Institutionalizing the Adoption of E-Readers at Scale in Ghana

Client: Worldreader

Nadia Anggraini | Ethan Hamilton | David Jonason

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Executive Summary

Worldreader distributes e-readers loaded with carefully curated international and local content to improve literacy rates and classroom engagement in the developing world. As of May 2015, Worldreader has distributed over 9,000 e-readers containing 1.3 million books to 133 schools and libraries across Africa - but its leadership is pushing the organization to seek new models for scaling. Specifically, Worldreader is interested in advocating government support for the adoption of e-reader technology as an integral core of countries’ education and literacy policies. Our team is tasked with investigating how Worldreader can institutionalize the adoption of e-readers, beginning with its key market, Ghana.

We approached this problem by (1) reviewing literature and case studies on past ICT4E projects to glean best practices and learn from failures; (2) using these learnings to create a market entry analysis framework; and (3) through primary and secondary research, assessed Worldreader and Ghana’s positions against the framework.

Overall, we do not believe that Worldreader is currently well-positioned to scale its program nationwide in Ghana, due to challenges ranging from lack of government fiscal resources, to poor infrastructure and accessibility. We do believe however that Worldreader’s program has tremendous value in improving literacy, and recommend the organization focus on these next steps to build its case and capability for nationwide expansion: (1) partner with District Education Offices to roll out its program district by district, and (2) conduct rigorous studies to build sufficient evidence to secure donor funding and government buy-in.
With a robust evidence base and strong district-level partnerships, we believe Worldreader will be well positioned to secure government support and donor funding to institutionalize e-readers nationally in Ghana.
I. Introduction

Purpose

Over 785 million people around the world, 250 million of whom are children of primary school age, lack basic reading and writing skills. In response to this problem, Worldreader, a non-profit headquartered in San Francisco since 2010, is devoted to the distribution of e-readers with carefully curated international and local books as a means of improving literacy rates and overall classroom engagement in the developing world. Our team is partnering with Worldreader to tackle the problem of global illiteracy.

As of May 2015, Worldreader has distributed over 9,000 e-readers containing a total of 1.3 million books to 133 schools and libraries across Africa through a strong network of global partners and local offices for on-the-ground support. Yet, in order to have a meaningful impact on the 50% of schools in Africa that have few or no books at all, Worldreader's leadership feels the organization needs to scale further, and that the path forward is for Worldreader to advocate and support government adoption of e-reader technology as an integral core of their education and literacy policy. This would represent a radical transition for an organization that has little prior experience in lobbying or advocating for broad policy change. Furthermore, Worldreader operates in countries with complex, semi-informal, and often opaque decision-making process and stakeholder relations.
Scope

The challenges of this path forward are why Worldreader requested we take an independent and holistic approach to evaluate how and if it should advocate for the institutionalized adoption of e-readers in its target markets. Given the difficulties related to getting a clear understanding of the on-the-ground realities from afar, we decided together with Worldreader to focus specifically on advocating the institutionalization of e-readers in schools and libraries throughout Ghana. Worldreader’s well-established presence in Ghana, along with the country’s relative political and macroeconomic stability and strength of education outcomes in the region, makes it a likely first candidate for the roll-out of an advocacy program.

Research Design

In order to provide a rigorous and transparent analysis, we begin by laying out a market assessment framework informed by lessons from the experiences other education technology initiatives. Using previous efforts as the foundation for our research ensures we are incorporating best-practices into our ultimate recommendations. We then deploy this framework in an effort to map and assess the education and library landscape of Ghana. Informed by the analysis, we aim to take a broader perspective to assess the strengths and weaknesses of Worldreader’s case for institutionalized adoption of e-reader technology. Finally, our report concludes by presenting actionable recommendations and a potential advocacy agenda on a two, five, and ten-year horizon. These recommendations are outlined and summarized briefly in the overview below.
Overview of Findings

Due to a combination of lessons learned from similar initiatives, prevailing academic research on information and communication technologies (ICT) in language acquisition, and findings during a field trip to Accra in December, our team does not believe Worldreader has a sufficient proof of concept to secure adequate government buy-in, nor to secure third-party funding necessary to implement the nationwide institutionalization of e-readers using the Worldreader program in Ghana’s public school system.

To build a more substantial case for a transition from traditional textbooks to e-readers, Worldreader will need to convince policymakers and third-party funders of its program’s perceived value, or benefit per dollar spent. This can be done by demonstrating stronger evidence of its comparative effectiveness and return on investments (both tangible and intangible). We recommend several study designs that build off the successes of the 2014 Ghana iREAD study, specifically implementing a multi-treatment cluster-randomized control trial (RCT) at the district level in the Eastern Region within two years; an experimental-causal-chain study within five years; and finally, a pragmatic study within ten years. These study designs and their timelines are elaborated upon in the Recommendations section.

In the process of working towards institutionalization prior to the full deployment of the three-study series, Worldreader should explore alternative routes to scale its operations in Ghana. We propose a bottom-up approach that takes advantage of the increasing autonomy of district leadership, but also propose partnerships with local NGOs and organizations. These recommendations are discussed in greater detail at the conclusion of this report.
II. Developing a Framework

i. Lessons From Other Education Technology Initiatives

In order to develop an assessment framework that incorporates past lessons and best-practices from prior ICT4E (Information, Communication, and Technology for Education) initiatives, in developing countries especially, we have examined the methods and outcomes of a number of organizations that have been involved in the space. It is better to learn from others’ past mistakes and successes, than to try to reinvent the wheel. Below, we highlight two cases, which are especially relevant for Worldreader’s ambitions and showcase key takeaways that informed the factors of our framework.

1. One Laptop Per Child (OLPC)

As perhaps the most ambitious and well-known education technology initiative, One Laptop per Child is a great example of an international NGO pushing for the institutionalization of a ICT4E device in the developing world. The brainchild of MIT Media Lab’s Nicholas Negroponte, OLPC designed the XO, a ground-breakingy inexpensive and low-power laptop that would be sold and distributed to governments in the developing world and made available in turn to the children in those countries via their respective ministries of education.

In large part thanks to Negroponte’s high profile evangelization, the ambitious idea took hold. OLPC launched their XO device at a time in which a $100 laptop seemed like a far-fetched idea. The device included innovating features such as a custom software interface, a hand-cranked battery, peer-to-peer server-less communication, and a sturdy and child-friendly
physical design. Working directly together with high-level government officials, OLPC over time distributed over 2.5 million laptops to children in 60 countries, including Peru, Turkey, Thailand, Kenya, and Uruguay.¹

However, ten years after its launch, there is a widespread sense that OLPC didn’t live up to its promise. After failing to show that its programs had a clear impact on education metrics and to get more governments to sign on to the program, OLPC’s efforts have largely come to a halt. While the organization remains operational, still has activities in Uruguay, Peru, and Rwanda, it has downscaled severely. It is also gradually shifting its efforts away from making hardware to instead focus on developing better educational content for existing devices.

Yet, OLPC has undeniably left a mark. It’s XO tablet had a wide-ranging effect on the laptop market, leading the way for a whole range of low cost netbooks. Even more importantly, it significantly pushed forward the idea that technology has a role to play in classrooms across the developing world.

Key Takeaways

➢ **OLPC benefited from a multi-stakeholder model which involved many partners**

OLPC received considerable funding by corporate sponsors (such as Intel, AMD, eBay, and Google) and cooperated with the United Nations Development Program (UNDP) and with local NGOs (such as Paraguay Educa) to implement its programs. It also worked in

direct partnerships with high-level government officials, who shared OLPC’s inspiring and ambitious vision. Having to help pay for the XO devices, governments were invested in the success of the programs.

➢ OLPC fate rose and fell depending on the level of buy-in of political leaders

Negroponte was able to very successfully sell the idea that putting a laptop in the hands of every pupil was the solution to the developing world’s failing school system to top government officials across the world. This top-down approach allowed a fast deployment in a number of countries in the first years of the program and showed that political leaders in developing countries are prepared to adopt even radical policy reform to improve educational outcomes. However, this approach only went so far; after being unable to find buyers for their initially required minimum order of 1 million devices, the organization quickly lowered that amount to 250,000 and eventually allowed much smaller programs. Once the initial hype surrounding the program subsided, national leaders quickly lost interest in OLPC. Longstanding talks with the Indian and Chinese governments never materialized.

➢ The success of the XO’s deployment depended largely on the capacity and resources of partner Governments

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2 Warschauer and Ames, “Can One Laptop Per Child Save the World’s Poor?”

The execution of the XO deployments largely depended on the capacity and resources of the Ministry of Education of the partner country. The MOE of Uruguay, the first country to initiate a national deployment, put substantial effort into infrastructure and support services; extending wireless connectivity throughout the country, offering free or subsidized repairs to malfunctioning devices through local repair centers or mobile repair team, and providing extra devices as backups for when devices go out of commission. These measures allegedly helped insure a more successful implementation than many other OLPC programs.4

➢ Pilots and outcome assessments are necessary to show proof of concept

OLPC largely neglected deploying pilot programs, staged implementations, monitoring and formal outcome assessment in favor of quick so-called "one-shot" deployments. Negroponte argued that there was an urgent need to get laptops in the hands of children, and that positive outcomes on educational outcomes were self-evident. Yet, the fact that the organization was advocating channeling significant resources to its largely unproved program, let to some skepticism. Without evaluations of the benefits of the OLPC programs, governments and donors were skeptical and reluctant to make the significant investment necessary to launch the program.

➢ Being able to show measurable improvements in learning outcomes is key

4 Warschauer and Arnes, "Can One Laptop Per Child Save the World's Poor?"
OLPC was not explicitly focused on improving standardized test scores but instead on “developing the passion for learning and the ability to learn.” Yet, the XO’s failure to significantly improve test scores led to many partners’ disenchantment with the initiative. In fact, no independent study of the OLPC programs showed evidence of measurable increases in student performance outcomes in reading, writing, science or math. Peru, for instance spent $225m to deploy 850,000 XO devices to schools throughout the country in an effort to improve dismal test scores. Yet, an evaluation by the Inter-American Development Bank (IDB) a year after the launch found no difference in the test scores, motivation, or even time devoted to homework or reading, between pupils who did and did not receive an XO. Whether OLPC promised it could impact them or not, test scores are the currency and kingmaker of education politics.

➢ Cost-effectiveness is key, and both affordability and opportunity cost matter

Though OLPC’s initial goal was to sell the XO laptop for $100, it still hadn’t managed to bring down the unit-price to below $188 by late 2010. The total cost of implementing their program (including devices, infrastructure and development expenses) was then estimated at around $75 per student per year. This is a considerable cost for any low-income country which has little resources to spare; Rwanda for instance, spends approximately $109 per year per primary school pupil. Such countries, and the

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6 Warschauer and Ames, “Can One Laptop Per Child Save the World’s Poor?”

international donors that most likely and often are the ones footing the bill, want to know that their getting “bang for their buck” for such a large investment. Especially when compared to the proven cost-benefit ratios of other policies, OLPC had difficulties making a good case for itself. For instance, spending a mere $0.50 per student per year on deworming was found to increase school participation in Kenya by 14 percent.\textsuperscript{8} Alternatively, a variety number of lower-cost programs—such as hiring additional teachers, subsidizing school books, funding campaigns promoting girls’ access to education, and improving school infrastructure—have proven to significantly improve educational outcomes in impoverished countries.\textsuperscript{9}

\textbf{A focus on specific hardware has implications for the program’s sustainability}

The Worldreader program was very much centered around its own innovative XO hardware and software, which proved a problem as improvements in personal computing quickly rendered the device relatively obsolete. While OLPC’s XO device arguably led the way in the development of low-cost laptops, other manufacturers quickly caught up, offering even cheaper netbook devices for the developing market. The OLPC project was not adapted to a world where cell phones, not personal computers, are the main means to connect to the net in the developing world. It also preceded and was slow to adapt to the now ubiquitous affordable touchscreen tablet device and the open-source Android operating system (with its own ecosystem of hundreds of thousands of


applications that can be incorporated into a learning environment).\textsuperscript{10} The organization is now increasingly hardware and software agnostic, having shifted instead to a focus on developing a user interface and content which works across different devices such as Datawind’s $50 Aakash tablet.

\textbf{A lack of on-the ground implementation support weakened the OLPC program}

OLPC has a set of principles to guide how XO laptops should be deployed; each and every child of primary school age is to have its own free connected device. However, due to a highly hands-off implementation strategy (in Negroponte’s own words, “give a kid a laptop that’s connected and walk away”), there was a clear lack of adherence to these principles. In many cases, students were often not allowed to take their laptops home by their teachers who feared the devices would get stolen or broken. Additionally, critics argue that simply adding modern hardware to the classroom environment will fail to have any impact on learning outcomes without holistic improvements to the education system.\textsuperscript{11} In order to get results, ministries of education need to, among others, invest in teacher-training and on modernizing their curriculums. As Sandro Marcone of the Peruvian ministry of education put it: “If teachers are telling kids to turn on computers and copy what is being written on the blackboard, then we have invested in expensive notebooks.”\textsuperscript{12}

\begin{itemize}
\item \textsuperscript{11} Warschauer and Ames, “Can One Laptop Per Child Save the World’s Poor?”
\item \textsuperscript{12} “Error message,” The Economist, April 7, 2012. http://www.economist.com/node/21552202
\end{itemize}
➢ Local infrastructure is key to distribute and enable the effective use of devices

In many of OLPC’s low-income deployment countries, infrastructure turned out to be a major hurdle. In places such as Rwanda or even Peru, many of the country’s rural schools lack or have very limited access to electricity, and many more lack Internet access. Yet in many cases simply getting purchased devices into the hands of pupils has proved a challenge, simply many get lost due to theft and corruption before they reach their new owners. Of the 8,000 XOs donated to Iraq for instance, half were auctioned off to a businessman and the other half were unaccounted for.13

➢ Educators are essential stakeholders for a successful implementation of ICT4E technology

It appears OLPC had not adequately taken into account the need to support and train teachers into how to use and incorporate the XO devices into the classroom environment. In the abovementioned case of Peru, only about one in ten teachers received technical support while a mere 7% received pedagogical training.14 In part, this was a result of the idea that educators, due to absenteeism and incompetence, would

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hold their students back — pupils, Negroponte argued, would teach themselves and each other how to use the devices. The practical outcome, however, has been that teachers use the XO laptops relatively little inside the classroom. For instance, a mere 21.5 percent of Uruguayan teachers report using XOs in class on a daily or near daily basis for individual student work, while 25 percent report using them less than once a week.\textsuperscript{15}

\begin{itemize}
\item Devices and their deployment need to be adapted to local practices and constraints to be sustainable
\end{itemize}

The XO laptop was largely designed in its Boston laboratories along a traditional top down approach. Only in the latter stages of development were near-finished prototypes tested in rural and impoverished communities in India and Africa. As a result, end-users experienced that the device ignored local contexts and customs.\textsuperscript{16} Because the XO devices remained frail, especially for children with little experience handling electronics, a large numbers of XO laptops were rendered unusable within the first and second year.\textsuperscript{17} This made it very difficult to uphold their XO programs after they had received their original batch of devices.

