

**Is Educational Technology Opening New Learning Opportunities  
for Young Kenyans and Improving their Academic Outcomes?  
An Evaluation of the Lwala Community Alliance E-reader Program in Kenya**

Carolyn J. Heinrich  
Professor of Public Policy,  
Education and Economics  
Vanderbilt University

Caroline Martin  
Graduate student in International  
Education Policy and Management  
Vanderbilt University

Report to the Lwala Community Alliance (LCA)

April 28, 2017

Acknowledgments: We thank the LCA for the opportunity to engage in this research and Vanderbilt University for support of this research effort. We greatly appreciate the teachers in the LCA schools who opened their classrooms to observation by the research team and participated in interviews. We also thank Staci Sutermeister, Joseph Starnes, Liz Chamberlain and other LCA staff and collaborators for their contributions to developing the program and the research, including support for data collection, assembly and analysis and essential documentation of the development and planning of this initiative, and Christopher (CJ) Ryan and Jennifer Darling for their research assistance. And we are very grateful for support for this work from the research project, *Improving the Effectiveness of Digital Educational Tools in Increasing Student Achievement and Reducing Achievement Gaps*, which shared instrumentation and technical assistance for this research (<https://my.vanderbilt.edu/digitaled/>).

## Executive Summary – Key Research Findings

The research presented in this report was undertaken to understand the potential of educational technology to improve access to educational resources, enhance classroom learning and increase student achievement for students in North Kamagambo, Kenya. The Lwala Community Alliance (LCA) designed and implemented a pilot eReader program that provided eReaders equipped with course books and supplementary books to Class 6 teachers and students at three primary schools in this region. The research findings we summarize here are based on the analysis of both quantitative (baseline and endline student assessments) and qualitative (teacher interviews and observations, student focus groups) data from a quasi-experimental evaluation of the LCA pilot eReader program. We see these as preliminary but promising findings regarding the potential for eReaders to increase student engagement and achievement in low-resource educational settings.

Findings from baseline and endline assessments show that students in classrooms with eReaders consistently experienced larger academic achievement gains from baseline to endline on the oral reading fluency and reading comprehension measures (in Kiswahili and English) compared to students in the comparison classrooms (without eReaders), although only about one-third of these differences are statistically significant.

- The improvements in oral reading fluency and comprehension are larger (and more often statistically significant) for English reading skills, and controlling for student characteristics also increases the magnitude of the estimated differences.
- Teachers also reported higher academic achievement among students after receiving eReaders, citing students' improved and faster reading ability, as well as higher achievement in writing, math and science subjects.

Teacher interviews and classroom observations revealed many factors that might potentially explain the positive association seen between eReader use and student achievement outcomes.

- Teachers' attitudes towards the eReaders are very positive, with 100% of teachers interviewed at treatment schools expressing that the eReaders helped them achieve their objectives in their lessons.
- While the eReaders are not being used in their intended 1:1 ratio in many classes, teachers report a much higher level of student access to textbooks due to the availability of eReaders in their classrooms, as compared to before the pilot project.
- Increased access to textbooks makes it easier for students to concentrate during class, as well as to work individually on academic tasks, both at school and at home.
- Other benefits eReaders bring to classrooms (as expressed by teachers) include the addition of a wide variety of storybooks and revision books, a highly useful English dictionary feature, the time efficiency they provide by making it possible to transition between books with the click of a button, increased student engagement, higher attendance, and improved student attitudes towards learning.

While teachers were able to describe many benefits of the eReaders in their classrooms, at the same time, there is considerable variation in the average ratings of instructional quality

and learning opportunities across all dimensions observed, which suggests that there are opportunities for improvement, as well as opportunities for some teachers to learn from the best practices of others.

- Teachers had varying levels of training on the use of digital tools before e-readers were introduced. They expressed appreciation for Lwala’s training on how to manipulate the device, as well as a desire for future trainings.
- There was considerable variation in observation ratings measuring the extent to which teachers had constructive interactions with the students. This variation was supported by teacher interviews, which revealed that while most teachers experienced frustration with students’ difficulty in manipulating devices and the time lost from academic tasks, there was a wide range of teacher responses to this challenge. While some took additional time to ensure all students were tracking or to pair high and low-performing students, others simply moved forward to ensure the entire lesson was taught, regardless of how many students were able to keep up.

Other mediating factors that could be contributing to the variation we see in observation ratings of classroom use of the eReaders include level of access to power, level of access to course books necessary for a particular school subject, student digital citizenship, level of administrator support at a school, and classroom culture.

- The primary factor reducing the number of eReaders available to students is the lack of consistent access to a power source. All treatment schools were affected by an inadequate power source; however, schools varied in their ability to keep eReaders charged for all students when this challenge emerged.
- While a few teachers reported students using eReaders in unintended ways, in more than 80% of these observed sessions, all or most students were acting responsibly with the devices.
- Level of administrator (eReader patron) support varied at treatment schools, with the highest level of support evident at Komito Primary and the lowest level of support evident at Sumba Primary.
- While eReaders did appear to improve student motivation and learning, there were many aspects of classroom culture that could be hindering teachers and students from realizing the full potential of the eReaders to improve academic outcomes. Negative aspects of classroom culture observed included a lack of involvement of students throughout lessons, a high percentage of “teacher talk”, and a culture of apprehension in classrooms due to students’ fear of embarrassment or physical reprisal by teachers. These factors may be linked to the finding that students are off-task (from eReader use) about 20-25% of the time in a given classroom session.

The factors listed above will be important for the LCA to consider addressing through teacher training and additional technical support. However, despite the challenges that exist, overall, the introduction of eReaders in classrooms in the North Kamagambo region appears to be a promising initiative and worth expanding to additional schools. We outline recommendations for the LCA to consider in their support of both schools that currently use eReaders and future schools to which they expand at the end of this report.

## Introduction

As engagement and competitiveness in the knowledge economy becomes an increasingly high priority for developed and developing nations alike, and as the digital divide between developed and developing nations continues to grow with technological advancement, governments, schools, and nongovernmental organizations have turned to information and communication technology (ICT) development and expansion as a possible solution. Educational technology is often directed toward low-resource schools in developing countries to improve access to instructional resources and increase student engagement (and thereby reduce the “digital divide”). Indeed, ICT in education is often seen as providing boundless opportunities for enhancing education quality, by improving teachers’ access to educational resources from around the world, accessing virtual learning communities and distance learning opportunities, increasing the efficiency of administrative processes, and most importantly, by improving teachers’ ability to meet diverse student needs and create a more student-centered learning environment (Wong, 2008; Twining et. al., 2013; Tessema, 2012).

The overarching objective of this research is to understand the potential of educational technology to improve access to educational resources, enhance classroom learning and increase student achievement. Existing research shows how the enactment and implementation of educational technology in classrooms is mediated by a range of malleable factors, including administrative planning and resources, teacher capacity and training, instructional models and student engagement, technical support and other aspects of the physical environment in which technology is used.

More specifically, we investigate in this research how ICT and these factors interact to influence student access, learning and outcomes in a developing country context (Western Kenya), where electronic readers (eReaders) were introduced to increase literacy levels among primary school students. The Lwala Community Alliance (LCA) received a grant for 150 eReaders from Worldreader, an international provider of eReaders to NGOs in developing countries. Worldreader specializes in supporting development organizations in their provision of digital textbooks and supplementary reading materials for libraries and classrooms. With this grant, Lwala designed and implemented a pilot eReader program that provided eReaders equipped with course books and supplementary books to Class 6<sup>1</sup> teachers and students at three primary schools in the region. Along with the eReaders, Worldreader provided a strategy and tools for encouraging buy-in and investment within the community, initial training of teachers in manipulation of the devices, and tracking progress on program goals. The goals of the eReader program are to improve the quality and experience of learning for primary school pupils in North Kamagambo and to enhance student academic performance and other learning outcomes, including increasing literacy skills and overall academic performance and building a culture of learning among the students.

---

<sup>1</sup> Class 6 students in Western Kenya are primary school students typically of the age of 11-14 years, although in this study sample, student reported ages ranged from 9 to 19 years.

This report begins by describing the motivation for this research, drawing from the literature on educational technology adoption and integration in low-resource school settings. We then introduce the sample for this research and the study instrumentation and measures, followed by a discussion of the data collection activities and procedures. Turning to the research findings, we first present our quantitative analysis of associations between the introduction of eReaders and changes in student academic performance. We then discuss our findings from a rich array of qualitative study components, including observations of technology use in the classroom, teacher interviews and focus groups with students. We conclude by offering recommendations for improving educational technology integration in North Kamagambo as well as in other low-resource educational settings.

## **Research Motivation and Literature Review**

While educational technology has the potential to provide teachers and students access to resources that would otherwise be very difficult to obtain and to transform pedagogical approaches (i.e., making them more student-centered and engaging), there are many challenges to the implementation of ICT programs that can diminish their effectiveness. The limited resources available in contexts such as North Kamagambo, Kenya often lead to challenges of both access and capacity building. Examples of access challenges include constrained choices in technology, the need for student sharing of tools, and limited technology support and web access. Capacity building is also a challenge where limited resources hinder investments in professional development and training for teachers in the effective use of the tools. The following literature review discusses some of the ways these challenges interfere with technology implementation in educational settings in both developed and developing country contexts.

### *Constrained choices in technology*

Many different types of technology aimed at improving student engagement are used in schools in low resource settings including individual student computers, computer labs, and smaller hand-held tablets. Each of these devices may also be equipped with a variety of features that have been shown to affect student engagement and achievement to varying degrees. Some of the most effective tools include features that respond to student academic levels and drive their academic content (Dangwal, R., Sharma, K., & Hazarika, S. (2014); Cristia, J. P., Ibarra, P., Cueto, S., Santiago, A., & Severin, E. (2012). Often, in areas where resources are constrained, schools or funding organizations are required to settle for the cheapest option, which may not include the features that allow the device to adapt to a student's academic level and differentiate for student needs. Additionally, these types of features often require Internet access, which is frequently unreliable or unavailable in many low-resource settings, especially in developing countries (Khan et al, 2012; Pelgrum, 2001; Richardson, 2011; Rodrigo, 2005; Tiene, 2004;). Additionally, lack of resources can also lead to an insufficient number of devices to be available for use by all students and teachers in their intended ways, which hinders teachers' ability to effectively teach all students with the devices (Budhedeo, 2016). This challenge is exacerbated in schools where classroom sizes are typically very large, which is frequently the case in low-resource, developing country settings (Mndzebele, 2013).

### *Deficient technology supports*

Many schools in developing country settings also lack the technological support necessary to take full advantage of the tools they do have access to (Richardson, 2011; Tiene, 2004). First of all, remote locations in developing countries often lack access to internet, or even a power source, which can make using electrically charged devices difficult, and those that require internet (which include most devices that adapt to students' academic needs) impossible (Khan et al, 2012; Pelgrum, 2001; Richardson, 2011; Rodrigo, 2005; Tiene, 2004;). In their study on the implementation of ICT in Bangladesh, Khan et al (2012) found that lack of ICT supported infrastructure and resources, including a reliable electricity supply, up-to-date software, and access to internet, was one of the primary barriers to effective implementation in the country. This is especially true in rural settings where access to Internet rarer than in urban areas (Mndzebele, 2013).

Moreover, in places where teachers are not very familiar with the device or have never seen it used before, teachers often struggle to use the devices correctly or are incapable of addressing technical malfunctions that arise. Tiene (2004) suggests that one of the primary challenges of ICT adoption in developing countries is the difficulty end users face with troubleshooting hardware and software (p. 90). He goes on to note that not only do schools and districts in developing countries often not have the funds to invest in ICT support personnel or resources, but they also often don't include teachers in ICT planning and therefore are not able to develop the kind of ICT solutions that will best support the end user. In Tiene's words, "the most dynamic applications of ICT are those facilitated by a teacher who is prepared to take full advantage of its potential." (Tiene, 2004, p. 92). In Richardson's study of the adoption of ICT in Cambodia (2011), he additionally found that schools in developing settings are often the recipients of donated, used devices, which makes it even more difficult for teachers to manipulate them and adapt them to their specific needs.

### *Limited resources for investing in professional development*

In addition to lacking access to sufficient resources, a lack of adequate teacher training and capacity development can stifle the effectiveness of technology implementation. Sanyal (2001) cautions against reliance on technology devices themselves, stating, "Putting computers in classrooms and wiring up schools does not of itself create exciting new learning situations that are about changing the ethos of classrooms and the culture of institutions" (Sanyal, 2001, p. 21). There is much literature suggesting that successful technology initiatives require ongoing, quality professional development and support from school leadership to develop instructors' technical and instructional capacities (Barrios et al., 2004; Bebell & O'Dwyer, 2010; Cavanaugh, Dawson, White, Valdes, Ritzhaupt, & Payne, 2007; Holland, 2001; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). Adequate hardware, software, and technical support is a prerequisite to any technology initiative but insufficient for implementation fidelity and the full realization of desired student outcomes (Barrios et al., 2004; Becker, 2000; Cuban, Kirkpatrick, & Peck, 2001). Technology access can facilitate new instructional strategies that encourage active learning and engagement

(Becker, 2000; Watwood, Nugent, & Deihl, 2009), but only if teachers see technology use as aligned with their teaching philosophy and goals (Bebell & Kay, 2010; Bebell & O'Dwyer, 2010; Stanhope & Corn, 2014). Only with comprehensive planning, support, and buy-in from teachers can a technology initiative fulfill its promise of transforming learning (Barrios et al., 2004; Bebell & Kay, 2010; Cavanaugh et al., 2007).

Technology also has the potential to disrupt teaching, moving beyond "sage on a stage" teaching methods to instructional techniques that engage students in active learning (Barrios et al., 2004; Watwood et al., 2009). Higher student engagement is observed when teachers use technology as an instructional tool versus solely to teach technology skills (Becker, 2000). However, schools may not realize the full benefit of technology integration without investing in teacher training – not only on how to use the technology, but also on how to reframe teaching philosophies to take full advantage of available digital tools (Barrios et al., 2004; Bebell & O'Dwyer, 2010). Unfortunately, the reality in low-resources settings in developing (as well as developed) country contexts is that very few resources exist to provide teachers with adequate training, and professional development, and technology training is rarely prioritized. Furthermore, research indicates that one-off technology integration training will not lead to higher levels of technology integration on its own. There is a need for more post training (after the technology is introduced) or one-on-one mentoring experiences in order to better support teachers' integration of technology (Zhao, Y., & Bryant, F. L. (2006).

