A Framework for Evaluating Appropriateness of Educational Technology Use in Global Development Programs

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Introduction

This report details a study undertaken as part of the Comprehensive Initiative on Technology Evaluation (CITE) at MIT, relating to the use of educational technologies in the developing world. CITE both evaluates products in use in the developing world, and develops methodologies for performing such evaluations. The study in question was a small-scale pilot focusing on methodologies for evaluating educational technologies, as opposed to the evaluation of particular products. Since it is nevertheless useful to test these methodologies in a specific context, this study focuses on implementations of Literacy and English Language Learning (ELL) software applications in India. It was performed in collaboration with the Indian Institute of Management (IIM), Ahmedabad.

In the course of this study we developed a framework to be used by various stakeholders in assessing the suitability of new educational products or interventions. Stakeholders include developers of new technologies, or adopters, including system-wide administrators, school principals or teachers. The framework is intended to be used before the adoption of an intervention, or as a formative assessment of that intervention as it is being deployed. Though we piloted this framework in the context of the specific domain of language learning, our larger goal was to create a tool that would be more broadly applicable.

It would be difficult to overstate the challenges inherent in any effort to objectively evaluate the effectiveness of a given educational technology. To begin with, the notion of what constitutes effective education is highly contested, even in a developed country such as the United States, with an educational system that has had 150 years of relative peace and prosperity in which to progress and evolve. One need only look at the lively debates that revolve around such questions as the uses of standardized testing, common core curricula, charter schools, or the role of computers in children's educational development to acknowledge that there is no consensus on what educational success looks like, and similarly no consensus on how to measure any putative success. Even when one identifies the desired and measureable outcomes of particular intervention, the challenges and costs of performing scientifically valid assessments using randomly assigned, single variable treatment and control groups in sufficiently large populations can be staggering.

If we shift our attention to the developing world we are likely to find even greater challenges resulting from under-funded schools, a shortage of professional educators, and a limited technological infrastructure. In addition, one encounters the same disagreements about the purpose of education and what constitutes sound pedagogy as are found in the developed world. Any meaningful evaluation must accommodate itself to all these factors.

We begin by acknowledging these challenges not in the spirit of resignation, but rather to avoid the grandiose claims that are all too often made on behalf of educational technology. The authors of this report have worked for decades both developing and evaluating educational technologies. We remain optimistic about the role of technology

in education, but we also understand that the greatest risk to the adoption of any technology may be unrealistic expectations, and subsequent discouragement and premature capitulation to defeatism. Accordingly, this report documents our effort to identify methods of evaluating educational technologies that are both practical and adaptable to a wide range of educational settings, and that will result in the adoption and use of technologies in ways that are potentially sustainable in developing environments.

Background

CITE evaluates products for:
- Suitability—does a product perform its intended purpose?
- Scalability—can the supply chain effectively reach consumers?
- Sustainability—is a product used correctly, consistently & continuously over time?

Prior CITE studies have looked at specific technologies with relatively focused applications, such as solar-powered lanterns, or home water filters. Even such straightforward applications can prompt complex questions (e.g. in a given context is turbidity or toxicity a greater concern in the water supply), but consensus exists for the goals for these products, and that in turn makes it possible to perform evaluations that will be broadly useful.

Questions of suitability, scalability and sustainability are all relevant to educational technologies. However, the challenges in taking a comparable approach are several-fold. To enumerate the most salient factors:

Diversity of pedagogies: As already alluded to above, there is no consensus on what constitutes sound educational practice. At the risk of oversimplifying, there is an ages-old debate as to whether education is primarily for the transmission of knowledge from teacher to student, or for the provision of experiences through which students construct understanding. Even if one presumes that both pedagogies are desirable, the relative balance of each approach, and the means for achieving it can be hotly contested.

Diversity of goals: Distinct from, but related to the above is the question of what the purpose of education is. Should we view education as preparation for a vocation, with an emphasis on knowledge and/or skills necessary for the workplace? Or do we see the purpose of education as teaching the student how to be a life-long learner, so that education can continue outside of the walls of school, and after graduation? Again, these need not be seen as mutually exclusive, but the balance of these two goals has an enormous impact on how and what we teach.

Diversity of assessments: If we cannot agree on how we should learn, or what we should learn, then there is little chance that we can agree on how we

assess learning. For any existing form of standardized assessment, one can find volumes of argument as to validity of the measured outcomes. Such widely used assessments as the IQ test, the SAT or the PISA exam are all subjects of fierce debate among learning scientists as to their merits. These same questions of validity arise when developers of educational technology seek to make claims for the efficacy of their products based on standardized assessments. Even if we could prove that a particular intervention improved scores on a standardized test (difficult to prove given the multiple variables present in the classrooms studied), we would still be left with intense disagreement on the validity of that test.

Diversity of technical infrastructures: In the course of this study we visited villages without schools or dedicated classrooms, where learning takes place in the open air. We visited schools with computer labs, some quite old and under-resourced, others fully functional and up-to-date. We met students who were just learning to use a mouse, and others who had access to the latest smart phones. This variation is not unique to the developing world (schools in the U.S. vary greatly), but the differences are even more extreme.

Diversity of technologies: the term educational technology encompasses a vast array of software applications and hardware products. For example, software applications that function as tools (word processors, spreadsheets) have little in common with software intended to convey content in the fashion of a traditional textbook. In terms of hardware, desktop computers, laptops, tablets and smartphones may all contain comparable computing power, but they are designed for vastly different functions, and are likely to be accessible to entirely different populations. Other items, such as interactive white boards or video projectors also qualify as educational technology. No particular technology can be evaluated free of understanding the educational goals or the context in which it is used.

Diversity of products: As one can imagine, given the varied goals, technical infrastructures, and technologies deployed, the range of products defined as "educational" in the marketplace is vast. Evaluating one product (or even a small sample of products) might only have relevance to relatively narrow slice of the larger field, and if done without regard to the larger systemic questions posed here, might yield little that would be more broadly instructive or useful.

The complexities outlined above provide the context in which this study was developed. While this was to be a relatively small-scale study—in effect the pilot step in what might eventually be a more thoroughgoing effort—we nevertheless concluded that meaningful first steps could be taken toward creating a broadly useable framework, and what follows is the documentation of those efforts.

Problem Statement

As digital media proliferate, and increasing amounts of daily work are performed in digital environments, there are increasing demands from parents, educators, and governments to deploy educational technologies, whether as a means to improve the quality of education in general, or as tools to familiarize students with the technologies that will shape their future lives. This demand can be driven by:

- enthusiasm for emerging technologies;
- expectations (realistic or otherwise) for what technology can achieve;
- fear of being left out of emerging socio-cultural developments;
- or all of the above.

While all schools may share a common goal of educating students, there is a broad diversity of means, depending on such variables as:

- school funding
- teacher preparedness
- educational philosophy
- technical infrastructure.

Unfortunately, many consumers of technological interventions—policy makers, administrators, teachers, and parents—fail to account for these variables in making decisions about the adoption of any particular technology (Davies). And many developers create technological interventions without fully understanding the educational systems into which they will be introduced.

Therefore, there is a need for evaluative tools that will:

- aid various stakeholders in determining which educational interventions are most promising for any particular context; and
- help stakeholders evaluate interventions as they are in the process of implementation (i.e. formative assessment).

Project Teams

The project team at MIT included a principal investigator, project lead, staff researcher and two graduate research assistants (see Appendix for full bios). Collectively the staff had extensive experience in researching and developing educational technologies, including the development of educational games and simulations, as well as ELL products. Project leaders have advised education policymakers at the federal and state levels, and various team members have been deeply involved in teacher professional development, and the development of educational frameworks.

The team from IIM-Ahmedabad consisted of a faculty member who works extensively on education policy, a doctoral fellow pursuing research in education, and a research assistant (see Appendix for full bios).

Methodology

The project was initiated at MIT, where the initial efforts were undertaken. At the beginning of the process, the nature of the framework to be developed was still somewhat speculative. We had not yet narrowed the audience for the framework, nor developed use cases for how the framework might be applied. The only fixed element was that we would pilot it in the context of use of ELL software in India.

Accordingly, we planned for 4 phases of project work over the course of just over one year, from late 2014 through calendar year 2015. The phases were:

1. Literature review and development of a working hypothesis.
2. Site visits in India
3. Creation of the framework
4. Field tests in India

The MIT team used the findings of the lit review to identify potential partners and sites to visit in India. It also developed a theoretical approach that would then be tested during the site visits in India. The validity of the approach was explored through both conversations with stakeholders, and through direct observation of schools and other sites of technological interventions. Upon returning to the United States, and based on the findings in India, the MIT and IIM teams developed the framework in consultation. The IIM team in turn tested the framework at sites in India in the fall of 2015. More detailed discussions of each phase follow.

Literature Review

The literature review focused on several areas of inquiry:
- India's population, economy, language
- India's Education System
- Education Technologies in India
- English language learning in India
- Pedagogy of Educational Technologies
- Existing Technology Evaluation Frameworks

A full bibliography is included in the appendix of this document. We briefly summarize here some of the most salient findings.

India's Population, Economy, Language

India has a rapidly growing economy, and while a significant percentage of population lives below the poverty line, that number has declined from 40% to under 30% during this century—although by some measures poverty rates are substantially higher. While illiteracy is also declining, it remains at roughly 30%, and is disproportionately large as

measured against global figures (Kingdon, 2007). In some Indian states, there are large gender differences in illiteracy, while other states have successfully eliminated the gender gap.

There are 18 major regional languages, and 122 languages with over 10,000 speakers (Kam, 2008, Azam). Hindi and English are the two national languages. Roughly 20% speak Hindi as their native language. In the north, where other native languages are closer to Hindi than to English, Hindi is more likely to be spoken as a second language than English is. In the linguistically distinct south and northeast, English and Hindi are equally dissimilar from native languages, and in these locales English is more likely to be the second language. Throughout the country, fluency in English is equated with being in the middle and upper classes. It is the language of all professions, and of higher education (Kam 2008). It is perceived that "anyone with an education, computer skills, and some English can make it" (Das). Less than 5% of the population have computers or Internet connections within their home.

While there has been dramatic migration into cities, the rural population is still roughly 70%. Manufacturing jobs are not growing as compared to agriculture and service industries, and the poor have few prospects in the latter. While India has a large and growing IT sector, its growth is limited by the education system's ability to produce enough English-speaking graduates (Das). In summary, there is both a push from the general public, and a pull from employers for an English speaking, computer literate workforce.

India's Education System

Available statistics sometimes conflict, but it is still possible to get a general picture of the state of education. The Indian education system includes government (public) schools, aided private schools (which receive government subsidies) and unaided private schools. Low cost private schools are expanding even in slums and rural villages, and nationally 29% of students attend private schools (ASER, 2013), even larger numbers in urban areas (Kingdon, 2007). Students must pay fees even to attend government and aided private schools, with fees being higher for private schools. Elite students tend to go to unaided private schools. In surveys of poor parents, English language and computer skills are the most requested subjects.

While enrollment rates for primary schools are 93.4%, they are higher for boys than girls, and enrollment continues to fall off as students age (ASER 2006, Kingdon 2007). Enrollment also correlates with socio-economic status (SES) and parents' education levels. Overall, actual attendance rates in schools are 80%, lowest in poorer states.