2. South Africa’s Gauteng Province “Paperless Classroom Initiative”


\textsuperscript{16} Nussbaum, Bruce, “It’s Time To Call One Laptop Per Child A Failure.”

\textsuperscript{17} Warschauer and Ames, “Can One Laptop Per Child Save the World’s Poor?”
South Africa’s Gauteng province’s ongoing effort to transition to “paperless classrooms” is a good example of ICT4E being adopted as the result of the initiative of local political champions in sub-Saharan Africa.

Gauteng is the country’s smallest but most populous province with 12.3 million inhabitants and two major cities, Johannesburg and Pretoria. Just last year, its provincial government rolled out a program which intends to put 17,000 tablets with unlimited 4G data bundles into the hands of public school students in their last year of secondary school (grade 12), starting with rural and township schools.\(^\text{18}\) The effort is part of a broader “paperless classroom” initiative which has been named the "Big Switch On" which outfits schools with high speed internet connections, classroom with smart boards and teachers with laptops. Teachers undergo some training as they enter the program; educators at over 300 public schools spent the 2015 mid-year school holidays preparing for the new paperless education system.

The Gauteng Education Department hopes to roll out the program to all its township and rural schools before the end of 2018.\(^\text{19}\) In total, the Gauteng education department plans to invest $1.3 billion in education technology over the next few years in an attempt to address South African schools’ dismal performance in international ratings, in particular in mathematics and sciences.\(^\text{20}\) In a World Economic Forum report, South Africa’s global e-readiness ranking

dropped from 47th place in 2007 to 70th in 2013 which pushed the country to adopt a national e-skills plan.21

The campaign is the brainchild of the dynamic and popular provincial education minister Panyaza Lesufi who has been heavily involved in championing, implementing and overseeing the campaign. The rhetoric used to promote the program has centered on several recurring themes that lie at the heart of South African politics: promoting equality across income and race, putting education at the center of the country's strategy for development, tackling youth unemployment and preparing students for the knowledge economy, as well as addressing a relative shortage of e-skills. According to local news outlets, most of the students in the province have never owned a smartphone or a tablet, so this will be their first device.22

The initiative started with a pilot project with seven schools in January 2015. According to a government press release, the tablets were programmed for educational purposes only, with lessons and learning material pre-loaded, and permanent IT specialists were on site to help the teachers and pupils with the new system.23

Key Takeaways

The program in Gauteng is still in its infancy, but while it is too early to draw general conclusions from the program, several early takeaways are relevant for our purposes.

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22 “South Africa turns on digital classrooms,” South Africa Info.
Decision-makers in developing countries are looking for ICT4E to improve education, but also because it can be good politics.

In the case of Gauteng, introducing technology into the classroom is seen as a way to address a failing education system. Yet, it also serves a political purpose, as leaders wish to make bold and aspirational statements by introducing radical policy changes such as Gauteng’s switch from to a “paperless” classroom model. Furthermore, the Gauteng project is by and large the result of one single politician’s initiative; displaying that a strong ICT4E champion can be instrumental to trigger reform. In many developing countries, the opinion of one influential leader can make or break policy reform.

More dynamism and flexibility at the regional rather than national level

South Africa’s provinces have significant autonomy and executive authority, not least when it comes to education policy. Gauteng, has here taken the initiative to try its own approach to address the failing South African education system. Although it doesn’t have the most acute need – Gauteng is actually the top performer in national tests – it has more resources to spend than its peer provinces. Interestingly, costs and alternative costs still play a significant role even on the regional level. Gauteng’s leadership argued that the project, while expensive will save about 30% of the budget previously was used to buy books.²⁴

➢ Theft and security should be a main concern

The students’ new tablets have been attracting the attention of criminals to such an extent that Mr. Lesufi has had to advise students to travel in groups. Additionally, tracking software has been installed on the tablets, and the pilot schools have been fitted with surveillance cameras, burglar bars and armed security officers. Despite such security measures, the devices are getting stolen. Students have been mugged, and schools robbed of their computers and interactive “smartboards”. Last year, an entire shipment of 1,600 tablets was stolen from a supplier’s offices. According to several local news sources, the department was missing 12,000 out of the 64,000 tablets it had distributed to pupils at the beginning of the academic year.\textsuperscript{25}

ii. Market Entry Analysis Framework

Based on lessons from case studies of the Information Communication and Technology for Education (ICT4E) and education projects outlined above, as well as input from our faculty advisor, we developed a framework for assessing the feasibility of institutionalizing Worldreader’s program at scale. The elements of this framework are outlined as follows, and we

\textsuperscript{25} “South Africa’s paperless classrooms lead to computer theft”, The Economist.
plan to assess Ghana’s position on each in order to determine the country’s potential for adopting an e-reader program at scale in Table 1:

<table>
<thead>
<tr>
<th>Framework Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy-In and Champions Among Key Decision-Makers</td>
<td>Identify key decision-makers for ICT4E initiatives and assess their likelihood of championing Worldreader’s program</td>
</tr>
<tr>
<td>Buy-in and Champions Among Educators</td>
<td>Assess school and teacher capacity for incorporating technology in classrooms and libraries; and identify pathways and roadblocks for teacher ICT training</td>
</tr>
<tr>
<td>Fiscal Resources</td>
<td>Analyze government and donor budgets and funding process for textbooks and other Teaching and Learning Materials (TLMs), to assess feasibility of incorporating digital textbooks into budget</td>
</tr>
<tr>
<td>Partnership Potential</td>
<td>Identify potential project partners with implementation capability/funding, and whose objectives align with those of Worldreader</td>
</tr>
<tr>
<td>Enabling Policy Environment</td>
<td>Identify existing policy frameworks that will pave the way for nationwide adoption of Worldreader’s program (e.g. curriculum, ICT4E, textbook procurement policies)</td>
</tr>
<tr>
<td>Proof of Concept &amp; Proven Technology</td>
<td>Assess benefits and challenges associated with use of e-readers (at scale) given the specific country’s context</td>
</tr>
<tr>
<td>Long-Term Sustainability</td>
<td>Identify existing community and other support structures that promote continued ownership and accountability for e-reader programs in the long run</td>
</tr>
<tr>
<td>Infrastructure, Distribution, and Access</td>
<td>Assess country’s wireless, electricity, transportation, and other infrastructure needed for successful implementation of ICT programs</td>
</tr>
<tr>
<td>Cost-benefit</td>
<td>Assess cost-benefit of digital vs. physical textbook program, based on data from Worldreader’s existing programs in the country</td>
</tr>
</tbody>
</table>

Table 1

III. Country: Ghana

Overview

As part of the 2000 adoption of the Millennium Development Goals (MDGs), the international community reaffirmed its commitment to achieving education for all, working to ensure universal access for boys and girls alike to primary education. This includes the 250 million primary school-aged children worldwide unable to read or write. In Ghana’s primary schools, as revealed by the 2013 Ghana Early Grade Reading Assessment (EGRA), the majority of public school students could not read with comprehension, neither in English nor their native Ghanaian tongue.26 Fewer than half of the almost 8,000 students in the study had an English-language reader (42%), and only 35% had a reader in any Ghanaian language.27,28

Much of this problem can be explained by Ghana’s inconsistent and unreliable textbook procurement process. Among the successes of the Ministry of Education’s (MOE) curriculum policy are the standardized curriculum nationwide and the emphasis on Ghanaian-produced textbooks. Major budget constraints, however, have proven to be a significant obstacle in the textbook procurement process. Although the MOE’s policy is to release calls for tender from

26 Kochetkova and Brombacher, “Ghana 2013 Early Grade Reading Assessment and Early Grade Mathematics Assessment”, 2014.


28 Kochetkova and Brombacher 2014.
publishers on a 3-5 year cycle, budget shortfalls mean textbooks are actually only replaced every 5-7 years, and orders that are intended to supply schools with a 1:1 textbook-to-student ratio are curtailed. In addition, while publishers that win the bids are responsible for delivering books to District Education Offices (DEOs) for distribution to classrooms, a broken supply chain leaves many books missing and many orders simply unfulfilled.  

Worldreader recognizes the breakdown of reliable textbook supply to classrooms as a resource bottleneck that can be solved through e-readers, which greatly increase students’ access to cheap, relevant literature that can be downloaded instantly without the current concerns of incomplete deliveries. Given its ongoing relationship with influential policymakers, relatively high level of infrastructure, previous in-country research, and its 2007 Education Plan aimed to align goals of universal, free primary education with the MDGs, Ghana is a strong candidate for Worldreader to scale its program.

Ghana’s education system is also highly decentralized. There are three governing bodies responsible for an estimated 14,000 pre-tertiary public schools—the MOE, Ghana Education Service (GES), and Ghana Education Trust Fund (GETFund), the responsibilities of which are described below. Among the country’s ten regions (populations varying roughly between 1-4 million people) are 216 districts (11-30/region); each district, headed by a District Education Office (DEO), is responsible for about seven circuits, of which are headed by a Circuit Supervisor and contain 8-14 schools/circuit. That is, there are generally an average of 75 schools/district. In these schools Basic Education is eleven years of schooling: two years of Kindergarten, six years of


Tony Read, “Where Have All the Textbooks Gone?”, World Bank Group, 2015.
primary school (Worldreader’s target age), and three years of Junior High School. The sole official language of instruction is English, although there are eleven local languages used in classrooms throughout Ghana. Currently, all textbooks and supplementary materials are in English.

There is a great deal of opportunity for Worldreader in its mission to deploy e-readers across Ghana’s classrooms, but the path ahead is not straightforward. Rather, it is fraught with numerous challenges and potential spoilers. These include stakeholders invested in traditional textbook publishing, basic water and electricity infrastructure limitations, actors involved in petty corruption along the current supply chain, teachers trained in the Worldreader program that are often transferred without notice, the absence of clear evidence that the Worldreader program has demonstrated a proven superiority of e-readers to traditional textbooks in improving literacy rates, and most importantly, funding. Over the past five years, 97% of the MOE’s expenditure in basic education went to teacher salaries, crowding out spending in every other budget category.\(^{31}\) In repeated meetings within each of the three major government agencies involved in education, the message was clear: e-readers are an exciting idea, but if the Ghanaian government has to pay for any of it, this program will not be implemented. The attitude can be characterized by one representative’s statement: “For now, [e-readers] cannot replace reading hard books.” In order to move forward, Worldreader must respond to these challenges.

Education Landscape

Overview of the Education System

Ghana’s education sector is decentralized in nature. The Ghanaian government embarked upon a decentralization program in 1988 in a bid to stimulate mass participation in governance at the grassroots level. As such, the country’s 22 central government agencies, including the Ministry of Education, Science and Sports (MOE), each operate district-level departments with varying levels of responsibilities.

Decentralization has led to an increasingly complex policy and management environment. A 2014 World Bank study noted that, “for MOE and GES to deliver education, they must work with, through, or in collaboration with the following: more than 15 “subvented” agencies (which operate in full or partial autonomy of MOE), at least three other Ministries, Universities and Colleges of Education, Regional Ministers, MMDA governments, Teacher’s Unions, Civil Society Groups and Development Partners. Ongoing decentralization of roles and responsibilities has resulted in new complexities.”

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Darvas and Balwanz, 2014.
Education Sector Stakeholders

Figure 1: Mapped stakeholders of the Ghanaian education system (simplified). A more complete version can be found in Appendix III.

Ministry of Education, Science & Sports (MOE)

- Responsible for education policy and planning;
- Leads regular strategic planning exercises, e.g. Education Strategy Plan 2003-2015; and,
- Submits annual education sector operational plans and budgets to Parliament for approval.

Ghana Education Service (GES)
• Policy implementation and operations, including provision of inputs and oversight and management of teachers and District Education Directorates.

_Ghana Education Trust Fund (GETFund)_

• Ancillary to the education system is GETFund, a public trust set up by the Ghanaian government, whose mandate is to fund education infrastructure and facility projects;
• Limited decision-making power in terms of deciding what education projects to allocate funds to (follows MOE directives); and,
• Funded 3% of total education expenditures in 2014.

_Planning, Budgeting, Monitoring and Evaluation (PBME) at MOE_

• Central coordination and capacity building, supporting capacity strengthening initiatives for monitoring, evaluation, and reporting; and,
• Aggregate data from across regions, districts, and schools in order to evaluate national progress and to make comparisons across regions, districts, and schools. Uses findings from policy research, monitoring and evaluation at all levels to inform policy-making, educational planning, and programmatic decisions.

_Monitoring and Evaluation (M&E) Teams at MOE_

• Oversee monitoring and evaluation of general sector-wide activities and in a number of specific topical areas;
• Conduct broad sector-wide and nation-wide monitoring and evaluation activities by sampling from the broad population in question; and,
• Work with the M&E Unit within PBME to implement effective sector-wide monitoring and evaluation practices.

*Education Management Information System (EMIS)*

• Collect data regularly from schools, districts, regions, and other entities of educational relevance around the country; and,

• Provide educational information and data to PBME and other MOE/GES divisions and agencies on a regular basis.

*National Accreditation Board for Tertiary Education (NATBE)*

• Oversee monitoring and evaluation pertaining to tertiary education in Ghana;

• Conduct comparative analyses regarding the performance of tertiary institutions and create associated summary reports and recommendations; and,

• Publicize and share information on best practices in tertiary education delivery and management.
National Inspectorate Board (NIB)

- Inspect schools, set and enforce the required standards for both the public and private educational institutions.
- Evaluate first and second cycle institutions periodically; and,
- Monitor the computerized school selection and placement system (CSSPS).

District Education Oversight Committees (DEOCs)

- Monitor the condition of school building and the school infrastructure requirements, including cleanliness, lands, and facilities, as well as the supply of textbooks and other teaching and learning materials;
- Monitor complaints relating to education, and pertaining to or emanating from teachers, students, principals, parents, and/or community members
- Collect information on private educational institutions operating within the district; information should include basic statistics, operating information, etc.

District Education Directorate

- Inform and educate all community stakeholders to make informed contribution to the District Education Strategic Plan (DESP) development process; and,
- Implement DESP at community and school level.

Circuit Supervisor

- Assess instructional and management operations of schools;
- Advise teachers, head teachers and school representatives;
- Conduct annual school visits: two comprehensive assessments, six brief/random/emergency visits; and,
• Attend general meetings of School Management Committees in his or her circuit.