Research specific to developing country settings has likewise found professional development related to technology implementation to be critical to technology effectiveness. A meta-analysis of 77 randomized experiments on instructional interventions at primary schools in developing countries found that some form of teacher development aimed at delivering effective classroom instruction was included in almost every successful instructional intervention (McEwan, 2014, p. 380). However, in developing country settings, resources available for professional training are even scarcer. For example, in Swaziland, the government has prioritized partnering with the private sector to provide technology equipment to schools, especially in rural settings. Yet, there is not a single tertiary institution in the nation that is training teachers for a degree in ICT (Mndzebele, 2013). In Cambodia, a research study consisting of 379 surveys (out of 524 total teacher trainers in the country) and 17 interviews aimed to identify the major challenges of adopting the use of technology in less developed countries (Richardson, 2011). The study's findings revealed that while there are many barriers to the adoption of ICT (including technical and connectivity issues, limited English proficiency, and insufficient number of computers), the teachers who rejected ICT skills most frequently mentioned a lack of opportunities to practice new skills as their primary barrier. While studies find that the, "most dynamic applications of ICT are those facilitated by a teacher who is prepared to take full advantage of its potential," (Tiene, 2004, p. 92), ICT implementation initiatives often fail to take teacher capacity to effectively employ the tool in the classroom into consideration. This appears to be largely due to insufficient means to invest in such training.

### *Administrator and teacher support*

Studies in developed country contexts such as the U.S. also show that administrative and teacher support is an important component to effective technology implementation in schools. Administrative support is necessary to allocate resources for technology implementation, including school infrastructure, resource centers, professional development, technical support personnel, hardware, and planning time to integrate technology in content standards and curriculum (Glenn, 1997; Holland, 2001). In a survey of 73 teachers working in schools involved in the North Carolina Teaching Initiative, those with access to a technology facilitator reported more favorable perceptions of teaching and student learning with technology (Stanhope & Corn, 2014). Access to such personnel was made possible due to supportive administration at those schools. From a logistical standpoint, extending class periods and allowing teachers to teach fewer subjects, which are decisions made by school administrators, also increase teacher technology use (Becker, 2000).

In addition to allocating physical resources and investing in professional development, clear direction from school leadership and alignment with teachers' collective beliefs about teaching and learning increased the probability of full implementation (Bebell & O'Dwyer, 2010). Holland (2001) found that principal advocacy of technology use resulted in all but the most opposed teachers gaining some level of proficiency with digital tools. On the other end of the spectrum, teachers who received award-winning technology practices reported that support from others, including administrators and personal learning networks, shaped their instructional practices (Ertmer et al., 2012).

Research in developing countries likewise has found that teacher and administrator beliefs and attitudes towards technology are major predictors of their use in instructional settings. A report by Budhedeo (2016) analyzing the primary challenges to implementation of ICT-enabled education in rural schools found that "often in developing nations, the educational organizations and school management fail to perceive the importance and seriousness of the role of ICT in education enhancement," (p. 4763). Khan et al. (2012) also found that a primary obstacle to effective ICT implementation in Bangladesh was a lack of a school vision and plan for technology integration, stating that, "integration is clearly related to actions taken at the school level, such as the development of an ICT plan, ICT support, and ICT training," (p. 69). If administrators do not develop such a plan beforehand, implementation often fails.

Studies show that teacher support for technology is equally important to its effective implementation. Mumtaz (2000) states "teachers' beliefs about teaching and learning with ICT are central to integration, (Niederhauser et al. 1999, p. 157). Other studies have shown that teachers with positive attitudes "require less effort and encouragement to learn the skills necessary for the implementation of ICT in their design activities into the classroom," and that these are therefore the teachers who are more likely to adapt the technology to be useful in their classrooms (Khan et al, 2012, p. 71). The literature points to the clear

importance of investment and leadership and teaching faculty when introducing a new technology to a school.

The use of technology to enhance academic opportunities and student achievement in classrooms in low-resource settings, while promising, is an approach that comes with many challenges. The literature points primarily to the barriers of limited funds, leading to inadequate access to technological devices in both number and type, deficient technology supports including internet, electricity, and technology support personnel, limited resources for investing in professional development, and a lack of administrator and/or teacher support for new technology. The research we describe here provides additional evidence of these obstacles in the rural Kenyan context and seeks to provide a better understanding of the role each factor plays in the implementation of eReaders in primary (Class 6) classrooms in the region where we conducted our research.

### **Sample Selection**

The LCA is collaborating with government-funded primary schools in the North Kamagambo region of Western Kenya to implement and evaluate the eReader project, which was first proposed by head teachers in 2014. A total of 10 primary schools in North Kamagambo submitted proposals to participate in the eReader initiative. Prior to choosing schools (among these 10) for the initiative, the LCA Education Team categorized 13 schools in the North Kamagambo region by their average scores on the 2014 Kenya Certificate for Primary Education (KCPE) test into three distinct achievement tiers (low, middle and high). The top four performing schools (by the KCPE average score) were identified as high achieving; five schools were identified as mid-achieving, and the four remaining schools were categorized as low achieving. The 10 schools that submitted proposals were subsequently sorted into these three tiers. The LCA Education Team then selected two proposals from each of the three tiers, considering the schools' commitment to working with LCA and the aim to choose one school from each of the following sub-areas (to receive eReaders): Kameji, North Kamwango, and South Kamwango. The three "treatment" schools are Kadianga Primary (64 students), Komito Primary (19 students), and Sumba Primary (29 students). The three comparison schools (that did not receive eReaders) are Minyenya (48 students), Ofwunga (48 students) and Tonye (60 students). Within the treatment schools, the Class (level) 6 classrooms were selected for distribution of 150 eReaders, in proportion to the number of teachers and students at each school.

Prior to the evaluation start, the LCA Education Team obtained informed consent from head teachers at the participating schools, and all Class 6 students in the treatment and comparison schools were assigned a three-digit student code for baseline data collection. After obtaining informed consent from each student, academic assessments and a survey designed for this evaluation (described below) were administered to the students. A total of 109 students from treatment schools and 144 students from comparison schools completed the baseline assessments and survey in January and February of 2016. At the end of the school year (in November 2016), these same assessments were completed by 112 students from treatment schools and 136 students from comparison schools. When the baseline and endline data are linked to the survey data, there are a total of 223

observations—95 students in the treatment group and 128 students in the comparison group—for which the records are complete.<sup>2</sup>

## **Study Instrumentation and Measures**

### *Student academic assessments*

The Early Grade Reading Assessment (EGRA) and Progress in International Reading Literacy Study (PIRLS) assessments were initially considered for measuring student literacy levels in this study. The suitability of the EGRA for this setting was assessed with six Class 6 students (three girls and three boys) from a low to mid-achieving school that was not among the six study schools. The pilot test results suggested that the fluency and comprehension levels of Class 6 students would be too advanced for the EGRA. The PIRLS (written) assessment was also unsuitable in its customary form, because it is unable to differentiate between nonreaders and emergent readers (in contrast to orally administered tests like the EGRA).

A custom evaluation tool was subsequently developed by a LCA Monitoring and Evaluation (M&E) team member, drawing on the EGRA and PIRLS assessments, as well as input from a U.S.-based elementary school psychologist who regularly uses standardized assessments to evaluate reading abilities of primary school children (see Appendix A). The assessment consists of a reading abilities evaluation containing three subtests on pronunciation, oral reading fluency, and comprehension in both Kiswahili and English, sourced from Class 8 Kiswahili and English textbooks.<sup>3</sup> The three subtests in Kiswahili were administered first, followed by the three subtests in English. Subtest 1, pronunciation, consisted of 10 words ordered from low to high difficulty levels. Subtest 2 consisted of small reading passages to measure oral reading fluency. Subtest 3, comprehension, consisted of 7 questions on each passage.

During subtest 1, the administrator displayed each word to students on a tablet through a QuickTap survey, reversing the tablet to record scoring. During subtest 2, students received paper copies of the passages, and the administrator recorded incorrectly pronounced words on a separate copy of the passage. This number was also reported on the tablet survey. A QuickTap stopwatch was used to record student reading time, which was stored internally, manually recorded on the administrator copies, and entered directly in the tablet survey to prevent data loss. Comprehension questions were listed at the bottom of student copies, and the administrator copies included an answer key. Students read the comprehension questions on their own. The administrator recorded comprehension scoring on the tablet survey and conducted the remainder of the evaluation on the tablet.

---

<sup>2</sup> At baseline, 20 students were unable to read Kiswahili and English, and two students were unable to read English. At endline, six students were unable to read Kiswahili and English; three students were unable to read Kiswahili, and one student was unable to read English.

<sup>3</sup> Class 8 was selected to increase assessment difficulty level. Because the Class 8 English textbook did not have any comprehension questions associated with the passage, an M&E team member created this set of questions.

The scoring of student performance on the assessments was calculated individually per subtest. Pronunciation of each word was scored on a 0-1 scale, where 1 point was awarded for the correct pronunciation or 0 points otherwise. During the reading passages, the students' total reading time and number of incorrectly read words were tracked. Both metrics were used to calculate correct words per minute (CWPM). The comprehension section included multiple-choice questions, one-answer open-ended questions, and multiple-answer open-ended questions. For questions with one answer, a 0-1 scale was used, where 1 point was awarded for the correct answer or 0 points otherwise. For questions with multiple answers, a 0-2 scale was used, where 2 points were awarded for a fully correct answer with higher-level thinking, 1 point was awarded for a partially correct answer without higher-level thinking, and 0 points otherwise. The objective of collecting these data is to examine the relationship between eReader use and literacy metrics, i.e., pronunciation, CWPM, and comprehension in Kiswahili and English.

### *Student demographic survey*

Following the administration of the reading abilities assessment, a student survey was administered to gather information on student demographics, home environments, study habits, etc. (see Appendix B). The survey includes questions to collect data on: gender, age, primary caregiver, male and female caregiver reading abilities, language spoken at home, reading habits at school and at home, availability of books at school and at home, self-assessment of reading capabilities, and caregiver involvement in the student's education. The survey was administered again during the endline assessment, and an additional set of questions was included to gauge students' educational aspirations.

### *Classroom observation instrument*

In order to capture information on how the eReaders were being used in the Class 6 treatment classrooms—as well as other information about the classroom environment, instructional models, instructor and student engagement, etc. in both the treatment and comparison classrooms—we adapted an observation instrument that was developed for evaluating the implementation of educational technology in K-12 education. The research-based observation instrument evaluates the extent to which an instructional session (and integration of educational technology) facilitates quality learning opportunities for students, using a set of indicators or dimensions of quality elements that capture the type of interactions occurring between teachers, students, and the educational technology (when in use). These dimensions are described in more detail in Appendix C.

Ratings of the nine core elements of digital and blended instruction (shown in Appendix C) are recorded on a 0-4 (i.e., 5-point) scale. The instrument also records narrative comments and vignettes, total instructional time and total time on task; total time a student interacts with an instructor; whether the format facilitates live interaction between instructors and students around instructional tasks; the number of students using a device, and the functionality/operability of the technology. The adaptations that were made to use this instrument in classrooms in Western Kenya include adding items to record: (1) the primary language spoken by the teacher in instruction; (2) the primary language spoken by

students inside and outside the classroom; (3) the types of lessons the eReaders were used for (subjects); and (4) the main challenges encountered by teachers and students in using the eReaders in the classroom. Although the observation instrument is fully qualitative in nature, the data collected in the classroom observations are digitized and can be linked to student assessment and survey data.

### *Teacher interviews*

Interviews were conducted with classroom teachers in the treatment and comparison schools in order to better understand their strategies for supporting student learning, and for the treatment teachers, to gather information about their experiences with the eReaders and the challenges and opportunities they encounter in using them to improve student learning. In the interviews conducted with the classroom teachers (8 treatment, 5 comparison), the following questions/issues were addressed:

- Teacher background and experience with educational technology;
- Instructional practice and strategies for using the eReaders (and time spent using them) in the classroom;
- Training and support that is received for using the eReaders;
- Whether the eReaders (and curriculum and instructional plans) are adapted in any way for students with special needs;
- How teachers assess the effectiveness of eReaders in the classroom and any impediments they see to their access and effective use by students, and
- Teachers' plans for future use of eReaders and changes they would like to see in the program.

The teacher interviews were recorded and transcribed to identify common themes and to analyze them in conjunction with the observation data on teacher and student use of the eReaders in the classroom. The interview protocol and consent form are shown in Appendix D.

### *Focus groups*

During endline data collection, a random subset of students from both treatment and comparison schools participated in focus group discussions (see the protocol in Appendix E). Students were asked to provide their opinions on the use of eReaders in treatment schools and more generally on reading behaviors in treatment and comparison schools. A total of 17 students from treatment schools and 26 students from comparison schools participated in the focus groups.

## **Data Collection Procedures and Activities**

Prior to beginning data collection, a one-day training session was held in January 2016 with four evaluation administrators selected from LCA's Education Team to discuss the intent, procedures and scoring of each section of the academic assessments. A similar training was

conducted in August 2016 in advance of the endline data collection. Several protocols were developed to guide administration of the assessments. During Subtest 2, administrators were directed to prompt students to move on if a student was stuck on one word for more than three seconds to avoid inaccuracies in reading time. While answering comprehension questions, students were allowed to reference the passage. At any point, students were able to ask administrators clarifying questions, however, the administrator could not provide clues or direction within the passage. Administrators were instructed to never translate comprehension questions into Dholuo. At baseline and endline, a practice administration of the tests was conducted at Andingo Primary school.

In addition, before the start of the 2016 school year, Class 6 teachers from the treatment schools received a 1-day eReader training led by education staff. All eReaders were loaded with Class 6 workbooks and supplementary reading in Kiswahili and English and distributed to the classrooms in February (after baseline testing).

Data were collected at both the treatment and comparison schools through classroom observations and teacher interviews during the period of May 23-July 28, 2016. In the week prior to starting this phase of data collection, meetings were held with the LCA education team to determine a schedule and plan for the following seven weeks of data collection. In the following week (5/23/16- 5/29/16), initial meetings were held with head teachers and Class 6 teachers to introduce the research team (data collectors) and to obtain consent for interviews. A calendar was created to indicate the proposed days that data collection would take place at each school, and after review by the head teachers, adjustments were made to accommodate school sports, music competitions and regional testing (when classes would not be held).

Classroom observations, conducted during each of the weeks, 5/30/16 – 7/3/16, prioritized the tested academic subjects (English, Mathematics, Social Studies, Science, Kiswahili, CRE - Religious Studies); Creative Arts and Life Skills classes were not observed. Each classroom observation covered one block (35 minutes); on average, these observations covered approximately 4-5 subjects at treatment schools on each visit. In addition, the research team observed at least two classroom blocks at each of the three comparison schools. Although the study design and field research plan prioritized observations of eReader use at treatment schools, it was also of interest to obtain a clear understanding of the educational environment, curricular content and instructional practices at comparison schools and any important differences between treatment and comparison schools that might affect student learning and educational outcomes.

Fridays during these data collection weeks were reserved for conducting interviews with teachers. A total of 13 interviews, eight at treatment schools and five at comparison schools, were conducted. In the final week of data collection period (7/11/16 – 7/15/16), a teacher training was also held to support teachers in their use of eReaders, during which teachers were also given ample time to share challenges they were facing and best practices emerging from their use of the eReaders. Table 1 presents a summary of the observation and interview data collected at the treatment and comparison schools.