Facilities in schools are quite basic. In 2012, 10% of schools in India lacked water, and 40% lacked toilets. Many schools lack adequate numbers of desk or chairs (Rao). Teachers are absent 25% of the time, with higher absenteeism at government schools, and in poorer states (Kremer). Although no single measure can define the quality of an educational system, overall measures of achievement are not promising. Indian

students do poorly on the Trends in International Mathematics and Science Study (Kingdon, 2007), and to quote one statistic, 52% of rural children, ages 7 to 14 could not read a paragraph at a 2nd grade level. (Muralidharan).

Education Technologies

Widespread adoption of computers in school is limited by both technical and institutional barriers. High among the technical barriers is the problem of electricity. It can be unreliable, and fluctuating voltages damage power supplies (Kumar). Equally challenging is the ongoing cost of maintenance. A computer that fails for even the most trivial of reasons (e.g. bad cable) may go undiagnosed, and unused (Arora). From an institutional perspective, teachers often lack the time, or training to utilize computers, and scheduling issues in overcrowded schools limit their availability (Mathur). Even where teachers do have access to computers, they've rarely learned techniques that take advantage of their full affordances, and end up using them merely as e-textbooks (Arora). In many poorer schools, computers are hard to justify when students are deprived of adequate nutrition and health care (Keniston). According to a Government of India website, only 22% of schools had computers in 2013, though percentages were in the 90's in some states.

In the U.S., computers in education tend to bridge from the school to the home, but as we've seen, computer ownership in homes in India is very low. However, most homes in India now have cell phones (Kumar), and the adoption of smart phones, though still limited, continues to grow. At the time of this writing, it was announced that a $4 android smartphone would soon be on the market. Accordingly, there is growing interest in educational applications delivered on phones and tablets with mobile operating systems. On the positive side, phones tend to be useable even with intermittent power, and children don't have usability issues with them (Kam, 2008). Challenges remain, as in some studies children were too afraid to carry mobile devices out of the house for fear of theft.

Our research did uncover large numbers of developers creating software applications as well as hardware, such as tablets and low-cost projectors aimed at the school market. While poverty is high and rates of adoption are still low, the sheer size of the market incentivizes innovation, and adoptions can only increase over time.

English Language Learning in India

Numerous statistics suggest speaking English leads to higher income (10 – 34% higher), with higher rewards for those who are fluent, male, and higher SES (Azam). Graduates of schools in which English is the primary language of instruction increase income by 25% (MUNSHI AND ROSENZWEID). Anecdotally, on our subsequent site visit we were repeatedly told that the demand for such *English Medium* schools is increasing rapidly among all strata of society. In 2011 the numbers of English Medium schools ranged from 13% of primary to 26% of secondary schools (Meganathan).

Hindi and English are the primary second languages taught, and in regions where the native language is not related to Hindi (i.e. not Indo-European), English is heavily preferred. English is the native language of less than 1% of the population, and as of 2005, 20% spoke some English, 4% fluently (Azam). One can assume this number will grow with the proliferation of English medium schools. English speaking skews male, and younger, and 89% of people with bachelor degrees speak some English.

Unfortunately, the quality of English language instruction is very low. Many English teachers are themselves uncomfortable speaking it, and there is no methodology for teaching English prescribed in the National Curriculum Frameworks. The absence of audiovisual equipment in most schools means that students don't get to practice listening to standard pronunciations, nor view English medium programming. The quality varies significantly by state, with the highest attainment in some northeastern and southern states where the native languages are not Indo-European.

Pedagogy of Educational Technology

The work of the MIT Education Arcade for the last 15 years has been to research, design, and develop new technology tools for education. Accordingly, our work on this project involved the application of the theories and practices that have animated all our work. While contexts in the developing world introduce distinct challenges, the preponderance of the literature suggests that the same theories of teaching and learning are generally applicable.

Outside of school, children are naturally drawn to opportunities to explore and invent, and when they engage in those activities they are preparing for future learning. When that exploration and invention is coupled with formal instruction, learning can be at its most effective, increasing students' abilities to continue to learn from new situations and resources (Schwartz, 1999). Digital technologies can provide particularly immersive environments to engage students in this exploratory and inventive activity (Papert), but technologies alone are not sufficient to motivate all learners (Klopfer). Rather teachers must be active participants, adapting the technology to match objectives based on student needs (Okojie).

Accordingly, successful adoption of new educational technologies requires that they align with the curricular activities teacher are engaged with, and depend upon the active participation of teachers, with the support of administrators (Okojie). Over time, adoption of educational technologies can lead to positive change in teacher practice, but only with the active agency of teachers (Klopfer) Properly used, frameworks can help teachers and school systems integrate new technologies into current practice (Groff).

Developing a Working Hypothesis

The results of the literature review, and the application of our own research led to several conclusions in preparation for the site visits in India.

1. Beyond what the data told us, we needed to see first hand the range of classroom conditions, and understand better teachers' engagement with technology
2. We similarly needed to meet with practitioners most engaged in promoting educational technology to learn whether their experiences align with the data, and whether they were seeing new trends that were not yet captured in the data.
3. While hardware—computers and mobile devices—would continue to change at dramatic rates, the underlying pedagogy of most educational software shifts more gradually. It therefore made sense to focus our attention more on software applications than hardware. The device in use several years from now might be radically different, but the pedagogy of software applications used would still be relevant and recognizable.
4. The sheer diversity of school conditions in India suggest that no learning technologies would be universally applicable, and it would therefore be critically important that any evaluative tools are adaptable to widely different contexts.

Accordingly, the working hypothesis that helped guide our choice of site visits and our interviews with practitioners was that we would be developing a framework to be used to evaluate technologies—generally software—either before adoption, or in the early phases of adoption. Its expressed purpose would be that of helping outside evaluators or stakeholders (developers, teachers, administrators, policy-makers and possibly parents) determine whether any technology was an appropriate *fit* for a specific context of student needs, pedagogical goals, and technical infrastructure.

Site Visits

Members of the team from MIT visited India for roughly 10 days in April 2015. Our visits largely fell into three categories:
1. Visiting sites, primarily schools, where educational technologies were being deployed;
2. Meeting with developers of educational technologies; and
3. Meeting with universities and NGO's working in educational development and educational technology.

Given India's size and diversity, and the relative brevity of our visit, the purpose of the visit was to interrogate whether our proposed framework might be applicable across the range of sites and circumstances we would encounter, and to identify partners in further developing the framework and piloting evaluations.

Educational Sites

The schools we observed ranged from the most basic to the most modern. We visited a rural village in Uttar Pradesh without a school building or dedicated classroom, where NGO Ekal Vidyalaya[1] had trained volunteers in the delivery of rudimentary math and reading lessons to children from ages 5 to 10 (after which age they would travel several kilometers to the nearest public school). There was no electricity in the outdoor classroom, and the only technology was a blackboard. We noted that there was a reasonably strong cell phone signal, should there ever be an opening for further educational development (although permanent school facilities and professional staff would be higher priorities).

We also visited a rural village in Gujarat, where another NGO, Planet Read[2] provided villagers with DVDs of subtitled Bollywood movies to be viewed communally. The intent was that the subtitling would help reinforce literacy, and Planet Read has studies supporting their effectiveness, though in the village we visited it appeared that the DVD's were rarely viewed.

At the other end of the spectrum was the Riverside School, a modern independent school in Ahmedabad with facilities that would match those of a progressive private school in the U.S. It was clear that the students used computer technology regularly in their schoolwork, though the teachers stressed that computers were merely tools in the service of an inquiry-based curriculum that did not depend on computers for its delivery.

In between these extremes we visited a series of computer labs in both public schools and community centers in Mumbai and Pune. These were run by the Pratham Education Foundation[3], one of the most influential NGO's working to improve education in India. The labs we visited were reasonably up to date in having networked, internet-enabled computers, though the computers were several years old. In most cases the hardware was donated by local industries, and the centers were staffed by volunteers who were paid minimally by Pratham, and whose jobs as facilitators were seen as steppingstones to more lucrative jobs in the high tech industry. In both the schools and community centers we visited, students/community members seemed eager to use the facilities.

The school-based labs included curricular activities around math and literacy as well as computer skills. By the report of the volunteers and teachers we spoke with, there was variation as to how well these activities would be integrated with the standard curricula taught by classroom teachers. Teachers had only limited contact with the activities in the computer labs, and were not necessarily tech savvy. Although the schools we visited with Pratham were low-income, the facilities were still judged above average thanks to the contributions of Pratham and their business partners.

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[1] http://www.ekal.org
[2] http://www.planetread.org/literacy.php
[3] http://www.pratham.org

Our school visits confirmed our supposition that in any given setting multiple variables were in play, such as: funding, technological infrastructure, pedagogical models, and teacher engagement. For a framework to be effective it would have to help evaluators or stakeholders determine the fit of a given technology with all such variables accounted for.

Technology Developers

We were able to meet with two developers, Education Initiatives (EI) in Ahmedabad, and Sesame Street in Delhi. EI creates and implements assessments, as well as Mindspark adaptive learning software (which was being piloted in the Riverside School).

Along with producing an Indian version of the popular television show, Sesame Street is creating tablet-based math and literacy games, as well as professional development for teachers using the products. Both EI and Sesame Street expressed an interest in applying the framework when it was developed, and we ended up evaluating Mindspark as part of this study.

NGOs and Universities

Along with the NGOs whose representatives we worked with on the above school visits, we met with two other organizations involved in using technology to effect educational change. The Kaivalya Education Foundation[4] assists principals and other administrators in the use of technology to support data analysis, and aid in their decision-making processes.

The Tata Trust[5] is currently collaborating with MIT on the CLIx project, developing new inquiry-driven, technology-based curricula to be used broadly at the high school level throughout India. In all of our meetings with NGO's there was a common interest in the potential use of our framework to help with the formative evaluation of their efforts.

We also met with colleagues at the Indian Institute of Technology, Gandhinagar, and the Indian Institute of Management, Ahmedabad. In both meetings there was agreement that the term "educational technology" encompassed a very wide range of activities, and that all too often technology was seen as a cure-all, applied without due consideration for the ills such technologies were meant to cure. These meetings further reinforced our working hypothesis about the nature of the framework to be developed. The interests and values shared between the teams and MIT and IIM would pave the way for the subsequent collaboration developing and piloting the framework.

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[4] http://www.kefindia.org
[5] http://www.srtt.org

Creating the Framework

In order to develop a useful tool in such complex contexts, we chose to develop a framework that pulls from and synthesizes the existing literature related to this space, as well as data and feedback from real world contexts that are seeking to effectively choose learning technologies and would benefit from external supports and tools in doing so. Frameworks offer several benefits. First, they clarify complex or ambiguous situations (Whetten & Cameron). A good framework lays out the dimensions of the complexity of the problem space--many of which would often be otherwise overlooked. A good framework puts all of these elements and dimensions on the radar of the people involved so that each can be confronted and addressed appropriately in the real-world context and problem. Second, a good framework will also help prompt and support effective engagement with each of those dimensions as it relates to their context. In other words, the framework not only frames the entire problem space, but it frames how to take steps in getting towards an effective solution. Even in a complex problem space, frameworks serve as both anchors and/or touchstones to return to, providing stability in the midst of constant change (Whetten & Cameron). Examples of earlier frameworks are included in the appendix.

We chose to structure our framework as a questionnaire, with the questions (and by extension, the framework itself) performing two functions:

1. When used by an outside evaluator, the questions can structure the exploration of all the salient elements of a proposed intervention, or one already in process.
2. When used by a stakeholder either creating, or adopting an intervention, the questions act as prompts to help the stakeholder fully reflect on the range of relevant issues, some of which may have previously gone unconsidered.

