Comprehensive Initiative on Technology Evaluation

A FRAMEWORK FOR EVALUATING APPROPRIATENESS OF EDUCATIONAL TECHNOLOGY USE IN GLOBAL DEVELOPMENT PROGRAMS

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Introduction

As digital media proliferate, and increasing amounts of daily work are performed in digital environments, there are growing demands from parents, educators, and governments to deploy educational technologies in global development programs, 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; or
- 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, 2011). 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).

It would be difficult to overstate the challenges inherent in any effort to objectively evaluate the effectiveness of a given educational technology. To begin, 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 identifies 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.

Developing a Framework

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, 2014). 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, 2011).

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.

Informing the Framework

Following an extensive literature review, the framework was developed by researchers at the Massachusetts Institute of Technology, and then tested in India, with a small team of investigators from the Indian Institute of Management, Ahmedabad carrying out fieldwork and analysis. The aim in the pilot was twofold: (1) to test the framework out in various contexts where educational technology was being used and see whether the questions we were asking were relevant in these contexts and (2) 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.

The schools we observed in the pilot study ranged from the most basic to the most modern, including:

- A rural village in Uttar Pradesh without a school building or dedicated classroom, where NGO Ekal Vidyalaya had trained volunteers in the delivery of rudimentary math and reading lessons to children from ages 5 to 10

- A rural village in Gujarat, where another NGO, Planet Read, provided villagers with subtitled Bollywood movies to be viewed communally to reinforce literacy

- Riverside School, a modern independent school in Ahmedabad with facilities that would match those of a progressive private school in the U.S.; students used computer technology regularly in their schoolwork

- A series of computer labs in both public schools and community centers in Mumbai and Pune run by the Pratham Education Foundation, one of the most influential NGOs working to improve education in India

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.

In addition, we studied three English language learning technology interventions that had either been recently deployed or were in the process of deployment, taking into account (a) diversity of context, nature of use and stage of implementation and (b) access to the various stakeholders. The technologies included:

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.

2. Mindspark (MS) English: A commercial adaptive learning software, marketed to both schools and individuals. Mindspark is intended for use directly by learners and its subscription fee makes it inaccessible to lower-income groups who 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. 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.

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. The framework that follows is informed by the findings of this pilot study, which are detailed in the full report available at cite.mit.edu.

Generalizability and Use in Other Contexts

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. There is nothing in the experience of this initial pilot to suggest there are significant gaps in its current scope.

Using the Framework

In the course of this study we developed a framework to be used by various stakeholders in assessing the appropriateness of new educational products or interventions including:

- Developers of new technologies;
- Adopters of new technologies, including system-wide administrators, school principals or teachers; or
- Funders of new technologies.

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.

The framework is designed to assist multiple stakeholders to more successfully plan and implement an educational technology in a given setting. This could range from a single teacher wanting to try a new technology in his or her classroom, to an entire district or state system of education seeking to implement a technology-based learning program.

For the case of individual teachers, this might involve reviewing the elements of the framework in regards to any particular educational technology they desire to use, and reflecting on the answers in order to identify and address and barriers that may come up. For example, the framework includes elements such as "technology resources required," where a teacher might identify that the tool in question requires high-speed Wi-Fi in order for the students to effectively do the types of learning activities in the classroom that the teacher imagines, and therefore the teacher might either choose to not use the technology or find ways to work around this. Another example would be "access to resources and supports," and in reviewing this part of the framework teachers might realize that they don't have anyone in their school who can help them and therefore seek out someone in their professional network who knows about this tool that they can connect with should they run into any problems while using the tool in the classroom.

For any of the elements, the individual might respond to the prompt in one of four ways:

1. I don’t know the answers yet;

2. No the specific conditions are not present;

3. It will require additional resources to work; or

4. There is a fit/the conditions are present

For a given aspect of the framework, if the response is #1, then the user needs to dig deeper and better understand the tool and/or the context and resources he or she is working with. If the response is #2 or #3, the user needs to consider what would need to change, and if that change desirable or even possible. If the response is #4, the user has identified an area of strength for this implementation, which may be able to help support other areas that are lacking.

Framework Overview

TEACHERS

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T.2. Competence
T.3. Openness to Change
T.4. Role
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SCALABILITY & MARKET IMPACT

SM.1. Broader Community Impact
SM.2. Adoption & Scaling

Comprehensive Framework

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?*

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?*

Considerations for Future Application

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 online 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.

The benefits to the user from a self-administered framework would be two-fold. The first benefit would derive from the reflection it fosters in users, alerting them to issues they may not have fully anticipated in adopting an intervention. This benefit would not be dependent on automated responses from the online framework. Nevertheless, the branching paths of an automated framework would make it more efficient to use.

The second benefit would result from the computational engine behind the online framework. We anticipate that based on users' responses, the framework could categorize their particular context as belonging to specific, familiar levels of technological preparedness and capability, and could then point users to both research and products that had been previously identified as being relevant for those circumstances. The framework couldn't necessarily evaluate the appropriateness of a proposed intervention if that intervention had not previously been documented within the framework's knowledge base. However, if users were to add information as to how they evaluated a given intervention based on the framework and with regard to their context, that intervention might be incorporated into the knowledge base for the benefit of future users.

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.

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