## Quantitative Analysis of Changes in Student Academic Performance

The student assessment and survey data collected at baseline and endline (at the start and end of the 2016 school year) were linked at the student level (n=253), and then the observation data collected during the mid-term months (May-July) were merged at the classroom level (n=49). As indicated in the discussion of the sample, there are a total of 223 student records in the fully linked data that include values for both the baseline and endline assessments and classroom-level observation information. Because the selection of classrooms for distribution of the eReaders was made via the explicit criteria discussed above (and not via random assignment), it is important to assess and compare the characteristics of the treatment and comparison groups and adjust for pre-treatment differences in estimating the association between the eReader program and student outcomes.

Table 2 presents summary statistics and tests of statistical significance for differences between the characteristics of the treatment and comparison groups at baseline, including on the pre-treatment academic assessments described above. The results show that students in classrooms receiving the eReaders scored significantly lower on average on three measures of academic performance (before the start of the 2016 school year): the measures of oral reading fluency in Kiswahili and English and the Kiswahili comprehension measure. On the other five measures of pronunciation and comprehension, there were no statistically significant, pre-treatment differences in academic performance between the treatment and comparison group members. In addition, children in classrooms with eReaders reported having more access to books at school and at home, but they were also older and significantly more likely to report that they only read when they had to. On other student-reported measures shown in Appendix B, there was very little variation among the students, such as on the item “Reading is easy for me,” to which 87 percent strongly agreed and another 6 percent agreed.

Of primary interest in this analysis is how students’ pronunciation/oral reading fluency and reading comprehension (in Kiswahili and English) changed from the beginning to the end of the academic year, and whether any such changes differed significantly (in magnitude) between the treatment group (with access to eReaders) and the comparison group. In light of the pre-treatment differences in academic performance and student characteristics shown in Table 2, we estimate regression models that control for student characteristics and baseline academic performance, along with controls for other potential moderators of the eReader use, such as the teacher’s primary language of instruction (English or other), the class size (student:teacher ratio) and the percent of the time students were observed to be “off task” during instruction (in classroom observations). Educational research shows that one of the most important control variables in estimating the effects of an intervention on student achievement is a measure of students’ pre-test academic performance (using the same test instrument as used in measuring outcomes), which we have available (Cook and Steiner, 2010). Given that the eReaders were distributed to students in a single grade and year in three schools (with students in three other schools serving as the comparison group), we do not include grade-level or school fixed effects; with only six schools in the sample, the inclusion of indicator variables for

school attended is highly correlated with the treatment (eReader) indicator. However, we estimate robust, clustered standard errors that take into account student clustering within classrooms.

In this estimation, we do not make any causal assertions about the relationship between eReader use and changes in student achievement, as we observe baseline differences between students in eReader and comparison classrooms that suggest the potential for unobservable differences in student characteristics as well. We estimate two alternative specifications of the model predicting student achievement: one that predicts the change in student achievement from the beginning to the end of the 2016 school year (with the gain score as the dependent variable,  $A_{it} - A_{it-1}$ ), and the other that predicts the endline level of student achievement, controlling for the baseline student achievement (on the same measure) and other student characteristics at baseline ( $X_{it-1}$ ).

$$A_{it} - A_{it-1} = \alpha + \beta_1 eR_{it} + \beta_2 X_{it-1} + \epsilon_{it} \quad [1]$$

$$A_{it} = \alpha + \beta_1 eR_{it} + \beta_2 X_{it-1} + \beta_3 A_{it-1} + \epsilon_{it} \quad [2]$$

Table 3 summarizes the results of these estimations for each of the academic performance measures (for both specifications above), and it also shows the estimated changes in student performance controlling only for their baseline academic performance and adjusting for student clustering in classrooms. The findings show that students in classrooms with eReaders consistently experience larger academic achievement gains from baseline to endline on the oral reading fluency and reading comprehension measures (in Kiswahili and English) compared to students in the comparison classrooms (without eReaders), although only about one-third of the differences are statistically significant. The improvements in oral reading fluency and comprehension are larger (and more often statistically significant) for English reading skills, and controlling for student characteristics also increases the magnitude of the estimated differences. Focusing on the results for the models with all controls, students in classrooms with eReaders, for example, are reading 19 more words correct per minute in Kiswahili and 25 more words correct per minute in English compared to students in the classrooms without eReaders. For the comprehension measure with a 0-2 scale (compiled across seven questions), students in classrooms with eReaders scored 1 point higher on average on the summary measure of English comprehension (compared to those in classrooms without eReaders). And on the English comprehension measure using a 0-1 scale (where an incorrect answer received 0 points), students in classrooms with eReaders received significantly fewer zeros.

We view these findings as preliminary but promising in terms of the potential for the eReaders to increase student literacy and academic performance. In the next section, we draw on data from the classroom observations, teacher interviews and student focus groups to illuminate the pathways (and obstacles along them) to improving student learning and achievement through the integration of eReaders into primary classrooms in North Kamagambo, Kenya.

## Qualitative Data Analysis Findings

In addition to quantitative data collected through ratings of dimensions of digital and blended instruction on the observation tool and student achievement scores on the baseline and endline assessments, qualitative data from observations and interviews provided a much richer picture of both the challenges still present in eReader classrooms, as well as the many benefits of eReaders that could be contributing to improved student outcomes.

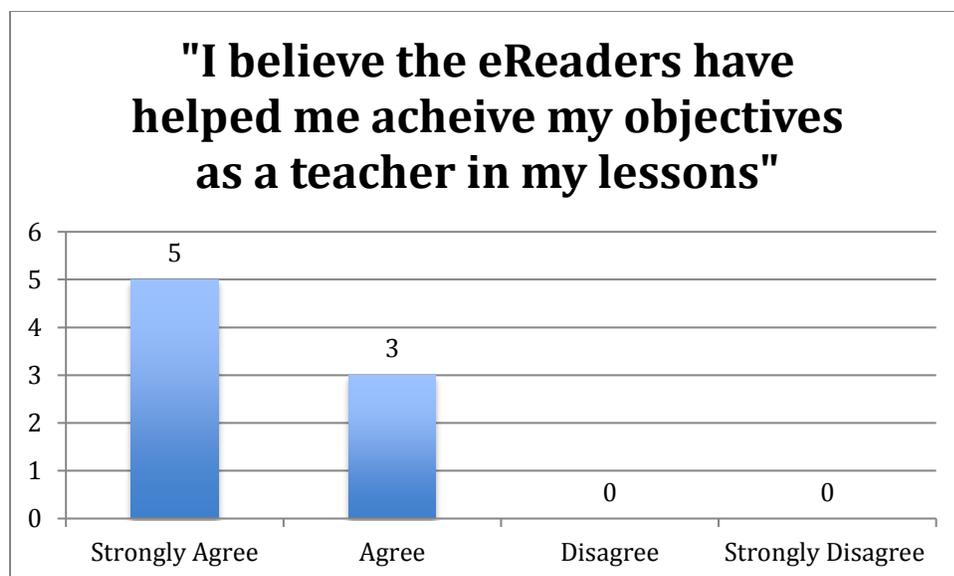
*Relationship between teacher, classroom, student and environmental factors in tech use and student outcomes (observation data, teacher and student surveys, and test score data)*

While challenges certainly exist in eReader classrooms, teacher interviews and classroom observations revealed many factors that might explain the positive association we see between eReader use and student achievement outcomes.

Teacher responses to technology: First of all, most teachers have voiced very positive attitudes towards using the eReaders and have expressed a desire for their expansion and continued support. When asked to rate the degree to which they believe the eReaders have helped them achieve their objectives in their lessons, all eight teachers interviewed at treatment schools either agreed or strongly agreed (5 strongly agreed and 3 agreed). Specifically, they have stated that eReaders have provided more books and opportunities for students to read, exposed students to the digital world, and provided more opportunities for students to practice educational tasks, both during class and remedial lessons and at home/outside of school.

When asked in what ways the eReaders served as a valuable tool in their classroom, teachers mentioned that, as a result of increased access to the course-work by each individual student, their participation and interest in lessons has increased, as has their focus, due to the fact that all coursework is in one place. While students were not interviewed in this study, teachers expressed in their interviews that students were also very excited about the eReaders and that they connected students to the digital world.

***“We appreciate the assistance given; most parents cannot afford to buy the textbook, so we really appreciate the donor, Lwala (Community Alliance), and everyone having a hand in this. If they can, they should extend it and give it to the rest so they also benefit.”***



**Student responses to technology:** In focus groups, students also expressed positive feelings about the implementation of e-readers in their classrooms. When asked if they liked learning from e-readers or textbooks better, all 11 of the students who addressed this question said that they preferred e-readers (3 students at Kadianga; 5 students at Komito; 3 students at Sumba). Moreover, students felt that the eReaders were positively affecting their ability to learn material in class. When asked if they agreed or disagreed with the statement “the e-readers improved my learning during lessons,” students strongly agreed. They highlighted aspects of the e-readers such as their ability to efficiently provide meanings of unknown words, their inclusion of interesting and varied storybooks that they wouldn’t be able to afford otherwise, the inclusion of revision books, and the fact that they don’t have missing pages like many textbooks do. Some students also attributed their improved grades to the eReaders, with one student mentioning an increase in his marks in science class, another citing an improvement in his writing skills, and many students at Komito reporting higher rankings on national exams with the eReaders.

**Student access to texts:** One of the most pressing concerns raised by teachers—evident after our first week of observations at the six primary schools—was the fact that every student did not have access to their own individual eReader. In the project plan developed by both LCA and the head teachers from the primary schools involved in the project, each school would be allotted a sufficient number of eReaders to have a 1-to-1 ratio between students and the digital tool. In the treatment classrooms observed, about 30 percent of the devices had two students sharing, and the eReaders were shared by three or more students in 38 percent of the observed classroom sessions. Thus, in less than one-third of the observed classroom sessions was the intended 1:1 eReader ratio met.

However, while the eReaders are not being used in their intended 1:1 ratio in many classes, 7 out of the 8 interviewed teachers at eReader schools specifically emphasized the much higher level of student access to texts on account of the eReaders, as compared to before

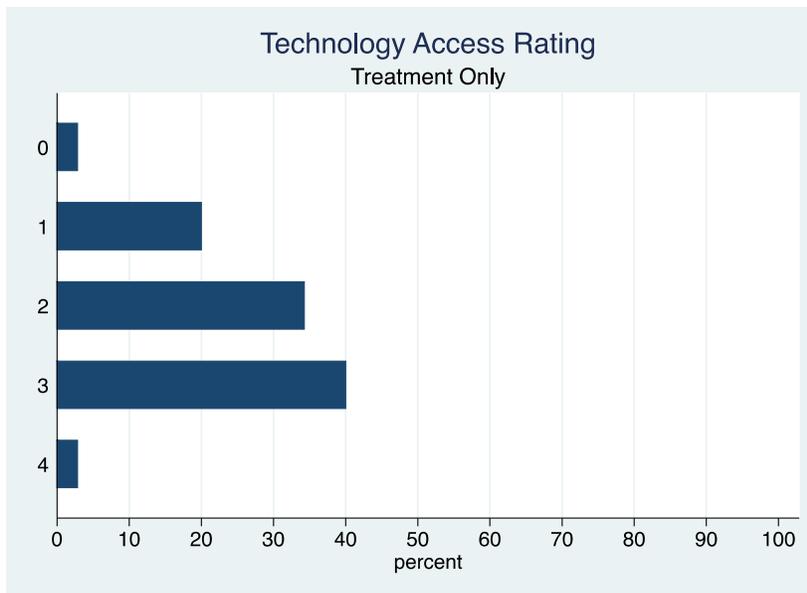
the pilot project. They explained that before, as many as 8 students would share a textbook, and in some cases, there was not a single textbook available to students. When this occurred, the teacher, as the only person with access to the course material, would copy all exercises from the teacher textbook onto the whiteboard for students to copy into their exercise books.

***“In a class environment with no books, the eReaders help each and every pupil to work at their own pace because they each have their own eReader – they can use them anytime. They don’t have to share with anybody.”***

Currently, while technical difficulties have at times reduced the number of eReaders available, only an average of 3 students are sharing an eReader in these cases as opposed to 8. Furthermore, teachers report that the eReaders have helped them with lesson planning since all students, as well as the teacher, have access to the same course book. Before, teachers had to spend time creating lessons that were accessible to all students, realizing that only a few would have access to the textbook. This required additional time and creativity on the teacher’s part, and often required pulling together many different resources. One teacher elaborated, “during morning and evening preps, I now have a plan to work with students, which creates more time with them.”

With fewer students sharing each digital textbook in eReader classrooms in comparison to these ratios in classrooms using regular textbooks, it makes it easier for students in eReader classrooms to complete homework (both in class and at home), students’ concentration is improved, and it saves the classroom time it would normally take for students to pass around the course material or copy all notes from the board.

The graphic below shows the distribution of observer ratings of technology access in the eReader (treatment) classrooms (June 2016), which took into consideration access to power, the hardware (devices), and the safety, operability and accessibility of the technology (n=36). The modal response is [3], which implies that students had access to the technology in the instructional setting throughout most of the observed sessions; few had full access [4] or no access [0]. In addition, an analysis of variance analysis showed that observer ratings of technology access were (statistically) significantly lower in classrooms where more students were sharing e-readers.



**Individual student practice:** Teachers also mentioned in interviews that increased access to textbooks provides more students with increased opportunities to work independently and at their own pace, both at home and at school. Multiple teachers expressed the value eReaders provide in terms of allowing students to engage in individual homework assignments and projects. One teacher expanded, “In the past, when we gave them (students) homework, they had to visit each others’ homes to share the textbook. But now they have it, so they’ve improved in managing time and in doing personal studies, assignments, and homework.” Another teacher emphasized the increased time students now have to access the texts stating, “The eReaders help the pupils because they have them all the time, so pupils can use storybooks in their own free-time.”

In the classroom, not only does this make differentiation based on students’ needs possible, but it also gives students the chance to practice skills independently, which they will need to be able to do well on the Kenya Certificate for Primary Education test (KCPE).

**Additional course books:** When asked specifically about the additional learning opportunities eReaders provide that cannot be gained simply from face-to-face instruction, teachers mentioned that the eReaders not only improve student access to regular coursework, but they are uploaded with many supplementary resources as well, including storybooks and revision books. The wide variety of storybooks located on the eReaders allows students the opportunity to read on grade level and for fun outside of class. One of the English teachers interviewed also revealed how eReaders have allowed him to “beef-up the storytelling lessons” since there are more stories available in the eReader. Revision books provide multiple choice questions, aligned to the KCPE, which can be used by students to review at the end of a 1 week or 2 week topic. They include answers so that students can assess their own learning.

Dictionary feature: Two teachers also specifically highlighted the value of the dictionary feature on the eReader. Before the eReaders were available, a dictionary was an additional cost for the student, and very few students could afford them.