Though it would be beyond the scope of this study, it was our hope that if the framework proved effective, we would seek the means to develop an on-line version that could be administered either by evaluators or stakeholders. This would take advantages of the branching capabilities in a digital environment to tailor navigation through the framework based on user responses.

The goal for the initial pilot was to test the usability of the framework in the field, and to modify it where appropriate based on use experiences. The team at IIM joined this project after the April site visit, and contributed to the creation of the framework. Given the need to work in both English and Hindi, and of course the location of the study, it was logical that IIM take the lead on the pilot.

The Framework in Action: Piloting

The framework was tested in India, with a small team of investigators from the Indian Institute of Management, Ahmedabad carrying out the fieldwork and analysis. Our aim

in the pilot was twofold: (a) to test the framework out in various contexts where education technology was being used and see whether the questions we were asking were relevant in these contexts and (b) whether there was anything of importance to various stakeholders in the field that we were not asking, but should be. We therefore used this as an iterative process to improve the framework based on data from the field.

To meet our requirement of simultaneously testing and adding to the framework, we decided on holding semi-structured interviews and/or group discussions with various stakeholders—developers, implementing or facilitating agencies, school leaders or administrators, teachers, students and where available, parents—in sites where the technologies studied had been piloted or deployed. A semi-structured format allowed us to guide the discussions based on the framework, but also to be open to divergences and open-ended responses that might lead us to topics that our framework should focus on, but did not. However, because the data collection and analysis from such methods are resource-intensive, the number of sites for our study were limited. Surveys may have allowed us to scale up the pilot but would have restricted the open-endedness as well as the dynamic contextualization of questions that interviews allow. In our case, we felt this quality in the data was more important than the quantity.

The questions we asked were based on the framework but it is important to mention that the framework itself is not intended to be a field questionnaire. Rather, it is an interview guide for the investigator(s). To use an analogy (Silverman), these are like questions a detective might want answers to—such as who committed the crime—but doesn't always go around asking suspects or witnesses directly. Some questions, such as how often the technology is used, are fairly straightforward to ask, but others—for example, how open teachers are to changing their pedagogy to integrate technology—might require oblique questioning to prevent responses that conform to policy. As in any qualitative research, it is important for the investigator to use their discretion in deciding how to find the required answers.

Since the pilot was intended to be an iterative process to improve the framework, the data collected from each site was discussed extensively by the team and used to make additions or modifications to the framework. This updated framework was used at the next visit, whether to the same site or a new one.

Interventions Studied

Our first step was to identify a few technologies to study. We wanted technologies that had either been recently deployed or were in the process of deployment. The rationale for this was that the initial implementation challenges would likely be less salient to stakeholders for interventions that had been running for a while. In keeping with the project plan, we studied technologies that focused on English-language learning. Based on these conditions, we shortlisted about five technologies, of which we then selected three taking into account (a) diversity of context, nature of use and stage of

implementation (as explained for each intervention below) and (b) access to the various stakeholders. We provide here a brief introduction to each intervention and our initial justification for selecting it - a detailed section on each, including description of the technology and our findings in the field, follows.

1. EnglishHelper (EH) RightToRead: A read-along software for classrooms, described as multisensory since it simultaneously engages vision and hearing. The primary target seems to be students in early stages of learning to read English as a second (or third) language. The program was started in 2013, implemented in 325 government schools across 9 states in 2014-2015, and planned to expand to 5000 schools in 2015-2016[6]. The scale and recentness of deployment made this intervention relevant for our study.

2. Mindspark (MS) English: A commercial adaptive learning software, marketed to both schools and individuals. While the Math version has been around for several years, the English version of the product is under development and is currently being piloted at a private school in Ahmedabad. Mindspark is hence very different from EH: it is intended for use directly by learners and its subscription fee makes it mostly inaccessible to the lower-income groups who tend to enroll their children in government schools.

3. EkStep: A project that aims to address learning gaps in English and Math in primary education at a national scale using technology. The current strategy seems to focus on developing a meta-app meant for smartphone and tablet devices that can track learner trajectories. Other apps can then plug in to provide the required content. Currently the meta-app is in late development stage with some pilots having been conducted recently. EkStep was interesting to us since it targets both formal and non-formal education, and aims to quickly scale to millions of learners once deployed.

The following three sections will describe each intervention studied and our findings in detail. We will then come to modifications made to the framework based on these findings. The term 'technology' in the following sections refers specifically to digital technology.

EnglishHelper

Developer and Technology

EnglishHelper Inc. (EH) is a Boston-based organization that aims to "offer unique technology solutions to improve English language proficiency."[7] Their subsidiary in India, EnglishHelper Technologies Pvt. Ltd, has developed a RightToRead program that involves using a version of their read-along software, ReadToMe, in English classrooms. ReadToMe is a proprietary read-along software that allows learners to hear a text being

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[6]www.englishhelper.co.in/righttoread.php

[7]www.englishhelper.com/about.php

read aloud as the corresponding word is highlighted on the screen. The rationale behind this is provided in a white paper published by EH on their website[8]. To summarize, the paper cites studies from neuroscience showing that the relation between spoken and written word is the most difficult for our brains to learn. Hence increased exposure to multisensory modes of language learning, that is to say modes that engage the visual and auditory senses simultaneously, should help in learning to read by focusing on this difficult area.

RightToRead adapts the ReadToMe software for classroom use, for example by enlarging the word being read so that an entire class can read it when projected or displayed on a screen. This adaptation dilutes the requirement of personal devices and software licenses for each learner, thus reducing costs significantly and making it accessible to a wider range of schools. The content -- mostly the local school textbooks -- are uploaded to allow congruence with the school curriculum. The software can either read aloud the text itself, enlarging each word on the screen while reading it, or remain silent to allow the teacher and/or students to read the words. A picture dictionary is also provided and can be referenced while reading.

Implementation at Site Studied

EH has partnered with several agencies that carry out the implementation in the field for RightToRead. We chose to study its implementation in the state of Gujarat since the schools were geographically proximal and satisfied the requirement of recent implementation. In Gujarat, RightToRead is implemented by the American India Foundation[9] (AIF) as part of a broader Digital Equalizer (DE) program. The DE program uses technology and pedagogical guidance to help "under-resourced government schools" "transform teaching and learning into a collaborative, project-based approach."[10] While EH was used for English, other subjects involved, for example, interventions like getting teachers to make presentations and design classroom sessions that emphasized interactivity and conceptual rather than rote learning.

AIF relies heavily on facilitators to implement and sustain the DE intervention. These facilitators are mostly recruited from the same district and each one is assigned a cluster of schools in an area. The facilitators visit the schools twice a week, and primarily their role seems to be to support teachers in using the technology and pedagogical practices that are part of DE. For example, they might help teachers learn the technology and how to use it, or help them make the kind of presentations that would enable a more interactive classroom session. They also were responsible for making sure technical glitches were quickly resolved, and while the hardware was the responsibility of a third party, AIF had over time established good relations with the vendor's support team and could leverage that to expedite any required maintenance.

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[8]www.englishhelper.co.in/whitepaper.pdf

[9] http://aif.org/about/about-aif/

[10] http://aif.org/wp-content/uploads/2015/09/DEFlyer_3-31-15.pdf

The program in Gujarat currently runs in 80 schools across Amreli, Gandhinagar, Ahmedabad and Rajkot with half of them in Amreli, where the donor is based. The number of schools was decided based on the total funding available, and the schools themselves were selected based on a field survey of whether they had the technological infrastructure as well as administrative willingness to support the program: although all government schools had been provided a few computers, it seemed not all had kept their equipment equally well-maintained. As part of the program, two out of the 80 schools were also equipped with "TabLabs"—labs with several tablets installed that could be used by students themselves. The tablets were reportedly used for accessing instructional content such as videos that reinforced what was being taught in the classrooms.

Our Study

Our study was based on visits to three schools, two in urban areas in Ahmedabad, and one rural school in the nearby district of Gandhinagar. All the three schools had about 40 students for each class. Since these were government schools, in general they tended to cater to lower-income families, though the proportion of the community that sends its children to government schools varies based on the accessibility and affordability of private schools. The rural school was one of the two that had received TabLabs.

At each school, we spoke to at least one group of students, one or more teachers, the principal or head teacher, and the AIF facilitator responsible for that school. We tried to speak to parents, but multiple attempts at getting a group of parents together at the school only resulted in one conversation with a single parent. Most of the interactions had to be in Hindi, and we were able to record conversations at two out of the three schools. We also spoke to the leadership teams at both EH India (by phone) and AIF, and briefly observed a couple of classroom sessions.

While our focus remained on EH, for certain responses to questions in the framework, the effect of EH and the larger DE program were inseparable. For example, the comfort level and enthusiasm of the students in using technology for learning cannot be attributed to any one technology alone. This is especially true of children with limited exposure to technology for whom "technology" might be a monolithic concept, and who might hence not have bothered to distinguish between its various forms and uses. With teachers this was less difficult since they tend to teach particular subjects, and EH was dedicated to English.

Use of EH

The EH software was used three to five times a week in replacement of a regular English class, though not all schools used this for all the grades. In one of the urban schools, however, the "brighter" halves of two classes (in the same grade) were brought together and they alone received exposure to the software—the others were seemingly considered incapable of benefiting from EH. This selection seemed to be based on

academic performance, though it was not clear whether some objective parameter was used or teacher's perceptions played a role.

The most common modes of use seemed to be with the software reading aloud, while the students in a group either listened quietly or repeated aloud each word as it was spoken by the computer. Supervision of students while using the technology varied across the three schools we visited and also varied across groups of students. Students who performed well in class were more likely to be permitted to use the technology unsupervised, provided they had the exposure and comfort to operate it.

Stakeholder Perceptions

Students seemed to enjoy using technology for learning, although as mentioned it was occasionally difficult to isolate effects of EH on their enthusiasm. From classroom observations, reading aloud with EH seemed to be a fun activity for them. While effects of our presence cannot be discounted here, in general teachers did report that students looked forward to their EH session. However, given that most of these children have limited exposure to digital technology outside school, it is difficult to gauge the cause for this engagement: they could be learning better and hence have an enhanced sense of competence and self-efficacy (Ryan and Deci, Bandura); they could find the activity simpler with less chance to be individually judged; they could be excited about the novelty of using technology; they could also just be excited at the opportunity to exercise their lungs, though it is not clear why this is not possible in a regular classroom.

Teachers' feedback about EH also ranged from mildly positive to enthusiastic. Some were not trained English teachers, and were just glad to have their students exposed to correct pronunciation of English words. Others found that EH allowed them to better monitor the class and ensure discipline, since they didn't need to be on the blackboard as much. These might be the primary advantages of EH, rather than its multisensory nature, which is essentially present in any classroom where reading aloud happens with a textbook. However, teachers did consider EH a supplement rather than a substitute for regular classes, one of the primary reasons being that EH sessions did not involve any writing by the students.

Administrative willingness had been considered at the time of school selection by AIF, and hence school administrators—head teachers and principals—seemed largely in favor of the technology, especially given the positive feedback from the teachers. One of them did mention that the facilitators interacted very often with the teachers, but very little with students or administrators. One of the urban schools had multiple digital technologies being implemented at the same time, which overlapped and hence competed with each other for certain grades and subjects. This proliferation of options might have diffused the school's enthusiasm for such initiatives as compared to the other schools, where DE was more of a novelty.