*Parent Teacher Association (PTA)*

• Comprised of parents, teachers, and a head teacher;
• Theoretically focuses on student achievement, but in reality also deals with practical issues such as security, feeding, ensuring electricity access;
• These issues require funding, which current financing schemes fail to cover, so PTA collects levies from parents.

*School Management Committee (SMC)*

• PTA stakeholders plus community members, e.g. District Assemblyman, Chief’s Representative;
• Responsible for monitoring school operations, leading school improvement projects, tracking budget expenditure and developing school budget.

Textbook Industry Landscape\(^{33}\)

*Authorship and Publishing*

State publishing has been gradually phased out since a new national textbook policy was introduced in 2000. All textbook publishing is now undertaken by private sector publishers in response to bidding procedures organized by the MOE. Textbook publishing in Ghana has been indigenized so that all local textbook publishers are majority owned Ghanaian publishers, although many maintain close contacts with their original owners. Publishers are responsible for identifying and contracting authors, who are mostly Ghanaian nationals. Despite the move

\(^{33}\) iRead, 2015.
towards indigenization of the publishing industry, there remains some importation of secondary school textbooks.

**Procurement**

Textbook requirements are put out to bid by the MOE. Up to five publishers may be approved as a result of the bidding process, but there is no school-based selection and ordering because the MOE allocates different titles to different districts on a monopolistic basis in each district. Publishers have typically had full license to select printers to subcontract to, resulting in 97% of textbook and TLM materials being printed overseas and imported into Ghana. However, for the upcoming textbook procurement cycle in 2016, the government has agreed to build in local printing requirements into publishers’ Request for Proposals (RFPs).

The World Bank argues that there are aspects of the textbook bidding process that need to be reformed: the evaluation procedures are not considered transparent, price is not a criterion for evaluation and selection but is subject to direct negotiation with government, and the allocation of districts can be used as a lever to get lower prices. Payment to publishers is typically subject to long delays.

**Printing**

All textbook printing is required to be undertaken in Ghana, but as mentioned above, in practice the majority takes place abroad at international printing centers, where publishers enjoy competitive prices, higher quality results, and reliable delivery.

The Ghana Printers and Paper Converters Association (GPPCA) has successfully lobbied the government to incorporate local printing requirements into the RFP process for the
upcoming textbook procurement cycle - an indication of the strength of this stakeholder group as well as the strength of pro-protectionist sentiments in the government today.

Distribution

On the primary level, publishers deliver textbooks to District Education Offices, which are in turn responsible for last-mile delivery to schools. On the other hand, secondary school textbooks are delivered directly by publishers to schools. According to the World Bank, “recent distribution surveys suggest that up to 50 percent of districts do not maintain adequate stock control systems and have difficulty in accounting for the textbook supplies delivered to them. There have been reports of state textbook stock being sold to private schools.”

Education Sector Policies and Strategies

Strategic plans introduced by government and donor agencies can significantly impact what education initiatives and programs are adopted or abandoned. Below we have included the key education sector plans currently in place:

Government of Ghana Education Strategic Plan (ESP), 2010 - 2020

The ESP outlines a set of comprehensive priorities and strategies to be undertaken by the government for the education sector from 2010 - 2020. We have extracted the targets and strategies that are relevant to Worldreader in Table 2:

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<table>
<thead>
<tr>
<th>Target/Strategy</th>
<th>Relevance to Worldreader</th>
</tr>
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<tbody>
<tr>
<td>Ensure that no child is excluded from Basic Education (BE) by virtue of disadvantage</td>
<td>Given the MOE’s emphasis on equity, Worldreader’s program needs to be as accessible in poorer, more remote schools as it is in urban schools with adequate infrastructure.</td>
</tr>
<tr>
<td>Primary, Junior High School (JHS) and Senior High School (SHS) textbook ratio of 1:1 for core subjects by 2012</td>
<td>Indicator that government will be increasing textbook purchases and continuing to replenish textbook supplies to ensure 1:1 ratio is maintained.</td>
</tr>
<tr>
<td>Develop and upgrade teacher training programs to train teachers in the new curricula at all levels, from 2013 onwards</td>
<td>Opportunity for Worldreader to insert e-reader training program during the course of the teacher training program overhaul.</td>
</tr>
<tr>
<td>Provide suitable ICT school facilities for all students and teachers at all levels</td>
<td>E-reader as a relevant ICT product that students and teachers need to get trained on</td>
</tr>
<tr>
<td>Ensure textbook and digital materials are revised and conform with new SHS curricula in 2014</td>
<td>Worldreader missed an opportunity to incorporate e-reader programs into the SHS curriculum in 2014, and will need to wait for the next update cycle</td>
</tr>
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Table 2

*Ministry of Education ICT in Education Policy, August 2015*[^35]

The MOE’s latest ICT in Education Policy is underpinned by the country’s 2007 Education Reform Act, which mandates “the integration of ICT in education to facilitate effective teaching, learning and management through the provision of computer labs, internet and network....

connectivity to schools, and supply of laptops to teachers and students and capacity development of teachers.”

The fact that Ghana has an ICT in Education Policy in itself is a boon for Worldreader, as it indicates that ICT4E is a priority area for the government. While the bulk of the ICT in Education Policy document had focused on computers as the primary medium for ICT education, it explicitly noted that “it is imperative (to ensure) that the ICT policy does not focus on specific restrictive prescriptions (determined choice) for Hardware (and to some extent, Software) but rather on Teaching and Learning on sustained growth and developmental path, knowing that a long-term lock into a hardware technology may not be beneficial or practical to meet our national aspirations.”

Additionally, as part of the Content Development thematic area of the policy, the MOE outlined its plans to “develop and digitize content to supplement education delivery,” and “modify and convert traditional materials into electronic format for e-learning.” Given that Worldreader has digitized core Ghanaian textbooks and reading books, it will be well set up to offer its services to help the MOE meet its ICT4E goals.

That said, Worldreader primarily focuses on the primary school, JHS, and SHS levels, which are not priority areas for ICT4E deployment (see Table 3 below). As such, it may not receive adequate support or resources to push its program through.

<table>
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<th>Prioritization of Deployment</th>
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<td>6</td>
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Table: ICT4E Policy Prioritization of Deployment by Level

*Source: ICT in Education Policy*

Additionally, the policy document acknowledged that past efforts by the MOE and GES to introduce ICT4E initiatives had faced a number of challenges, with more than half of all initiatives initially launched as pilots but with none expanding nationwide. Implementation challenges include:

- Poor selection of schools without the involvement of GES / MOE, resulting in duplication and some schools having several parallel initiatives while others (especially those in the remote rural towns) having none
- Lack of policy direction at all levels (schools, districts, national) for the integration of ICT in education
- Heavy dependency on external funds, with most initiatives stopped after depletion of initial funding
• Low levels of ownership at the level of the schools, due to external motivations, and low levels of understanding on the part of recipients about the potentials of ICTs in education

• Lack of trained ICT personnel (including teachers), with most capacity building efforts being one-off with no continuous trainings planned for

Given this poor past track record of ICT program implementation in Ghana, any nationwide initiative proposed by Worldreader needs to be able to address the challenges above.

**USAID Ghana’s Education Development Objective**

Simply stated, USAID Ghana’s Education Development Objective is “improved reading performance in primary schools.”\(^{36}\) The agency aims to improve reading proficiency for at least 2.8M primary school students in Ghana by 2020, and in 2014 spearheaded a $71 million multi-year, multi-stakeholder Partnership for Education Project (PEP) to work towards this goal. PEP is still in the process of allocating grants and resources to organizations that can contribute towards achieving its goals, and Worldreader thus has the opportunity to align itself with this project.

\(^{36}\) USAID, “Education”, 2015
Library Landscape

The Ghana public library system has a relatively well-established history relative to many other African countries. During colonization, the British council established a network of libraries across the Gold Coast, beginning with Ghana’s first library in 1926. Its founding director had an excellent working relationship with Kwame Nkrumah, who became prime minister and then president after independence in 1957. The public libraries flourished under Nkrumah, who was a strong advocate for literacy and education, and who saw the libraries as an essential tool for promoting development and Pan-African culture. However, the libraries soon fell out of favor in a series of military coups which plagued much of the country’s modern history.

Today, Ghana’s public library system shows signs of decades of neglect. Ghana’s libraries, divided by a national and a municipal system, are largely uncoordinated, underfunded and ignored by political leaders. Yet, a number of initiatives to improve the country’s public libraries and dynamic not-for-profit initiatives provide a glimmer of hope. We examine the main bodies of Ghana’s library ecosystem below.

The Ghana Library Authority (GLA) and the National Public Library System

The GLA is the centralized headquarters for all national public libraries in Ghana. It heads the regional library in each of the 10 regions as well as an additional 53 branch libraries. Each regional branch has its own head librarian and a share of the authority’s approximate 500 staff.


members. After decades in disrepair, the GLA has been slowly getting its feet back on the ground. A couple of years ago and after a long period of hibernation, the Authority's Board (chosen by the President) and management leadership were restored.39

According to its charter, the GLA's mission is to promote a lifelong reading habit among Ghanaians, and the youth especially. Its vision is to establish public libraries throughout the country, so that citizens do not have to travel more than eight kilometers to reach a well-equipped and well-stocked libraries with adequate staff. Yet, the GLA has not been given the resources necessary to work towards this ambitious goal. In fact, chronic underfunding has left its facilities in disrepair, its libraries understaffed, and its stocks of books lacking. In order to support its activities, the GLA has turned to other sources of funding and has gotten support from corporate and NGO donors. These include:

- Telecom companies MTN and Huawei, which have supported the construction and repair of several libraries.
- The Ghana Investment Fund for Electronic Communications (GIFEC), which provides financial resources for the establishment of universal service and access to ICT and basic telephony for the country's underserved rural communities.40 GIFEC has supported the public libraries by providing a significant number of computers (for which it also provides maintenance and Internet access).

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39 Kedem, "Leadership Excellence in Public Libraries"
• The Social Security and National Insurance Trust (SSNIT) a government agency which administers Ghana’s National Pension Scheme. SSNIT has pledged to fund a new national children’s library and bankroll existing mobile libraries.

• Books for Africa and Book Aid International, a US and UK-based not-for-profit book donation programs that provides GLA with free library books.

• EIFL Electronic Information for Libraries), an international not-for-profit that promotes library connectivity in developing countries. EIFL provides access to international journals and databases, and provides funds for computer-equipped mobile libraries.

While most books are donated from western book drives, the government does supply funds to purchase children’s books as well as books by Ghanaian authors, as chosen by a Selection Committee. School textbooks exist in the libraries, but do not seem to receive much use.

All the cataloging and processing of books is done at the GLA Main Library in Accra, before being shipped in bulk to the regional and branch libraries. However, it was clear to us when we visited the main library as well as a more rural branch library that the latter hadn’t received many new books in quite some years. A passport picture as well as proof of identity are required to obtain a borrowing card, yet most patrons use the facility without ever obtaining a card.

Besides serving the role of libraries, internet cafes and reading rooms, libraries also often play the role of community centers and help coordinate activities and programs for children and adults alike. However, many libraries are increasingly finding it difficult to attract patrons, especially the youth, to their facilities. Many of those who do find their way to the library do so for other purposes than simply reading books; during our visits, we found many patrons there to
charge their phones, and a computer room full of young kids playing age-inappropriate video games.

Mobile Libraries

For many years, the GLA has been running a mobile library program consisting of ten vans which crisscross across each of the country’s ten region, providing access to books to rural communities which have no local library. The program is expensive to run, due to fuel and maintenance costs, and has therefore been halted many times over the years. Thanks to the support of GIFEC and EIFL however, the program is up and running and incorporates an ICT component as each van carries a couple of laptop computers. Patrons can use the computer will the van is visiting their community, with the assistance of a librarian if needed. The GLA representative we spoke to expressed an interest in cooperating with Worldreader to also carry e-readers on their mobile libraries.

With the support of EIFL and a grant from the phone manufacturer Nokia, the Volta Regional Library has extended on the mobile library program by equipping vans with Wi-Fi internet, solar panels and additional laptop and tablet computers. After a successful pilot in the Ho Municipality where the vans has provide computer classes for 450 Ghana children’, the program is expanding to three more regions in Ghana, reaching over 1,800 more children.41

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Municipal and Community Libraries

Besides the national public library system administered by the GLA, there is a patchwork of hundreds of municipal and community libraries spread across the country. There appears to be no available official count of how many such libraries there are, or how many are currently operational. According to a GLA director we interviewed, each region has about 40-50 such libraries.

The municipal libraries technically fall under the supervision of municipal district assemblies, yet these often do not have any formal mechanism to manage and fund the libraries, which often end up neglected. The GLA does in many cases provides and pays staff for the libraries, many on a rotational basis. The GLA is also making efforts to revitalize inactive libraries; we visited a rural library which had been closed for many years before the GLA took it under its wings. There has long been talk of a new Ghana Public Libraries Services Bill that would officially decentralize public libraries to District Assemblies. Yet, in a similar fashion to primary education, the administration of many of the country’s smaller libraries appear stuck in a semi-decentralized state with an unclear distribution of responsibility.

The Ghana National Bibliography

The Ghana National Bibliography serves as the national agency for the management of numeric book identifiers (ISBN, ISSN, and ISMN), and lists all works written by authors in Ghana, Ghanaians abroad, and even the titles of individual articles written about Ghana. They receive on average about six requests per day, representing a total of approximately 36 new published titles a week.43

The Ghana Library Association

The Ghana Library Association was founded in 1962 as the main parasol body representing libraries and information services in the country. The Association was dormant during in the mid 1970’s to the early 1980’s, but was revived in 1983. The GLA, which at about 200 members remains small, organizes seminars, professional training, and represents librarians’ interests during public debates on library policy.44

Private Not-For-Profit Libraries

The lacking resources and coordination of the public library systems has led to the emergence of a number of private initiatives. The size and model of these organizations vary widely. Some are fully run by foreign and local NGOs, others are more integrated with local institutions and partners. We highlight two such examples below.

43 http://oclfvolunteer.blogspot.com/p/visit-to-ghana-library-board-and-three.html
The Osu Library Fund (OLF)

The Osu Library Fund is a non-profit Ghanaian charity backed by a parent Canadian non-profit organization. In close partnership with local authorities and communities, the 'Fund' has developed a network of libraries, primarily in Ghana, which promote reading for children and literacy classes for adults. The Fund has built eight large community libraries in Greater Accra and have helped to create more than 200 libraries in Africa. The Fund follows a set of key principles, including partnering with community leaders at a grassroots level; supplying culturally relevant and meaningful books and to supporting local librarians. The Nima Maamobi Community Learning Center is a good example of how the Fund's libraries are run together with local stakeholders. While land and the salaries for the staff and the cost of utilities are paid by the Accra Metropolitan Assembly, the building itself was built with donations from OLF and local community members. OLF also provides books and performs maintenance on the building. OLC credits this model of shared investments and involvement for the sustainability of its program.