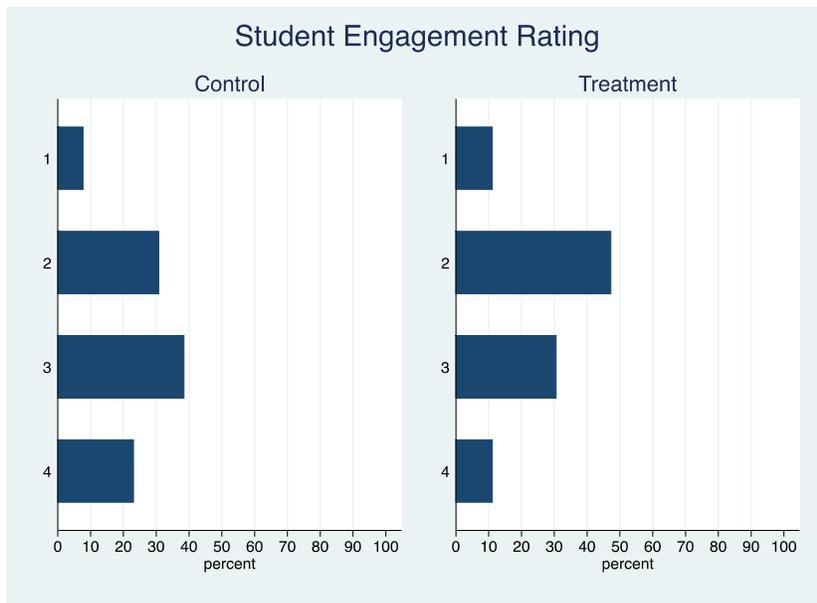
This feature in the eReader also saves time by allowing the user to stay on the course-book page and bring up a word's definition at the same time. One teacher stated, "The dictionary is very instrumental; They tap on word and get a meaning - this helps learners to build their vocabulary level in English, math, etc." Another teacher mentioned how much more quickly the class can learn a new word when everyone can look it up at the same time, as opposed to students waiting for the teacher to look up the word, and then reveal the definition on the board to the class. The benefits of this feature were observed in classrooms as well. The feature was most often used in English and Kiswahili classrooms, either as a drill exercise for students to look up multiple words, or in the middle of a story when students were unfamiliar with a word. The teacher would pause the reading of the story and ask students to find the definition of the word by clicking on it. In some cases, the teacher would be able to move on with the story in a matter of 20 seconds.

***"The dictionary is very instrumental. They tap on word and get a meaning - this helps learners to build their vocabulary level in English, math, etc."***

Time efficiency: When students know how to use the various features of the eReaders and effectively manipulate them, the eReaders certainly have the ability to save time in class. One teacher expressed that training students on how to quickly use the table of contents feature to rapidly access a topic and subtopic was the key to taking better advantage of her 35 minutes with students. It has allowed her to proceed quickly in lessons without wasting time. However, many teachers also expressed frustration with students' inability to manipulate this feature effectively, and that this new technology actually slows lessons down (see Device Manipulation section).

Increased student engagement: While student engagement and participation in the eReader classrooms was not observed to be higher than in control classrooms (as shown in the graphic below, n=49), data collected in teacher interviews suggest that the teachers believe the eReaders have, in fact, improved student engagement in school as a whole. Teachers' evidence for this includes decreased student absenteeism and drop-out rates, as well as a clear shift in students' attitudes toward learning.

***"In the past, we had 2-3 (drop-outs) per term, but this time, they have not (dropped out). We've only had one so far and we are in term 2."***



[4] Students have full engagement in instruction.  
 [3] Students are engaged in most of the instruction.  
 [2] Students are engaged in some of the instruction.  
 [1] Students rarely are engaged in instruction.  
 [0] Students are not engaged in instruction.

With respect to students’ physical attendance, 3 teachers mentioned that eReaders have promoted the attendance of pupils. One teacher stated specifically that since they received eReaders, students are rarely absent. Another provided specific numbers saying that, “in the past, we had 2-3 (drop-outs) per term, but this time, they have not (dropped out). We’ve only had one so far and we are in term 2.” Yet another teacher mentioned that they’ve had as many as 3 students transfer to the eReader schools from other schools.

Teachers attribute these changes to a shift in students’ mindset. Seven out of the 8 teachers interviewed at treatment schools discussed students’ improved attitude towards school and learning as a result of the eReaders. One teacher stated, “The students we have now are academically oriented - they have passion of getting to class 8, form 1, etc.; they know the importance of education.” Another described the change saying, “now pupils like school; being in school leads to getting something out of that school.” Teachers had a lot of evidence to support these statements. They described students working more without being told, even when the teacher is not present in the room, as well as students coming in as early as 6:30 in the morning and using the eReaders to read storybooks. Furthermore, eReaders have had the effect of increasing motivation of students in other classes, as they try to compete with the class six students who get to use the eReaders.

Furthermore, one teacher also mentioned that the eReaders have improved teacher-pupil relationships by increasing the opportunities they have to communicate with one another. This was evident in classrooms where many more individual students could be called on to read or engage in questions in class since they had access to the text.

***“The young ones like to discover more and are interested in the next unit. It is motivating them to learn because they want to read and know what is on the next page in the eReaders.”***

Increased student learning: When asked how eReaders have impacted student learning, teachers once again provided ample reports. Teachers indicated that students are reading

more, with one teacher reporting that three of his students can now read who were not capable at the beginning of the school year. He attributes this to students' curiosity with the eReaders. Teachers also report that the eReaders have promoted faster reading and learning among pupils. The eReaders are boosting student interest in other subjects as well. One math teacher stated that his students are much more interested in learning math, and they do more math problems on their own now.

#### *Teacher role in supporting their use (teacher interviews/surveys and observation data)*

While teachers were able to describe many benefits of the eReaders in their classrooms, at the same time, there is considerable variation in the average ratings of instructional quality and learning opportunities across all dimensions observed (see Appendix C) in both treatment and control classrooms, i.e., average ratings varying from a low of 0.67 to a high of 3.83 (on a 0-4 scale). This suggests that there are opportunities for improvement, as well as opportunities for some teachers to learn from the best practices of others. Teachers reported multiple challenges in interviews that provide a better understanding of where improvement might be needed.

From Report (Teacher Training and Teacher and student eReader use): In interviews, teachers described themselves as starting the year and the eReader program with little or no experience with digital tools and acquiring extensive experience through the training provided by Lwala at the initiation of the program. At the same time, 7 of the 8 teachers interviewed at the treatment schools also described having some exposure (through their time at university) to an introductory computer course and/or other computer training in software. In addition, two teachers reported earning an IT certificate through a part-time night program while they were teaching. Still, many of the teachers discussed difficulties they had in staying up to date on their skills and finding ways to practice while working in North Kamagambo. One teacher stated, "I'm not doing it (computing) currently because we don't have the equipment. But in Nairobi, where I was employed at private school, we had computers, so we were using them. But if you don't use them, you lose the skills."

Teachers indicated that the training provided by Lwala was very helpful in instructing them on how to operate the eReader, including charging the devices, quickly accessing books, pages, and locations, safe storage and troubleshooting, and how to teach students to use them effectively in the classroom. While teachers appear to feel very confident after the training, at least one teacher mentioned that refresher trainings would be helpful.

#### *Device manipulation*

Among the treatment school teachers, 5 out of 8 reported experiencing technical difficulties that prevented students from using the eReaders effectively in class. Most of these teachers cited student difficulty finding specific locations in the eReaders as the primary challenge. One teacher stated, "They still don't understand how to control it...sometimes they go to a different one (book)...that they did not require. This makes it very difficult...and it takes a lot of time reorganizing it to make them be together in class. Students would benefit from having a review of how to access books." The additional amount of time it takes to

transition from one lesson to a new lesson was noted by another teacher as well who said, “It is not very fast because it takes time to turn to the lesson and look for the books. For example, if they were in another lesson and you enter for a new lesson, it will take them time to settle and transition to the next lesson.”

Teachers attributed student difficulty to their status as “slow-learners”, with one teacher specifically stating, “we don’t have enough time in a lesson to help every pupil access (the eReader), so slow learners cannot use eReader during lesson. If you go one by one to teach them how to open a page, the lesson will be over.” However, there were likely additional factors leading to this challenge, such as insufficient student training on device manipulation, or unclear directions from teachers guiding students to a specific place in the eReaders.

Many teachers also voiced frustration that the time it takes some students to manipulate the eReaders disrupts the flow and pace of their lessons. As mentioned in the review of the literature, ongoing professional development can be instrumental in supporting teachers with the adoption of a new device and is recommended to ensure teachers and students are able to use the new technology successfully in classrooms. We discuss this recommendation further in the recommendation section.

Teacher approaches to addressing these challenges: It is unclear exactly how much initial training students at each school received in how to manipulate eReaders when they were first implemented in classrooms, nor is it clear how much remedial training struggling learners receive. However, it was expressed in teacher interviews (and observed in classrooms) that some teachers take time out of class to make sure every single student has accessed the correct page before moving on. One math teacher stated, “I make sure all learners can use (the eReaders) effectively. Maybe they were trained a bit, but I always confirm that everyone is on the same page and help those who are lagging behind.”

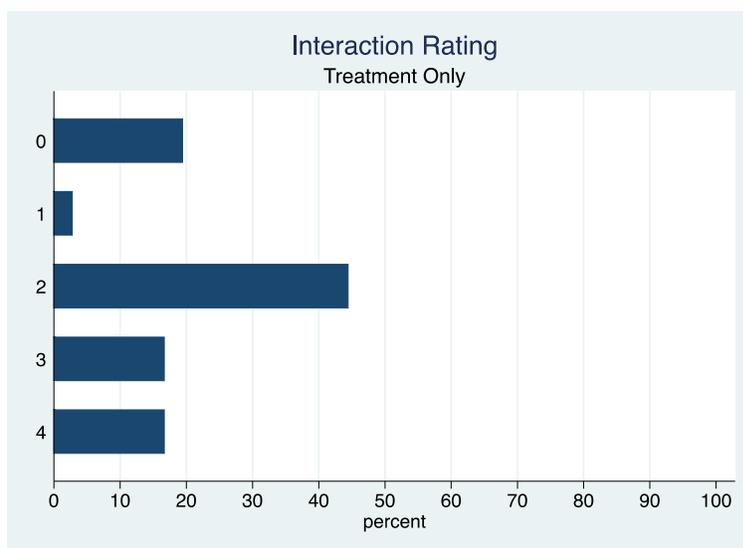
Another teacher described the way they taught students about the eReaders, stating, “First, we made them to know how to use the eReaders (terms, symbols in eReaders, when to move to next page, back, and to the homepage). During lessons...we've allocated more time for students to familiarize themselves in the eReaders. We also rewarded students who were able to use them well to encourage the rest to know how to use them.” In observations, it was evident that while some teachers took the time to support every student in using the device, this was not the case in all classrooms. Three teachers mentioned in interviews that it would be helpful if the timetables for schools could be changed to allow for longer periods for subjects that use eReaders, in order to account for the extra time it takes to help students. One teacher stated that currently, “you complete lesson with eReader in 35 min. You have to spend more time in order to be effective (checking that you are on the same page, etc). Time for lessons with eReaders should be increased a little to 50 minutes.”

Other teachers have paired slower learners (who generally struggle more with manipulating the eReaders) with higher performing learners (who have mastered manipulation of the eReaders), so that they can help ensure students who struggle more

academically and with the eReaders are in the correct location for class activities. One teacher stated, “Those who have problems, you use the high performing students – you pair them – to help them catch up. We have weaker students who we pair with those who are stronger in learning, so that when we give work, they’ll be on par with us.” Teachers at another school explained that they hold an additional tutorial with the eReaders for students from 4:00-5:30 pm after games. A few teachers mentioned that Reading Clubs were designed to support students’ who struggled both in reading with the eReader manipulation. However, observations at schools revealed that only one school held reading club meetings regularly.

One observation made during classroom visits that could be contributing to student difficulty is that many teachers did not provide explicit directions for locating items they expected students to find in class. Some teachers provided page numbers, while others provided location numbers, and very few identified the heading or sub- heading of the section students should be finding on the eReader. Due to the eReader feature that allows students to choose a font-size specific to their needs, location and page numbers can be different for each student, making it necessary for teachers to be explicit about the heading of the eReader section for the lesson. Additionally, few teachers wrote the location or heading of the course book section on the board, which appeared helpful for students in other classrooms.

In the classroom observations, the extent to which teachers had constructive interactions with the students and technology resources (eReaders) was rated (n=36). As the graphic below shows, there was a considerable range among these ratings, from [4] indicating constant, constructive interaction between teachers, students and the devices to [0] capturing destructive interactions among them.



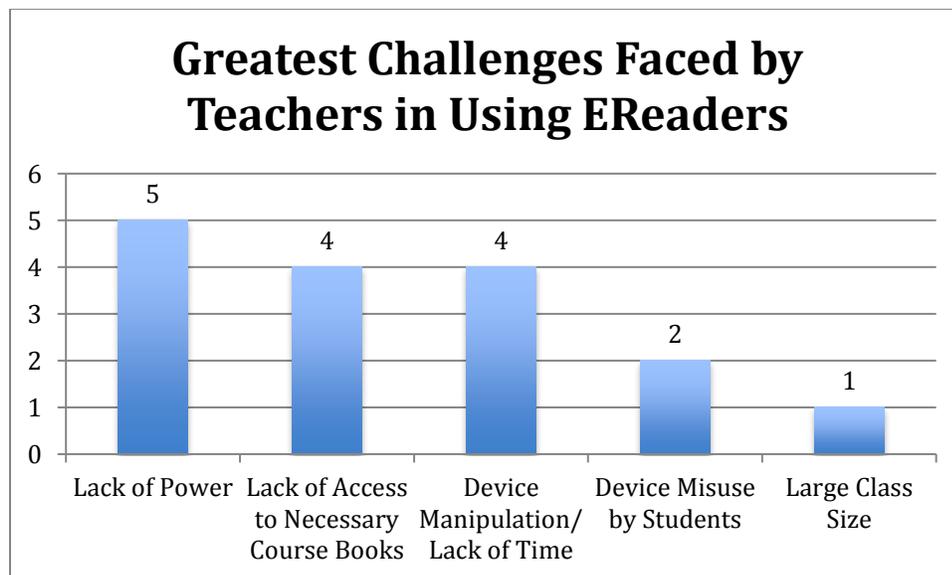
While there were a few teachers observed who incorporated students into all aspects of their lessons and who required students to demonstrate their understanding of the material, the bulk of many lessons using eReaders consisted of teachers copying notes from

the eReaders onto the board, teachers lecturing about what these notes meant, and students then copying these notes or practice questions into their exercise books. In most lessons, teachers talked for the majority of the time, and there was very little student dialogue. Expectations for student participation included listening attentively, repeating the teacher when prompted, reading a passage or question from the eReader when called on, and providing the answers to practice questions when prompted (either chorally or by raising their hands). Students were rarely asked to demonstrate that they understood the skill being taught until the very end of the lesson on their homework assignment (to be checked by teachers after class).

### Mediating Factors

In addition to the varying levels of ability and knowledge among teachers and students on how to manipulate the digital devices, there were multiple other mediating factors that could be contributing to the variation we see in observation ratings of classroom use of the eReaders. These mediating factors include level of access to power, level of access to course books necessary for a particular school subject, student digital citizenship, level of administrator support at a school, and classroom culture.