Facilitators and the AIF core team reported that while teachers exhibited some reluctance in the earlier months of the program, and hence required some

encouragement from the facilitators, most were using the technology regularly now. The pedagogical changes took time to percolate, but AIF conducted regular meetings of school heads, as well as teachers whom they judged to be using the new pedagogy well, to help build and sustain momentum. Their funding was for three years, and they hoped that by then the pedagogical changes would become part of the teachers' teaching habits, and that the success of the program would bring additional funds to continue licensing EH software.

While we could not interact with parents or the broader community, we were able to glean some insights about them from other stakeholders. As mentioned earlier, most children were from low-income families and their parents had little time or knowledge to participate in school affairs - beyond ensuring the child's attendance. However, the AIF coordinators did report that rural communities exhibited a greater interest in their respective schools' initiatives than urban ones. For example, the rural *sarpanch[11]* has held AIF accountable and questioned them in multiple instances, for example when a facilitator was not available for two months. On the other hand, in urban areas the principal and teachers just wait for the government to deal with issues like dysfunctional computer mice. This difference in community interest and involvement could be a function of the variance in social and economic structures in rural and urban areas - for example professional requirements or the closeness of the community.

MindSpark English

Developer and Technology

MindSpark (MS) is a commercial adaptive learning software developed by Educational Initiatives (EI), a firm in Ahmedabad[12]. EI was founded in 2001 with a focus on personalized learning[13]. They are responsible for designing and conducting the Assessment of Scholastic Skills through Educational Testing (ASSET) tests, which are aimed at assessing skills and conceptual understanding of students in grades 3-10 across various subjects[14]. Through these tests, EI tries to provide "information on the strengths and weaknesses of individual students and also entire classes"[15] so that teachers can customize instruction based on their students' capabilities.

After years of conducting ASSET, EI used the large amount of data they had collected from these tests to develop MS for Math. MS is an adaptive learning software that enables learning by continuously asking the students questions, while introducing concepts incrementally between questions. The difficulty level of the questions as well as the learner's progress through a module depends on prior responses. Content

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[11] Head of the *gram panchayat* (local village government), constitutionally elected by village members

[12] http://www.ei-india.com/

[13] http://www.ei-india.com/about/

[14] http://www.ei-india.com/asset/

[15] ibid

generation is done entirely by EI, though they do rely on feedback from students and teachers. An elaborate reward system including points, medals, competitions, etc. has been created to provide additional motivation for learners.

While the software is designed to be able to instruct without any teacher present, it is used both in schools and homes. When used in schools, a live teacher dashboard allows teachers to keep track of the learning trajectories of each child and customize instruction accordingly for individuals, groups or even whole classrooms. MS is a browser-based application, and can only be used over the Internet unless a school installs a local server, in which case it can also be used over the Intranet.

While MS has had a Math version in the market for many years, it has recently made the move to diversify into English language learning. However, as an adaptive software MS relies mostly on assessments that are easy for a computer to conduct, such as multiple-choice questions or creating matching pairs out of two lists. Such assessments may be better suited to a subject like Math than English, since they severely restrict open-ended answers. EI is trying to use natural language processing (NLP) to increase the assessment scope of MS, and for the English version even plans to keep a team of evaluators for essay-length answers.

Implementation at Site Studied

MS English is still under development, but a substantial amount of content has been created and the software is currently being piloted at a private school in Ahmedabad. As opposed to the schools we studied under EH, this school caters to children of well-to-do families, which is the typical audience for MS given their regular subscription fees[16], as well as the need for personal computing devices and a regular Internet connection at both school and home. Correspondingly, teachers and students at the school are well exposed to digital technology and seemed to use various devices—laptops, smartphones, and tablets—regularly.

Digital technology is used by both teachers and students at school as well. Students not only have regular computer classes, they are asked to make Powerpoint presentations for other subjects as well. They could also be taken to the computer lab during other subject classes to be shown videos or clips related to their lessons and projects. Teachers believe that going beyond the textbook enables better understanding and hence make sincere attempts to do so: for example they try to make graded assignments activity-based, which could involve watching a video clip and answering questions based on it. Technology use by students without adult supervision, however, is discouraged, and teachers scrutinize all content, such as scenes and dialogues of movies, for appropriateness.

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[16] The rate for schools is negotiated, but for retail users the price plans range from $45 per three months to $125 for a year (as per http://www.mindspark.in/registration.php)

We spoke to the head of the MS English team at EI and visited the school where they are currently piloting, where we met, separately, a group of teachers and a group of students who were participating in the pilot. One of the teachers was the coordinator for the pilot: MS relies on teacher-coordinators at every school to act as liaisons. The pilot was not running consistently because of some server issues, exams, festivals, etc. but we were able to get valuable insights into some important aspects of MS use and perceptions regarding it.

Use of MS and Stakeholder Perspectives

The software was reportedly being used once a week at school with the additional option of accessing it from home. While the use at home is not compulsory, it is encouraged and most students reported accessing the software from home, though with varying frequencies. A few students, however, did not have access to a laptop or PC at home. While the use at home was optional, the students reported that those without access to technology at home were more nervous while using it in class, and also struggled to cope with the pace of the regular classroom session. Teachers were aware of gaps in student abilities in the class, and tried to help students who were erring in their answers or otherwise had doubts. MS seemed helpful to them in this regard since it provided spontaneous assessment.

The majority of students, however, had been exposed to technology since a very early age and seemed extremely comfortable with the use of technology. They needed little or no support in learning how to use MS: an orientation and demo session was arranged for an entire classroom session but took only about 5-10 minutes. The students were good to go once username and password details were provided at this orientation session, and need little supervision while using MS, though teachers did report having to monitor the extent to which answers were shared among the students. Most issues with the software are solved by teachers consulting each other, unless there are higher-level technical issues, such as issues with the local server.

The students are in general willing to use the technology at home and school, and recognize benefits from it. Using technology is seen as a needed break away from the regular classroom sessions. Teachers confirmed that students find it engaging to use MS in the class. Interactive learning on software like MS was seen as a natural extension of the activity-based pedagogy that they believed in. They understood that answering multiple-choice questions in a notebook may not be as interesting as doing the same on a computer that provides immediate feedback. They also noticed that students' egos get a boost because of the reward system in MS - encouragements like 'well done' by the software were mentioned as being helpful.

There is regular spirit of competition among the students to complete questions in MS sessions. One teacher reported students being so excited that they got pocket dictionaries to class in case they come across an unfamiliar word, something they never did earlier. The students did not face any nervousness while using MS as per the

teachers, but rather took it up as a challenge. Students were known to express severe disappointment in case an MS session had to be replaced with regular teaching.

EkStep
Developer and Technology

EkStep is a not-for-profit organization based out of Bangalore that is looking into scalable technology solutions for the problems of education in India[17]. Among its co-founders is Nandan Nilekani, a co-founder of Infosys Limited and former Chairman of the Unique Identification Authority of India. The organization focus is on finding solutions that can address the gaps in India's primary education at a national scale. Their belief is that this can be done through technology that assesses gaps in learning of individual students and tries to fill those gaps.

The need for national scale has led EkStep to relying on applications for smartphones and tablets that can be used both inside and outside the formal education system. However, rather than being just content developers, they want to enable the use of educational technology to amplify the efforts of people working in education, such as schools, NGOs, independent tutors, etc. While the team still seems to be working out its exact roadmap to achieve this vision, we discussed with them some of the steps they are taking in their approach.

One of the ways in which they are currently approaching the problem is to develop a 'meta-app' called Ekstep Genie. This is envisioned to be an application into which several educational applications can plug in to allow for an ecosystem of content that a child can navigate through. The Genie app will keep track of individual learners' trajectories through continuous assessment, and suggest relevant content based on the learner's present capabilities. By allowing other apps to work within the Genie app, the hope is to create an ecosystem of developers who provide engaging content for learners at any point in the learning trajectory.

Currently, therefore, EkStep is working mostly on creating tests that can help map a learner's current abilities, so that their learning journey can be personalized. These tests seem to be heavily based on the Annual Status of Education Report (ASER) survey conducted annually by an NGO, Pratham, to measure the learning levels of primary schoolchildren across India. ASER results have been widely cited as evidence of the poor state of primary schooling in the country, showing that a majority of children in fifth grade cannot read or do Math that is expected to be learned at a second or third grade level. EkStep cites several of these results on its website to highlight the problems that it is attempting to tackle.

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[17] www.ekstep.org

Our Study and Findings

The pilot was being conducted by an NGO, Head Held High Foundation (HHHF)[18], which works on projects ranging from conducting health camps to training people to work in the Business Process Outsourcing (BPO) industry. For this study, we visited their office in Tumkur district (about 70 kms from Bangalore), where the pilots were being conducted. We spoke to the project manager as well as two volunteers at HHHF, and also visited two schools nearby where the app was being piloted. We also visited EkStep's office in Bangalore to speak to their CEO and members of the development team, who showed us the app as it currently is.

Developing a robust testing platform seems to be EkStep's first priority right now. The pilot was essentially a process of a volunteer from the NGO taking a tablet with the EkStep platform installed to a school, and testing individual students with it. There did not seem to be any learning processes currently in place, and hence it was very difficult to evaluate exactly what the EkStep solution might look like, or what reactions it might evoke, once it takes shape fully. Many parts of our framework, therefore, were not well suited to investigating such an early-stage product. However, our investigations did lead to some interesting insights regarding the development of and ideology behind such an intervention.

The two schools we visited were private unaided schools where the pilot has been regularly conducted. The private schools did not have children from affluent backgrounds and were hence excited about getting some opportunity to use technology. Government schools, on the other hand, were reported by volunteers to exhibit more reluctance since they felt their performance would be judged based on the tests. This leads to the important realization that while digital platforms enable detailed and continuous assessment that can lead to personalized instruction, they also simultaneously enable greater surveillance, which can be perceived as a threat by many and also has serious implications for the level of control possible.

The other question that came up was the focus that such an intervention might put on meeting the requirements of standardized tests like ASER. To the extent that one believes that such tests are a comprehensive evaluation of all the learning that is desirable, this sounds encouraging. However, several criticisms have been made of constant evaluation in general (Ball) and standardized testing in particular (Rogers). Broadly speaking, it is difficult to attain perfect construct validity in such measurements, and the more instructional content caters specifically to them—in effect an extreme form of teaching to the test—the more their imperfections could get amplified to replace measurable gaps in learning with gaps that are not so easy to measure.

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[18] www.head-held-high.org

Vicarious Learnings from a Panel Discussion

At the Episteme 6 Conference held in Mumbai[19], one of the sessions involved a panel discussion on large-scale technology implementation in India, with the panelists representing three to four different educational technology projects. Some interesting points were raised both by the panelists and by the audience, and we discuss here a couple of them that we found relevant to our study, specifically the framework.

One discussion centered on the potential that digital technology provides to decentralize content production by enabling users to be both producers and consumers on the one hand. However, on the other, it also enables increased monitoring and surveillance and hence can lead to greater centralization of decision-making regarding curriculum and pedagogy with decreased room for appropriation at local levels. Which of these is encouraged might depend on underlying normative beliefs about the nature of knowledge that should be privileged. Therefore, it becomes imperative to probe how a particular intervention locates the role of knowledge or education in changing or sustaining power systems: by enabling 'underprivileged' communities to better connect to and aspire towards the dominant mainstream, or by empowering the generation and distribution of local forms of knowledge.