The Ghana Street Library

Since 2011, the Ghana Street Library has been collecting books into car trunks and brought them to children in rural villages. With support from The Global Fund for Children and several other foundations and corporations, the organization has been able to gradually grow its footprint. It now runs a variety of initiatives, including three kiosk-like community libraries and a mobile van which all carry laptops, tablet and e-reader devices, and also organizes a mentoring program, an oral history recording program, and an online platform for digitized books.
Worldreader’s Position in Ghana

Ghana is one of Worldreader’s key markets: it was the country in which the organization launched its first full e-reader program (in 2010), as well as its second office. To date, the organization has distributed 9,056 e-readers in schools and libraries across Ghana through 14 projects.

Importantly, Worldreader’s most rigorous impact study to date was conducted in Ghana. The quasi-experimental study, iREAD 2, was conducted from 2013-2014 with funding from USAID, AusAid, and World Vision, in partnership with the District Education Office (DEO) of the Eastern Region of Ghana. The study found that students who received Worldreader’s intervention outperformed their peers in the Early Grade Reading Assessment (EGRA), an internationally accepted standard for reading proficiency (see Figure 2 below). This study, if proven to be of sufficient rigor, could potentially unlock support and acceptance from Ghana’s MOE and donor agencies of Worldreader’s effectiveness over existing physical textbook programs. This will be discussed in greater detail in the upcoming sections.

![Figure 2: EGRA study results from iREAD 2](image-url)
## Market Feasibility Framework Assessment of Ghana

### Summary Assessment

<table>
<thead>
<tr>
<th>Element</th>
<th>Assessment</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partnership potential</td>
<td>High</td>
<td>• Potential synergies and partnership interest with NGOs and libraries. Partnerships could help explore new channels and address specific challenges (e.g., Teach for Ghana)</td>
</tr>
</tbody>
</table>
| Buy-in and champions among decision-makers | Med        | • General sentiment that education results, esp. in science & math, are poor and some sort of intervention is necessary  
          |            | • See Stakeholder Assessment section for detail on individual stakeholder groups           |
| Buy-in and capacity among educators | Med        | • Low capacity: Inertia in modification of pre-service teacher training; limited in-service training opportunities  
          |            | • Teachers trained for iREAD program are committed, but can be transferred to other locations by the government |
| Enabling policy environment      | Med        | • Nationwide ICT4E policy in place, but government (i) prioritizes deployment at higher education levels, and (ii) does not have good past track record of implementing ICT4E initiatives  
<pre><code>      |            | • Stronger enforcement of local textbook printing policy due to lobbying from GPPC            |
</code></pre>
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Rating</th>
<th>Notes</th>
</tr>
</thead>
</table>
| Proof of concept & proven technology          | Med    | • WR content **in demand and appreciated by students, teachers**; seen as comparative advantage  
                                          |        | • WR technology has **solid track record, but difficulties remain** (electricity, theft, limited by kindle tech, e.g. color)  
                                          |        | • iREAD a good start for impact study, but **more evidence necessary** to make viable argument to government and funders to invest in e-readers  |
| Cost-effectiveness                            | Med    | • Cost-effectiveness remains lower than physical textbooks, although there’s potential to continue decreasing costs  |
| Fiscal resources                               | Low    | • The one thing we heard repeatedly: **government has no money**  |
| Long term sustainability                       | Low    | • Difficulties finding a sustainable model for program post iREAD: Long term funding to replenish stock; lack of support from municipal decision-makers  |
| Infrastructure, distribution, and access       | Low    | • Nationwide distribution confined to schools with infrastructure - raises **equity problems**  
                                          |        | • Potential **losses through corruption** if distribution done through existing channels  |

Table 4:  
**High:** Country well suited for national uptake of e-readers based on this dimension and/or Worldreader has strong position on this dimension.  
**Med:** Some barriers exist in nationwide e-reader expansion due to this factor/dimension.  
**Low:** Deal breakers that need to be addressed before nationwide e-reader program can be successfully implemented in country.
Figure 3: Stakeholder Map - assessment of stakeholders’ level of buy-in and importance to Worldreader’s success

We identified nine key stakeholder groups relevant to Worldreader’s success, and conducted interviews with each group in order to assess their level of buy-in to Worldreader’s program as well as their importance in the education, library, and ICT4E ecosystem in Ghana. Overall, the majority of stakeholders are relatively excited about the potential of Worldreader’s program for the education and library ecosystem in Ghana. We have included below more detailed commentary on our assessment of each stakeholder group’s position:
• **Eastern Region District Education Office (high importance | high buy-in)**

The Eastern Region DEO had previously partnered with Worldreader for its iREAD 2 study, and are excited about continuing to expand Worldreader’s program in additional schools in the district.

Given the decentralized nature of Ghana’s education system, the DEOs in each district has significant influence and latitude in implementing education initiatives in schools. As such, the DEO will be an important partner for Worldreader as it expands its model.

• **Ministry of Education and Ghana Education Service (high importance | medium buy-in)**

The MOE is responsible for setting national-level education policy and targets, while the GES is responsible for the implementation of these policies (including coordinating with individual DEOs). While these two stakeholder groups are more “removed” from the day-to-day process, we heard from multiple interviews that it is critical to get MOE and GES’ stamps of approval before proceeding to implement new education initiatives, particularly if there is a goal to scale the initiative in the future. The MOE and GES are also important stakeholders for teacher training reform, textbook policy, as well as budget, and as such their buy-in is critical for Worldreader’s success, particularly at scale.

The representatives we met from MOE and GES were generally interested in Worldreader’s program and its potential to improve the country’s education outcomes. The country’s Senior High School students performed particularly poorly in Math and Science in the 2015 West African Senior School Certification Examinations (WASSCE), and there is currently an added urgency in seeking solutions to this problem. One hypothesis that part of this poor
performance stems from a low level of literacy, such that students do not necessarily understand the questions on the WASSCE. To the extent that Worldreader can prove its success in improving literacy rates among students, it may be able to garner support from the MOE and GES.

That said, the burden of proof lies on Worldreader to prove the cost-effectiveness of its program, in order to convince the MOE and GES to adopt its program. The MOE representative we interviewed was very interested in impact assessments that prove Worldreader’s effectiveness, and even suggested greater MOE and GES involvement in future pilots of Worldreader’s program.

- **Publishers (high importance | medium buy-in)**

  Worldreader has done a good job of gathering support from local publishers and making the case for partnership between the two entities. Publishers appear generally supportive of e-readers, seeing digital textbooks and storybooks as sources of incremental sales, rather than cannibalizing on physical textbook sales.

  That said, publishers we spoke with voiced complaints about Worldreader’s pricing policy, insisting that the organization needs to increase prices of its digital books - which would make it less affordable to schools and students particularly in the poorer regions of Ghana. Publishers also expressed a desire to have more control over the digital book publishing process, including copyright and distribution.

  Overall, it does not seem like this stakeholder group would block Worldreader’s expansion in Ghana, although it is important for Worldreader to continue cultivating them as partners and addressing their grievances.
• **Schools (high importance / medium buy-in)**

It is critical for schools (principals, teachers, students, and even Parent Teacher Associations) to be bought in to Worldreader’s program if it is to have any chance of success and sustainability.

In one of the schools we visited, the principal and teacher we spoke with both expressed excitement about the e-reader and recognized it as a source of value for the students. That said, price was a critical concern for them - this was a private school run by an orphanage, and thus had limited funding - and they would not be able to afford e-readers if they had to pay out of their own budget. Additionally, given the option of purchasing e-readers vs. physical textbooks with a given budget, they would unequivocally choose to purchase physical textbooks, as it will benefit more students.

• **Donor Agencies (high importance / medium buy-in)**

Donor agencies such as DFID and USAID contribute a significant amount of funding towards the education system in Ghana, given the lack of fiscal space in the MOE’s budget. As such, these agencies’ buy-in is critical to Worldreader’s success.

Support from donor agencies will first depend on whether the work of the organization in question falls into the agency’s realm of interest. For example, USAID’s goal is to improve reading performance at the primary school level, which is well aligned with Worldreader’s objectives. That said, funding from donor agencies will also be contingent upon Worldreader’s past track record of impact.
• **Ghana Library Authority (medium importance | high buy-in)**

The GLA is the primary agency overseeing the public library system in Ghana, and would thus be an important partner if Worldreader opts to expand via libraries (rather than schools). However, several stakeholders we interviewed expressed concern about GLA’s ability to implement projects at scale - it is resource and budget-strapped, and had not appeared to have achieved significant impact in the country.

When the team met with a representative at the GLA, they expressed strong interest in partnering with Worldreader to pilot the use of e-readers in libraries across the country.

• **Printers (medium importance | medium buy-in)**

Printers should, in theory, be the stakeholder group most adamantly opposed to Worldreader, or any program that advances the digitization of books. However, the Ghana Paper and Print Converters’ Association (GPPCA) representative we spoke with did not appear to see digital books as a threat, primarily due to the electricity and infrastructure barriers in Ghana.

It would be important for Worldreader to continue maintaining good relations with this stakeholder group though, as they have some past track record of successful lobbying. In particular, they had successfully lobbied the government to remove pre-production tariffs on locally produced books, as well as to enforce the requirement for publishers to use local printers in the textbook procurement process.
• **NGO partners (low importance / high buy-in)**

We spoke with two education non-profits in Ghana (Teach for Ghana and Tap2Educate) that were very interested in partnering with Worldreader. While neither partnership would be critical to Worldreader’s success, Worldreader can consider partnering with either of these organizations (or other education NGOs/non-profits) in order to advance its goals.

• **Ghana Education Trust Fund (GETFund) (low importance / medium buy-in)**

GETFund is a public trust set up by the Ghanaian government whose mandate is to fund education infrastructure and facility projects. While GETFund is a significant funder in the education space in Ghana, it has limited ability to decide which education initiatives or projects to allocate funds to. GETFund allocates its annual budget to projects based on recommendations by the MOE.

**Detailed Assessment of Individual Elements of Market Feasibility Framework**

**Buy-In and Capacity Among Educators (Medium)**

Educators in the schools that had adopted Worldreader’s program under iREAD 2 were very positive about the program, viewing the e-readers as a source of pride for their school. Teachers are committed to the program, even bringing the e-readers home to charge when the school’s electricity is down, and had integrated the e-readers into the classroom. During the team’s visit to one of the iREAD 2 schools, teachers mentioned that e-readers had made teaching easier and more enjoyable.
While educators appear to see value in the e-readers, capacity building may be more of a challenge. In the Ghanaian public school system, teachers are transferred at the behest of the GES and DEO. While Worldreader had requested that teachers in the iREAD 2 schools who had been trained on the use of e-readers not be transferred out, this request was not fulfilled. Retraining new teachers on the use of e-readers will lead to additional costs incurred.

More broadly, training teachers on a national scale to use e-readers and incorporate them into classrooms will be much more challenging. Ghanaian teacher training is divided into two parts: pre-service (in teacher training colleges, prior to deployment) and in-service (regularly scheduled trainings for teachers to be upskilled). From conversations with even MOE staff, it appears that making changes to pre-service teacher training curriculum will be a herculean endeavor that takes years to pass through, due to high levels of inertia. On the other hand, in-service teacher training appears more flexible - the MOE allocates funds for schools to provide teachers with professional development opportunities. Schools could theoretically apply these funds towards teaching teachers on the use of e-readers.

However, in our conversation with the founder of INTED, a Ghanaian non-profit dedicated to teacher training, things are not as straightforward in practice. The MOE’s budget for in-service teacher training is tiny, such that only approximately 500 out of 40,000 teachers get trained each year. Schools have very limited funding for discretionary spending, and has to allocate these funds towards purchasing uniforms, school feeding programs, and other daily needs. In this context, it is unsurprising that teacher training is not a priority.

If Worldreader were to be successful in Ghana, it will need to devise a scaled, low-cost method of training teachers on the use of e-readers, and to offer that to schools for free.
Enabling Policy Environment (*Medium*)

See *Education Sector Policies and Strategies* section and *Printers* sub-section of the *Stakeholder Assessment* section for detailed analysis.

Proof of Concept and Proven Technology (*Medium*)

Worldreader has done a good job of building up an evidence base for the effectiveness of its program, particularly through the quasi-experimental iREAD 2 study. This evidence for impact will be important in unlocking support and funding from the MOE and donors. To quote one of the MOE staff we spoke with, “once there is evidence that this program promotes reading, we [MOE] will be very interested”.

However, there are additional areas that Worldreader needs to build an evidence base for before it can garner support for nationwide implementation. First, its program would need to prove that it is equitable - e-readers need to be usable not just in wealthy or urban schools, but also in schools located in rural and deprived districts. Second, it needs to be cost-effective. Third, it needs to be sustainable in the long run, and Worldreader needs to have a clear plan for building up schools’ capacity to run the program as well as to maintain and repair the e-readers. These will be areas that are particularly important to address as Worldreader continues to improve its program.

Cost-Effectiveness (*Medium*)

Based on cost and impact data from Worldreader and the iREAD 2 study results, as well as forecasts of enrollment and textbook: student ratio targets from the government, we built a cost-effectiveness model for e-reader vs. physical textbook programs (see Appendix II for
screenshot; Excel model sent to Worldreader separately). The model is intended to help Worldreader better understand the cost drivers of its program and what to focus on to "move the needle" in terms of bringing costs down going forward. Additionally, we hoped that the model could be used by the team on an ongoing basis as a way to compare the cost-effectiveness of its e-reader program and the traditional physical textbook program.

Based on current assumptions, on a national level, the e-reader program remains more expensive than physical textbook program, with the highest delta at the primary school level (Appendix II). That said, once effectiveness is taken into account (as measured by improvements in the number of correct words per minute, one of the key metrics in the Early Grade Reading Assessment), the digital and physical textbook programs are relatively comparable.

Fiscal resources (Low)

97% of the MOE’s expenditure in basic education over the past five years has gone towards teacher salaries, crowding out expenditure in other budget categories. The Ministry of Finance (MOF) is responsible for setting the overall budget and determining civil service remunerations. However, because (i) the budget provided by the MOF to the MOE perennially underestimates the number of teachers on payroll, and (ii) there is no hard ceiling on amount of education budget that can be used towards Personal Emoluments (wages), PE expenditure consistently goes above budget and crowds out other categories. For example, 2014 actual PE expenditure was GHC 5.11B, against a GHC 4.39B budget. Further, the government in 2010
migrated to a Single-Spine Salary Structure for civil servants, which led to a significant increase in the government wage bill\textsuperscript{45}.