The chart below illustrates the greatest challenges teachers expressed facing when using eReaders to improve student learning. Five out of the 8 teachers interviewed at treatment schools highlighted the lack of power as a primary challenge. Four teachers mentioned lack of access to necessary course books, revision books, and supplementary books, and four teachers also mentioned students' difficulty in manipulating the device as a major challenge that took time away from the lesson itself. Two teachers highlighted the fact that some students misuse the devices, which requires heightened monitoring by teachers. Finally, one teacher mentioned the obstacle of implementing a new device when his class size is so large.



### *Lack of power*

The primary factor reducing the number of eReaders available to students is the lack of consistent access to a power source. Moreover, 5 out of the 8 teachers interviewed at treatment schools named this as the primary challenge they face when attempting to use eReaders to improve student learning. While Worldreader states that eReaders require little power and only need to be charged every 2-4 weeks (with the WiFi off and backlight at level 10 or less), this is under the assumption that eReaders are only being used as a library resource for 1 hour of reading per day (worldreader.com). In Lwala's project, e-readers are used to replace traditional textbooks and are therefore used by teachers and students for all lessons during the day, as well as for additional time at home to complete assignments and supplementary reading. Thus, a plausible estimate of eReader use in the Lwala school setting is about 10 hours per day. While it only takes about 1 hour for the device to fully charge, the eReaders would need to be charged at least once per week, if not more, in order to remain charged for all students.

In focus groups, many students also mentioned that access to a power source to charge the e-readers was frequently lacking, which limited their ability to learn from the eReaders, since the power would often "go out without notice," or would go out while the student was in the middle of reading a storybook.

In initial project planning, headmasters at all three treatment schools committed to having consistent power at their schools so that eReaders could be charged daily. However, we found during observations and interviews that this promise was kept at only one of the three treatment schools (Komito). The other two schools, Kadianga and Sumba, lacked access to power and therefore had to find alternative options to keep the eReaders charged. At Sumba, teachers take the eReaders home at night during the week to charge them. Still, most students were sharing eReaders in every observation made at this school, so this method did not allow Sumba to meet their goal of a 1-to-1 ratio. At Kadianga, teachers take the eReaders to Kameji, a neighboring secondary school, to be charged. However, teachers reported that the timing for charging the eReaders at this school is inconvenient, and they didn't like being a burden to the school. While the third treatment school, Komito, does have power, teachers still experience difficulties in keeping all eReaders charged due to a lack of power outlets and the headmaster's unwillingness to purchase power strips for charging.

When the eReaders are not used in their intended 1- to-1 ratio, students may not be able to fully take advantage of many important features that facilitate personalized learning. These features include adjusting the font size to a level that is aligned with the vision needs of the individual child; the ability to read and complete other activities on the eReader at the student's own pace; and the ability for every child to take an eReader home to complete practice exercises and personal reading for homework. All of these features are believed to be integral components to the desired improvement of student reading skills and reading culture that cannot be fully utilized without the 1-to-1 ratio of students to eReaders.

### *Lack of essential course books*

Another logistical challenge that is likely influencing teacher and student use of eReaders is the fact that a few fundamental course-books are currently not loaded onto the eReaders.

During interviews, most teachers voiced frustration that the eReaders did not contain enough storybooks in both English and Kiswahili for their fast learners. One math teacher at Kadianga did not use the eReaders at all due to the fact that her preferred course book, which she believes is both more rigorous and includes more exercise problems, is currently not loaded. The English teacher at Komito complained that the English course book is not loaded as well, but she has managed to switch back and forth in class between using the English printed textbook and the supplementary/revision books that are uploaded on the eReaders. She explained that, “the themes in the eReader are more or less the same (as the course book). So, after the course book, I tell them to use the story found in the eReader.”

***“There are not enough stories in Kiswahili; they've read almost all of them, and they need something new to keep them interested in***

Students also mentioned in focus groups that eReaders sometimes lacked important course books, and they listed books they would like to be added to the e-readers in the future, including the Kiswahili storybooks entitled, “malkia wa kobe, kwanini paka hula panya, Joki the Kimi, Kido.” One student added that “some books appear on list, but when opened, there is nothing to display.” Multiple students also stated that some books take a long time to load, such as the World Atlas, and that at times, the device will prompt you to restart the application if you accidentally press an unknown button.

All Kiswahili teachers have voiced their need for Kiswahili dictionaries to be uploaded onto the eReaders. Only one Kiswahili teacher (at Komito) has been able to ask parents to purchase hard-copies of Kiswahili dictionaries for student use in his classroom. Members of the Lwala education team are currently in conversation with publishers in order to load these necessary course materials onto eReaders, however, publishers have been very slow in their response. Until LCA is able to negotiate the uploading of these course materials, eReaders will be underutilized, primarily in English and Math classrooms.

### *Student digital citizenship, administrator support and other challenges*

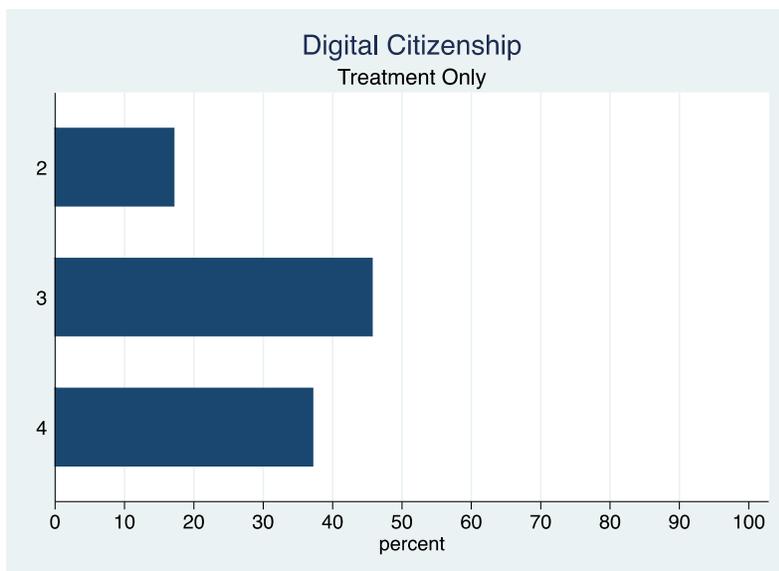
An additional challenge voiced by teachers was device misuse by some students, what is described in the literature (and recorded in our observation instrument) as a lack of “digital citizenship.” One teacher described how students’ curiosity had led them to using eReader features that were not intended by teachers stating, “some of the pupils have gone too deep and discovered things we didn’t tell them, like resetting passwords and then forgetting them.” When students reset passwords, teachers are not able to access the device, which reduces the number of eReaders available for a given lesson.

Some teachers at Kadianga where the class size is the largest (with a total of 64 pupils) complained that the large class sizes make it difficult to support every student in using the new device. One teacher explained, “there are a lot of students, and it is very difficult to manage. A normal class should have 35-40, and we have 60.”

At Sumba, an interview with the eReader patron raised similar concerns about the eReader program and student use of the eReaders. This patron voiced that students often misused the devices and that the eReaders served as a distraction rather than a source of motivation. At Kadianga as well as Sumba, problems surfaced with students mis-handling the eReaders and breaking the screens. While LCA had designed a clause in the project plan and established agreements signed by parents that families would be responsible for replacing any broken eReaders, this financial expectation is simply not realistic for most parents living in North Kamagambo, and LCA is currently incurring the costs of broken eReaders. Over the course of the research, Sumba had a total of 4 broken eReaders and 2 locked passwords, while Kadianga had a total of 2 broken eReaders and 2 locked passwords. No eReaders were broken at Komito.

The eReader patron at Sumba went on to state that “eReaders are a detraction from face-to-face interaction which can be a bad thing because you have to spend time controlling students attention within the lesson. Monitoring is difficult because you never know what a child is doing in the eReader. They could be on another chapter or another book. All of this results in wasting of time.” These issues were occurring at Sumba despite the fact that class sizes were relatively smaller there (29 pupils, the 2<sup>nd</sup> smallest of the six schools in the study).

Classroom observations of digital citizenship (rated on a 0-4 scale) did not show any major problems on this dimension of eReader use (n=36). The lowest rating received was a [2], indicating some students were using the technology in unintended ways but distractions were minimal. In more than 80% of these observed sessions, all or most students were acting responsibly with the devices.



The negative perspective shared by the eReader patron at Sumba might also reflect the level of administrative support the school is receiving for eReader use. The educational technology literature points to the importance of administrator support at schools when implementing a new technology requires a shift in school structure/processes or teacher pedagogy. In the treatment schools using eReaders, interviews and observations revealed that there were varying degrees of support from school leadership (principals), teachers, and eReader patrons. Support for eReader use was very high by the majority of teachers at Komito, and especially high by the eReader patron. This school was also the only one of the three treatment schools where reading clubs were implemented, providing the students even more practice with the eReaders.

Other factors contributing to the underutilization of eReaders included the problems of locked passwords (as well as broken screens). While each eReader was assigned a password by Worldreader, (as noted above) teachers reported that students had identified how to change the passwords on their eReader. In addition, students would often forget their personal passwords (which they acknowledged in focus groups), rendering their eReaders inaccessible to both the teacher and student.

Finally, one science teacher mentioned that he wished the eReaders could include color pictures instead of solely black and white images, explaining that color makes it much easier to explain certain scientific topics.

### *Classroom culture*

We also observed and heard teachers report student off-task behavior that we suspect is linked to classroom culture. Our analysis of the observation data showed that students are off-task (from eReader use) about 20-25% of the time in a given classroom session, and that this is likely related to the lack of involvement of students throughout lessons and the heavy percentage of teacher talk versus student exchange in any given lesson. Students were rarely asked to demonstrate knowledge and were primarily expected to listen and copy down information, which diminished student incentives to remain fully engaged in the lesson. We saw this play out in observations through low levels of student participation when questions were posed to the class and in a few instances when students were reading books for other subjects during a lesson.

Another potential reason for problems with student engagement is the culture of apprehension sensed in many of the classrooms observed. In many lessons, teachers harshly criticized students for incorrect answers or for not being able to read. A few teachers physically hit students for not providing what the teacher considered to be an intelligent answer or for not being engaged in class. In one instance, a teacher threatened to cane students who did not get every homework question correct. While this type of interaction with students was not present in all classrooms, it appeared to cause students to fear participating and to avoid embarrassment or upsetting the teacher in many classrooms. This style of teaching was observed in both treatment and control schools.

In addition, teachers at all schools (treatment and control) appeared to be highly focused on student test scores. The number one goal expressed by all teachers when asked about their goal for instructional sessions on a typical day was that students would “get good marks” and be able to answer questions about the content taught. This “hyper focus” on KPCE is not surprising given that passing the KPCE is required for students to move on to secondary school.

### *Other student feedback and vignettes illustrating exemplars and challenges*

Although there were numerous challenges to integrating the eReaders into the classroom learning environment, on the whole, student feedback (like that of the teachers) was positive about their experiences with the eReaders. Below are some examples of Class 6 student reflections on the eReaders that they offered in the focus groups:

- “My academic performance has improved from #10 to 5 due to eReader; It has brought a culture of learning and reading to everyone due to availability of books,” -
- “I am motivated and I can now find meanings from the eReader. It has boosted my literature skills.”
- “I have the motivation to work hard and understand how the eReader is working and is made.”
- “I feel confidence and love using eReader.”
- “I was unable to read in class six but now due to eReader I can read.”
- “It has improved my learning esteem and courage to learn more.”

In addition, from the classroom observations, we have selected an exemplar of classroom instruction and eReader use at one of the LCA eReader schools (Komita Primary), and in Appendix F, we present a rich description of this observation. We also present an example from a classroom observation that illustrates some of the challenges we have described in this report and how they can impede instruction with the eReaders (see also Appendix F).

## **Recommendations**

In this final section, we present recommendations for the LCA leadership team to consider as they continue to work on implementing and improving eReader use in Lwala schools, as well as for informing the new “library model” that is being rolled out and tested in the current school year.

First of all, as described in existing literature and in the research we present here, professional development and capacity building to support technology implementation is critical to realizing the potential of technology to improve student learning and achievement. We accordingly offer the following recommendations to empower and support teachers in eReader use:

- LCA should strive to provide continuous teacher training and support for use of digital tools in the classroom setting. Research shows the importance of teacher training that is on-going and frequent, in contrast to a single training on a specific topic.
  - Some NGOs in Uganda have estimated that only 10 percent of teachers actually change their behavior in the long term when teacher training on a particular topic is a one-time occurrence (SSIR).
- LCA could either: 1) create their own curriculum for teacher training on the use of e-readers by adapting materials used by existing school systems, or 2) partner with an existing teacher training organization to coordinate and sustain ongoing teacher e-reader training.
  - Option 1: LCA's e-reader project coordinator could lead a teacher training once per term (at the end of each term or beginning of each new term). This would provide opportunities for both the project coordinator and teachers to present best practices observed or experienced in the previous term. These LCA-led trainings for treatment school teachers could also provide increased opportunities for teachers to share their challenges, as well as what has been working well for them, which is an opportunity that multiple teachers mentioned during interviews would be helpful. These meetings would also provide a prime opportunity for addressing logistical concerns with all treatment school teachers at one time and enhancing general communication between LCA and teachers.
  - Option 2: If LCA decides to further expand the eReader program to additional treatment schools in coming years, investment in additional human capital will undoubtedly be necessary to create teacher training that is research-based, sustained long-term, and available to all treatment teachers on a regular basis. Time and expertise will need to be devoted to creating the curriculum, as well as coordinating and delivering the trainings. Therefore, LCA should consider partnering with an organization that specializes in teacher training and empowerment. One such organization, the Stanford Social Innovation Review (STIR), is a promising option for partnership, due to their community-driven approach and focus on enhancing teacher motivation. STIR describes their method as a "micro-innovation search"—where teachers share their classroom innovations with each other—generating huge, positive buzz among teachers and helping to restore their intrinsic motivation. (Stanford Social Innovation Review, Jeevan & Townsend).
- No matter which option is used for training, Lwala or their partner organization should empower teachers in North Kamagambo to themselves role-model effective behaviors and invite other teachers to join them (SSIR).
  - Through our observations, we identified 1-2 teachers at each treatment school who have very high average ratings based on the indicators in the observation tool, and who's teaching strategies we believe other teachers would benefit from learning. Many of the strategies discussed in the teacher

training conducted on July 14, 2016, were observed in these teachers classrooms.

Second, there are also actions that the LCA can take to increase consistent access to the technology resources in classrooms and to reduce interruptions to classroom learning associated with eReader use.

