[34] Platform interfaces must be designed in a manner that is easy to use for all children and teachers. A study conducted in Uganda that tested two products with different focus groups, found that applications were sometimes not compatible with the hardware, and students often experience problems with rudimentary actions like swiping on a touchscreen.[35] During the first year of the COVID-19 pandemic, Kenyan learners and teachers preferred to use the messaging app, WhatsApp as a medium to access and disseminate lessons, rather than access lessons through the Kenya Education Cloud and Remote Teaching and Learning Project.[36]

Implementation Talent: Teacher Training and Capacity Building

> "Hardware is only one part of a long chain of challenges that include provision of contextualised content and teacher capacity."

Teachers' attitudes and skills are extremely important for the effective adoption and use of ET. While public schools in East Africa still lack the hardware, the bigger challenge is for teachers to use existing products.[37] Capacity-building among teachers for the adoption of ET entails both, building ICT and pedagogical skills to effectively integrate ET into teaching and learning. Teachers in East Africa often lack both.[38] Current trainings are short and one-off conducted in parallel to ET deployments. A consultant working with the EdTech Hub[h] in Kenya says that current training modules focus more on how to use the hardware, and less on how to integrate such hardware into teaching.[39] Tanzania also adopts such an approach.[40] Such fragmented approaches to skill building do not address the specific needs of teachers in ET integration teaching and prove to be ineffective in the long run.[41] The lack of adequate training for teachers, and the weak integration of technology into the education systems, often result in computers being merely locked up in school rooms. In time, these computers become obsolete without giving returns on the investment.[42]

h The EdTech Hub is a global non-profit research partnership set up by the UK Aid Direct (funded by the former Department for International Development (DFID), now Foreign, Commonwealth & Development Office (FCDO)) and the World Bank Group — that aims to build evidence through rigorous academic research on the use of technology in education primarily focusing on the global south. For more visit: https://edtechhub.org/about-edtech-hub/

In Rwanda, according to a stakeholder from a civil society organisation, teachers need to be trained so that they can maximise the potential of the government's One Laptop per Child (OLPC) programme.[43] As East Africa aims to move towards a knowledge economy, with Rwanda and Kenya adopting a Competency Based Curriculum (CBC), the countries plan to integrate ET at all levels. The imperative is to move from 'training' to 'continuous professional development'.[44] To this end, countries recognise the need to re-design teacher training to impart effective and contemporary pedagogical practices through ET to improve education delivery.[45]

Engaging Communities

The education value chain consists of various stakeholders whose participation is necessary for achieving successful learning outcomes. According to a USAID report, 'First principles: Community Engagement in Education Programs', community involvement and ownership in school management boosts accountability on student learning outcomes and school resources. People tend to contribute resources available within the community for education which enhances sustainability of initiatives and eventually leads to success over time. [46]

Equally crucial is the awareness and commitment of parents and local communities to the potential of ET in improving student learning outcomes.[47] The point is to "demystify" the use of ICT in education.[48] An ET consultant and school owner in Kenya believes that community engagement is important to reverse the sceptical attitudes of parents towards their children using devices to access learning.[49] This is even more crucial today as lockdowns force students to learn from home and many may not immediately go back to schools once they reopen. Supporting home and community learning will therefore be important for the region.[50] To this end, providing access to devices, available within the

> "It is important to make communities aware of the potential of EdTech, and demystify the use of ICT in education."

community, to children outside school can benefit learning.[51] Such community-shared infrastructure, in the long run, can also help support adult learners and out-of-school youth by providing them with requisite skills that will allow them to participate in building an informed society.[52]

Indeed, community and parental engagement so far has been low. For example, in Tanzania, only 50 percent of parents visited their children's teachers in 2017.[53] This pattern needs to be reversed, as the role of parents is crucial in complementing the efforts of ministries and development partners in improving learning.[54]

The challenges outlined in this part of the paper underline the fact that adopting and scaling ET is not only a design process, but more importantly, a "whole philosophy trying to be solved."[55] The procurement of the right hardware and digital content is as important as developing teacher capacities, transforming teacher attitudes, ensuring community buy-in, and making available technical support at all times. This necessitates engagement not only between governments and the private ET sector, but also with civil society organisations who should be equal stakeholders.

> "Scaling-up the use of tech in education is not only a design process, but an entire philosophy."

This section discusses the work of three Indian organisations whose innovations and interventions have resulted in a certain degree of improvement in student learning outcomes. All the organisations have a technology component, albeit to varying degrees, in their intervention and have shown scale in low-resource settings. They work in both online and offline modes, and their content is compatible for basic and low bandwidth purposes. In the following paragraphs, this paper examines how these innovations have succeeded, and explores their potential in being applied in East Africa.