As a result, funding for other components of basic education, such as classroom infrastructure, training, and textbook provision, has to come from other sources. As seen from Table 4 below, Internally Generated Funds (IGF), i.e. revenue sourced from individual districts, were the biggest source of funding for Goods & Services in 2014; while GETFund, a public trust whose mandate is to fund educational infrastructure and facilities projects, was the largest contributor towards expenditure in Assets.

<table>
<thead>
<tr>
<th>Sources</th>
<th>Compensation</th>
<th>Goods &amp; Services</th>
<th>Assets</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoG</td>
<td>5,114,256,299</td>
<td>121,516,459</td>
<td>159,781</td>
<td>5,235,932,539</td>
<td>79.8%</td>
</tr>
<tr>
<td>Donor</td>
<td>-</td>
<td>321,166,618</td>
<td>637,689</td>
<td>321,804,307</td>
<td>4.9%</td>
</tr>
<tr>
<td>IGF</td>
<td>-</td>
<td>799,309,305</td>
<td>229,051</td>
<td>799,538,356</td>
<td>12.2%</td>
</tr>
<tr>
<td>GETFund</td>
<td>-</td>
<td>108,590,733</td>
<td>88,058,680</td>
<td>196,649,413</td>
<td>3.0%</td>
</tr>
<tr>
<td>Annual Budget Funding Amount (ABFA)</td>
<td>-</td>
<td>-</td>
<td>10,667,891</td>
<td>10,667,891</td>
<td>0.2%</td>
</tr>
<tr>
<td>Total %</td>
<td>5,114,256,299</td>
<td>1,350,583,115</td>
<td>99,753,093</td>
<td>6,564,592,507</td>
<td>100%</td>
</tr>
</tbody>
</table>

| Source: 2014 Education Sector Performance Report |

Table 5: 2014 Education Expenditure Categories, by Source

Realistically, financial support for Worldreader’s program will likely need to come from external donors and districts, rather than the MOE. Based on our conversation with USAID, it appears that multilateral agencies make their funding decisions based on (i) whether a

\textsuperscript{45} Darvas and Balwanz, 2014.
proposed initiative is proven to be effective in addressing the said agency’s area of focus (e.g. improving literacy at the primary school level), and (ii) whether it is in line with the MOE’s goals and priorities. Thus, to unlock funding from these agencies, it will be important to also secure buy-in from the MOE. Most likely, Worldreader would need to orchestrate a project that involves MOE and/or GES staff and with a donor agency’s financial support.

Additionally, Worldreader can propose a cost-sharing model with districts to alleviate the cost of the program as well as increase buy-in. The Eastern Region DEO, for example, had seen benefits of Worldreader’s programs, and is interested in expanding it to additional schools in its district. This would be an opportune time for Worldreader to propose a cost-sharing model, with specific cost breakdowns negotiable based on the amount of discretionary funds the district has.

Long-Term Sustainability (Low)

The fact that the e-readers are still used in iREAD 2 schools, 1.5 years after the study ended, is promising. However, from our visit to one of these iREAD 2 schools in Suhum, it is apparent that the school is struggling to keep the program running. Electricity access has become more challenging in Ghana overall, with increasingly frequent power outages even in Accra. The Suhum School had only had intermittent electricity access over the past three months, forcing teachers to bring the e-readers home for charging. While Worldreader offers a solar charging solution, a single solar unit costs USD 500 - a price that would be unaffordable for most basic schools in Ghana.

Additionally, out of the 150 e-readers provided at the start of iREAD 2 to the Suhum School, only 100 were still operational. The rest had been broken, lost, or stolen. With only ⅔ of
the e-readers available, students have had to move from an individual model (each student getting one e-reader) to a shared model, which could impact the program’s effectiveness.

Long-term sustainability of ICT4E projects is a key concern for the MOE, as highlighted above, and Worldreader needs to offer a clear program model that can be sustained over 5 years, which is the expected life duration of is e-readers.

Infrastructure, Distribution, and Access (Low)

We have highlighted infrastructure and access challenges faced by Ghana in preceding sections. To compound these issues, corruption is also a significant problem in the education system in Ghana. A World Bank report cites that up to 50% of textbooks are lost during distribution and stockage. We spoke with a representative from the Ghana Integrity Initiative during our travels, who reiterated this issue, and highlighted that the corrupt actors would likely resist the implementation of e-reader programs if it means they will lose their “cut” of the textbook pie as a result. On the other hand, should Worldreader choose to distribute its e-readers to schools through the same channels used to distribute physical textbooks, it faces the risk of theft as well.
Assessment of Opportunities and Challenges in Government Adoption of Digital Textbooks

Overview of Scaling Options

Worldreader’s overarching goal is to scale its program nationwide in Ghana. Given this goal, it has several options for expansion: first, should it expand through the school or library system? Second, should it take a top-down approach (securing buy-in from the top level and influencing changes in national-level policies), a bottom-up approach (expanding through individual schools or libraries), or something in the middle? Based on the contextual analysis of Ghana’s education system outlined in prior sections, we have summarized the pros and cons of expansion through each of these models in Table 6.
<table>
<thead>
<tr>
<th>+ pro</th>
<th>- con</th>
<th>SCHOOLS</th>
<th>LIBRARIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATIONAL (Top-down)</td>
<td>- Lack of resources on the national level; government lacks funds for larger initiatives and multilateral orgs have their own agendas and targets</td>
<td>+ GLA displays interest in partnership and has nationwide reach, both with traditional and (especially) regional mobile libraries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- MOE is enthusiastic but reluctant to approve broad adoption without sustainable source of funding and clear evidence of effectiveness in terms of ROI (require larger pilot study under MOE supervision)</td>
<td>- Underfunded, but potential for a cost-sharing model with gov’t support</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- E-reader technology does not align with planned ‘ICT for education’ policies and investments</td>
<td>- Limited impact (vs. going through schools) due to limited library attendance and lack of continuous teacher supervision</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Complications due to lack of adequate collaboration between MOE and implementation agencies, as well as slow-moving procurement and curriculum reform</td>
<td>- Additionally, GLA libraries have reasonable access to children’s literature and limited reach to the most underserved communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Need for pilot to measure impact in order to garner political/financial support</td>
<td></td>
</tr>
<tr>
<td>DISTRICT (Goldilocks)</td>
<td>+ DEO partners wish for continued partnership, creating an opportunity to involve MOE/GES stakeholders in next iteration for proof of concept</td>
<td>- Municipal library systems are chronically underfunded and disorganized as a whole, which makes for difficult partnerships</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+ Districts have autonomy to raise own funds, providing an opportunity to begin roll-out from wealthier districts</td>
<td>+ if viable partners can be identified, the lack of children’s lit create impact opportunity</td>
<td></td>
</tr>
<tr>
<td>INDIVIDUAL (Bottom-up)</td>
<td>+ Selectively and gradually expanding the program helps maximize success rate, address sustainability concerns</td>
<td>+ Organizations such as OCLF or the Street Library would allow bypassing administrators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Slow adoption rate hinders impact</td>
<td>- Limited reach and little scaling opportunity</td>
<td></td>
</tr>
</tbody>
</table>

Table 6
IV. Recommendations and Advocacy agenda

Introduction and Summary

Given the above analysis, it does not appear that Worldreader has a sufficient proof of concept to secure government buy-in and the third-party funding necessary to implement a fully institutionalized roll-out of e-readers in Ghana’s public school system. To make a more substantial case for a transition from traditional textbooks to e-readers, Worldreader will have to provide more evidence of its comparative effectiveness and the tangible returns on investments for such a program. We provide recommendations for potential study designs that could address this.

Rather than stalling operations and redirecting all resources and personnel towards new studies, however, Worldreader should continue the process of working towards nationwide institutionalization by exploring alternative routes to scale its operations in Ghana. We propose an approach that takes advantage of the increasing autonomy of district leadership, beginning with the Eastern Region’s Kwaebibirem DEO that has hitherto been strong partners and advocates of Worldreader.

Finally, Worldreader can leverage potential partnerships with education NGOs to overcome outstanding roadblocks. For example, it can partner with Teach for Ghana (TFG) to train TFG teachers on the use of e-readers. TFG aims to recruit, train, and deploy highly educated and motivated young teachers to underserved schools in Ghana, where these teachers would serve for a two year term. Through this TFG partnership, Worldreader will be able to mitigate the
issue of having to train low-capacity teachers to use e-readers, and have the teachers be transferred to other schools within the span of less than a year.

District-level Partnerships in Building Momentum

As previously stated, district education directorates in Ghana have gained increased autonomy following the process of decentralization. Such autonomy does not afford the districts the self-determination to change the curriculum or test standards at will, but they do have a relative level of financial independence. This financial autonomy provides Worldreader with an opportunity for partnership that is advantageous given its cyclical benefits (Figure 4).

Figure 4: Representation of the cyclically-reinforcing benefits of a district-level approach: District funding goes toward efficacy studies that would further demonstrate the effectiveness of the e-reader program, thus providing increased incentives for multilateral organizations to provide Worldreader funding for future studies and programs.
Motivated district education offices (DEOs) are more versatile in their funding opportunities, access to key decision makers, and speed at which decisions are made. The increased status or prestige derived from using e-readers in its schools’ curriculum with Worldreader’s program is a convincing argument for many districts. By securing district-level support, Worldreader would be able fund future efficacy studies more reliably. Such studies, as described below, will not be inexpensive and will require a great deal of human and financial capital to adequately demonstrate the e-readers’ effectiveness in improving literacy across varied and difficult classroom environments. Those studies are critical, however, in unlocking funding from major multilateral organizations like USAID and DFID—funding from which that can go towards future programming.

The cyclical nature of these reinforcing benefits is a major strength of the district-level approach. It affords more versatility than working directly with the MOE to implement the program and the influence needed to scale its impact. With this approach, we recommend Worldreader reach out to the Eastern Region Kwaebibirem DEO leadership, as well as other DEO’s that have expressed interest in working with Worldreader in the past. We also recommend working to secure a representative at the MOE and/or GES that would act as a liaison between Worldreader and the districts. Building a relationship with a Ministry representative would act to give Worldreader a political champion and provide the MOE with a sense of ownership and investment in Worldreader’s ongoing programs and studies. Such studies are described in detail below, both theoretically and practically.
Study Design Recommendations

Introduction

While the Ghana iREAD 2 study (2014) provided strong evidence for the beneficial effects of e-readers in participating Eastern Region classrooms using the Worldreader program, there are several changes to the methodology that our team recommends for future iterations of effectiveness studies. Given the high costs associated with implementing high-quality and meaningful research, these recommendations detail study designs on a 2, 5, and 10-year horizon that would continually build off the findings of previous research. Specifically, we recommend conducting progressively-expanding studies as follows: a multi-treatment cluster-randomized control trial (RCT) at the district level in the Eastern Region within two years; an experimental-causal-chain study within five years; and finally, a pragmatic study within ten years. These timelines are general estimations given the increasing scale of the progressive study designs, both in terms of the number of participants and financial resources required for methodological rigor.

A multi-treatment cluster-RCT would allow Worldreader to work directly with the Eastern Region’s Kwaebibirem District Education Office to randomly cluster schools at the district level and conduct multiple treatment arms. This explanatory study design is beneficial for three primary reasons: first, it allows Worldreader to compare the effects of its program (assuming similar positive effects observed in iREAD 2) against a separate but similar treatment (i.e., supplying schools with equivalently-valued textbooks); second, it controls for many of the unobservable environmental variables that influence observed outcomes; and finally, it reduces confounding variables that correlate with both the dependent and independent variables (e.g.,
other education initiatives in the past that correlate with both testing scores and literacy rates), as well as perceptions of inequity among control and treatment schools within a cluster. A proposed study design is described at length below.

An experimental-causal-chain design, the second study we recommend in the series, would allow experimenters to isolate both effect sizes caused by the e-reader program and the mechanism that most holistically explains the effects. Such a study design, while ambitious, would be methodologically rigorous sound and explain the how and why of e-readers’ benefits as a means of improving literacy rates in the developing world. Properly implemented, the results of a study that demonstrated positive effects through the use of e-readers would greatly advance the value of Worldreader’s proposals. The significance of promising evidence yielded by such a study cannot be understated in the field of ICT4E, a difficult reality considering the state of many contemporary experimental study outcomes in education research.

Finally, whereas explanatory trials aim to test whether an intervention works under optimal situations (such as both designs described above), pragmatic studies are designed to evaluate the effectiveness of interventions in real-life routine practice conditions. Pragmatic trials produce results that can be generalized and applied in routine practice settings. Since most results from exploratory trials fail to be broadly generalizable, the “pragmatic design” has gained momentum. A pragmatic study design would be most useful in determining the generalized preparedness and ability of schools across Ghana to adopt the Worldreader program effectively. It would likely also be the most effective study in convincing policymakers that the Worldreader program is highly valuable and worthy of consideration for nationwide institutionalization.
Below is a detailed rationale for the use of RCTs in research on ICT in education initiatives. Although many recent studies have proved inconclusive, there are some methodological concerns that offer guidance to improvement on studies of the past. Following the rationale for a rigorous study design, we explain the statistical principles and importance of an experimental design for explaining causal mechanisms (the how and why of an intervention’s effects on an observed outcome). With consultation from Professor Justin Grimmer at Stanford University, we outline clear recommendations for designing a promising RCT based on the structure of Ghana iREAD 2. In an effort to balance the financial and personnel limitations that might make a study of this scale impractical, we cite which components of the proposed study design are most critical to maintain the statistical integrity of the study and which components could be modified or removed due to concerns of cost. Finally, the recommendations conclude with a discussion on reducing costs and a list of additional resources to consult for implementing a low-cost RCT.

Rationale for Rigorous Study Design

Until fairly recently, widespread enthusiasm for the potential of computer-based ICT in helping children learn to read generated high expectations for the possibilities of new technologies in education.46 However, expectations in this domain have run far in advance of

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existing evidence that technology can aid in literacy improvements.47 Beyond measuring the effectiveness of the technology's implementation, it is important to also determine relationships between ICT use to contemporary models of reading acquisition and effective pedagogical models for applied technology. That is, studies examining the efficacy of technology in the classroom must consider more than the quality of treatment; researchers need to understand how the technology works within the current understanding of how students learn to read, as well as how teachers use it to improve their teaching, described below.

Several reviews of recent research that involved quasi-experimental studies have generally seen small, positive effect sizes for ICT on literacy, and such reviewers are cautiously optimistic about ICT in literacy programs.48 However, quasi-experimental studies are insufficient in confidently asserting that technology causes improvements in reading. Their non-random, non-comparative study design restricts the ability of researchers to adequately compare the effectiveness of a treatment to a control group while minimizing the influence of unknown environmental conditions on the effect. Observational or quasi-experimental studies are limited to finding associations (non-directional relationships between two variables) that do not establish a clear direction of cause and effect.