- To improve the ratio of students to eReaders, the LCA should seek resources for subsidizing the cost of solar panels as an option for schools to address electricity problems that limit e-reader charging.
  - One estimate for this cost is \$500; see <http://www.worldreader.org/wp-content/uploads/2013/06/Solar-1-Page-2016.pdf>
- Alternatively, the LCA could place additional pressure on treatment schools to improve their infrastructure for supporting technology use:
  - Condition continued access to the eReaders on installation of or improvements in power connectivity at Kadianga and Sumba and the purchase of power strips at Komito
  - Another option would be to reward Komito for having zero breakages by giving them power strips.
- The LCA should also consider conducting more rigorous screenings when choosing new schools for expansion of the eReader program:
  - Explicitly outline the type of connectivity schools must have and how often e-readers must be charged in new MOU with schools.
  - Inquire as to the types of support available to schools from parents and the community in meeting basic functional needs for e-reader use.
  - Investigate whether the school has a head teacher who is supportive of the program and dedicated to ensuring its success. That is, are they: willing to push teachers to improve, willing to do what is necessary to have power connectivity, and willing to let teachers come to trainings throughout the year?
  - In addition, is there a committed teacher at the school who can be the patron and lead the program?

Another critical element to success of technology integration (shown in the literature and in this research) involves working to improve student engagement and interaction with the technology (eReaders). We accordingly recommend these actions for the LCA in its ongoing eReader implementation efforts:

- Explore the potential for introducing new books and/or additional applications to eReaders that provide more opportunities for learning and assessment and accountability for student learning.
  - Assessment and accountability are elements of several of the internationally identified conditions for effectively leveraging digital tools, and they are also regularly-voiced claims for increased use of digital tools, given their advantages in capturing, processing and sharing information on student use of and learning from digital tools.

- Introducing additional applications (or instructional interventions) that provide feedback to students could increase constructive interactions between students and the eReaders and student engagement.
- Given the logistical difficulties of providing internet access for all eReaders, investigate the potential for providing internet access for teachers along with projectors that would allow teachers to share their screens with all students and expand the number and types of applications that could be used in the classroom.
  - Explore forming partnerships with other schools and foundations that are implementing eReader programs to increase support for their effective use and program expansion by the LCA.
- Explore the potential for conducting review sessions for students to assist them in learning how to manipulate the eReaders:
  - In interviews, many teachers at treatment schools discussed the challenge of supporting students who struggle with using the eReaders efficiently, and that the time it takes to check in with every student prevents them from accomplishing all of their intended lesson objectives in a class period. The challenges they described illustrate that many students are still struggling to manipulate the devices quickly and that review sessions for struggling students could be useful. Students also seem to think there is a need for more support on how to manipulate the devices.
  - There seems to be inconsistency in the degree to which students can successfully manipulate the eReaders, and students appear to desire increased learning opportunities for improving their ability to use the e-reader effectively. In focus groups, when asked what recommendations they have for how eReaders are used for learning in the future, one student mentioned that he wished schools were better at “fostering the culture of cross sharing what one has learnt in the eReader,” which speaks to the fact that some students feel that certain students are gaining more from the eReaders than others. We recommend inviting the students who struggle the most with device manipulation to attend after school tutoring and practice on how to quickly identify locations in the eReader, as they would have to do in class.

Finally, we recommend that the LCA continue its research and evaluation efforts in the next phase of the LCA eReader program that includes plans for a new “library” model for distribution of the eReaders. It is anticipated that with the library model, students and teachers will be able to check out the eReaders and take them home for use outside of the school day (in addition to their use in the classroom by Class 6 students during the day). Baseline data have already been collected for Class 6 students in the two of the library model schools and two comparison schools.

- We recommend that the LCA develop one or more strategies for tracking the eReaders as they are checked out and used by both by students and teachers, and to the extent possible, gathering information on how they are used (e.g., the types of books accessed and length of time of used).

- The LCA should also monitor schools with classroom and library e-reader models to ensure devices are used as intended.
  - The evaluators should pay particular attention as to whether or not the eReaders are being used for purposes outside the scope of the project. For example, one student at Sumba mentioned that he wished there were more devices available to be used by other grades, so that they didn't have to share the e-readers with the 7th and 8th graders. When asked if he would change how the e-readers were used for learning, this student explained, "I wish it could be used by all the pupils from class 6-8; this is because there are times of interruption when e-reader is taken to class 8 for revision." Such administrative decisions, while well-intentioned, could limit e-reader usage by the pupils under study, as well as affect the amount of time students have access to the devices, and ultimately, the degree to which the devices are able to influence student achievement.

**Table 1: Summary of Observation and Interview Data Collected by School**

<b>Data collection</b>	<b>Total</b>
<b>Treatment School Observations</b>	
Kadianga:	13
Komito:	13
Sumba:	10
Total:	36
<b>Comparison School Observations</b>	
Minyenya:	5
Tonye:	4
Ofwanga:	4
Total:	13
<b>Total Lesson Observations</b>	<b>49</b>
<b>Treatment School Interviews</b>	
Kadianga:	4
Komito:	3
Sumba:	1
Total:	8
<b>Comparison School Interviews</b>	
Minyenya:	1
Tonye:	1
Ofwanga:	3
Total:	5
<b>Total Interviews:</b>	<b>13</b>

Table 2: Baseline Measures for eReader Treatment and Comparison Groups	Treatment group			Comparison group			Mean difference (T-C)	p-value
	N Obs	Mean	Std. Dev.	N Obs	Mean	Std. Dev.		
<b>Baseline academic performance</b>								
% correct words: Kiswahili	95	0.88	0.22	128	0.89	0.19	-0.009	0.736
% correct words: English	95	0.51	0.25	128	0.51	0.21	0.006	0.841
Kiswahili correct words per minute	95	44.67	23.10	128	63.23	31.68	<b>-18.565</b>	0.000
English correct words per minute	84	68.74	22.19	119	95.98	33.92	<b>-27.246</b>	0.000
Kiswahili comprehension	95	2.40	1.88	128	3.18	2.04	<b>-0.780</b>	0.004
English comprehension	95	3.42	2.09	128	3.64	2.05	-0.220	0.434
Kiswahili comprehension (incorrect)	95	3.79	2.16	128	3.38	2.06	0.407	0.155
English comprehension (incorrect)	95	2.77	1.95	128	2.87	1.96	-0.099	0.710
<b>Student characteristics (pre-treatment)</b>								
Parents are primary caregiver	94	0.71	0.45	127	0.64	0.48	0.08	0.243
Male	94	0.50	0.50	127	0.54	0.50	-0.04	0.526
Age	93	12.88	0.15	127	12.39	0.10	<b>0.49</b>	0.005
Access to less than 5 books at school	94	0.12	0.32	127	0.16	0.37	-0.04	0.349
Access to 5-10 books at school	94	0.46	0.50	127	0.69	0.46	<b>-0.23</b>	0.000
Access to more than 10 books at school	94	0.43	0.50	127	0.15	0.36	<b>0.28</b>	0.000
Less than 5 books at home	93	0.37	0.48	128	0.69	0.47	<b>-0.32</b>	0.000
Child: I read only when I have to	95	0.51	0.50	128	0.29	0.46	<b>0.22</b>	0.000
Caregiver rarely/never reads to child	95	0.25	0.44	128	0.18	0.39	0.07	0.188
Caregiver rarely/never checks schoolwork	95	0.21	0.41	128	0.20	0.40	0.01	0.893

Table 3: Estimated changes in student academic performance associated with eReader use	Predicting gain scores [1]					
	Pre-test control only			All controls		
	N	Coefficient	Robust std. error	N	Coefficient	Robust std. error
<b>Dependent variable:</b>						
Δ in Kiswahili correct words per minute	222	<b>16.539</b>	8.502	218	<b>19.027</b>	6.256
Δ in English correct words per minute	198	<b>23.206</b>	7.913	197	<b>25.275</b>	6.236
Δ in Kiswahili comprehension	222	0.918	0.542	218	0.726	0.435
Δ in English comprehension	222	0.883	0.504	218	0.401	0.420
Δ in Kiswahili comprehension (incorrect)	222	-0.807	0.594	218	-0.656	0.504
Δ in English comprehension (incorrect)	222	-0.725	0.494	218	-0.507	0.510
	Predicting endline academic performance [2]					
	N	Coefficient	Robust std. error	N	Coefficient	Robust std. error
Kiswahili correct words per minute	222	1.923	2.265	218	2.636	2.946
English correct words per minute	198	7.640	4.026	195	6.309	6.481
Kiswahili comprehension	222	0.260	0.202	218	0.069	0.228
English comprehension	222	<b>0.763</b>	0.187	218	<b>1.054</b>	0.322
Kiswahili comprehension (incorrect)	222	-0.423	0.340	218	0.074	0.208
English comprehension (incorrect)	222	<b>-0.834</b>	0.213	218	<b>-0.878</b>	0.328

## References

- Barrios, T., Ambler, J., Anderson, A., Barton, P., Burnette, S., Feyten, C.,... Yahn, C. (2004). Laptops for learning: Final report and recommendations of the laptops for learning task force. Laptops for Learning Task Force.
- Bebell, D., & Kay, R. (2010). One to one computing: A summary of the quantitative results from the Berkshire Wireless Learning Initiative. *The Journal of Technology, Learning, and Assessment*, 9(2).
- Bebell, D., & O'Dwyer, L.M. (2010). Educational outcomes and research from 1:1 computing settings. *Journal of Technology, Learning, and Assessment*, 9(1).
- Becker, M. R. (2000). Faculty development research: A comparison of two faculty development programs for reducing computer anxiety of in-service teachers (Dissertation).
- Budhedeo, S. H. (2016). Issues And Challenges in Bringing ICT Enabled Education To Rural India. *International Journal of Scientific Research and Education*. 4(1). 4759-4766. DOI: <http://dx.doi.org/10.18535/ijsre/v4i01.01>.
- Cavanaugh, C., Dawson, K., White, S., Valdes, N., Ritzhaupt, A., & Payne, D. (2007). Leveraging laptops: Effective models for enhancing student achievement. Project research report 2006.
- Cook, Thomas D. and Steiner, Peter M. (2010). Case matching and the reduction of selection bias in quasi-experiments: The relative importance of pretest measures of outcome, of unreliable measurement, and of mode of data analysis. *Psychological Methods*, Vol 15(1): 56-68.
- Cristia, J. P., Ibararan, P., Cueto, S., Santiago, A., & Severin, E. (2012). Technology and child development: Evidence from the one laptop per child program (IDB Working Paper Series No. IDB-WP-304). Inter-American Development Bank.
- Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research*, 38(4), 813-834.
- Dangwal, R., Sharma, K., & Hazarika, S. (2014). Hole-in-the-wall learning stations and academic performance among rural children in India. *Journal of Multicultural Education*, 8(1), 31-53.
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423-435.
- Glenn, A. D. (1997). Technology and the continuing education of classroom teachers. *Peabody Journal of Education*, 72(1), 122-128.

Holland, P. E. (2001). Professional development in technology: Catalyst for school reform. *Journal of Technology and Teacher Education*, 9(2), 245–268.

Jeevan, Sharath & Townsend, James. 2015. Forging a New Deal in Education. *Stanford Social Innovation Review*, August 10.

Khan, S. H., Hasan, M., & Clement, C. K. (2012). Barriers to the Introduction of ICT into Education in Developing Countries: The Example of Bangladesh. *International Journal of Instruction*. 5(2). 1308-1470.

Mcewan, P. J. (2014). Improving Learning in Primary Schools of Developing Countries: A Meta-Analysis of Randomized Experiments. *Review of Educational Research*, 85(3), 353-394. doi:10.3102/0034654314553127.

Mndzebele, N. (2013). Teachers Readiness in Using ICT in the Classroom: The Case of a Developing Country. *International Journal of Information and Education Technology*, 409-412. doi:10.7763/ijiet.2013.v3.309.

Mndzebele, N. (2013). Challenges Faced by Schools when Introducing ICT in Developing Countries. *International Journal of Humanities and Social Science Invention*. 2(9). 1-4.

Mumtaz, S. (2000). Factors Affecting Teachers' Use of Information and Communications Technology: A review of the Literature. *Journal of Information Technology for Teacher Education*, 9(3), 319-342.

Niederhauser, D. S., Salem, D. J., & Fields, M. (1999). Exploring teaching, learning, and instructional reform in an introductory technology course. *Journal of Technology and Teacher Education*, 7(2), 153–172.

Pelgrum, W. J. 2001. "Obstacles to the Integration of ICT in Education: Results from a Worldwide Educational Assessment." *Computers and Education* 37:163–78.

Richardson, J. W. (2011). Challenges of adopting the use of technology in less developed countries: The case of Cambodia. *Comparative Education Review*, 55(1), 8-29.

Rodrigo, M. M. T. 2005. "Quantifying the Divide: A Comparison of ICT Usage of Schools in Metro Manila and IEA-Surveyed Countries." *International Journal of Educational Development* 25 (1): 53–68.

Sanyal, B. C. (2001). New functions of higher education and ICT to achieve education for all, Paper prepared for the Expert Roundtable on University and Technology-for-Literacy/Basic Education Partnership in Developing Countries to be held in Paris from 10 to 12 September 2001.

Shapley, K. S., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2010). Evaluating the implementation fidelity of technology immersion and its relationship with student achievement. *Journal of Technology, Learning, and Assessments*, 9(4).

Stanhope, D. S., & Corn, J. O. (2014). Acquiring teacher commitment to 1:1 initiatives: The role of the technology facilitator. *Journal of Research on Technology in Education*, 46(3), 252-276.

Tessema, A. (2012). Teacher Educators' Professional Development towards Educational Research in Student-Centered Instruction Supported by Dynamic Mathematics Software. University of Amsterdam. Retrieved from <http://dare.uva.nl/cgi/arno/show.cgi?fid=454610>.

Tiene, D. (2004). Bridging the Digital Divide in the Schools of Developing Countries. *International Journal of Instructional Media*; 31 (1), 89.

Twining, P., Raffaghelli, J., Albion, P. and Knezek, D. (2013). Moving education into the digital age: the contribution of teachers' professional development. *Journal of Computer Assisted Learning*, 29(5) pp. 426–437.

Watwood, B., Nugent, J., & Deihl, W. (2009). Building from content to community: [Re]thinking the transition to online teaching and learning: A CTE white paper. Richmond, VA: Virginia Commonwealth University Center for Teaching Excellence.

Wong (2008). Insights into innovative classroom practices with ICT. Retrieved from [http://ifets.info/journals/11\\_1/18.pdf](http://ifets.info/journals/11_1/18.pdf)

Zhao, Y., & Bryant, F. L. (2006). Can teacher technology integration training alone lead to high levels of technology integration? A qualitative look at teachers' technology integration after state mandated technology training. *Electronic Journal for the Integration of Technology in Education*, 5(1), 53-62.

## **Appendix A: Assessment Tool**

### **Lwala Community Alliance eReader Baseline Evaluation Developed by Kelly Peuquet**

#### **Introduction**

Display: “We are conducting a reading evaluation among pupils for the EReader program. This evaluation is made up of 5 parts. Part 1 is a list of Kiswahili words for you to read. Part 2 is a list of English words for you to read. Part 3 is a reading passage in Kiswahili. Part 4 is a reading passage in English. Part 5 is a survey to learn more about you, your reading habits, and your feelings about reading. Your results on this evaluation will be kept confidential, and will not be shared with your teachers or your caregivers. Your results will not affect your marks in school. Would you like to continue with the evaluation?”

