TECHNOLOGIES

FOR SMARTER, STRONGER, AND KINDER DEVELOPMENT IN INDIA

It is the role of technology in development to expand equitable access to transformational learning opportunities to all populations. Specifically, ICTs work to enhance capability, provide opportunities, and provide access to the most vulnerable populations (NetHope 2015). When considering the use of technology for learning and development, there are a series of considerations to make in order to ensure high acceptance, high impact, and successful monitoring and evaluation of the intervention. This report reviews the current landscape of technology use in the field of development and discusses the relevent considerations in employing technology to future Sesame Workshop India's mission of helping children grow smarter, stronger and kinder.

1. GLOBAL TECHNOLOGY

Technology interventions will always follow the electric grid. Therefore, it is crucial to address the failing electrical grid in many regions within LMICs (NetHope 2015). Currently, there are innovations such as home generators, micro grid systems and off grid systems, designed to address the lack of electricity in many communities. When designing technology interventions, it is important to ensure that all intervention includes a strategy for powering devices AND has a backup solution to mitigate the impact of power outages.

One of the fastest growing technologies in ICT4ED is mobile learning technologies. South Asia is the fastest growing market and saw an increase in phone subscriptions of 70% between 2000-2010. Currently, the populations in LMICs are seeing a much more drastic expansion in ownership than access. People are having personal access to devices as opposed to shared access to devices (NetHope 2015). In a study of the use of mobile devices of children in a slum in Hafeezpet, Rangaswamy and Cutrell (2013) observed the natural ways that children and young people acquire and use the internet via mobile devices. Their observations concluded first that children and young people are highly motivated to acquire internet with entertainment being the primary motivator. Second the observed the ways that they use the internet primarily resolved around games and viewing content. Finally, the researchers observed a burning desire to collaborate with technology. Independent from adult influence, children formed what they called an Adda which acts as an internet hub where young people come together and share usage technologies. The use of the internet for entertainment not only provides agency, accessibility, play and learning, but it also utilizes intrinsic motivation to integrate technology into the daily lives of people which opens the door for guided development and learning opportunities.

Mobile devices provide unique opportunities in India where there are moderate income rates, low literacy rates and relatively high device ownership rates. According to UNESCO's EFA global monitoring report from 2015 the female literacy rates for adults and youths in India was 24 and 14 percentage points lower than for males respectively and up to 90% of people in India lack digital literacy disproportionally affecting girls (Nikhoo and Jöhnson 2017) Prices are declining and technologies are improving which provide a promising future for mobile devices in development. Mobile devices see many challenges yet. Even though technology is advancing, phones are still cost prohibitive to many people (especially those that have the most potential to benefit). There is also still a lack of digital literacy and often cultural barriers prohibit women and children from regular access to mobiles. There is also still a wide

perception in LMICs that mobile devices are strictly for communication and not for learning or development.

That being said, mobile learning has the capacity to expand reach and equitable access to education, facilitate personalized learning through private device ownership, support learning anytime "anywhere", provide immediate student feedback, and build learning communities (UNESCO 2012).

Mobile Learning Recommendations:

1. Consider using ICT in all programs in a culturally and contextually relevant fashion
2. Integrate activities that enhance digital skills (specifically those of women) and that encourage men to empower women with mobile technology.
3. Train teachers and learning facilitators to use mobile technology
4. Optimize educational content for mobile devices
5. Ensure gender equality for mobile students
6. Promote healthy use of technology

To truly reap all of the benefits of ICT4ED, an innovation will rely heavily on connectivity. Connectivity is expanding rapidly (mobile broadband market penetration has increased 12-fold since 2007). Yet, there remains a significant population living beyond the last mile of coverage. In the future, innovations such as satellite internet and the utilization of unused broadcasting frequencies to deliver the internet will remedy these problems but for now, people in LMICs face many connectivity challenges. It is not uncommon for people to live in areas without internet coverage, areas with expensive internet coverage, or in areas without coverage but potentially economically viable internet services.