To establish a cause and effect relationship between independent variables of interest and a dependent (outcome) variable, RCTs must occupy a central role, as they provide the greatest statistical confidence in findings.\textsuperscript{49} However, even among methodologically-robust RCTs concerning ICT in the classroom, several comprehensive systematic reviews of over 2,300 studies have yielded inconclusive evidence for ICT-based interventions in children ages 5-16 years.\textsuperscript{50} Although some studies yielded positive effects, none showed large positive effect sizes, and many of the studies showed negative effects. In sum, Andrews et al. (2007) concluded that of the 2,103 contemporary reports they analyzed for impacts of technology on language learning, none of the reports that had purported to have demonstrated effectiveness of ICT had done so convincingly. They concluded their findings as such:

\textquote{[T]he field is in a pre-paradigmatic state where definitions of English, literacy, and ICT are still relatively unclear and where the causal or reciprocal relationships between them have yet to be fully theorized.}\textsuperscript{51}

The pessimistic findings of the literature above should not dissuade Worldreader from improving on inconclusive studies and conducting further experimentation in search of promising evidence.


\textsuperscript{51} Andrews et al., “The Effectiveness of Information and Communication Technology on the Learning of Written English for 5- to 16-Year-Olds.”
evidence for ICT4E, provided they consider three conceptual issues of broad study methodology. The first issue concerns study implementation, the second issue concerns the quality of the technology used in research studies, and a final issue concerns what we term the coherence of the technology as it relates to teachers’ instruction and students’ reading acquisition.52

Looking first at study implementation, research on teacher-led reading interventions suggest that the quality of a program’s implementation has a significant impact on intervention outcomes, and variation in implementation among different experiment sites is the biggest factor in moderating outcomes and can often entirely explain the effects reported by an intervention.53 Practically, changes in a literacy program’s implementation across different classrooms can dramatically affect how well the intervention is adopted, and ultimately, adapted. Adoption can be characterized as teachers’ systemic adherence to treatment protocols. At the adoption level, although teachers follow the minimum standards that hold to a treatment’s integrity, Teachers at the adoption level they use the technology with only minimal experimentation and rarely use it to make links to other forms of learning (such as collaborative or experientially-based learning), although they follow the minimum standards that hold to a treatment’s integrity. By contrast, adaptation moves beyond the sphere of technical adoption.

52 Savage et al., “A (Pan-Canadian) Cluster Randomized Control Effectiveness Trial of the ABRACADABRA Web-Based Literacy Program.”

towards transforming the classroom to integrate the technology into multiple forms of learning. Teachers that have adapted the technology in a treatment produce significantly greater gains in student reading levels than teachers at the adoption level.\(^{54}\)

To address variation in study implementation, an ICT study needs to explore how participating teachers do (or do not) implement the intervention. Research suggests that a number of teacher factors—including teachers’ use of ICT at home,\(^ {55}\) comfort with computers,\(^ {56}\) beliefs and expertise,\(^ {57}\) and fear and other emotional reactions toward computers—affect teachers’ actual use of computer technology in an ICT intervention. By focusing on three broad motivational categories: perceived expectancy of success, perceived value of technology use, and perceived cost of technology use, Worldreader can influence the effects of implementation quality on student outcomes. In a 2006 study on teachers’ use of technology, expectancy beliefs were the most important in motivating teachers to use technology effectively, followed by perceptions of value. Beliefs about cost were negatively associated with using technology.\(^ {58}\) These findings are particularly salient as they relate to the use of e-readers in developing world classrooms, where the perceptions about cost, value, and expectancy of success are heightened.

\(^{54}\) Savage et al., “A [Pan-Canadian] Cluster Randomized Control Effectiveness Trial of the ABRACADABRA Web-Based Literacy Program.”


\(^{58}\) Wozney, Venkatesh, and Abrami, “Implementing Computer Technologies.”
Another opportunity for encouraging teachers’ effective use of technology in a program is ensuring careful and comprehensive training on the technology and its use in the classroom. This is an area in which the Ghana iREAD 2 study was especially successful, and the format for two 3-day workshops and multiple refresher trainings should be repeated in further studies.

The second conceptual issue is the quality of the technology used in the intervention. There is a temptation among many experimenters to choose the best technologies available, either to maximize their use of cutting-edge technology, encourage the expectancy of success among teachers (discussed above), or prolong the longevity of a technology’s relevance in the classroom. This is problematic, however, if there have not been prior assessments of the quality of the technology in the context of the study’s participants, as is often the case with the newest available technology. This is another area in which the Ghana iREAD 2 study was successful. Although technologies exist that are technically superior to the Kindle e-reader, it is critical to ensure that the device most appropriate in cost and quality be used in the program.

The final issue is evaluating the technology as a link between contemporary pedagogical theories and reading acquisition theories. It must be stressed that ICT4E is not a “magic bullet” in education outcomes, but rather a medium with varying degrees of usefulness in equipping teachers to instruct and inspire their students. The quality of a program’s implementation or of the technology itself is secondary to its place as a central link in the classroom between the teacher, students, and curricula. As discussed above, if the teacher only adopts the technology in accordance to minimum standards of treatment protocols, it hasn’t been synthesized as a tool to reinforce instruction. In designing effective studies, researchers should look to articulate the
strengths and limitations of ICT to embed the technology in regular classroom teaching. The technology must revolve around and complement the instruction, not vice versa.

Just as the ICT should be coherently integrated with pedagogical best practices, Worldreader should explicitly identify the role of the ICT in students’ learning. In the National Reading Panel report, the Panel notes that effective reading interventions must be comprehensive and balanced.\(^{59}\) Truly balanced approaches emphasize reading skills such as: phonemic awareness—the ability to hear and manipulate individual sounds in spoken language; phonics—the ability to relate specific written letter(s) to specific sound(s) (grapheme–phoneme correspondence); fluency—the ability to read text effortlessly and expressively; and comprehension—the ability to understand and interpret text; and an emphasis on meta-cognition—ability to reflect and regulate knowledge construction.\(^{60}\)

While enthusiasm for the potential of computer-based ICT as a means of improving literacy rates has waned, there remains reason to be optimistic in finding evidence to support the positive role of ICT in the classroom. Observational or quasi-experimental research, however, is not sufficient to assert the cause and effect relationship of an intervention and its observed outcome. The Ghana iREAD 2 study laid promising groundwork and suggests positive effects of the Worldreader program on literacy in Ghanaian classrooms, but there is opportunity to explore the insights gained from its lessons in much greater depth. To that end, we recommend

\(^{59}\) National Reading Panel (US), National Institute of Child Health, and Human Development (US), Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction (National Institute of Child Health and Human Development, National Institutes of Health, 2000).

implementing a multi-treatment cluster-RCT as the next iteration of the Ghana iREAD study series. The proposed study design is outlined below.

Cluster-Randomized Control Trial

The iREAD studies would be strengthened by taking place over a single academic year, using a pretest-posttest experimental intervention design and randomizing schools at the district level across participating districts in a cooperating region such as the Eastern Region (Figure 5). Schools among participating circuits would be randomly assigned to a treatment or control group. Among schools assigned to a treatment group, half would randomly be assigned to the first treatment arm (i.e., the Worldreader program used in iREAD 2); the other half would be assigned to the second treatment arm (i.e., given books valued equivalently to the Worldreader program). This multi-treatment design accomplishes two main objectives: first, it would be the first experiment using the Worldreader e-reader program in a fully-developed RCT; second, it would allow experimenters to quantify the difference in improved literacy rates between providing schools with e-readers and a dollar-equivalent of textbooks. This answers the question “how much more effective, if at all, are e-readers than textbooks at improving literacy rates?

Demographics and Sampling

The Eastern Region has 25 districts, each of which have 7-10 circuits. The Kwaebibirem Education District, which maintains a strong relationship with Worldreader, has been divided into
Figure 5: The figure above illustrates the study design as follows: a representative of the MOE (R) acts as a liaison between the MOE and the participating DEO, in this case the Kwaebibirem DEO. Worldreader should also engage the Circuit Supervisors (S) the head every participating circuit. Among the circuits, Schools are randomly selected to one of the treatment arms (T1-T3) or a control group such that the final distribution is equal across the treatment groups and control group. Within circuits, the schools are paired based on socio-economic data and BECE scores.

10 circuits. 61 Those circuits averaging about 320 students/school at the primary level (35,358 primary school students in the district, 8-14 schools in each circuit), of which 51.2% are male and 48.8% are female. Experimenters should allow the circuits to apply for the program, ensuring the sense of ownership and accountability outlined in the iREAD 2 program. Schools within this study should be nonselective urban, suburban, and rural primary schools. No student should be excluded due to language or exceptionalities. If possible, student-level data should be collected to construct a set of derived variables that describe the socio-economic characteristics of each

school, including occupational status, unemployment rates, family income, and years of education.

Sample Selection

Circuits’ designation as treatment or control is randomly assigned. The minimum number of groups needed to be randomized in order to ensure the intervention has a meaningful effect can be determined through a power analysis. Power analyses require experimenters to make a judgment about the minimum effect size they are seeking to detect—one that may be based on such factors as what previous studies suggest as the intervention’s likely effect size and what effect size would justify the intervention’s cost, especially in a resource-constrained setting.62 Appendix IV contains R code to help an experimenter determine their statistical power given the expected means of treatment and control groups, standard deviation, and sample size. In a single treatment versus control trial, using treatment effects similar to the iREAD2 study, 400 participants would likely be sufficient to achieve a minimum power threshold of .80 (the standard for many disciplines; in a multi-treatment study with two treatment arms and a control, that number may need to be doubled or more. This is discussed at greater length in Appendix IV.

Another factor in designing an adequately sized cluster-RCT is the intraclass (intracluster) correlation coefficient (ICC).63 The ICC between clusters is analogous to the variance between


subjects in a randomized controlled trial. Just as when randomized controlled trials exhibiting high variance between subjects means a larger study is needed, less correlation between clusters indicates more clusters are needed.

Within a circuit, schools are paired based on their similarities in two areas: academic performance, as measured by Basic Education Certificate Examination (BECE) results for the junior high schools (which the selected primary schools fed into), and participation in the educational opportunity program (see iREAD 2) Within each designated pair, schools are randomly assigned to a treatment (although which arm of treatment remains unassigned) or control group. Such prior identification reduces bias in cluster RCT designs.\textsuperscript{64}

Baseline

Reading assessments for treatment and control students should be conducted at two intervals: Baseline (prior to study start)) and endline (10-12 weeks following conclusion of second year, if possible). The assessments should aim to sample as many of the treatment and control students initially enrolled in the target grades as possible. A midterm report between academic years should aim to assess a small random sample of students to provide a general progress report on the initial impacts of the project. A review of the teaching evaluations conducted during the prior period (discussed below) should work to improve but not drastically alter perceived gaps in the quality of instruction.

Multi-Treatment, District-Level Rationale

This district-level cluster-RCT allows Worldreader to control for numerous environmental variables that might change between districts. It also facilitates a multi-treatment study design. By pairing schools within circuits, experimenters can limit external biases from influencing the observed effect of its treatment(s). Explicable environmental variables that introduce bias include the quality of instruction, socio-economic background, parent literacy, leadership of the circuit by the circuit supervisor, infrastructure constraints, and geography—all of which are mitigated by pairing schools within clusters.

Multiple treatment arms are useful in this case because there is not clear evidence that, within the Worldreader program, e-readers are the dominant explanatory variable affecting the literacy gains observed in iREAD 2. Extra-curricular activities were a flagship feature of the iREAD 2 study, but it may be the case that the extra instruction was responsible for the e-readers’ success. It also may be true that literacy rates would improve at a comparative level among schools that were supplied with traditional textbooks. If Worldreader were to calculate the cost of its program per school, using the same dollar amount to purchase textbooks for schools in the second treatment arm of the study, it would be able to examine outcomes for statistically-significant differences.

Pre-Intervention Procedures

Before the intervention, teachers should undergo workshops similar to those in the iREAD 2 program (two, 3-day workshops and two refresher trainings, held by the Olinga Foundation). Workshops should include class and head teachers, circuit supervisors, the Director of Supervision from the District Education Office, and a representative of the GES. Directly
involving head teachers who could train teachers at other schools, a training-of-trainers approach, can cement learned concepts and extend the influence of best teaching practices. Additionally, by involving district-level GES officers, the program can engage local education authorities who could consequently monitor and provide supervision in the schools, just as it did in the iREAD 2 study. Workshops and periodic check-ins by Olinga Foundation staff should include the developmental and pedagogical philosophy of the e-readers and be given hands-on time outside of the workshops to explore the devices.

These workshops are designed to align the study with the three broad methodological principles cited in the discussion above (study implementation, quality of the technology, and the coherence of the technology as it relates to teachers’ instruction and students’ reading acquisition). Teachers should be made aware that e-readers are only a tool, not an ICT “magic bullet,” and that the Worldreader program requires skilled teachers to implement it well and to link it effectively to cross-curricular learning outside the sessions. The concept of adaptive transformational use of technology (rather than simple adoption) should be discussed explicitly with all intervention teachers. Workshops should also include time in which teachers train each other on how to use the devices and answer any questions their teacher counterparts have about the devices. Beyond workshops to train teachers in the best practices of teaching literacy through e-readers, all teachers in both study groups should be encouraged to continue their instruction as normal. The conceptual and methodological reasons for this request should be explained and often revisited with teachers.

Following workshops and hands-on exposure to the devices, investigators should present and review a suggested pedagogy using the e-readers. Teachers should be encouraged
to use presented activities but to ultimately select activities relevant to the appropriate point in the pupils’ development. It should be reiterated that the suggested curriculum is a fairly flexible guideline and should be adapted to meet the individual needs of their students as well as their own teaching styles and that the responsibility for developing appropriate specific lesson plans and interventions always rested with the regular classroom teachers.

**Intervention Procedures**

When the treatment begins, each classroom should have in-person support through the use of research assistants (RAs) to coordinate the implementation of the study during the first four weeks of the implementation phase. This is to provide technical support and answer general instructional questions regarding the use of the devices. RAs will also act as liaisons between the teachers and Worldreader. Researchers should provide additional support through weekly meetings via the web/phone interviews between teachers and the study coordinators, as well as monthly meetings using data collected by the RAs on the quality of the teaching environment (see below).