#### **Part 1 – Kiswahili Words**

Display: “We would like you to read 10 words in Kiswahili out loud. Try to read and pronounce the words correctly as best you can. We will not ask you what the words mean. Are you ready?”

1. Kipekee
  - a. Correct
  - b. Incorrect
2. Uamuzi
  - a. Correct
  - b. Incorrect
3. Geni
  - a. Correct
  - b. Incorrect
4. Udanganyifu
  - a. Correct
  - b. Incorrect
5. Unahusiana
  - a. Correct
  - b. Incorrect
6. Kuchapishwa
  - a. Correct
  - b. Incorrect
7. Msisimuko
  - a. Correct
  - b. Incorrect
8. Dhuluma
  - a. Correct
  - b. Incorrect

9. Lugha
  - a. Correct
  - b. Incorrect
10. Yashangaza
  - a. Correct
  - b. Incorrect

## **Part 2 - English Words**

Display: "We would like you to read 10 words in English out loud. Try to read and pronounce the words correctly as best you can. We will not ask you what the words mean. Are you ready?"

1. Values
  - a. Correct
  - b. Incorrect
2. Wishful
  - a. Correct
  - b. Incorrect
3. Quack
  - a. Correct
  - b. Incorrect
4. Theme
  - a. Correct
  - b. Incorrect
5. Anarchy
  - a. Correct
  - b. Incorrect
6. Neighborhood
  - a. Correct
  - b. Incorrect
7. Audacious
  - a. Correct
  - b. Incorrect
8. Decipher
  - a. Correct
  - b. Incorrect
9. Numb
  - a. Correct
  - b. Incorrect
10. Psychology
  - a. Correct
  - b. Incorrect

### Part 3 – Kiswahili Passage

Display: “We would like you to read a small passage in Kiswahili out loud. Try to read the words correctly and as quickly as you can. After you finish reading, we will ask you to answer several questions about what you have read. Are you ready?”

#### Uchungu wa mwana...

Teknolojia! Ewe teknolojia! Wewe ni adui yangu tena wa kufa kutozikana! Nakuambia paruwanya kwamba uhasama wetu sasa ni wa kondoo na mbwa.

Miaka michache iliyopita wewe teknolojia ulikuwa hupo. Tuliishi kwa furaha na buraha, raha mustarehe. Mara tu umezuka. Sijui ulitokea sayari gani; Zuhura au Utaridi? Nasikia tu ukitajwa na kuitwa teknolojia wala sijui wewe ni bin au binti wa nani? Ndiposa ukawa huna huruma na sisi binadamu. Unatumaliza tu!

Ulimleta roboti. Huko viwandani maelfu ya watu wakawa hawana kazi wala bazi. Mara ukamleta krini aliyewafuta hamali kama kimbunga cha Tsunami huko bandarini na kwenye majenzi ya nyumba. Watu hawa wamekuwa hawana mbele wala nyuma. Hukutosheka bali ukamzua tarakilishi au kompyuta. Naye akafanya makampuni mengi kufunga virago. Matokeo ni maelfu ya watu kukosa kazi na kuwa hohehahe. Sasa umekuja na simutamba au rukono; yaani simu ya mkononi kusudi kuwaachisha kazi wanaofanya kazi katika idara ya simu za kawaida. Watu hawa wote waende wapi?

Swali hili wewe halikukeri wala kukughasi kwa sababu huna mke wala watoto wa kuwatazama. Ndipo ukawa huna uchungu. Uchungu wa mwana aujua mzazi. Hii ndio sababu ukakubali kufanya kazi usiku na mchana bila mapumziko wala mshahara.

Basi kwa sababu ya tadi na inda zako hizo, ujue kwamba mimi na wewe ni lila na fila hatutaweza kutangamana. Na utakapomzua mwingine, basi tutakuwa kama maji na mafuta.

#### Comprehension Questions

1. Mzungumzaji anazungumza na nani?

**Correct Answer: Teknolojia**

2. Mzungumzaji...
  - a. anamsifu teknolojia.
  - b. anateta na teknolojia.
  - c. anamfurahia teknolojia.
  - d. amependezwa na teknolojia.

**Correct Answer: B**

3. Sentensi ipi si kweli: Mwandishi alitaka kujua teknolojia
  - a. anatoka sayari gani?
  - b. wazazi wake ni nani?
  - c. anakula nini?
  - d. ni wa jinsia gani?

**Correct Answer: C**

4. Roboti imeleta hasara gani?

**Example of 0 point answer:** Ulileta krini.

**Example of 1 point answer:** Watu wamekuwa hawana mbele wala nyuma.

**Example of 2 point answer:** Maelfu ya watu kukosa kazi na kuwa hohehahe.

5. Krini iliwadhuru nani?

**Example of 0 point answer:** Watu bandarini.

**Example of 1 point answer:** Wajenzi.

**Example of 2 point answer:** Hamali.

6. Teknolojia imeleta faida gani?

**Example of 0 point answer:** Halina faida.

**Example of 1 point answer:** Hufanya kazi vizuri.

**Example of 2 point answer:** Hufanya kazi usiku na mchana bila mapumziko wala mshahara.

7. Nini maana ya lila na fila havitangamani?

**Example of 0 point answer:** Rafiki na adui.

**Example of 1 point answer:** Mbingu na nchi.

**Example of 2 point answer:** Mbingu na nchi hazikutani.

#### **Part 4 – English Passage**

Display: “Next, we would like you to read a small passage in English out loud. Try to read the words correctly and as quickly as you can. After you finish reading, we will ask you to answer several questions about what you have read. Are you ready?”

#### **The Tortoise and the Hare**

One day, all animals held an athletics competition. The most interesting event was the 5km race between Hare, a rabbit, and Tortoise, a turtle. Some animals thought Tortoise was crazy to participate in the race. “By the time Hare is through, Tortoise will not have moved even an eighth of a kilometre,” some animals said.

Hare on his part said that the race would be a walkover for him. He ran two kilometres and stopped to have a bite of carrot. He saw no need of running continuously for he would have to wait for Tortoise at the finish line for hours. He climbed up a tree to take a nap.

When he woke up, it took him five minutes to remember that he was supposed to be in a race with Tortoise. He broke into a run not knowing in which direction the finish line was. After about a kilometre, he realized he was racing towards the starting point. He turned back and ran like a terrified animal.

Just a few metres from the finish line, Hare could see a huge crowd of animals cheering wildly. Thinking that the animals were celebrating his victory, Hare increased his

pace. What a disappointment it was for him when he realized that it was Tortoise who had won the race!

### Comprehension Questions

1. What kind of athletics competition was held between Tortoise and Hare?

**Correct Answer: A race**

2. Who was expected to win the race?

**Correct Answer: Hare**

3. Why did some animals think Tortoise was crazy to participate in the race?

**Example of 0 Point Answer:** Because Tortoise is not smart.

**Example of 1 Point Answer:** Because Tortoise is not as good as Hare.

**Example of 2 Point Answer:** Because Tortoise cannot run as fast as/is slower than Hare.

4. Why did Hare stop to take a nap during the race?

- a. He was too tired to continue running.
- b. He did not want to wait a long time for Tortoise at the finish line.
- c. He had finished the race and was bored.
- d. He did not want to win the race.

**Correct Answer: B**

5. What best describes Hare?

- a. He is not a fast runner.
- b. He does not like to win.
- c. He is not confident.
- d. He is too confident.

**Correct Answer: D**

6. Why did Tortoise win the race?

**Example of 0 Point Answer:** Because he is a faster runner than Hare.

**Example of 1 Point Answer:** Because the Hare got lost.

**Example of 2 Point Answer:** Because he did not stop to eat or nap./Because he was slow and steady.

7. How could this story apply to your life?

**Example of 0 Point Answer:** Tortoises are faster than Hares.

**Example of 1 Point Answer:** Sometimes the faster runner does not win the race.

**Example of 2 Point Answer:** Slow and steady wins the race./When something looks impossible, if you give your best effort, you can succeed.

## Appendix B: Student Survey

Display: "We are now going to ask you some questions about you, your reading habits, and your feelings about reading. Again, your answers are confidential and will not be shared with your teachers or your caregivers. Are you ready?"

1. Are you a girl or a boy?
  - a. Girl
  - b. Boy
2. How old are you?
3. Who is your primary caregiver(s)?
  - a. Mother and father
  - b. Mother only
  - c. Father only
  - d. Grandparent(s)
  - e. Aunt/Uncle
  - f. Sister/Brother
  - g. Other (with entry)
4. What language do you speak most at home?
  - a. Dholuo
  - b. Kiswahili
  - c. English
  - d. Ekegusii
  - e. Other (with entry)
5. What other language(s) do you speak at home? **[select all that apply]**
  - a. I only speak one language at home
  - b. Dholuo
  - c. Kiswahili
  - d. English
  - e. Ekegusii
  - f. Other
6. Can your father/male caregiver read?
  - a. Yes
  - b. No
  - c. Not known
7. What is the highest level of education completed by your father/male caregiver?
  - a. None (he did not go to school)
  - b. Some primary school (Class 7 or below)
  - c. Class 8
  - d. Some secondary school (Form 1, 2, or 3)
  - e. Form 4
  - f. Some college/university
  - g. College diploma
  - h. University degree
  - i. Master's degree
  - j. PhD

- k. Not known
8. Can your mother/female caregiver read?
- a. Yes
  - b. No
  - c. Not known
9. What is the highest level of education completed by your mother/female caregiver?
- a. None (he did not go to school)
  - b. Some primary school (Class 7 or below)
  - c. Class 8
  - d. Some secondary school (Form 1, 2, or 3)
  - e. Form 4
  - f. Some college/university
  - g. College diploma
  - h. University degree
  - i. Master's degree
  - j. PhD
  - k. Not known
10. How often does your teacher have you read books as a class at school?
- a. Every school day
  - b. A couple days a week
  - c. One day a week
  - d. Less than 4 days a month
  - e. Never
11. How often does your teacher have you read books on your own at school?
- a. Every school day
  - b. A couple days a week
  - c. One day a week
  - d. Less than 4 days a month
  - e. Never
12. How many books do you have access to at school?
- a. I do not have access to books at school
  - b. Less than 5
  - c. 5-10
  - d. 11-20
  - e. 21-50
  - f. 51-100
  - g. More than 100
13. Do you read outside of school?
- a. Yes > Q14
  - b. No > Q15
14. On average, how often do you read outside of school?
- a. Every day
  - b. A couple days a week
  - c. One day a week
  - d. Less than 4 days a month

15. About how many books are there at your home (not including newspapers, magazines, or your current schoolbooks)?
- None
  - Only the Bible
  - Less than 5
  - 5-10
  - 11-20
  - 21-50
  - 51-100
  - More than 100
  - Not known
16. Do you have any of the following at home? **[select all that apply]**
- Study desk/table for your use
  - Dictionary
  - Encyclopedia (book or CD)
  - Newspapers
  - Magazines
  - Internet connection
  - Computer
  - I do not have any of these
17. I would like to have more time for reading at school.
- Strongly Disagree
  - Somewhat Disagree
  - Neutral
  - Somewhat Agree
  - Strongly Agree
18. I would like to have more books to read at school.
- Strongly Disagree
  - Somewhat Disagree
  - Neutral
  - Somewhat Agree
  - Strongly Agree
19. I would like to have more time for reading at home.
- Strongly Disagree
  - Somewhat Disagree
  - Neutral
  - Somewhat Agree
  - Strongly Agree
20. I would like to have more books to read at home.
- Strongly Disagree
  - Somewhat Disagree
  - Neutral
  - Somewhat Agree
  - Strongly Agree
21. Reading is easy for me.
- Strongly Disagree

- b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
22. Reading is harder for me than for many of my classmates.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
23. Reading is harder for me than any other subject.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
24. I read only if I have to.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
25. I enjoy reading.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
26. It is important to be a good reader.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
27. I learn from reading.
- a. Strongly Disagree
  - b. Somewhat Disagree
  - c. Neutral
  - d. Somewhat Agree
  - e. Strongly Agree
28. My teacher encourages me to read.
- a. Never
  - b. Rarely
  - c. Sometimes
  - d. Often
  - e. Always

29. I read with my caregiver.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always
30. My caregiver encourages me to read.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always
31. My caregiver asks me what I am learning in school.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always
32. I talk about my schoolwork with my caregiver.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always
33. My caregiver makes sure I set aside time for my schoolwork.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always
34. My caregiver checks if I do my schoolwork.
- Never
  - Rarely
  - Sometimes
  - Often
  - Always

ADDED TO THE ENDLINE:

35. How far would you LIKE to go in school?
- Less than Primary School
  - Complete Primary School
  - Complete Secondary School
  - Complete Polytechnic or College Courses
  - Complete University
  - Complete Professional Degree
36. Realistically speaking, how far do you THINK you will get in school?

- a. Less than Primary School
- b. Complete Primary School
- c. Complete Secondary School
- d. Complete Polytechnic or College Courses
- e. Complete University
- f. Complete Professional Degree

**Thank You**

Display: "Thank you very much for your participation!"

## Appendix C: Dimensions of Digital and Blended Instruction Rated in Observations

The following dimensions of digital and blended instruction and the settings in which they are used are rated by the observation instrument we employ in this study.

- **Physical environment:** How and where students access the instructional setting, including the technological setting and any associated limitations, and who else in the same physical environment as the student could assist with technological problems and support learning;
- **Technology and digital tools:** How students access instruction, including internet connectivity, hardware and software in use, and the safety, operability and accessibility of the technology;
- **Curricular content and structure:** Content and skill focus, who developed it and where it is located (e.g., software loaded onto a tablet, paper workbook), stated learning objectives, sequence and structure, level of rigor or intellectual challenge, and ability to meet and adapt curricular content to student needs;
- **Instructional model and tasks:** Role of instructor and software in instruction (what drives instruction); purpose or target of instruction; student/instructor ratio and grouping patterns, multimodal instruction; order of thinking required and application of technology in instructional tasks, and ability to meet/adapt instructional model and tasks to student needs;
- **Interaction:** How much interaction with a live person, and does the technology affect the ability of the instructor or student to positively interact with one another and the instructional resources?
- **Digital citizenship:** Are students using the technology as intended by the instructor and/or instructional program?
- **Student engagement:** Overall student engagement levels, level of student self-regulation and persistence, and level of community within the instructional setting;
- **Instructor engagement:** Overall instructor engagement levels (passive or active) and instructor efforts to encourage engagement;
- **Assessment/feedback:** Who develops and manages the assessment (instructor, provider via software), structure, and whether it is individualized to student learning and relevant to stated learning goals.

## Appendix D: Teacher Interview Protocols

### *Instructional Staff Interview Protocol*

#### Introduction:

- Description of goals of study
- Discussion of confidentiality of individuals and completion of consent form
- Purpose of interview/discussion: looking for broad patterns and insights about the use of digital education tools in public schools in North Kamagambo, Kenya.