PraDigi Open Learning Programme (Pratham Education Foundation)

Pratham, one of India's largest NGOs, has extensive presence in the country's education landscape. It works both at the grassroots with communities, students, teachers, parents and youth, as well as with governments on large-scale projects. The NGO is well-known for its two pioneering initiatives: the Annual Status of Education Report (ASER)[56] — the only source of data on children learning outcomes in the country,[57] and the Teaching at the Right Level (TaRL) programme that fosters foundational skills in numeracy and literacy in children with inadequate learning levels. In 2018-19, Pratham partnered with the governments of Uttar Pradesh, Punjab, Himachal Pradesh, Bihar, Madhya Pradesh, Karnataka, Jammu and Kashmir, Andhra Pradesh, Chhattisgarh, Jharkhand and West Bengal to help children acquire foundational skills.[58]

The TaRL intervention has had a significant impact in improving the foundational skills of children across India. In 2014-15, the TaRL (through the Read India III Learning Camps) intervention reached 424,190 students (in grades 3-5) directly and over 6 million students indirectly through state or district government partnerships.[59] The Read India III Learning Camp resulted in the following: a) an increase in reading among children by 51 percent; a 37-percent decline in the number of children who could not identify letters of the alphabet; and b) a 33-percent increase in the number of students who could subtract and multiply.[60] Pratham's activities, through a succession of Read India phases between 2005-2008, have reached nearly 30 million children.[61] Several studies by Abdul Latif Jameel Poverty Action Lab (J-PAL),[i] comprising of rigorous and randomised evaluations have shown evidence on the efficacy of the TaRL intervention.[62]

i J-PAL is a global research center that aims to inform policy through evidence in order to reduce poverty. Through a network of more than 200 affiliated university professors, the organisation aims to answer important questions in order to reduce poverty by conducting randomised impact evolutions. See: https://www.povertyactionlab.org

Activities and learning materials in the TaRL intervention are tailored to the individual's learning levels and are based on Pratham's pedagogical philosophy—the Combined Activities for Maximized Learning (CAMAL)[63] which involves group activities and "learning by doing."[64] Using the CAMAL pedagogy,[65] and building on its wide-ranging know-how and success in its education programmes across India, Pratham in 2015 launched its ET intervention, called PraDigi Open Learning – a tablet-based hybrid learning programme that includes the Foundational Course and Assessment mobile applications.[66]

Pratham initially forayed into ET in 2005 through the computer-assisted learning (CAL) in municipal schools.[67] They installed computers with maths-focused software that had well-designed games to sustain the interest of the child while also adapting to their learning levels.[68] While the programme showed a positive impact on math scores,[69] the gains were short-lived[70] and the use of computers eventually reduced as teachers prioritised completing the curriculum during school hours.[71]

Pratham believed that technology allows for a non-linear exploration of knowledge, while classrooms are more rigid, and placing technology in classrooms would end up "distorting" or "suppressing" its true potential.[72] Pratham therefore took an approach (through the Hybrid Learning programme) wherein devices are provided to children outside school hours, and communities are co-opted to take ownership of children's learning in villages. Groups of children (of around five each) in villages are provided with tablets and guided by youth volunteers from the community to engage in "choice-based" learning. The group activities aim to prepare students for school, life and work through computational and creative thinking, communication and collaboration.[73] Engaging village leaders, generating awareness and providing education ratings for villages, motivates people in the community to act, and provide ad-hoc spaces for children to learn in groups.[74] The community facilitates learning activities and assessments where children conduct project activities and present them to a live audience or their parents, especially during village fairs. Report cards at the group and village levels are issued. Group members help each other in completing the activities.[75]

Pratham's internal assessment found a 12 percentage-point increase in performance amongst children who engaged in the Hybrid Learning programme as compared to those enrolled in school curricular subjects.[76] The intervention has presence in 2000 villages,[77] reaching 300,000 learners through 18,000 tablets.[78]

Pratham's digital learning applications in the Hybrid Learning programme are available for free and accessible by anyone. However, the availability of digital

devices in rural India is a key challenge. Pratham's approach seeks to address this by striving to create a conducive social structure within communities so that digital devices/smartphones that are available in the communities are shared to enable children groups learn. Financing and purchasing of a kit (comprising of three tablets and one Raspberry Pi local server) by communities is often a challenge. Pratham is iterating innovative models of ownership by tapping into retail fundraising, microloans from Self-Help Groups (SHGs) and incentivising youth groups within communities. Youth in communities are provided with courses for their own development and in turn are asked to mentor and work on the education of young children by providing their own devices.[79]

