E-books 4 Khmer

Implemented by Kampuchean Action for Primary Education in Cambodia

SEPTEMBER 2017

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List of Acronyms

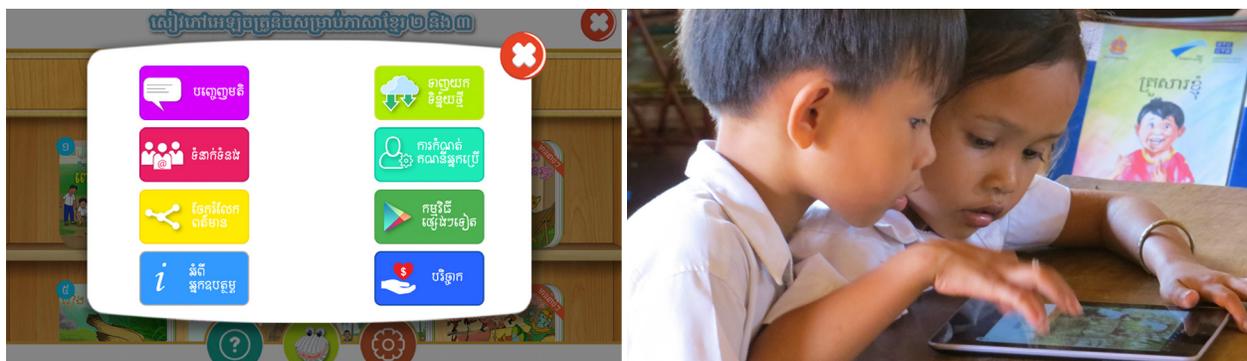|	
ACR GCD	All Children Reading: A Grand Challenge for Development
App	Application
CFWPM	Correct Familiar Words per Minute
CLNPM	Correct Letter Names per Minute
CNWPM	Correct Nonwords per Minute
CWPM	Correct Words per Minute
DI	Differentiated Instruction
E-book	Electronic Book
E4K	E-books 4 Khmer
EGRA	Early Grade Reading Assessment
EOP	End-of-Project
FOI	Fidelity of Implementation
ICT	Information and Communications Technology
INGO	International Nongovernmental Organizations
IRB	Institutional Review Board
KAPE	Kampuchean Action for Primary Education
M&E	Monitoring and Evaluation
MoEYS	Ministry of Education, Youth, and Sport
ORF-sentence	Oral Reading Fluency-Sentences
ORF-story	Oral Reading Fluency-Story
SD	Standard Deviation
STS	School-to-School International
TRAC	Total Reading Approach for Children
USAID	United States Agency for International Development

I. Executive Summary

All Children Reading: A Grand Challenge for Development (ACR GCD)—a partnership between the United States Agency for International Development (USAID), World Vision, and the Australian Government—is an ongoing series of grant and prize competitions that leverage science and technology to source, test, and disseminate scalable solutions to improve literacy skills of early grade learners in developing countries. Round 2 of ACR GCD, which started in 2014 and continues through 2017, supports technology-based innovations to improve early grade reading outcomes in developing countries.[1] These technology-based innovations concentrate on three focus areas:

1. Mother tongue instruction and reading materials

2. Family and community engagement

3. Children with disabilities

ACR GCD Round 2 increased its focus on the assessment of early grade reading skills to understand the ability of technology-based innovations to improve the literacy skills of early grade learners. To measure this, ACR GCD uses the Early Grade Reading Assessment (EGRA) to systematically assess reading skills across all Round 2 grantees. The EGRA is an oral assessment that measures students' most basic foundational literacy skills in the early grades—specifically, recognizing letters of the alphabet, reading simple words, understanding sentences and paragraphs, and listening with comprehension. The EGRA methodology was developed under EdData II and has been applied in more than 30 countries and 60 languages.[2] The EGRA instruments used by ACR GCD grantees were adapted to reflect the specific context of each grantee's project, including adaptations for students who have low vision or are blind and students who are deaf or hard of hearing.

Kampuchean Action for Primary Education (KAPE)—an ACR GCD Round 2 grantee—implemented the E-books 4 Khmer project (E4K). The E4K project, concentrating on ACR GCD's mother tongue instruction and reading materials focus area, aimed to improve the Khmer reading proficiency of students in Grades 2 and 3—specifically their pre-reading and foundational skills through fluency—by providing access to standard reading textbooks in electronic form and by training teachers on differentiated instruction (DI). The main technological innovation of the project was the conversion of standard reading textbooks into leveled, basal electronic books (e-books) that were embedded in an application (app) called SmartBooks. SmartBooks includes interactive features like multi-modal presentations that supported students' oral language skills. The e-books also featured games and quizzes that awarded stars to students for their achievements and allowed them to advance to the next, more difficult, e-book level. KAPE provided students with access to the SmartBooks app through tablets housed at primary school libraries.