Connectivity Recommendations

1. Support the development of connectivity services
2. Utilize OCAs (Occasionally Connected Applications)
3. Employ second generation network only as an interim solution

Digital Services (mobile applications) provide a low cost ICT intervention for development. The market of cloud based applications is expanding rapidly and provides access to customized content. The market of digital services is moving towards a network of digital identities where people can exchange ideas, content, and currency. However, it is difficult for many people to develop an authentic digital identity and take full advantage of the subsequent services.

Digital Services Recommendations

1. Target digital needs to address the usage needs of women (privacy, security, time flexibility)

One of the most affordable and scalable interventions in ICT4D is still radio – especially interactive radio instruction (IRI). A radio intervention will be heavily influenced by its ability to be heard clearly and regularly. In a study that looked at 16 IRIs in 16 countries (including India), Ho and Thukral (2009) saw that mathematics learning saw an effect size of .41 in grade one (children saw a 16 percentile increase in their ranking. These effects were witnessed through grade 4. They also saw that Local Language Literacy skills saw an effect size of .48 in grade on (18 percentile increase) that remained effective (though lesse effective) through grade 4. English learning saw improvements across all grade levels as IRI students consistently outperformed controls with an effect size of 1.7 (46 percentile increase. After grade 4, the learning impact decreased. In addition, the researchers saw that teachers were able to learn and improve their practices in a much shorter time frame as IRI was used to distribute pedagogy strategies. Crucially, they saw only a very small gap between knowledge acquisition of girls and boys and children in rural and urban regions saw similar gains. In English instruction, the meta-analysis found that IRI was able to virtually eliminate the knowledge of rural and urban foundations. The largest IRI effect size was recorded in grade 1 and 2 across English, local language literacy, and mathematics.

Qualitiatve analysis of our interactive radio program called RadioPhone, showed that 30% of the stories told to researchers demonstrated changes in the quality of life in listeners and mentioned changes

or improvements in children's learning levels. An additional 12% of respondents spoke of behavior changes as a result of exposure to the radio show. Across learning outcomes,

3D printers are one of the more obscure technologies on the horizon. However, they are no longer simply an unusable and highly expensive prototype. There are now solar powered models that come at much more affordable costs. Currently, 3D printers have the capacity to create manipulatives in preschools. In the future, 3D printers will have the capacity to change livelihoods, adjust production lines, reduce waste, and improve access to tools and supplies such as prosthetics, school supplies, and even meals. Artificial intelligence will be able to interpret inputs from children and support customized and language diverse innovations. This will eradicate the "one size fits all" approach often employed in TechEd interventions (World Bank 2016).

2. TECHNOLOGY FOR DEVELOPMENT

2.1 International Development

While 60% of the people (World Bank 2016) in the world continue to live their lives offline and are unable to communicate to the global economy, the future of ICT4D must make a shift towards considering data and technology as a dignity and not simply a way to monetize people (Heeks 2016). Supporting people's dignity through technology is one way to increase the likelihood that a technology based intervention will be accepted. At its core, promoting the acceptance of a technology comes down to two key principles: ease of use and perceived usefulness (Davis 1989). If a technology has both a high ease of use and high perceived usefulness then it is much more likely to make a meaningful impact in the lives of the users and in their communities.

Ensuring acceptance requires a proactive utilization of very specific strategies. First and foremost, technologies must be low in cost. Next, they must fit well into the local context (World Bank 2016). In addition, ease of use will be positively influenced if the intervention capitalizes on technologies that the population is already familiar with. Finally, In nearly every situation, technology will first benefit those in the population with the most privilege. Close attention must be paid to equitable distribution of technologies. Further, an intervention will reach a diverse set of communities if the government supports the introduction of a technology program. (Hanna 2016)

Once a technology has been accepted by a targeted population, its impact success will rely on key elements of the intervention design. Interventions with a guided use technology (one that has an intended outcome and guides users towards that outcome, will promote increased learning. In addition, users are much more likely to learn if the curriculum is relevant to their lives in both language and content. Success in intervention impact is also positively influenced when devices are shared and special attention is given to supporting teachers and facilitators in the utility of technology. Teachers and facilitators are crucial to the success of tech innovations. Technology will likely not replace teachers. However, teachers who use technology will almost certainly replace those that do not. Finally, success relies on a tandem focus on improving analog skills alongside digital literacy. Hardware centric interventions, such as One Laptop Per Child, in which technology is simply distributed show very minimal impact as they neglect attention on improving the necessary analog skills (introducing a technology to a classroom without teaching the skills and supporting the accountability required to use it effectively) (World Bank 2016).