Another interesting discussion revolved around the sustainability of a technological intervention. It might be important to ask what exactly one is looking to sustain: the technology or the enhancements in learning it provides? While these might not be mutually exclusive, there might be cases where there are conflicts of interest between learners and technology providers or promoters of certain interventions. Therefore, it is important to ask, how a technological intervention sees and negotiates the tensions between its own self-sustenance and what is best for learners.

Framework Modifications

As mentioned earlier, the framework was iteratively transformed during the pilot, with each site studied leading to some modifications that were used in the next one. However, we present the modifications here in an integrated form.

Implementing Agencies and Facilitators

Our framework before the pilot mostly focused on actors within the school. While a section on implementation did ask explicitly about the role of external facilitators, it was accompanied by a comment that expressed doubt on whether such facilitators were common. The pilot leaves no doubt that implementing agencies, such as AIF in the case of EnglishHelper, and the facilitators they employ are important actors to consider while evaluating any technology. The role of such third-party agencies is especially important

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[19] http://episteme6.hbcse.tifr.res.in

when both developer and school lack the interest or capacity to initiate the intervention. Similarly, the need for facilitators increases if teachers and students lack the ability or willingness to learn and use the technology. In the case of MindSpark, for example, no third party was required.

Some questions that might be important to ask of such agencies are: What are the backgrounds, capacities and resource costs of facilitators? What are the motivations of such third parties? How do their levels of motivation affect the quality of implementation, and what implications does this have for the scalability of experience of the intervention? How does the voice and/or agency of the facilitators compare with that of other actors? Is the implementing organization a stable one - what are the chances of it dissolving, and how would that affect the intervention and the school?

Pedagogy, Curriculum and Assessment

The initial framework did question the pedagogical and curricular shifts that the technology under study might require. We found it was also important to consider whether pedagogy, curriculum and assessment were shifting in harmony with one another, or—at the other extreme—whether they were becoming too aligned with the technology. For example, does the technology enhance the achievement of already measured outcomes or does it lead to changes in skills that are missed by current assessments?

The sites from our pilot provide a study in contrast in relation to these considerations. EH, and the DE program in general, deal with pedagogical changes while not dealing at all with curriculum or assessment. However, the better pronunciation brought about by EH and the greater conceptual understanding aimed at by DE are not necessarily reflected in current school assessments. Technologies like MS and EkStep, on the other hand, tend to 'fit' learner trajectories to dynamic assessments made by the software, possibly at the risk of overlooking otherwise meaningful outcomes that they do not or cannot measure. Also, unless such assessments are seen in a formative rather than summative light, they might pose a threat of continuous monitoring and surveillance to learners as well as teachers and school administrators.

On a similar note, it makes sense to ask who is responsible for content generation and monitoring. While the initial framework did ask questions about appropriateness of content, and its fit with the curriculum, the process of content generation was not explicitly looked at. In the case of EH, content is mostly local textbooks, while MS and EkStep tend to centralize content production. Important questions to ask, therefore, are: Does the technology enhance or take away teacher voice in the content students are exposed to? Who is responsible for the quality of the content?

Finally, while we did ask about what pedagogical shifts a technology might entail, one important aspect that is necessary for anyone implementing the technology is to ask whether there is a backup in place in case the technology fails. Both EH and MS faced glitches in implementation that made their software unavailable for some period of

time to the respective schools. In such cases, are teachers prepared with alternate teaching plans?

General Equilibrium Questions

General equilibrium questions are important to ask with respect to scalability and sustainability of projects, and while are few of these were in the framework, we found a few others to be important that weren't. For example, at sites where EH was implemented, exposure to digital technology was otherwise rare: how does exposure to such technology affect student perceptions of their otherwise technology-poor education and lives? To what extent does novelty play a role in engagement and what would happen if digital technology became more pervasive in their educational environment?

As per the thinking that went into the framework, one of the factors in evaluating technological interventions is their sustainability. However, as mentioned in the learnings from the panel discussion, it is important to consider sustainability from a critical perspective as well. The framework did ask about opportunity costs in terms of time and resources of any intervention, but the following questions need a more explicit place: Does the intervention have boundaries for its sustainability - that is, is there an exit point based on when the intervention is no longer necessary, or might it crowd out other interventions in the future?

Engagement

The initial framework had very little focus on engagement, apart from asking whether students were excited to use the technology or not. However, our pilot shows that a more nuanced understanding of the nature of engagement can help better evaluate the suitability, sustainability and scalability of an intervention.

One important factor to consider here is the level of extrinsic motivation that a technology relies on to engage users. The line between extrinsic and intrinsic motivation is not very clear, and Ryan and Deci (2000) suggest that these might fall on a continuum rather than be binaries. However, studies have shown that extrinsic motivation tends to crowd out intrinsic motivation (Ryan and Deci; Gray). Software like MS rely heavily on gamification to keep students motivated. While students did report finding the immediate feedback fun, and such reward systems are quite common in educational systems in general, the long-term effects of these need to be considered. Of course, it is important to simultaneously ascertain whether sufficient intrinsic motivation exists or can be nurtured if extrinsic motivation is avoided.

The alignment between the educational aspects of the technology and those that students find engaging is important to consider (Cordova and Lepper), especially when the technology is in their hands. For example, in MS students bringing dictionaries to the classroom to better compete against their peers might be seen as a step towards better English learning, provided such competition does not take away from reflection on and

retention of the knowledge used. Again, it would be useful to compare the extent of these with a regular classroom.

Broader Learnings About the Framework
What Kind of Evaluation

Prior CITE projects have primarily focused on evaluating particular technologies to aid users and policy-makers in developing countries to make better choices of technology. We were aware that this project would be quite different from earlier ones; especially given the much larger role that context plays in educational interventions. Our pilot confirmed that it can be difficult to separate evaluation of educational technologies from the particular contexts in which they are deployed. Success of the intervention is not just about the technology but also about how the various stakeholders interact with each other and with the technology.

The study also confirmed that the scope for some form of decontextualized summative evaluation, therefore, is limited. As we anticipated, the framework would be more useful as a formative assessment: given a particular context, one can use the framework to understand potential costs, benefits, and obstacles to implementation and thus better design a technological intervention. Selection of a particular technology could be part of this process but the framework would be of limited use if this were done independent of context.

Adapting the Framework to Other Domains & Locales

As initially developed and subsequently modified, the framework addresses questions of "fit" between a particular intervention and a given educational context. For the sake of focus, we piloted the framework by evaluating the use of English language and literacy products being deployed in India. The particular circumstances we encountered on the ground informed our thinking and contributed to further refinement of the framework.

While it follows that further applications of the framework might lead to further refinements, we nevertheless believe that this framework is robust enough to successfully be deployed in other contexts, be they other academic domains or other countries' educational systems. We base this confidence on the nature of the modifications that occurred during the piloting. Specifically, these modifications tended to introduce new dimensions to questions already present in the framework, like those of implementation, equilibrium, or engagement. In no cases did these modifications suggest that the general drift and direction of the evaluation had been off the mark. There is nothing in the experience of this initial pilot to suggest there are significant gaps in its current scope.

Self-Administered Evaluation, Potential Technological Implementation and the Building of a Knowledge Base

This document details the findings from the use of the framework as an evaluative tool in three distinct contexts in India. In all cases the evaluation was performed by the IIM members of the CITE research team, and the pilot demonstrates the value of the framework as a tool for third-party evaluators.

The framework was designed for a second purpose, for which this pilot did not provide adequate scope, and that is as a self-administered evaluation. To repeat a point made in our initial problem statement, there are a number of variables that are not always fully accounted for by various decision makers in the educational system. The framework was intentionally constructed as a series of questions so that a technology developer, an administrator or a teacher might use it to prompt reflection as they contemplate the creation of, or adoption of a new technological intervention.

This second use of the framework as a self-administered evaluation would lend itself well to an on-line implementation. Users logging into the framework would be prompted to identify the roles they play in an educational system, and that would in turn influence the nature and sequence of the prompt questions to which they would be exposed. Certain key questions would be used as triggers to lead to additional resources, be they research about a particular domain, or evaluations of existing products, or resources for solving particular implementation problems identified through the process of completing the framework.

To be successful, such an-line framework would require careful design, and rigorous iterative development, but it would not be computationally complex. Ongoing maintenance would only require the occasional refreshing of linked resources, which would in all cases remain outside of the core computational architecture, and therefore be easily updated. The framework would be adaptable to multiple languages, and could be maintained by a network of NGOs or academic institutions around the world, with only a modest investment of effort. Properly structured, such a network might also function as a community of practice, continually building out the framework and associated resources. In the process this network would be creating and sustaining an interactive knowledge base, built upon shared findings as the tool is used with increasing frequency throughout the developing world.

Acknowledgements

We are also grateful for the advice of our colleagues on the CITE project, and at USAID. Their input was essential in the initial formulation and ongoing execution of this project, and we benefitted greatly from the methodologies they have developed, and their extensive experience performing evaluations in other domains.

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Appendix One: CITE Framework for Educational Technology Adoption and Implementation

TEACHERS	
T.1.	**Comfort**
T.1.1.	Comfort with Technology *How comfortable are the teachers with technology?* *In terms of general use as well as in an educational setting.*
T.1.2.	Comfort with Teaching Students Technology *How comfortable are teachers in teaching students how to use the technology?* *As is, and then with additional training.*
T.2.	**Competence**
T.2.1.	Professional Development Required *How much learning of the technology would teachers need?* *And what is the structure? (one day vs. multiple sessions?)*
T.2.2.	Resources for Professional Development *Who would provide the instruction?* *Outside vs. in-school employee*
T.2.3.	Professional Development Scheduling *When would the instruction happen?* *Are additional work hours needed?*
T.2.4.	Professional Development Costs *What additional costs are associated with the instruction?* *Do the teachers, school, or technology company cover these costs?*
T.3.	**Openness to Change**
T.3.1.	Learning Technology *Are teachers willing to learn how to use the technology?* *How much time are they willing to put in to learn how to use the technology?* *Is there an associated job training benefit of learning the technology?*
T.3.2.	Learning New Pedagogies

	Are teachers willing to change their pedagogy to accommodate the use of technology? *Has it been made clear to teachers why they are using the technology?* *Is the technology in alignment with teachers' current learning goals for students?* *Is the technology in alignment with the school-wide goals for learning?*
T.4.	**Role**
T.4.1.	Role with Technology *What is the role of the teacher in the implementation of the technology?* *Is the technology seen as an "added responsibility" or a "teacher replacement" without any benefits?* *Is the technology perceived in a positive light, as a tool to aid in teaching/learning? How does the teacher interact with students using the technology?*
T.5.	**Classroom Management**
T.5.1.	Monitoring Technology Use *How will the technology use be monitored (so students cannot access inappropriate content)?* *Does the technology company put restrictions in place?* *Are the teacher/school responsible for monitoring content? Do they know how to effectively set up monitoring?*
T.5.2.	Demands by the Technology *Does the technology create a burden of extra management for the teacher?* *Does the technology make learning more efficient and effective in terms of time for the teacher?* *Is the teacher aware of how the students are using the technology at an individual level?* *Does the teacher receive usage and progress reports or can they monitor usage easily?* *Does monitoring the usage take a lot of extra effort for the teacher?*

STUDENTS	
S.1.	**Comfort**
S.1.1.	Comfort with Technology *What do they know how to do/ what is their comfort level with technology?* *Including the kinds of technology they have comfort with (phones, tablets, PCs, etc.) and the actions they are comfortable with using the technology for (i.e. word processing, apps, internet, etc.)*
S.1.2.	Student Support

How much instruction would students need to use the technology?
WHEN would this happen?
In school vs. after school hours
Would students be willing to come in after school for the instruction?
WHO would provide the instruction?
Teachers vs. outside facilitators
HOW MUCH would the instruction cost?
In terms of teacher time or outside facilitator cost/time
Will students master technology with greater facility than teachers?
Could they assist the teacher in mastering the technology?