Pratham is working in 10 African countries through direct government partnerships and indirectly by partnering with local CSOs to implement its TaRL initiative. It works directly with governments in Nigeria, Cote'D Ivoire and Zambia. The first and largest TaRL pilot intervention is in Zambia. With internal programmatic data showing improvement in learning outcomes,[80] the Ministry of Education has now scaled 227,000 learners in 1,800 schools (nearly 20 percent of total in the country) with plans to further expand it after the re-opening of schools.[81] These programmes are helping Pratham figure the social structures in local communities in Africa. While there have been improvements in learning, Pratham has also witnessed unlearning as well due to reticence in children groups. Sustaining these learning outcomes by understanding communities through local stakeholder partnerships is a crucial challenge that Pratham is tackling. This can provide the requisite know-how to launch ET initiatives in the region.[82]

Pratham's approach of working with communities has been helpful during the first year of the COVID-19 pandemic. Pratham's ET products were able to facilitate learning for children by leveraging the extensive networks in

> "Pratham provides devices outside school hours, and communities take ownership of the children's learning in the villages."

communities across India through staff, volunteers and NGO partners. Lessons, on a daily basis, are disseminated on WhatsApp and its open content repository is also accessed through an Android App (PraDigi). Pratham has also created a repository of SMS questions for those with access to basic phones and community volunteers are able to regularly relay feedback for product iterations.[83]

The Co-Founder of EdTech East Africa mentioned that, "not every child will get back when schools reopen. It is important to be able to support those outside of school through community based learning and ET tools."[84] The Executive Director of Uwezo Tanzania (who visited a Pratham village community learning camp near Aurangabad), stated that, "If India can support learning (in Tanzania) the way Pratham is doing in applying technology, you can support learning of out of school children in communities and such an intervention can a breakthrough in Tanzania."[85] Pratham's Hybrid and Open Leaning programmes have shown that students can learn outside formal education structures.[86]

The Hybrid Learning Programme's application and content builds on Pratham's expertise in education and understanding of children's problems in low-resource settings. This, coupled with its approach of creating conducive social structures to empower communities with their own children's learning has proven successful.

Mindspark (Educational Initiatives)

Mindspark by Educational Initiatives (EI) uses technology-aided instruction to create a personalised adaptive learning (PAL) product, in which the pace of learning is adjusted and instructional approach is optimised to individual learners' needs.[87] It is a software product that was developed over 10 years and contains a repository of 45,000 questions[88] that were built based on 18 years of extensive research on children's cognitive pedagogical processes.[89] An independent third-party assessment conducted by J-PAL in showed that children who used the software displayed 200-250 percent gains in learning outcomes.[90] Mindspark is a Harvard Business School case study and one of the most promising ET products for low resource settings globally, and is currently used by 350,000 students across Indian government schools.[91] EI believes that teachers are important partners whose participation is crucial for the success of Mindspark; to this end, they are working to attract greater investments for teacher training and support.[92]

Through its Large Scale Education Programmes (LSEP), EI works with governments to undertake assessments of student learning and teacher needs;

deploy Mindspark; and develop individual educators' and systemic capacity to drive large-scale transformation in education systems.[93]

Assessments have been at the core of EI's work and form the basis of the development of Mindspark. Unlike ASER, assessments in EI's LSEPs not only provide insights into student learning outcomes, but also help teachers identify misconceptions and critical gaps in student learning.[94] Teachers are provided with practice worksheets and lesson plan recommendations to offer remedial support.[95] Such actionable data at a systemic level also allows for changes in curriculum.[96] Teacher needs assessment identifies strengths, weaknesses, and professional development areas for teachers, and helps the system align training with their needs. With East Africa moving towards a community-based curriculum, countries seek to transform their teacher training, and the LSEP initiative could be extremely beneficial for the region.

Furthermore, LSEPs also help build systemic capacities in creating assessments and formulating questions. For example, in Tamil Nadu, EI's intervention helped teachers understand how their own questions could capture learning gaps in children. Teachers are now able to create assessments themselves for subsequent assessments in the state. After the project ended, teachers continue to be in State Resource Groups, leading state textbook reforms while continuing their role as educators/teachers. Institutionalising capacities is helping a new cadre of teachers to be trained in assessments.[97]

A deep understanding of the creation of assessments and question-making, and children's misconceptions have been the core strengths and work of EI since its founding. EI's extensive educational research and insights obtained from assessment projects in the last 18 years have been the foundations for the creation of Mindspark. The economist, Karthik Muralidharan once remarked that what sets Mindspark apart is that it is a project created by educators who have come to the domain of technology, instead of a tech company getting into education.[98]

> "Mindspark is a product that highlights learning where the pace and approach is adjusted to the individual child's needs."