A technology based intervention is also much more likely to succeed if the organization is committed to advancing ICT strategies (NetHope 2015). A primary way to demonstrate and embody this commitment is with the creation of an organization strategy that aligns with the overall organizational strategy. This technology strategy will include solutions for organization-wide needs, an Enterprise Architecture (flow chart that helps organize the current technologies used by the organization AND helps make decisions about using new technologies in the future), a list of strategic technology partnerships, and a strategy to stay abreast of new technology innovations that have the potential to support the organizations mission.

Leapfrogging, a strategy deployed to evolve from current technology landscape to a modern technology landscape while skipping pieces of the normative technology development process, is often employed in international development. There are a few considerations to be made before leapfrogging. First, this strategy has a high upfront cost and a slow delivery of returns. Further, and most importantly, leapfrogging technology has the potential to further widen the digital divide. There are certain conditions to consider before 'skipping' technologies in evolution: market demand and competition, institutional capacity, equitable access, human capabilities, government support, stakeholder networks, and utility infrastructure. If the contextual conditions are deemed favorable, then the organization can choose to move forward. It is advised that the organization will consider the low end of the digital divide, develop a map of the current digital landscape with the population, and align this digital map with the current advanced designs in technology. Once this map is aligned, identify each step between the populations technology map and the modern global technology map. Work together to identify which of these steps is crucial to progress and which steps can be 'leapfrogged'. This strategy will expedite the development of a nation's technological capacity.

Five key considerations for designing a technology intervention for the purpose of development:

1. Always start first by identifying an educational problem
2. Ensure that the intervention will add value and be perceived as doing such
3. Focus on sustainability of implementation
4. Utilize technologies that have multiple uses to avoid over complication
5. Improve technology acceptability be increasing the user's perceived ease of use and perceived usefulness. (Winthrop and Smith 2012)

2.2 Technology For Learning

When using technology to support the learning of children, there are several additional considerations to be made. It is important to understand the ways children are currently interacting with technologies and the potential impact of said technologies on their development.

Digital reading devices provide opportunities for children to read in three formats: pdf's, digital adaptations of books, and digitally native texts. In 2012, there was a 121% growth of ebooks for children in the global market. However, 81% of parents reported print as the preferred format for their child to read as they fear that their child will be distracted by the bells and whistles of an edevice. As form always follows function, it makes sense to focus on digitally native text for ereaders (as opposed to simply pdfs or adaptations of physical books). Looking forward, Disney Research and Carnegie Mellon have committed to an initiatve to create an ereader that does not need to be charged or have a battery. It will instead be powered by natural human motions such as touch, tap or swipe. This will address the unique electricity focused difficulties presented by use in LMICs (Baron 2015).

Galli Galli Sim Sim continues to reach millions of children every year on their televisions. This device, present in many homes in India, is full of learning potential. In 2014, Kothari conducted an experiment to promote literacy simply using same language subtitles on Bollywood songs in films. Based on the premise that it is physiologically impossible to ignore subtitles (of the same language as the audio or different), the study recorded growth in literacy in children after exposure to SLS. Children with even low levels of self-report SLS exposure saw an increase of knowledge of 1.9 syllables over their non-viewing peers. Regular viewing of content with SLS reduced the number of children incapable of decoding a single letter after five years of schooling from 45% to 13%. This style of intervention shows promise as the cost of scaling is very low.

Designing technology interventions for learning young children is still a relatively new experience. Unger (2017) outlines the strategies for successfully designing applications for children. First, children apps must be challenging to promote the exploration of micro-conflicts for development. Second, apps for

young children must provide constant opportunities for feedback to avoid false rehearsal. Third, children are more susceptible to manipulation in devices so apps for children must incorporate a trust driven design. Finally, children develop rapidly. When designing apps for children, the target audience should focus on only two years. Further considerations:

- Apps must let children make and explore mistakes
- Young children are hypersensitive to the effects of advertising. Apps should avoid manipulative advertising strategies
- Children frequently touch the bottom of screens on accident. Leave the bottom portion of the screen free of buttons for ease of use.
- Children have the capacity to think beyond reality. Do not limit children's options by providing only realistic solutions
- Design for children. Do not simply adapt content for children as this is inefficient and costly. However, seek the input of adults as their support is crucial.