S.2.	**Access**

S.2.1.   Student Home Access

What technology, if any, do students have access to at home? In other public spaces (i.e. public library, afterschool programs, etc.)?
Do they share access or do they have individual devices?

S.2.2.   Student-Technology Access Needs

Would they need access to the technology at home as well as in school?
If they need access at home, how frequently and how much time per use?
Is technology equally accessible in all homes?

S.2.3.   Equitable Access

Will there be equitable access to technology for students between genders and age-levels (where appropriate)?
How can this be ensured?

S.3.	**Openness to Change**

S.3.1.   Learning Technology

How willing are students to use the technology in school/at home?

S.3.2.   Perspective on New Technologies

Do students view technology as an opportunity or a burden?
Are students excited about the chance to use this technology?
Are they nervous about using this technology?
Does this depend on their age/gender?

COMMUNITY / SOCIAL / POLITICAL

CSP.1.	**Implementation**

CSP.1.1.   Outside Facilitator Needs

	Is there a facilitator from outside of the school that is necessary to implement the technology? *How are they associated with the school?* *What is the dynamic between the facilitator and the teachers/students/administration? (in terms of interaction and culture)* *Does the school have to pay the facilitator? How much?* *What are the motivations of the outside facilitator?* *Is the facilitating agency stable over the long haul?*
CSP.1.2.	Teacher Requirements *What is the degree that the tech is implementable without the teacher?* *Do teachers/facilitators need to always be present? Sometimes present? Never present?*
CSP.2.	**Support**
CSP.2.1.	Perceptions of Technology *How is the technology perceived by the community?* *Opportunity vs. unnecessary*
CSP.2.2.	Support of the Technology *Is there political support for the use of the technology?* *In what form? Local government? State government?*
CSP.2.3.	Reporting Needs *Is it necessary to provide reports to any community/political/funding organizations?* *How often must these reports be done?* *What is the necessary content of the reports?* *Does the completion/accuracy/content of the reports determine funding or support of the program?*
CSM.2.4.	Governmental / Administrative Approval *Is government approval necessary to use the technology?* *If so, how does approval occur? Is there a long time lag to gain approval?*

COMMUNITY / SOCIAL / POLITICAL

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LEARNING

L.1.	**Learning Goals / Impact on Learning**
L.1.1.	Learning Goals *What are the learning goals? (teacher and school-based)* *Are these goals currently being met?* *Is the technology appropriate for addressing these goals?* *Is the technology necessary to achieve these goals?* *Is technology the best method for achieving these goals?* *What learning goals will not be met by the technology?*

L.1.2.	Evidence of Learning
	Is there evidence that the use of this technology aids learning? *What is the evidence? Is it reliable?* *Is the evidence generalizable to this context?*
L.1.3.	Measurement of Learning
	How will learning as a result of the technology be measured? *Standard assessments, pre/post tests?* *Qualitative measures?* *Will assessments align with existing learning goals or be tailored to the technology's affordances?*
L.2.	**Pedagogy**
L.2.1.	Current Pedagogical Model
	What is the pedagogical model right now? *Direct Instruction by teachers?* *Collaborative Learning?* *Inquiry-based Learning?* *Project-based Learning* *Problem-based Learning* *Are pedagogical approaches uniform across the school or do teachers have some autonomy in terms of teaching styles?*
L.2.2.	Current Classroom Tools
	What tools are used to teach in the classroom? *Textbooks* *Worksheets* *Hand-outs* *Games* *Hands-on models* *Other?* *Are computers used in the classroom? If so, how?* *Are mobile devices used in the classroom? If so, how?*
L.2.3.	Proposed Pedagogical Model
	What should the pedagogical model look like with the technology? *Does it need to be school-wide (all teachers adopt)?* *Student centered vs. teacher centered*
L.2.4.	Blended Learning Capacity
	To what extent are teachers prepared to implement a blended learning environment? *Are teachers willing to change their pedagogical practices to utilize the technology? (see teachers > willingness to change)*
L.2.5.	Impact on Current Practices

What would be the impact on teaching practices with technology in the classroom?
New pedagogical model?
Need to adapt to a new style of teaching?
Need to work closely with a second teacher/facilitator to help students use the technology?

L.3	**Curriculum**

L.3.1.	Technology-Curriculum Fit

How does the technology fit within the current curriculum?
Is it a natural addition to support learning?
Would the technology significantly change the current curriculum?
Is local adaptation/modification of the technology possible, and at what cost?

L.3.2.	Technology's Role

Is the technology designed to be a stand-alone tool or to provide extra support for the content that is already being taught?
Is the school willing and able to use the technology as it has been designed to be used? (i.e. throw out the old curriculum if necessary)
Does the technology empower learners to create knowledge, or require reliance on dominant/mainstream sources of knowledge.

CULTURE

C.1.	**Cultural Relevancy**

C.1.1.	Culturally Appropriate

Is the technology culturally appropriate? In terms of…
Content?
Structure?
Age level?
Implementation model (i.e. does it engage all necessary stake-holders
Interaction between students/teachers/genders?

INFRASTRUCTURE

I.1.	**Equipment**

I.1.1.	Equipment Required

What equipment is necessary for the technology?
Besides the main equipment (i.e. computers/tablets/other), are there other accessories (keyboards, projectors, etc.) that would be necessary to use the technology?
How much impact would the additional equipment (accessories) have on learning? (i.e. are they essential?)

I.1.2.	Equipment Sourcing
	Who is providing this equipment?
	Are they donating the equipment or is there a cost? What is the cost? Is it paid one time or as an annual fee?
	Will the distributor cover repairs and maintenance or will that be covered at the school level? If covered at the school level, what is an estimation of the cost? Is it paid as insurance (annually) or as problems arise (fee each time a repair needs to be made)?
	Does the technology help reduce other operational or capital costs?
I.1.3.	Storage
	How, and where, will the equipment be stored?
	Is the space secure? How will it be accessed? Who will have access to it, and when?
I.1.4.	Maintenance
	What ongoing maintenance can be anticipated?
	Who will conduct and manage this maintenance? Are there are enough resources available to support this?
I.2	**Electricity**
I.2.1.	Electricity Requirements
	Will electricity be necessary?
	If so, is it just for charging? Or does the technology always need to be plugged in?
	Is the electricity reliable? (How often does it go out at the school and for how long?)
I.3.	**Internet**
I.3.1.	Internet Requirements
	Does the technology require internet access?
	If so, what kind of speed is necessary per device?
I.3.2.	School Internet Resources
	Does the school have internet access?
	If so, where?
	How reliable is it? (always works vs. sometimes works)
	Is there sufficient bandwidth to support the technology?
	How many students could be online at once using the device/program?

SUSTAINABILITY
SU.1.   **Funding**
SU.1.1.   Technology Costs

What are the costs of the technology?
How much does the developer/donor agency pay?
How much does the school pay?
Are students/families responsible for any costs associated with the technology?
Are all families able to afford these costs?
Will cost be a deterrent to participation?
Are there ways to support students whose families can't or won't pay the cost?

SU.1.2.	Technology Funding
	What does the budget for technology at the school-level look like? *Is there a budget constructed for the technology (capital expense vs. overhead)?* *Is there a sustainable plan to continue funding the technology over a period of time?* *Are the costs paid annually or on some other time schedule or randomly as they occur?*
SU.1.3	Technology Return on Investment
	What are the trade-offs (in terms of resource allocation), if any, of implementing the technology? *If the school pays a significant price, what are they cutting to have that money available for technology?*
SU.2	**Maintenance & Repairs**
SU.2.1.	Technology Maintenance & Support
	Will frequent maintenance and repairs be needed? *What are the likely maintenance and repair needs?* *Can teachers/students/community learn to maintain equipment?* *If not, is support/repair easily accessible.* *Are there backups for when the technology fails?*
SU.2.2.	Support Plan
	Are there plans and funding for the necessary maintenance and repairs? *Insurance vs. paying costs as they arise?* *Dedicated budget for maintenance?*
SU.2.3.	Implementation Support
	Do the teachers know how to report problems and access maintenance for the equipment?

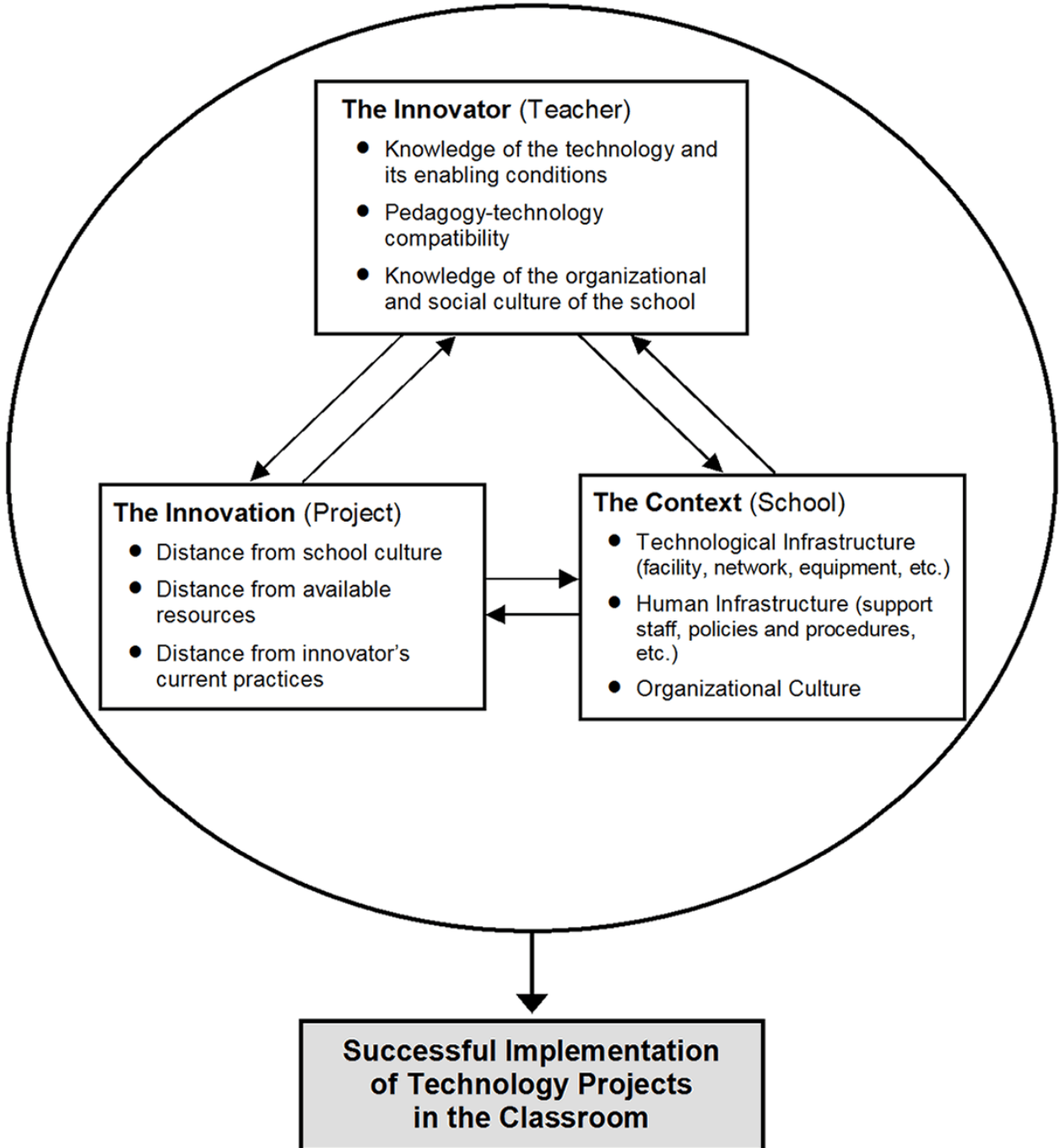| SCALABILITY / MARKET IMPACT	
SM.1.	**Broader Community Impact**
SM.1.1.	Key Stakeholders
	Are there other stakeholders for this technology (outside of the teachers, students, school,