RAs should use a document similar to the Literacy Instruction Questionnaire to collect information on various elements of the teachers’ language instructions.65 To capture potential mid-study changes in language instruction, teachers should be asked to complete the questionnaire during both the pre-and post-tests (in sync with the student assessments). A

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classroom observation form\textsuperscript{66} should be used to collect additional data about the details of classroom instruction and include four general sections:

- General classroom environment (including physical context and environment, classroom management, quality of teaching and learning and effects of technology)
- English language activities that pertain directly to the BECE or other assessment used during the pre- and post-tests
- Classroom management drawing attention to details of collaborative work such as types of collaboration, types of activities and time spent, and teachers’ facilitation and instruction
- A final scale to evaluate the overall classroom instruction

Students in the control classrooms should continue to receive regular English and Twi language instruction, although it must be stressed that those lessons should include the use of textbooks valued at the same or comparable price used to implement the e-reader program, including teacher training, devices and pre-loaded digital materials, and technical support.

Final interviews with teachers should be conducted shortly after the end of the intervention. These interviews will be used to learn about teachers’ attitudes towards the use of the technology, tensions about the use of the e-readers, and the teachers’ beliefs about the efficacy of the devices in teaching literacy as compared to the use of traditional printed

materials. Finally, to maintain equity, control classroom teachers should receive e-reader training and e-reader devices following the conclusion of the study, although they would not know this before the end of the study, as expectations of perceived “awards” may introduce unmeasurable bias through a change in teaching quality.

Below is an introduction and explanation of an experimental-causal-chain study design for future RCT studies. The advantages of this design would allow Worldreader to establish not only e-reader use as a cause of improved literacy, but to show the components of its program that make e-readers so effective as teaching tools. Rather than using a multi-treatment trial, the investigator would experimentally manipulate a controlled variable that they believe is an underlying mechanism in a relationship between a dependent variable and its covariates (establishing cause and effect).

The Mediation Model

In applied research, the most dominant approach is the single-experiment randomized control trial, where only the treatment variable is randomized between a group that receives the treatment and a comparison group that does not. The key advantage of randomized experiments is their ability to estimate causal effects without bias—that is, they allow researchers to control for unknown environmental changes that would otherwise influence, or bias, the real effect of the treatment on the outcome of interest. The fundamental difficulty of this approach, however, is that the absence of unobserved confounders (environmental variables) rarely holds in practical application. As a consequence, this kind of experimental research is often criticized as a “black
box approach” that only serves to estimate average causal effects but ignores causal mechanisms.\textsuperscript{67}

To overcome this limitation, a researcher may opt to use a mediation model in an alternative experimental design. Mediation models are characterized by the explicit use and manipulation of a mediator variable. Rather than looking for a direct causal relationship between one or more independent variables and the dependent variable (Figure 6), a mediation model formalizes not only the why, or the cause and effect relationship researches are normally investigating in experimental research design, but the why, or the causal mechanism of a cause and effect relationship. This causal mechanism is the vehicle by which as an intervention would actually act to affect an outcome. This is practically applied to specific recommendations below.

The mediation model begins by defining a mediator that is hypothesized to be the dominant channel by which the independent variable(s) affect the outcome (Figure 3). In fact, realistic systems are more complex, and thus compel experimenters to consider more than one

mediator. Rarely is a cause and effect relationship so simple to be explained by a single mechanism. Rather, variable relationships are complicated and sticky. Thus, researchers should search for multiple mediators that may explain the causal mechanism by which the treatment effects the observed outcome (Figure 7).

![Figure 7](image-url)

**Figure 7:** Treatment variable(s) (T) lead to an outcome (Y), in part through a mediator variable (M)

The key assumption under these experimental designs is that the action of manipulating the mediator does not directly affect the outcome (other than through the fact that the mediator takes a particular value). To satisfy this consistency assumption, the mediator must be manipulated in a way that experimental units behave as if they chose the mediator value on their own, as it allows the hypothetical cause (the e-reader) to produce an effect through a naturally observed mechanism, rather than in a study design explicitly controlled by the researcher. Unlike such explicitly-controlled aspects of a conventional experimental study, mediator variables might be aspects of the program that are available for one treatment group but not another. Central components of the treatment are applied consistently to both

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treatment groups, but components identified as mediators would only be applied to participants if they chose them.

Applied to Worldreader, an experimental-causal-chain study using the mediation model would be applied at the district-level (as is recommended in the cluster-RCT in Figure 5). However, rather than applying multiple treatment arms among schools, there would be a single treatment with multiple, small variations to one or more mediator variables identified prior to the intervention (Figure 8). Additionally, it should be noted that the participating district(s) in every study should be different districts than those included in previous studies, as prior-exposure to e-readers is an environmental variable that would bias results.

A flagship component of the iREAD 2 study was the use of extra-curricular time for students to use the e-readers beyond the normal classroom hours. If the extra-curricular allotment was manipulated by the study’s experimenters, they could measure the effects of the e-reader based on the mechanism by which students are using it to improve their literacy. We believe that supplementary time with the devices is a reasonable mediator variable, as it could be justifiably argued that it is the mechanism by which the e-readers affect the outcome (literacy rates).
Figure 8: In realistic systems, treatment variable(s) (T) lead to an outcome (Y), through multiple mediator variable (M1-M3)

For example, one treatment would allow students to spend extra-curricular time outside of class with the devices, another would not have additional time allotted. Rather than looking for whether or not e-readers are a cause of improvements in literacy acquisition (a question answered in the previous, multi-treatment study), this study would allow Worldreader to begin narrowing on how the e-readers are improving literacy. Specifically, are e-readers improving literacy by motivating students to spend more time reading after school? Or is the time they use the e-readers in schools actually more focused and effective per minute with the device?

The iRead2 study allowed Worldreader to deploy a full program on a selective basis, but a full program will eventually need to be downsized if it is to be scaled across multiple districts, or, if appropriate, nationwide. The benefits of this second study are to allow Worldreader to gain insights into what components of the program are critical to success, and which components
are less important that might be reduced or removed to keep costs down in preparation for the final recommended study in this series and scaled deployment.

Figure 9: In an experimental-causal-chain design, the overall structure is similar to that of the recommended cluster-RCT. The primary difference is the replacement of multiple treatment arms by multiple variations of a mediator variable controlled by the experimenter in a single treatment.

Pragmatic Models

Explanatory trials such as the two studies described above explore if and how an intervention works, and the entirety of the experiment is designed to control for known biases and confounders to maximize the intervention’s effect produced under ideal conditions. These conditions include carefully defined subjects using a carefully designed intervention in a carefully controlled environment. Perhaps the best characterization of such trials is “careful.” In contrast, pragmatic trials measure effectiveness, or the effect a treatment produces in a real
world context to maximize the intervention’s applicability and generalizability.\textsuperscript{69} The research question in a pragmatic trial is not if and how an intervention works in controlled circumstances, but rather if and how an intervention works in real life.

It is important to note that the difference between explanatory and pragmatic trials lies along a continuum rather than as a dichotomy.\textsuperscript{70} In fact, when introducing the idea for the first time in 1967, Schwartz and Lellouch characterized pragmatism as an attitude to trial design rather than a characteristic of the trial itself.\textsuperscript{71} The pragmatic attitude favors study design choices that maximize applicability of the trial’s results to generalized settings, testing a wide range of participants and measuring outcomes important to relevant decision makers. The specific differences are outlined in Table 7 and applied specifically to Worldreader below.

While explanatory approaches select as homogeneous population as possible to limit the influence of errors and biases, pragmatic approaches favor heterogeneity in all aspects of the study design. This means including students with differing academic and socio-economic backgrounds, classrooms well-equipped and ill-equipped alike, and allowing teachers to employ the use of e-readers as they see fit. Recommendations for the first explanatory study include trainings that focus on developing teachers beyond \textit{adopting} e-readers in the classroom according to minimum standards and moving toward \textit{adapting} them, or integrating them across all forms of teaching.

\textsuperscript{69} “Introduction to Pragmatic Clinical Trials,” Rethinking Clinical Trials (NIH Collaboratory, n.d.).


TABLE 7: Key Differences Between Explanatory and Pragmatic Trials

<table>
<thead>
<tr>
<th>Question</th>
<th>Efficacy—can the intervention work in controlled circumstances?</th>
<th>Effectiveness—does the intervention work when used in normal circumstances?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>Well-resourced, “Ideal” setting</td>
<td>Normal, uncontrolled setting</td>
</tr>
<tr>
<td>Participants</td>
<td>Highly selected—Poorly adherent participants and those with conditions which might dilute the effect are often excluded</td>
<td>Little or no selection beyond the indication of interest</td>
</tr>
<tr>
<td>Intervention</td>
<td>Strictly enforced and adherence is closely monitored</td>
<td>Applied flexibly and relatively inconsistently as it would be in normal practice</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Often short term or process measures</td>
<td>Directly relevant to participants, funders, communities, and decision makers</td>
</tr>
<tr>
<td>Relevance to Practice</td>
<td>Indirect—little effort made to match design of trial to needs of relevant decision makers</td>
<td>Direct—trial is designed to meet needs of decision makers to help them evaluate intervention in practical terms</td>
</tr>
</tbody>
</table>

In a pragmatic trial, no such training would take place, and Worldreader researchers would not work with teachers to incorporate the e-readers according to best pedagogical practices. Rather, teachers would be given e-readers with minimal direction beyond adequate technical training to operate them. Additionally, their application would be to the discretion of each teacher—this may mean that many e-readers go unused, gathering dust on a shelf behind locked doors, or they are lost, stolen, or broken over several months. It may also mean that teachers opt to use textbooks exclusively.

The design of the pragmatic trial reflects the variability and uncertainty of real world application, seeking to ensure generalizability and representation of students and teachers to whom the program will ultimately be applied. The generalized design of pragmatic trials allows researchers to answer the questions most relevant to policymakers’ agenda: the effectiveness of the intervention in routine practice. Implemented alongside a cost-effectiveness analysis, a pragmatic trial would allow Worldreader to demonstrate the per-dollar effectiveness of its e-

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72 Zwarenstein et al., “Improving the Reporting of Pragmatic Trials.”
reader program in real classrooms. Partnering with policymakers as active partners in the design of the pragmatic trial would give Worldreader strong advocates vital to transforming the evidence of its studies into political action.

Illustrated in Figure 6, we recommend employing a pragmatic trial of a simple, bare bones e-reader program guided by the results of the previous two studies across multiple schools of clusters in multiple districts, and if feasible, across multiple regions. It is important to note that not every school, cluster, or district of a region need participate in the study. Rather, by diversifying the participants and settings of the treatment, Worldreader will gain insights about their program’s applicability across Ghana’s classrooms. As mentioned above, the treatment would be left to the discretion of participating classrooms’ teachers, and Worldreader

Figure 10: The treatment (T) of the pragmatic trial would be loosely applied across multiple schools and clusters of multiple districts. MOE representatives (R) would be actively involved in the design and execution of the study.
should not intervene if the e-readers are not used “properly” or are at risk of becoming damaged or stolen. It is precisely these difficulties and challenges the Worldreader must address and respond to if it is going to convince policymakers to institutionalize their program nationwide.

Limitations

Given the unpredictability of the treatment’s application left to the discretion of teachers, as well as including poorly-equipped schools and struggling students in the study, it follows the pragmatic trials require a great deal of confidence in the intervention. The heterogeneity inherent in the design of pragmatic trials also leads to the dilution of the treatment effect.⁷³ Pragmatic trials must be large enough and simple enough to increase the statistical power needed to detect small effects. Large sample sizes can mean a high financial cost, even if the treatment is simplified (few or no trainings or workshops, little monitoring until the end of the study, etc.).

The evidence gathered from the high-quality, robust experimental and experimental-causal-chain studies we recommend implementing before a pragmatic trial may be effective within a specific sample and combination of schools/teachers/students, but it will likely be less evident in a broader population. Carefully-studied and designed interventions that produce promising effects in optimal settings may be ineffective in broad, suboptimal settings. Whereas a pragmatic trial can inform on the overall performance of the treatment, the suboptimal settings in which it will be applied make it very difficult to identify the specific components of a program

that are effective (or ineffective). This is where the narrowing process of the mediation trial is most important—it allows Worldreader to identify what components of its program are effective (and how so) before the difficult application of a pragmatic trial.

Finally, despite their active role in the design of a pragmatic trial and the generalized applications of its results, there is no guarantee that decision makers will have the same interpretation of the results, or even the same priorities given a well-accepted interpretation. After three increasingly ambitious and methodologically-rigorous studies demonstrating the positive effects of Worldreader’s e-reader program on literacy acquisition, it may be that policy makers do not believe a “one-size-fits-all” program is appropriate, that e-readers are valuable for certain schools or in certain districts, but that textbooks are better suited for other schools and other districts. While pragmatic trials are strong in their ability to demonstrate effectiveness in varying settings, they are still limited in their scope and applicability.

\footnote{Ibid.}
Conclusion

While the idea that technology has a role to play in the classroom has become widely accepted, it still has a long way to go to prove that it can have a strong positive impact on the quality of public education. An organization such as Worldreader trying to encourage a beneficial transition to ICT4E must be able to make a strong case for their methods and prove itself a viable long-term partner. Given Ghana’s systemic shortage of reading material, it appears that e-reader devices could play a role in improving the country’s poor literacy rates. We believe there is indeed political momentum in Ghana to deploy ICT4E initiatives to address the failings of a dysfunctional education system, and that Worldreader has an already established strong presence and track-record in the country.

Yet, there are many hurdles that will make a large-scale transition to e-readers difficult, including the low capacity of educators and a frail education infrastructure. What’s more, the government has no fiscal space for any large scale initiative—indeed, it often fails to pay its own teachers—and still relies largely on third party support to provide even basic school materials. Given the looming needs of Ghanaian schools, Worldreader has to be able to make a strong case for that institutionalizing e-readers will improve tangible education outcomes and do so in a cost-effective way in comparison to other investments such as physical textbooks.

We propose study design methodologies that can help to showcase the comparative effectiveness of e e-readers, which can be implemented in tandem with a bottoms-up approach which takes advantage of the increasing autonomy of district leadership, but also propose partnerships with education-focused NGOs. As Worldreader continues to grow its foot print in
Ghana while evaluating learning outcomes, it will be increasingly better positioned to act as a strong partner for an institutionalized transition to e-reader technology in Ghana’s classrooms.

The problem of illiteracy is not limited just to Ghana, sub-Saharan Africa, or the developing world. It extends beyond low test scores and struggling to read story books in a classroom. Literacy is an invisible stepladder out of poverty, a loudspeaker that lends a voice, the platform that allows us to reach beyond our circumstances. The words in every book are more than the ink raised against the page. They are, among every page of every book, the sum of all that mankind has done, or thought, or ever been. For millions of children, the pages of those books will go unturned, the words will go unread.