Designing technology interventions for young children is still a relatively new experience. In response, we must continue to rigorously research the impact of technology and rely on our knowledge of learning supportive psychology. There are five central psychological phenomena that are uniquely challenged by technological learning and each of them must be addressed to fully support learning with technology.

The context dependent nature of memory explains that learning is heavily influenced by context and environment (state dependent learning). So, when children take their learning to multiple places, the supportive effect of constant context may be reduced (Terras & Ramsay 2012). This may mean that lessons which are not provided in a specific and constant environment be shorter to ensure that learning is acquired before the mobile user changes locations.

To successfully learn from devices, children must develop superior attentional control. However, every human has finite cognitive resources. The distractions often associated with technology inhibit our prospective memory (remembering to do something in the future). Cognitive load also places a stress on our memory. Extraneous mobile load is likely to be heavier when learning on a mobile device as the content and attention is higher (Terras & Ramsay 2012). To remedy this restriction, it is pertinent that applications work to minimize the number of distractions present on the device.

Learning and cognition is shared among people in a process called distributed cognition, meaning that the definition of a particular schema is always evolving based on interpretations and inputs of a collective. Mobile learning provides a substantial support to interconnectivity. This means that learners must be able to understand contributors with value to add from those without value to add (Terras & Ramsay 2012).

Children must use their metacognition to be able to comprehend the potential benefits and risks of mobile learning so that they can properly manage their learning. Care for a refined metacognitive strategy will ensure that children remain intrinsically motivated to responsibly use technology for learning (Terras & Ramsay 2012). An intervention that directly stimulates the metacognitive processes of the child will promote continued interest and increase learning potential.

Technology has to be sensitive to the unique capacities and interests of each user. For mass acceptance, children must understand why and how children can assist them. This is especially true with capacity to use technology. We cannot assume that young generations understand technology (Terras & Ramsay 2012). Baseline and formative research are crucial to designing an intervention that addresses the diversities in capacity and interest of users.

Technologies, such as mobile applications and 3D printing, provide a unique opportunity to expand already present learning curriculum to students with disabilities such as blindness or deafness. This is especially important as children in India are at a higher risk of

experiencing "simultaneous deprivation" specifically combined poverty and disability (Subramaniam 2017).

Once a technology has been developed. The next opportunity for development is discovery. A successful technology will employ viral marketing (creating "buzz" using digital or in-person word of mouth). Viral marketing is ten times more successful when it is motivated from one friend to another as opposed to being introduced by an external influencer. Viral marketing as a strategy is effective, especially for young parents. Additionally, trends in video viewing makes it a prime strategy for advertising. Video News Releases are short videos, not labeled as advertisements, that deepen the audience's connection with a brand. Finally, when trying to stand out in a saturated children's market are unique considerations to be made. Parents have three roles in exposure to advertisements: (Calvert 2008).

- Coviewing: parents watch without discussion (does not influence the child's perception
- Active Mediation: discuss content with child
- Restrictive Mediation: parents control type and quantity of content that children are exposed to

When creating advertisements for content, children should be the focus but the role of the adults must strongly be considered. To make the largest impact, the content should satisfy the cultural qualifications of restrictive mediation parents and encourage discussion with active mediation parents. This will ensure that the largest number of children have access to discovery and discovery has the highest impact with the children exposed to it.

3. MEASURING IMPACT

One of the strongest opportunities provided by ICT's is the vast improvement on the quantity and quality of data collected and the speed at which it can be collected. 90% of the world's data was created in the last two years. All of this data can be collected and disaggregated to be interpreted by users of all skill levels. In the short term, the drastic expansion of data created by the growing ICT4D market provides opportunities for organizations to visualize data unlike ever before. In the long term, this same data will enable the optimization of resources and reduction of human powered needs through hyper-targeted interventions. The current challenges of mass data in ICT include poor data literacy, a lack of baseline data, and a lack of standards in the data collection processes. To respond, it is recommended that an organization work collaboratively with organizations to develop sets of standards, integrate analytics into the planning of every program, and invest in data literacy training.