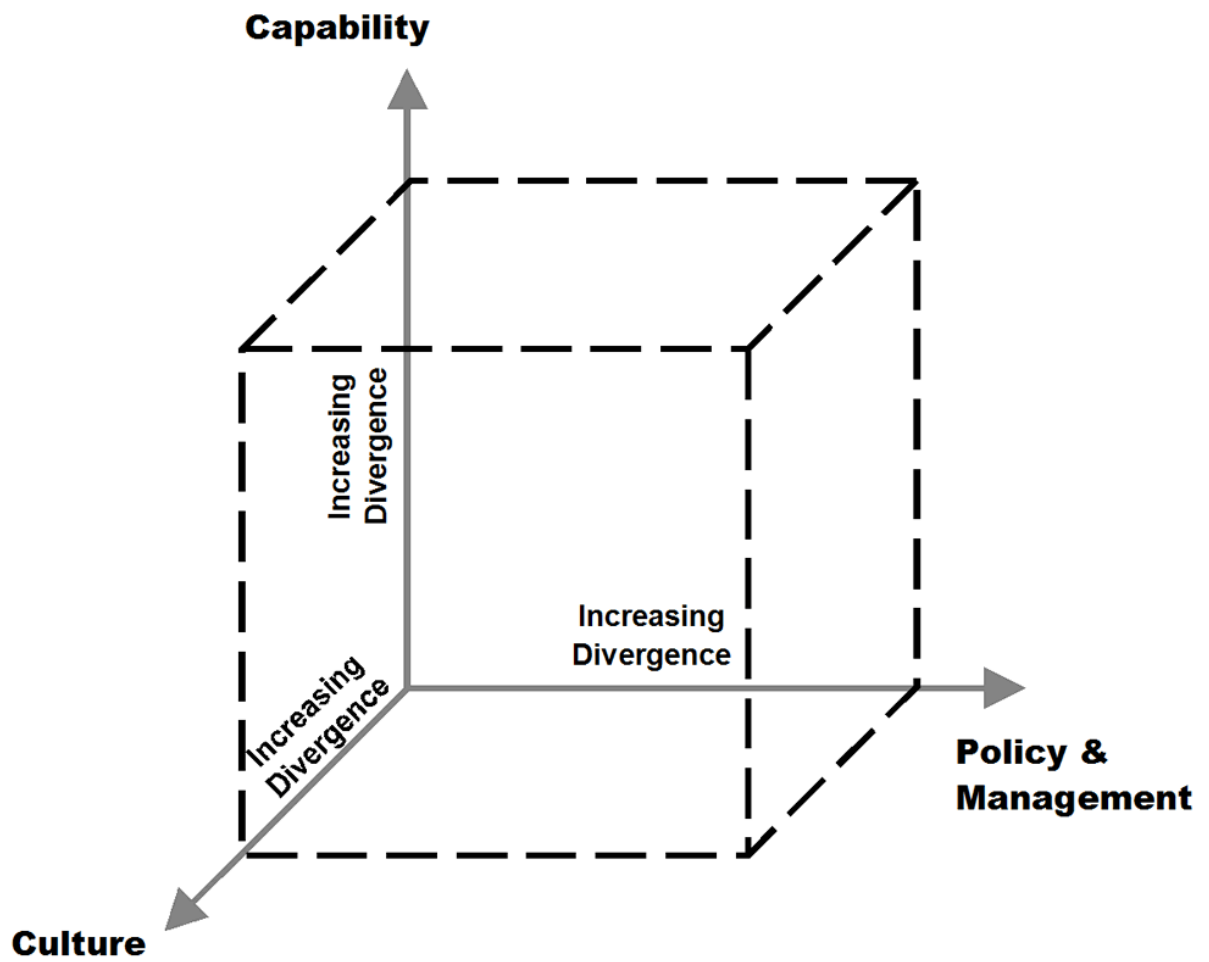|		
	and developers)?	
SM.1.2.	Communication Plan	
	What is the communication plan for informing the stakeholders about the technology and sharing it more broadly?	
SM.1.3	Best Practice Sharing	
	How will best practices be shared throughout the community using the technology? *Does the developer or a donor have an appropriate network or channel to share information?*	
SM.2	**Adoption & Scaling**	
SM.2.1.	Economic Benefits	
	Are there economic benefits to using this technology? *Tangible skills for students, teachers, or facilitators that would aid earning potential now or later?* *Are these based on content knowledge or digital literacy?*	
SM.2.2.	Incentives for Adoption	
	Do incentives to encourage technology adoption exist? *If so, what are they and how influential are they?*	
SU.2.3.	Adoption Mechanisms	
	Do informational structures to learn about benefits and scale the technology exist?	

Appendix Two

Earlier Research-Based Tech Integration Frameworks

The Innovator (Teacher)
- Knowledge of the technology and its enabling conditions
- Pedagogy-technology compatibility
- Knowledge of the organizational and social culture of the school

The Innovation (Project)
- Distance from school culture
- Distance from available resources
- Distance from innovator's current practices

The Context (School)
- Technological Infrastructure (facility, network, equipment, etc.)
- Human Infrastructure (support staff, policies and procedures, etc.)
- Organizational Culture

Successful Implementation of Technology Projects in the Classroom

SOURCE: "Conditions for Classroom Technology Innovation" framework developed by Zhao, Y., Pugh, K., Sheldon, S., & Byers, J. (2002). Conditions for Classroom Technology Innovations. *Teachers College Record, 104*(3), 482-515.

Capability

Increasing Divergence

Increasing Divergence

Increasing Divergence

Policy & Management

Culture

SOURCE: Framework to evaluate the usability of innovations developed by Fishman, B., Marx, R., Blumenfeld, P., Krajcik, J., & Soloway, E. (2004). Creating a framework for research on systemic technology innovations. *The Journal of the Learning Sciences, 13*(1), 43-76.

LoTI Framework

Level: 0   **Category:** Non-use

Description: A perceived lack of access to technology-based tools or lack of time to pursue electronic technology. Existing technology is predominantly text-based.

Level: 1   **Category:** Awareness

Description: The use of computers is generally one step removed from the classroom teacher. Computer-based applications have little or no relevance to the individual teacher's operational curriculum.

Level: 2   **Category:** Exploration

Description: Technology-based tools generally supplement the existing instructional program. The electronic technology is employed either as extension activities or as enrichment exercises to the instructional program, and generally reinforces lower cognitive skills development.

Level: 3   **Category:** Infusion

Description: Technology-based tools including databases, spreadsheet and graphing packages, multimedia, and desktop publishing applications, and Internet use are selected to augment specific instructional events.

Level: 4A   **Category:** Integration (Mechanical)

Description: Technology-based tools are integrated in a mechanical manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. Heavy reliance is placed on prepackaged materials and outside interventions that aid the teacher in the daily operation of their instructional curriculum. Technology is perceived as a tool to identify and solve authentic problems perceived by the students as relating to an overall theme/ concept. Emphasis is placed on student action and issues resolution that require higher levels of cognitive processing.

Level: 4B   **Category:** Integration (Routine)

Description: Teachers can readily create Level 4 (Integrated units) with little intervention from outside resources. Technology-based tools are easily integrated in a routine manner that provides rich context for students' understanding of the pertinent concepts, themes, and processes. Technology is perceived as a tool to identify and solve authentic problems relating to an overall theme.

Level: 5   **Category:** Expansion

Description: Technology access is extended beyond the classroom. Classroom teachers actively elicit technology applications and networking from business enterprises, governmental agencies, research institutions, and universities to expand student experiences directed at problem-solving, issues resolution, and student involvement surrounding a major theme.

Level: 6   **Category:** Refinement

Description: Technology is perceived as a process, product, and tool toward students solving authentic problems related to an identified "real world" problem or issue. Technology, in this context, provides a seamless medium for information queries, problem-solving, and/or product development. Students have ready access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task.

SOURCE: "Levels of Technology Implementation" framework for measuring classroom technology use by Moersch, C. (1999). Levels of technology implementation: A framework for measuring classroom technology use. *Learning and Leading with Technology, 26*(8), 59-63.

Stages of Instructional Evolution

Entry	• Teachers have little or no experience with computer technology • Nervous about using the technology • Experienced problems typical of a first-year teacher (i.e. discipline, resource management)
Adoption	• Concern for how technology can be integrated into daily instructional plans • Using technology to support traditional text-based drill-and-practice instruction • Students mainly receive undergo and individualized seatwork
Adaptation	• New technologies become fully integrated into traditional classroom practice • Lecture and seatwork are main student tasks, but supported with computer work • Productivity with computers is now the central theme
Appropriation	• Teacher's mastery of technology increases; ability to overcome challenges associated with the technology • New instructional patterns; team teaching, interdisciplinary project-based instruction, individually paced instruction • Teachers reflect on instructional practices
Invention	• Teachers experiment with new instructional patterns • Team teaching, interdisciplinary project-based instruction, individually paced instruction are common

SOURCE: The conceptual framework of patterns of teaching and learning by Sandholtz, J., Ringstaff, C., & Dwyer, D. (1997). *Teaching with technology: Creating student-centered classrooms.* New York: Teachers College Press.

Statements on the Stages of Concern Questionnaire

Stage 0 – *Awareness*
- "At this time, I am not interested in learning about this innovation."
- "Although I don't know about this innovation, I am concerned about things in this area."
- "I am completely occupied with other things."

Stage 1 – *Informational*
- "I would like to know how this innovation is better than what we have now."
- "I would like to know what the use of the innovation will require in the immediate future."
- "I would like to know what resources are available if we decide to adopt this innovation."

Stage 2 – *Personal*
- "I would like to know how my role will change when I am using this innovation."
- "I would like to have more information on time and energy commitments required by this innovation."
- "I would like to know how my teaching or administration is supposed to change."

Stage 3 – *Management*
- "Coordination of tasks and people is taking too much of my time."
- "I am concerned about time spent working with nonacademic problems related to this innovation."
- "I am concerned about my inability to manage all the innovation requires."