MDML (Multi- dimensional- multi- level) approach and PALEC (TIDE Learning)[99]

TIDE Learning employs a "whole of ecosystem approach" that addresses most of the challenges that are encountered in East Africa — both in terms of learning and teaching, and ET adoption. TIDE Learning's programme has reached more than 2,000 schools in Andhra Pradesh, Goa and Karnataka in India, and it also implemented a programme called PALEC (Programme d'amelioration de la lecture, l'ecriture et le calcul) in Cote D'Ivoire in partnership with the Ministry of Education — adapted from TIDE's MDML (Multi- dimensional- multi- level) methodology.

> "TIDE Learning gives great attention to continuous teacher development over many years."

Through its methodology, TIDE seeks to overhaul classroom and pedagogical practices by encouraging and focusing on the child's self-paced learning. The local curriculum is adapted and pedagogical practices are designed in a manner that addresses learning needs of all students. The use of ET through tablets is one of the many teaching learning methodologies (TLM) that students use to learn. The teacher acts as a facilitator of learning by managing and directing students on what to do to direct their own learning. This provides enough time for teachers to address the different learning levels in the classroom. Given the introduction of a complete new methodology of imparting learning, TIDE, in all its projects, builds capacities of stakeholders and provides tools for monitoring and support. Teachers are provided with effective pedagogical skills, through rigorous and continuous teacher professional development over three years.

Evidence from Cote D'Ivoire shows that the teaching learning processes are boosting the confidence of teachers. The local curriculum was broken down into easy and manageable tasks that has enabled uninterrupted teaching and processes. Teachers are able to better identify learner needs and address them effectively and are well prepared and ready with TLMs prior to each class. The tablets are used by children once a day for assessments and enable teachers to effectively track student learning.

TIDE also engages the local communities, who it sees as "key influencers". In Cote D'Ivoire, TIDE schools organise fairs where students are able to translate lessons into reality through role plays (for example as shopkeepers exchanging money) and local elders talk to children on their local culture, history and environment.[100] Preliminary evidence from Cote D'Ivoire suggests that students who attended PALEC schools out-performed their peers who attend formal schools. The use of tablets has built digital literacy skills for students and the overall curriculum delivery has helped them develop socio-emotional skills of collaboration, teamwork and problem solving. Moreover, teachers are encouraging students' inputs and voice in class.

Pratham already has presence in East Africa, albeit in a form where it works directly with governments and through partners to implement TaRL solutions.[101] EI has undertaken assessments in Tanzania, and TIDE's preliminary success in Cote D'Ivoire could be further expanded to other parts of the continent. Since East Africa is dependent on donor funding to implement ET initiatives, India's development cooperation can be the best way to scale its innovations.

India has engaged in various initiatives aimed at improving Africa's human capital: among them, the Indian Technical and Economic Cooperation Programme and tele education through the Pan African e-Network Project. However, these programmes cater only to tertiary level education, whereas in East Africa, the problems in education begin at the primary and secondary levels. For example, during the 2017 and 2018 academic years, more than 50 percent of students in Kenya obtained grades D and below in the Kenya Certificate of Secondary Education examinations. This hinders them from progressing to higher education or pursuing any professional course, more so from gaining meaningful employment.[102]

This paper offers the following set of recommendations for India to promote its EdTech ecosystem in Kenya, Rwanda, and Tanzania:

1. Take a **Demand-Driven Approach:** The "technology first and the rest will follow" approach has not worked for East Africa. There is a need to formulate an approach that understands the peculiar demands of these countries, which in turn necessitates the following:

    a. **Engaging the respective ministries and education boards** that handle primary and secondary education to identify the gaps in the current landscape.[103] India's efforts must complement those of the countries' themselves, in collaboration with their development partners. For example, Kenya, through its Digital Learning Programme, has provided 97.7 percent of its primary schools with digital devices. However, these devices and their digital content mostly cater to students of Grades 1 to 3 students.[104] India can explore contributing to content development and ET provision for higher grades.

    b. **Interacting with the broader ecosystem in East Africa**: As highlighted in this paper, governments have a tendency to procure hardware as a starting point, without considering the other real needs of their school-age populations. India must engage with the broader ecosystem of development partners, CSOs, startups, and school communities to understand current challenges and needs.