The process of changing that in Ghana and elsewhere will be a long one. They may not yet be ready to bring their program into every classroom, or put their e-readers into every book bag, but Worldreader has the opportunity to begin changing that. They don’t yet have the financial resources, political champions, or p-values to save every student in Ghana. For many students though, all it takes is a book.
Appendix I: Meetings

We met with 17 stakeholder groups on our Ghana trip:

- Government
  - MOE Budget, Planning, and M&E Division (Budget Officer)
  - GES Curriculum Research and Development Division (Director)
  - Eastern Region District Education Office (District Education Officers)
  - GETFund (Deputy Administrator of GETFund)

- Schools
  - Suhum School (part of iREAD study)
  - Royal Seed School (private school)

- Libraries
  - Ghana Library Authority & Accra Regional Library
  - Kathy Knowles Community Library
  - Suhum Municipal Library

- Multilateral Organizations
  - USAID

- Education NGOs
  - Tap2Educate
  - Teach for Ghana
  - INTED

- Printers and Publishers
- Ghana Book Publishers Association
- Worldreader publisher partners
- Ghana Printer and Paper Converter Association

- Anti-Corruption
  - Ghana Integrity Initiative
Appendix II: Cost-Effectiveness of Nationwide Digital Textbook Program (Screenshots from Excel model)

Cost-Effectiveness Estimates of Nationwide Digital Textbook Program vs. Physical Textbook Program

<table>
<thead>
<tr>
<th>Digital Model</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>(t+5) - (t+4) an Total</th>
<th>Note</th>
<th>Physical - Digital</th>
<th>Cost as % of physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># students enrolled</td>
<td>4,117,152</td>
<td>4,342,315</td>
<td>4,367,902</td>
<td>4,507,189</td>
<td>4,720,791</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental number of students</td>
<td>225,163</td>
<td>25,587</td>
<td>139,287</td>
<td>213,602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># e-readers to procure</td>
<td>4,117,152</td>
<td>225,163</td>
<td>25,587</td>
<td>139,287</td>
<td>213,602</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># textbooks to download</td>
<td>12,351,456</td>
<td>675,499</td>
<td>76,761</td>
<td>417,881</td>
<td>640,807</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>e-reader capital cost USD</td>
<td>32,937,216</td>
<td>34,736,520</td>
<td>34,943,416</td>
<td>36,057,513</td>
<td>37,766,331</td>
<td>12,388,860</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e-reader replacement costs USD</td>
<td>2,305,605</td>
<td>4,737,302</td>
<td>7,183,327</td>
<td>9,707,353</td>
<td>12,350,996</td>
<td>25,470,397</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Textbook cost USD</td>
<td>7,410,874</td>
<td>405,293</td>
<td>46,057</td>
<td>250,717</td>
<td>384,484</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Training &amp; maintenance costs USD</td>
<td>20,585,763</td>
<td>1,125,815</td>
<td>127,935</td>
<td>666,436</td>
<td>1,068,011</td>
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<td></td>
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<tr>
<td>Primary total</td>
<td>63,292,465</td>
<td>41,000,520</td>
<td>42,300,364</td>
<td>46,712,018</td>
<td>51,599,822</td>
<td>37,869,257</td>
<td>282,688,016</td>
<td></td>
<td>-101,268,365</td>
</tr>
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<td>5-year cost per student enrolled</td>
<td>$15.36</td>
<td>$9.44</td>
<td>$9.68</td>
<td>$10.36</td>
<td>$10.92</td>
<td>$55.78</td>
<td></td>
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<tr>
<td>JHS</td>
<td></td>
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<td></td>
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<tr>
<td># students enrolled</td>
<td>1,473,921</td>
<td>1,591,279</td>
<td>1,608,460</td>
<td>1,721,101</td>
<td>1,835,901</td>
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<td>Incremental number of students</td>
<td>117,358</td>
<td>17,181</td>
<td>112,641</td>
<td>114,800</td>
<td></td>
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</tr>
<tr>
<td># e-readers to procure</td>
<td>1,105,441</td>
<td>88,019</td>
<td>12,886</td>
<td>84,480</td>
<td>86,100</td>
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<tr>
<td># textbooks to download</td>
<td>4,421,763</td>
<td>352,074</td>
<td>51,543</td>
<td>337,922</td>
<td>344,400</td>
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<td>e-reader capital cost USD</td>
<td>8,843,526</td>
<td>9,547,674</td>
<td>9,650,761</td>
<td>10,326,604</td>
<td>11,015,404</td>
<td>5,693,051</td>
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<tr>
<td>e-reader replacement costs USD</td>
<td>819,047</td>
<td>1,287,384</td>
<td>1,962,937</td>
<td>2,685,799</td>
<td>3,458,878</td>
<td>7,272,344</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textbook cost USD</td>
<td>2,653,059</td>
<td>211,244</td>
<td>30,926</td>
<td>202,753</td>
<td>206,640</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Training &amp; maintenance costs USD</td>
<td>5,527,204</td>
<td>440,093</td>
<td>64,249</td>
<td>422,402</td>
<td>430,500</td>
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<tr>
<td>JHS total</td>
<td>17,642,834</td>
<td>14,468,396</td>
<td>17,108,053</td>
<td>13,637,558</td>
<td>15,109,422</td>
<td>12,965,395</td>
<td>82,550,657</td>
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<td>-36,327,692</td>
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<td>5-year cost per student enrolled</td>
<td>$11.97</td>
<td>$7.22</td>
<td>$7.28</td>
<td>$7.92</td>
<td>$8.23</td>
<td>$42.62</td>
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<td>SHS</td>
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<tr>
<td># students enrolled</td>
<td>750,709</td>
<td>804,974</td>
<td>986,973</td>
<td>1,190,606</td>
<td>1,304,622</td>
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<tr>
<td>Incremental number of students</td>
<td>54,268</td>
<td>181,999</td>
<td>203,633</td>
<td>114,015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># e-readers to procure</td>
<td>563,030</td>
<td>40,701</td>
<td>136,000</td>
<td>2,127,726</td>
<td>40,511</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># textbooks to download</td>
<td>2,252,118</td>
<td>162,804</td>
<td>545,998</td>
<td>610,899</td>
<td>342,046</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e-reader capital cost USD</td>
<td>4,504,236</td>
<td>4,829,844</td>
<td>5,921,840</td>
<td>7,143,638</td>
<td>7,827,729</td>
<td>8,911,368</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e-reader replacement costs USD</td>
<td>315,297</td>
<td>653,388</td>
<td>1,067,914</td>
<td>1,567,969</td>
<td>2,115,910</td>
<td>4,859,975</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textbook cost USD</td>
<td>1,351,271</td>
<td>97,882</td>
<td>307,599</td>
<td>366,539</td>
<td>225,227</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training &amp; maintenance costs USD</td>
<td>2,815,148</td>
<td>203,505</td>
<td>682,498</td>
<td>763,624</td>
<td>427,557</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHS total</td>
<td>8,965,951</td>
<td>5,784,417</td>
<td>7,999,851</td>
<td>9,841,770</td>
<td>10,576,423</td>
<td>13,770,433</td>
<td>56,958,845</td>
<td></td>
<td>-12,836,126</td>
</tr>
<tr>
<td>5-year cost per student enrolled</td>
<td>$11.97</td>
<td>$7.19</td>
<td>$8.11</td>
<td>$8.27</td>
<td>$8.11</td>
<td>$43.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cost USD</td>
<td>89,868,240</td>
<td>58,277,742</td>
<td>62,009,438</td>
<td>70,191,346</td>
<td>77,255,668</td>
<td>357,602,433</td>
<td></td>
<td>-175,837,097</td>
<td>197%</td>
</tr>
</tbody>
</table>
Comparison of Improvements in Correct Words per Minute between Physical and Digital Textbook Programs (Using iREAD 2 study results)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type (select)</th>
<th>Group</th>
<th># students</th>
<th>Correct Words Per Minute (English)</th>
<th>Correct Words Per Minute (Twi)</th>
<th>Cost</th>
<th>Cost-effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Baseline</td>
<td>Final</td>
<td>Change</td>
<td>Change (%)</td>
</tr>
<tr>
<td>P1</td>
<td>Primary</td>
<td>Treatment (Digital) Control (Physical)</td>
<td>159</td>
<td>5.34</td>
<td>26.58</td>
<td>21.24</td>
<td>398%</td>
</tr>
<tr>
<td>P2</td>
<td>Primary</td>
<td>Treatment Control</td>
<td>146</td>
<td>15.51</td>
<td>43.52</td>
<td>28.01</td>
<td>181%</td>
</tr>
<tr>
<td>P3</td>
<td>Primary</td>
<td>Treatment Control</td>
<td>113</td>
<td>33.66</td>
<td>60.36</td>
<td>26.48</td>
<td>78%</td>
</tr>
</tbody>
</table>

Sample interpretation:
For P1 students, $1 investment in e-reader led to 0.381 improvement in English cwpm and 0.311 improvement in Twi cwpm in one year, compared to a 0.444 English cwpm improvement per $1 spent on physical textbooks.
Appendix III: Education Stakeholder Landscape

All stakeholders are described in the “Education Landscape” section.
Appendix IV: Power Analysis in R

# Below is the R code for a statistical power analysis given the mean of a control
# and treatment group, respectively, the standard deviation (sigma), desired alpha, and sample
# size. It also provides a visualization tool for multi-treatment power analysis.
# This code, author Ethan Hamilton, is based on the tools available at:
# “Power Analysis Simulations in R,” Evidence in Governance and Politics, (2016),
# http://egap.org/content/power-analysis-simulations-r.
# It can be run in any console with R Version 3.2 or later.

# installing required packages
lapply(c("ggplot2","randomizr","reshape2"), install.packages, character.only=T)

# loading required packages
lapply(c("ggplot2","randomizr","reshape2"), require, character.only=T)

#------------------------#
FUNCTION: powerCalculator()
# USAGE: beta <- powerCalculator(mu_t, mu_c, sd, alpha, N)
#------------------------#
# DESCRIPTION:
# Takes the expected mean effect of a treatment and control group, standard deviation, alpha
# (default = 0.05), and expected sample size to calculate the beta, or statistical power of
# achieving a statistically significant result.
#
# PARAMETERS:
# mu_t: Average outcome of the treatment group
# mu_c: Average outcome of the control group
# sd: Expected standard deviation (sigma) of the outcomes;
# assumed to be the same for both groups.
# alpha: Significance level, by default set to 0.05
# N: Expected sample size for the study
#------------------------#
powerCalculator <- function(mu_t, mu_c, sd, alpha = 0.5, N){
  lowertail <- (abs(mu_t - mu_c)*sqrt(N))/(2*sd)
  uppertail <- -lowertail
  beta <- pnorm(lowertail- qnorm(1-alpha/2), lower.tail=TRUE) + 1- pnorm(uppertail- qnorm(1-alpha/2), lower.tail=FALSE)
  return(beta)
}
powerCalculator(20.9, 15.1, 20, .05, 400)  #sample code
Graphing sample sizes needed to achieve minimum statistical power threshold in multi-treatment trials

```r
possible_n <- seq(from=100, to=5000, by=100)
power_one <- rep(NA, length(possible_n))
power_both <- rep(NA, length(possible_n))
power_full <- rep(NA, length(possible_n))
alpha <- 0.1  # (one-tailed test at .05 level)
sims <- 100

# Outer loop to vary the number of subjects#
for (j in 1:length(possible_n)){
  N <- possible_n[j]
  p.T1vsC <- rep(NA, sims)
p.T2vsC <- rep(NA, sims)
p.T2vsT1 <- rep(NA, sims)
c.T1vsC <- rep(NA, sims)
c.T2vsC <- rep(NA, sims)
c.T2vsT1 <- rep(NA, sims)

  # Inner loop to conduct experiments "sims" (simulation) times over for each N
  for (i in 1:sims){
    Y0 <- rnorm(n=N, mean=60, sd=20)
    tau_1 <- 2.5  # effect size for treatment arm 1
    tau_2 <- 5  # effect size for treatment arm 2
    Y1 <- Y0 + tau_1
    Y2 <- Y0 + tau_2
    Z.sim <- complete_ra(N=N, num_arms=3)

    # num.arms is the number of treatment arms + control
    Y.sim <- Y0*(Z.sim=="T3") + Y1*(Z.sim=="T1") + Y2*(Z.sim=="T2")
    frame.sim <- data.frame(Y.sim, Z.sim)
    fit.T1vsC.sim <- lm(Y.sim ~ Z.sim=="T1", data=subset(frame.sim, Z.sim=="T2"))
    fit.T2vsC.sim <- lm(Y.sim ~ Z.sim=="T2", data=subset(frame.sim, Z.sim=="T1"))
    fit.T2vsT1.sim <- lm(Y.sim ~ Z.sim=="T2", data=subset(frame.sim, Z.sim=="T3"))

    # Need to capture coefficients and p-values (one-tailed tests, so signs are important)
    c.T1vsC[i] <- summary(fit.T1vsC.sim)$coefficients[2,1]
    c.T2vsC[i] <- summary(fit.T2vsC.sim)$coefficients[2,1]
    c.T2vsT1[i] <- summary(fit.T2vsT1.sim)$coefficients[2,1]
    p.T1vsC[i] <- summary(fit.T1vsC.sim)$coefficients[2,4]
  }

  power_one[j] <- mean(c.T1vsC>0 & c.T2vsC>0 & (p.T1vsC < alpha/2 | p.T2vsC < alpha/2))
```

101
power_both[j] <- mean(c.T1vsC>0 & c.T2vsC>0 & p.T1vsC < alpha/2 & p.T2vsC < alpha/2)
power_full[j] <- mean(c.T1vsC>0 & c.T2vsC>0 & c.T2vsT1 > 0 & p.T1vsC < alpha/2 & p.T2vsT1 < alpha/2)
if(j %% 10 == 0 ){
cat(j*2, "\n")
}

#aggregating the results
plot_df<-cbind(possible_n,as.data.frame(power_one), as.data.frame(power_both), as.data.frame(power_full))

#naming the results and shaping them using reshape2 package
colnames(plot_df)<-c("Sample","At Least One","Both Treatments","Full Ranking")
plot_df<-melt(plot_df, id = "Sample")

#graphing the results using ggplot2 package
ggplot(plot_df, aes(x = Sample, y = value, color = variable)) +
  geom_path(aes(y = value), size = 1) + geom_hline(yintercept = 0.8) +
  xlab("Sample Size")+ ylab("Power (Probability of Statistical Significance)") +
  labs(title="Power Analysis for Multiple Treatment Effects") +
  scale_color_manual(values=c("#4575b4", "#fdae61", "#a50026"), name ="Probability of\nSignificance")

Figure 1: Sample output for multi-treatment power analysis
Bibliography


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