Stage 4 – *Consequence*
- "I would like to use feedback from students to change the program."
- "I would like to excite my students about their part in this approach."
- "I am concerned about evaluating my impact on students."
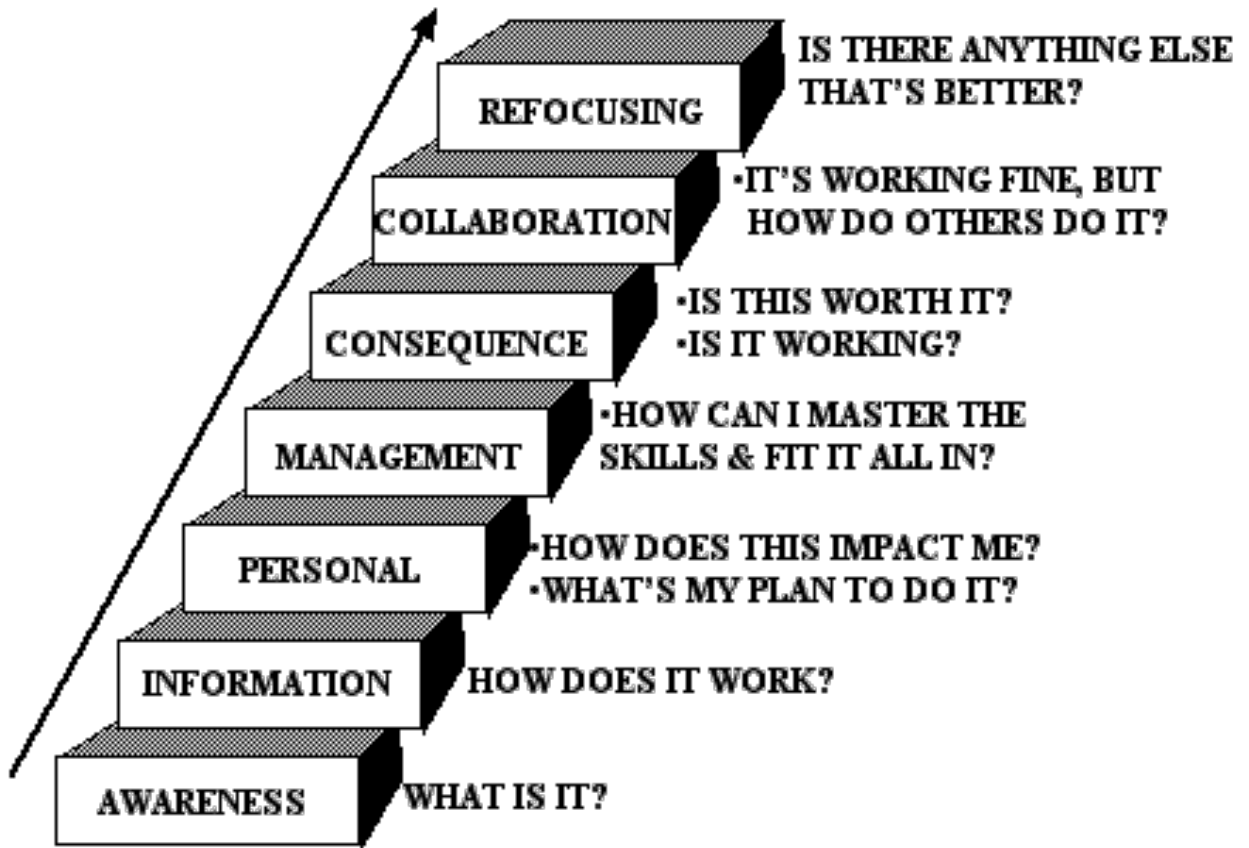
Stage 5 – *Collaboration*
- "I would like to know of some other approaches that might work better."
- "I would like to coordinate my effort with others to maximize the innovation's effects."
- "I would like to familiarize other departments or persons with the innovation's effects."

Stage 6 – *Refocusing*
- "I would like to determine how to supplement, enhance, or replace the innovation."
- "I would like to modify our use of the innovation based on the experiences of our students."
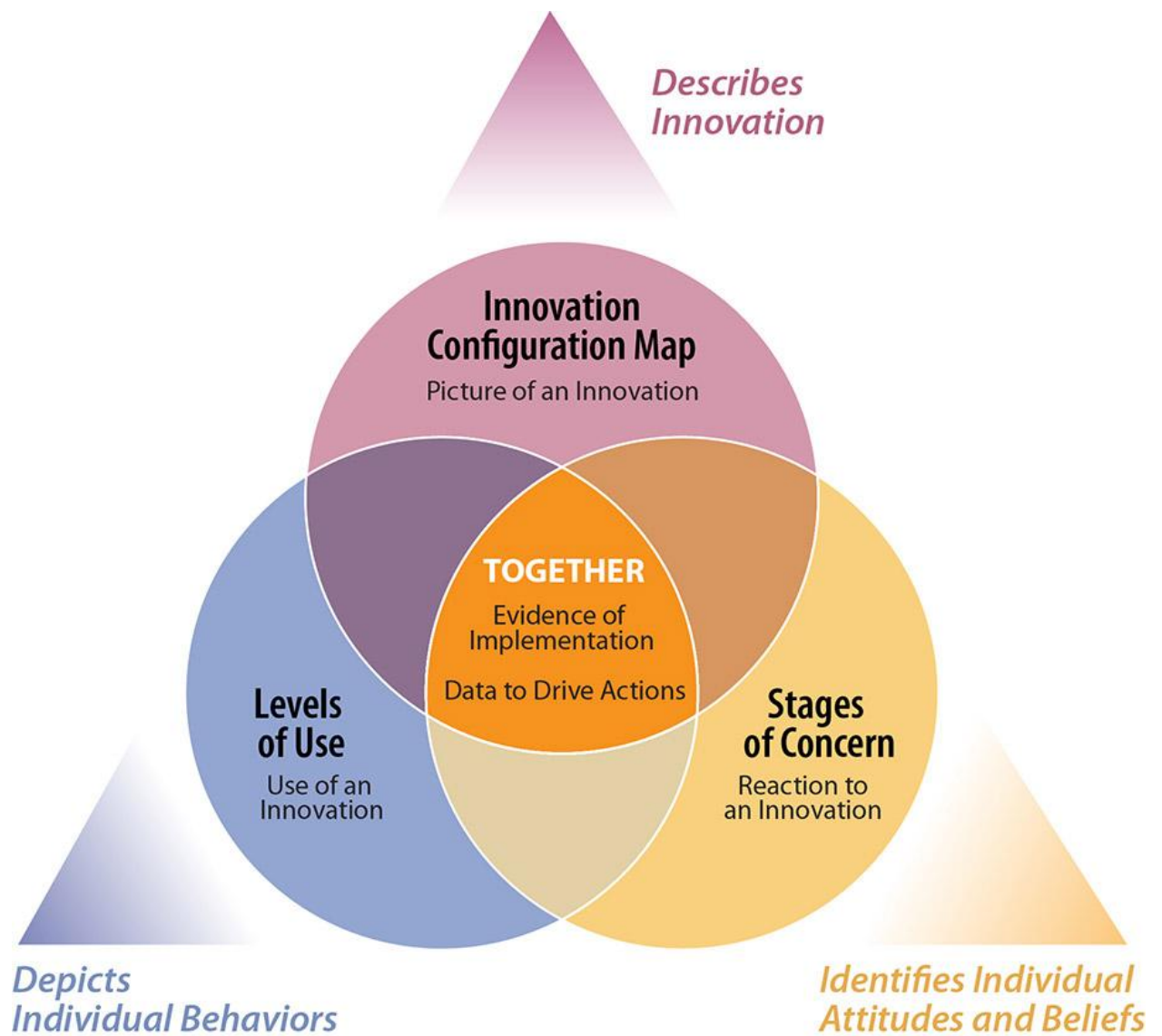- "I would like to revise the innovation's instructional approach."

SOURCE: The 7 Stages of Concern, adapted from Rakes, G., & Casey, H. (2002). An analysis of teacher concerns toward instructional technology. *International Journal of Educational Technology, 3*(1).

STAGES OF CONCERN (CBAM)

REFOCUSING — IS THERE ANYTHING ELSE THAT'S BETTER?

COLLABORATION — •IT'S WORKING FINE, BUT HOW DO OTHERS DO IT?

CONSEQUENCE — •IS THIS WORTH IT? •IS IT WORKING?

MANAGEMENT — •HOW CAN I MASTER THE SKILLS & FIT IT ALL IN?

PERSONAL — •HOW DOES THIS IMPACT ME? •WHAT'S MY PLAN TO DO IT?

INFORMATION — HOW DOES IT WORK?

AWARENESS — WHAT IS IT?

SOURCE: George, A. A., Hall, G. E., & Stiegelbauer, S. M. (2006). *Measuring implementation in schools: The Stages of Concern Questionnaire.* Austin, TX: SEDL.

Describes Innovation

Innovation Configuration Map
Picture of an Innovation

TOGETHER
Evidence of Implementation

Data to Drive Actions

Levels of Use
Use of an Innovation

Stages of Concern
Reaction to an Innovation

Depicts Individual Behaviors

Identifies Individual Attitudes and Beliefs

SOURCE: Hall, G. E., Dirksen, D. J., & George, A. A. (2006). Measuring implementation in schools: Levels of Use. Austin, TX: SEDL.

Appendix Three
Project Staff MIT

Principal Investigator

Eric Klopfer is a Professor at MIT, and the director of the MIT Scheller Teacher Education Program and the Education Arcade. His research focuses on the development and use of computer games and simulations for building understanding of science, technology, engineering, and mathematics. The games that he works on are designed to build understanding of scientific practices and concepts as well as critical knowledge, using both mobile and web-delivered game platforms. In the realm of simulations, Klopfer's work focuses on students understanding complex systems through, and connecting computer programming with, scientific practice, critical thinking, and real-world issues. He is the co-author of the books, Adventures in Modeling and The More We Know, as well as the author of Augmented Learning.

Project Lead

Scot Osterweil is the Creative Director of the MIT Education Arcade, and a Research Director in the MIT Comparative Media Studies/Writing Department. He has over 20 years experience developing educational software and games in a range of domains. He is currently leading the development ELL software with funding from the William and Flora Hewlett Foundation and the Bill and Melinda Gates Foundation. He has traveled and collaborated extensively in the developing world.

Researcher

Ilana Schoenfeld manages the development of educational content across various media including online courses, computer simulations, and accompanying student and teacher materials, and has worked in developing world contexts.

Research Assistant

Stacey Allen earned her master's degree in the Technology and Policy Program at MIT with a focus in educational technologies. Her research focused on the process of implementing educational technologies in school districts domestically and abroad.

Research Assistant

Jennifer Groff is a PhD student at the MIT Media Lab. Her research focuses on the design and development of learning technologies, curriculum and assessment ontologies, and the nature of innovation in learning environments and systems. She has done extensive research on educational technology frameworks.

Project Staff, IIM, Ahmedabad

Principal Investigator

Ankur Sarin is currently a faculty member of the Indian Institute of Management Ahmedabad's Public Systems Group and the Ravi J Matthai Center for Innovation in Education. He has a PhD in Public Policy from the University of Chicago and prior to joining IIM-Ahmedabad, was a Researcher at Mathematica Policy Research, Princeton.

He has worked on impact evaluations on a wide range of social policies and programs and his past work includes understanding the influence of technology on the social and economic life of disadvantaged communities.

Lead Researcher
Prateek Shah is a doctoral fellow in the 'Innovation and Management in Education' area at the Indian Institute of Management, Ahmedabad, where he also received his Post-Graduate Diploma in Management. His prior education includes a BS and MS in Computer Engineering from Georgia Tech. Innovative applications of technology in education is a research topic of significant interest for him.

Research Assistant
Sai Priya Kodidala is a Research Associate at the Indian Institute of Management, Ahmedabad. She is a student of Birla Institute of Technology and Science, Pilani, pursuing M.Sc. (Hons) Mathematics and B.E (Hons) Electrical and Electronics.