2. **Comprehensively map the Indian ecosystem**: This paper lists three Indian organisations and their respective EdTech innovations. It acknowledges, however, the need for a more comprehensive study of India's offerings and their respective potential and advantages. The paper argues that pure technology transfers, in the realm of education, will not augur well. India and the concerned ministry in the partner country must look for ET innovations that have evolved from the broader education ecosystems (CSOs, education research community) or that have been thoroughly designed or deployed in close collaboration with the ecosystem. Most importantly, the ET innovations should have a proven track record or at least preliminary evidence of improving learning outcomes.

3. **Find local champions for India's innovations**: India must find local champions in the key policy and political influencers/decision-makers who can raise awareness by advocating for India's innovations and involvement in improving local education and ET capacities.

4. **Develop evidence locally:** In the realm of ET, decision-makers usually have an incomplete understanding of what works and what does not and many policy decisions are not evidence-based[105] due to a lack of capacity within ministries.[106] Supporting Indian ET innovations to pilot and test locally in East Africa — especially in rural and low-resource settings that lack capacities — can help build evidence on the efficacy of the products. They can support decision-makers, help innovators iterate product designs, and create evidence for other Indian innovators on the needs of the region.

5. **Promote compatibility, contextualisation, and local partners:** ET products deployed in the region must be compatible with the available infrastructure. Given the intermittent supply of electricity and poor internet connectivity, using devices that can run on batteries for longer hours in an offline mode could be a solution. As an example, in remote areas that are off-grid, solar-powered tablets can be used. Likewise, digital content developed should be compatible with technological capacities of devices and ICT infrastructure in the different regions. This may necessitate the production of a spectrum of content, in terms of bandwidth, that can be compatible with low-tech, mid-tech and high-tech devices.[107]

Contextualisation of products and intervention is extremely important in the education sector. Content development must align with local curricula, be available in local languages, and should cater to cultural sensitivities.

If Indian technology-aided interventions are planned to be deployed, it is important to find local partners (for profit local ET companies or local CSOs). Indian ET innovators can find local ET companies and partner with them for content creation given their understanding of the curricula and local cultures. Understanding social structures and influencing them to create conducive environments for adoption of such interventions is also needed.

6. **Institutionalise systemic capacities in respective countries:** Whatever may be the scope in the ET ecosystem deployment (whether it is content development, teacher training and professional development, technical support, or community engagement), India must not only build individual capacities, but also institutionalise capacities within various levels of the system. This can create self-sufficiency for the countries and ensure sustainability of initiatives. For example, the need for content and lack of talent was highlighted by stakeholders in interviews with this author.[108] Chosen ET innovators can partner with existing ET companies to translate, align and contextualise content to local language, curricula and culture, and in the process build capacities for local innovators to update content in the future. In this regard, all three Indian ET organisations evaluated in this paper share this ethos.

7. **Explore the possibility of triangular cooperation:** Given that Indian development cooperation budgets are limited, the country should consider partnering with like-minded and established partners like USAID, UK Department for International Development (DIFD), and Japan International Cooperation Agency (JICA) to ensure the sustainability of initiatives. With the latter, India can initiate projects under the Asia-Africa Growth Corridor.

8. **Learn from best practices of other development partners:** In the realm of primary and secondary education, India must learn from the experiences of established foreign aid donors and development partners like USAID, DIFD, JICA, as well as the Korea International Cooperation Agency (KOICA) and Swedish International Development Cooperation Agency (SIDA)—which have all played various roles in supporting ET innovations in primary and secondary education systems of East Africa.

Conclusion

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Significant populations of children in India and East Africa are enrolled in public education systems mostly located in low-resource settings. For EdTech to succeed, the infrastructural and economic constraints, available technological capacities, and socio-cultural realities and structures of these regions necessitate technology interventions that comprise an ecosystem approach or are built on an entire ecosystem that addresses each of these issues. This would entail building teacher capacities, transforming teacher attitudes, creating content contextualised to local and cultural settings, and involving local communities to take ownership of children's education while adopting technology and models that are compatible with available infrastructure in the different regions.

This paper explored three Indian interventions that have been able to tackle these issues with a fair degree of success in improving learning levels of children at scale. The paper demonstrated that these interventions are the result not only of exceptional technology, but of the extensive work done by the respective organisations and their talent pool of researchers for public education systems that has allowed them to evolve into innovators of teaching and learning methodologies. In the process, they have built EdTech products and/or used technology tools in their interventions to further catalyse improvements in learning outcomes.

Given similar challenges in its education systems, India is better positioned to understand the concerns of countries in East Africa. Education-policymakers in the region are of the view that India will be capable of giving their countries a mix of solutions to a varied range of challenges in adopting technology for primary education. At the same time, given East Africa's challenges as analysed in this paper, transfer of technology alone will not work. India should transfer the broader ecosystems that have evolved around such products to help solve the education challenges in the region.

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