Interviewer initials: \_\_\_\_\_

1. Date:	
2. School:	
3. Teacher last name:	
4. Grade:	
5. Subject:	
6. Time:	

#### A. Instructor background

a. Teaching experience and current instructional role/position:		Notes
7. How many years have you been teaching or working in education?		
8. Are you pursuing additional education?	<b>Yes/No</b>	
9. What is your specific role or title at your school?		
10. How long have you been in this position?		
11. Are you an eReader patron?	<b>Yes/No</b>	
12. Do you have training particularly relevant to digital education, such as computer technology, media studies, software development, coding, etc.?	<b>Yes/No</b>	
13. In addition to teaching, are you involved in (or responsible for) other educational and/or extracurricular programs or activities in the school district? How much time do you spend	<b>Yes/No</b>	

in an average week (outside of your classes) with students?		
---	--	--

**B. Instructional core:**

<b>a. Instructional Practice:</b>	<b>Notes</b>
14. In a typical day with these students, what is the goal of the instructional session?	
15. How do you come up with your daily lesson plans?	
16. What is the length of a typical instructional period?	
17. How many times does this group of students meet for classroom instruction?	
<b>With respect to the eReaders:</b>	
18. What are your goals for using these eReaders?	
19. <i>When</i> do you incorporate eReaders into your lessons (during which parts of your lessons do you use them)?	
20. <i>What</i> are your <i>strategies</i> for using these eReaders to enhance student learning?	
21. On average, how much time (minutes) do you spend using the eReader in each lesson?	
22. On average, how many days per week do you use the eReader in class? a) 1 day b) 2 days c) 3 days d) 4-5 days	
23. Please rate on a scale how much you agree with the statement below: Overall, I believe the eReaders have helped me achieve my objectives as a teacher in my lessons.	
<b>b. Source and use of digital tools</b>	
24. How often do you have technology difficulties with the eReaders that prevent students from using them?	

<ul style="list-style-type: none"> <li>a. Never</li> <li>b. Rarely</li> <li>c. Sometimes</li> <li>d. Very often</li> </ul>	
<b>c. Support for use of digital tools:</b>	
25. Describe any training or other professional development specific to these eReaders. What aspects of the training were most useful to you in preparing for the use of the eReaders?	
26. Thinking back to the start of this school year, which of these terms best describes your past experience with using technology in instruction? <ul style="list-style-type: none"> <li>a) no experience,</li> <li>b) minimal experience,</li> <li>c) some experience,</li> <li>d) extensive experience</li> <li>e) expert at using digital educational tools (technology in the classroom)</li> </ul>	
27. How would you describe your level of experience with technology in instruction now? <ul style="list-style-type: none"> <li>a) No experience</li> <li>b) Minimal experience</li> <li>c) Some experience</li> <li>d) Extensive experience</li> <li>e) Expert at using digital educational tools (technology in the classroom)</li> </ul>	
28. What additional support for eReaders would you want or need?	
<b>d. Digital tool access and use by student subgroups:</b>	
29. How are you adapting the curriculum, instructional plans, or use of the eReaders in order to assist students with special needs (English language learners and/or students with disabilities)?	
30. What additional resources are needed when using digital tools with students with special needs?	<b>ELL:</b>  <b>Students with special needs:</b>

31. In what other ways do you group your students or organize your classroom when using eReaders?	

**C. Assessment and future use**

<b>a. Assessing the effectiveness of digital tools in the classroom:</b>	<b>Notes</b>
32. In what ways has the eReader been a valuable tool in the classroom?	
33. Do the eReaders offer learning opportunities that face-to-face instruction does not? What are some examples of such opportunities?	
34. In your opinion, how do the eReaders impact student learning? How does it impact their school engagement?	
35. Are the eReaders more or less effective for certain types of students?	
36. What are the greatest challenges you face in using eReaders to increase student learning?	
37. How have you attempted to address these challenges, and have you had any success with your approach?	
<b>D. Plans for ongoing use of digital tools:</b>	
38. Do you plan to continue using eReaders in your classroom after the program? Why or why not?	

39. How much input do you have into the extent to which eReaders are used in your school?	
40. What changes would you like to see in the eReader program?	
41. Any additional comments/feedback?	

## Appendix E: Focus Group Discussion Template

### READING MATERIALS:

1. How often do you have access to textbooks in school?
2. How often do you use textbooks in school?
3. How often do you have access to textbooks out of school?
4. How often do you use textbooks out of school?
5. What challenges do you face in the classroom?
6. Do you think these challenges affected your learning? Please explain.
7. In the future, how would you want your learning methods to change?

### PERCEPTIONS:

8. What did you like about your current classroom learning?
9. What did you dislike about your current classroom learning?
10. Do you agree or disagree with the statement, "Textbooks have improved my learning during lessons." Please explain.
11. Do you like learning from textbooks? Please explain.

### PERSONAL GROWTH:

12. Think back to the start of the school year. How often did you read?
13. How often do you read now?
14. Think back to the start of the school year. How confident were you in your reading abilities?
15. How confident are you in your reading abilities now?

## Treatment School Focus Group Discussion Template

### eREADER USE:

1. How many times per week did you use the eReader in school?
2. How many times per week did you use the eReader at home for school assignments?
3. How many times per week did you use the eReader at home on your own?
4. Do you think it was easy or hard to use? Please explain.
5. What challenges did you experience?
6. Do you think these challenges affected your learning? Please explain.
7. In the future, would you change how the eReaders are used for learning? Please explain.

### PERCEPTIONS:

8. What did you like about the eReaders?
9. What did you dislike about the eReaders?
10. Do you agree or disagree with the statement, "The eReaders have improved my learning during lessons." Please explain.
11. Do you prefer learning from textbooks or the eReader? Please explain.
12. Would you like to continue to use the eReaders? Why or why not?

**PERSONAL GROWTH:**

13. Think back to the start of the school year. How confident were you in using the eReader?
14. How confident are you in using the eReader now?
15. Think back to the start of the school year. How often did you read?
16. How often do you read now?
17. Think back to the start of the school year. How confident were you in your reading abilities?
18. How confident are you in your reading abilities now?
19. How do you feel when you are using the eReader at school?
20. How do you feel when you are using the eReader at home?
21. Has the eReader had any other effect on your life? (motivation, inspiration, etc.)

## Appendix F: Narrative Vignettes from Classroom Observations of eReader Use

### Narrative Vignette – Exemplar

During observations, there were multiple lessons that stood out to researchers as very positive examples of how eReaders could be used to improve student learning. One such case was in the classroom of a Kiswahili teacher and eReader patron at Komito Primary School. The following observations and analysis come from his lesson on punctuation. Observers flagged this lesson as a model for creative adaption of the device to deliver rigorous curricular content, positive interaction between teacher, student, and digital tool, an effective instructional model and effective learning tasks, and for its inclusion of student assessment.

While power outage was still an issue at this school, it was evident from the start of the lesson that the teacher was dedicated to making sure this limitation did not affect student learning, if at all possible. When the battery power in 3 students' eReaders ran out at the beginning of class, the teacher took 3 minutes to leave and get 3 more charged eReaders, ensuring that every student had access to the instructional setting throughout the lesson. It was clear the teacher and school staff had determined a system for charging e-readers in rotations, using the limited power outlets they had as efficiently as possible.

Curricular content: One reason this teacher seemed to be successful in using the eReaders is that he was able to adapt them effectively deliver the content he needed to teach, despite limitations. While some teachers quickly ditched the eReaders altogether if they did not have all of the course books they preferred, this teacher was able to switch back and forth from using the eReaders to using paper Kiswahili dictionaries, which are not loaded on the eReaders. The observer recorded, *"During blended learning, T (teacher) calls on students to read practice sentences out loud to the class. After each sentence, T goes over pronunciation and has whole class repeat. At 10:59, T instructs students to get KIS dictionaries (one student gets them from the back of the room) and T calls on a student to read definition (there are 13 KIS dictionaries and students share them to look up the word)."*

Interaction: The observer also elaborated on the teacher's high interaction rating (rating of 4) noting, *"T calls on many different students to read out loud and also asks students to read as a whole class together (as many as 14 individual students called on to read). T easily transitions to looking up words in KIS dictionary and then comes back to eReader. T is very lively and engaging. There are very quick transitions between students reading from the eReader and T explaining. T encourages and praises student answers ("mzuri cabeza" which means very good job)"*

Instructional Model and Tasks: This teacher made a concerted effort to meet the learning needs of all students, including with regards to manipulation of the eReader. With respect to the teacher's instructional model and tasks (rating of 4), the observer recorded, *"T says title of book three times (as well as "tab 2, ch. 4" and location in e-reader: 2551). This resulted in all students being on the correct page for the majority of the lesson. T has whole class pronounce difficult*

*KIS words. T writes vocab. words on board. T makes sure all students have an eReader. T calls on students to help 1 student who is struggling with pronunciation and then gives her another try. T walks around during IP to make sure students are on task/on correct page.”* By using these specific instructional strategies, the teacher was able to engage students of all levels in the lesson.

Assessment: Finally, at the end of the lesson, this teacher also provided feedback on student work, which was done in few other classrooms. The observer noted, *“T asks students if he can borrow a red pen. T walks around at 11:25 to check student work and gives individualized feedback (students have to put punctuation marks on sentences that are missing quotation marks, question marks, exclamation marks). Students raise hands when they are finished. T gives check marks if problems are correct.”* Since research shows that some of the most effective technology devices in classrooms are those that adapt to student academic needs and provide feedback, it is very important that teachers are conducting an assessment of student work when devices do not include this function, such as the eReaders in the Lwala pilot project. By saving time at the end of the lesson to walk around the classroom and check student work, the teacher was able to supplement the eReader content to ensure students were learning from mistakes and/or correcting their misunderstandings.

At the end of the lesson, the observer summarized what she saw, noting, *“This lesson has a lot of interaction between teacher, student, and eReader. The teacher takes students through examples of punctuation (?/!/””) in Kiswahili and calls on many students to read out loud, giving them pronunciation and reading practice. The teacher goes back and forth very quickly between students reading from eReaders and the teacher explaining in more detail. The teacher also engages the entire class by having them read some parts of sentences in unison. Additionally, the teacher has students practice looking up words in the Kiswahili dictionary and then transitions back to the eReader for punctuation practice. The teacher involved individual students in practice problems together as a class before releasing them to individual practice. The teacher reviews at the end of lesson by writing sentences on the board and having students come to the board to add punctuation marks (3 students come to board; 2 complete problems and 1 corrects the second student). The teacher has students clap for each other.”*

The observers identified this lesson and teacher as an exemplar case, from which teaching methods and strategies for eReader use should be disseminated to other teachers if possible.

## Narrative Vignette – eReader Implementation Challenges

During observations, there were also lessons that brought to light some of the challenges faced by students and teachers when using eReaders, as well as mediating factors that may have inhibited the effectiveness of eReaders on student outcomes. We highlight one such example from a social studies classroom, drawn from an observation of an instructional session on the “Partition of Eastern Africa”. During this lesson, some challenges that were evident to observers included student difficulties with device manipulation due to unclear directions given by the teacher on how to access the relevant text; an instructional model and learning tasks that prevented students from successfully interacting with the eReader and lesson content, and negative interactions between the teacher and students that contributed to an anxiety-laden classroom culture and low levels of student engagement.

Device manipulation and teacher instructions: One of the clearest challenges present in this classroom was student difficulty with device manipulation. Throughout the lesson, many students seemed to be lost, and students spent a great deal of time searching in the eReader for the locations the teacher was referencing. While this challenge could, in part, be due to the need for further student practice with use of the device, the teacher contributed to this challenge by neglecting to provide clear directions to students on how to access the text he was referencing, as well as giving students very little time to access the text. The observer notes, *“All students have eReaders, but the T is very unclear about where students are supposed to look in eReaders, and no time is given to students to access information. T tells students where to begin in the eReader by saying “partition” but there are two places in the eReader that use this word (“partition of E. Africa” and “Scramble for partition of E. Africa”) and students don’t know which one to look at. There are some students on each of these two locations. At one point, he asks students what date is on the page that they are supposed to be on, but because he asks for a choral response, he does not have a clear understanding of how many students are lost.”*

Curricular content: In this lesson, the teacher struggled to use the eReaders to deliver the lesson’s content in a meaningful way to students. While the teacher knew the material he was teaching, the teacher spent the majority of the lesson relaying historical information to students in his paraphrased form, and he had very little expectations for students to engage with the content. The observer noted, *“Most of lesson consists of T reading his own paraphrased notes about the topic in the eReader while students struggle to follow in the eReader. At times, T asks critical thinking questions, but then answers them without giving students opportunity to think critically about what the answer might be (ex: “What was the motive of the British to come to Africa?”). T does not give students any time to read from eReader, but expects students to be able to figure out where he is in the eReader paragraph based on his paraphrased notes. Students do not have any time for independent practice.”*

Instructional model and tasks: The teacher’s instructional tasks (rating of 0) and expectations during the lesson made it difficult for all students to participate, especially those with higher learning needs. The observer recorded, *“Drilling/practice consists of T asking students questions about what he just explained by looking at the eReader paragraphs.”*

*However, students are not given any time to read. At one point, T asks students why Britain wanted Somalia, but students don't know where to look. T then reprimands students for not knowing how to read. T tells students to read definition of partition, but does not tell them where to go in the eReader or give them any time to get there. T writes some notes on the board, but students do not write anything in their exercise books."*

Interaction: This lesson demonstrated how some teachers use fear as a motivator in their classrooms. The observer noted, *"When one student tries to answer a question, T says, "Have you answered the question I have asked? You don't know how to read!" Later, the teacher stated, "I will motivate you if you are not careful," referring to the threat of being caned."* The observer also noticed that the teacher did not know students' names, but instead called them "that boy" or "that girl", which could affect the classroom culture by depersonalizing teacher and student interactions. Another example of the teacher's harsh comments noticed later in the lesson was when he told students, "If you are talking about Germany, there is something wrong with you." These types of teacher-student interactions most likely lead to the low levels of student engagement observed in this classroom. When the teacher asked for choral responses throughout the lesson, very few responded and did so quietly.

At the end of the lesson, the observer summarized what she saw, noting, *"In this lesson, the T gives a review of the previous lesson (some students are using eReaders) and then goes through new information. The information is in the eReader, but T is not explicit about where students should look and he does not say exactly what is in the eReader. He paraphrases, so students are very lost and they do not get any practice reading. Students spend most of the class trying to find what the teacher is talking about in the eReader paragraphs. T does not let students answer any critical thinking questions. T often repeats himself and criticizes students for not being able to read when they are actually just lost."*

The observers identified this lesson observation as one that demonstrates multiple challenges related to both pedagogical practices and eReader manipulation. These challenges are not limited to this lesson and were observed in multiple classrooms, making them important factors for LCA to address as they continue to expand the eReader project in the North Kamagambo region.