Selecting Indicators in research in interventions that utilize ICT requires creativity. Because technology use alone often has some influence on learning, it is crucial to identify indicators that will provide instrumental information to the organization. Indicators, just as interventions, must focus on context and must assess the issue directly whenever possible. Often times with ICT, using just one indicator will not tell the complete story. It is often effective to try combining indicators to gather the complete story. Crucially, as ICT develops more rapidly than any prior tool used for technology, it is especially important to consistently reevaluate the indicators selected to measure progress. Finally, it is important to use data collected through ICT interventions to promote an equity agenda. ICT data collection can be used to promote transparent population information gathering and the reports of every program must be designed to demonstrate opportunities for expansion to highly marginalized populations (Wagner 2005).

4. CHALLENGES IN ICT4ED

With all of the promise that surrounds the future of ICT4ED, it is important to address its challenges. Technology remains an expensive intervention at scale. It is much easier to provide a tablet to every classroom in one school than it is to provide one tablet to every classroom in a country. Today, it is still virtually impractical to scale technology interventions (with the exception of software interventions) (NetHope 2015)

There remains a substantial gender disparity in terms of access to transformative education. Woman are 14% less likely in LMICs to own a mobile phone, 25% fewer women are on online today. Yet, an increase in internet access for 600,000 women across LMICs would contribute $13-$18 Billion to their combined annual GDP (NetHope 2015).

One of the biggest challenges in implementing a successful ICT4ED project is acceptance. To ensure acceptance, every technology initiative should address the following critiques:

1. Technology does not add value to educational outcomes or processes and technology investments can crowd out other investments that could bring value
2. The infrastructure needed for technology to be successful is weak and often only available for the elite in LMICs
3. Technology often breaks down and is unreliable, and becomes obsolete very quickly
4. Technology is difficult to use
5. Teachers are not train in technology
6. Technology seeks to replace the human dimension in the education process (Winthrop & Smith 2012)

5. RECOMMENDATIONS

As Sesame Workshop India is a multimedia organization and the field of ICT4ED is rapidly expanding, it is crucial that the technology strategy moving forward be focused on the ways to best support children in India to grow smarter, stronger and kinder.

1. Inter-user communication. As was demonstrated with the young people in Hafeezpet and the teachers using IRI, users have a high desire to communicate with similar users. Providing them with this opportunity will not only improve user experience with ICT interventions, but will also expand the program's reach.

2. ICT Strategy. A well thought out ICT for Development strategy will prepare Sesame Workshop India for upcoming rapid changes in the field of technology for development. The Strategy should start with the immediate needs of the organization and align with the organizational strategy. It should include a framework of all of the technologies currently used to support the mission and criteria for selecting technologies in the future. The strategy should include a list of tech focused partners and should encourage constant communication with partners. Finally, this strategy should include a mechanism for learning about new technologies and adapting content to include these shifts in the use of technologies in India.

3. Make the Case. In many parts of the world, including India, there is a significant shift in mindset that needs to occur before technology can truly make a sustainable impact with large populations. To help the progression of this shift, Sesame Workshop India, would benefit from documenting their stance on the utility of technology for learning. Specifically, this statement should include SWI's beliefs in the power of technology to support human development and national development. Further, this statement should take into considerations the many concerns of people with regard to adopting technologies for the purpose of development.

4. Measure Impact. Technology has immense potential to redefine the ways that organizations measure the impact of their interventions. An intentional integration of technology into the measurement and evaluation procedures at SWI would have immense potential. As data becomes much more readily available, it becomes more pertinent that all employees are able to accurately interpret data collected on interventions. In addition, M&E plans and reports should be designed as a tool to proactively demonstrate the potential of an intervention to be scaled to other populations in need. Its impact with one population should be reported alongside its potential to be scaled to include additional populations in need (another community, children with specific disabilities, minority populations, etc.)

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