To understand how the E4K project impacted participating students' reading skills, School-to-School International (STS) and KAPE conducted EGRAs twice throughout the project. Baseline data were collected in November 2016, and endline data were collected in June and July 2017. During the endline data collection, STS also conducted end-of-project (EOP) interviews with school directors, teachers, librarians, students, project management, and other stakeholders. Through the interviews, STS and KAPE sought to explore any lessons learned from project implementation, better understand how the project impacted students and family members, and assess the potential scalability of the project.

The following report presents a summary of lessons learned from project implementation, EGRA results, and scalability assessments.

Key Findings

Figure 1: **Average Gain Scores from Baseline to Endline by Subtask and Group[3]**
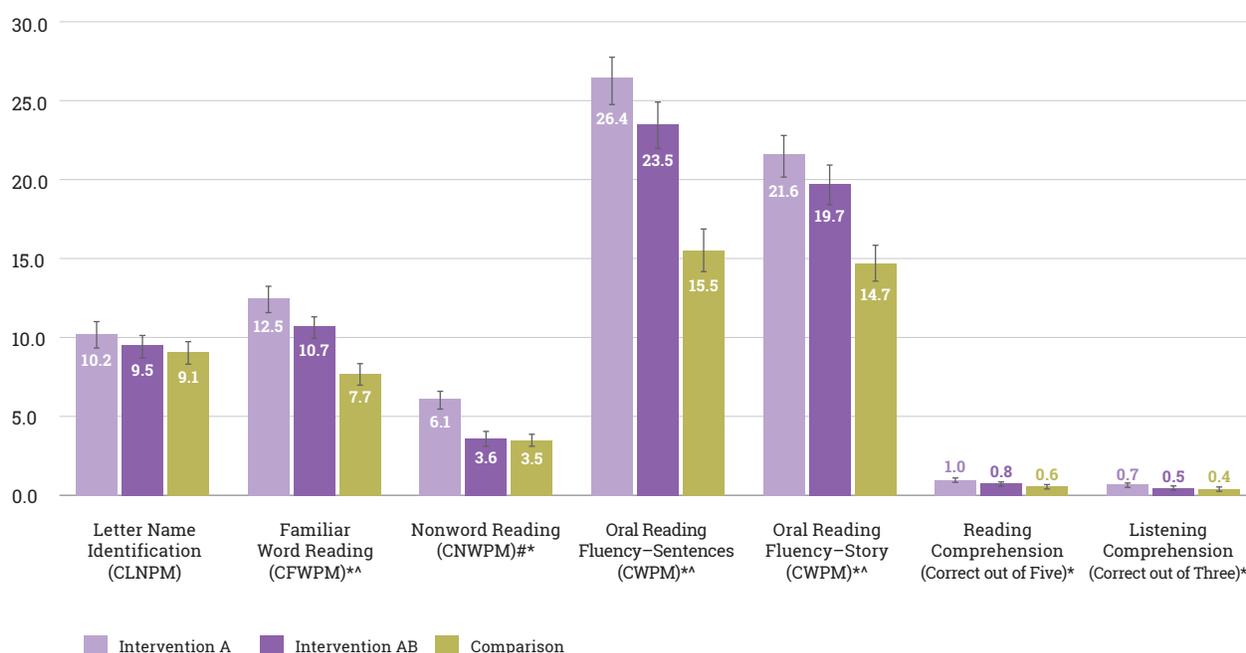
- Students who had access to the SmartBooks app—those in intervention A—had statistically significantly greater gains than did students in the comparison group—those who did not participate in any part of the E4K project—on all EGRA subtasks except the letter name identification subtask. Students who had access to the SmartBooks app and whose teachers received training in DI—those in intervention AB—had statistically significantly greater gains than did comparison group students on the familiar word reading, oral reading fluency-sentences (ORF-sentences), and oral reading fluency-story (ORF-story) subtasks (Figure 1). Notably, on the ORF-story subtask, intervention A students read an additional 21.6 CWPM at endline than at baseline, intervention AB students read an additional 19.7 CWPM, and comparison group students read an additional 14.7 CWPM. As students in both intervention groups had higher EGRA scores at baseline than students in the comparison group on several subtasks, it is not clear to what extent the average gains of intervention groups students were a result of exposure to the E4K project or the consequence of stronger reading skills at the start of the project.

3   An asterisk (*) indicates the gain score for intervention A students was significantly higher than the gain score for comparison group students at p<0.05. A caret (^) indicates the gain score for intervention AB students was significantly higher than the gain score for comparison group students at p<0.05. A hash mark (#) indicates the gain score for intervention A students was significantly higher than the gain score for intervention AB students at p<0.05. N sizes: All students N=682; Intervention A n=221; Intervention AB n=236; Comparison Group n=225.

- The differences in the proportions of students who received zero scores at endline were statistically significant on five of the subtasks: familiar word reading, nonword reading, ORF-sentences, ORF-story, and reading comprehension. On four of the subtasks, the comparison group had a higher proportion of zero scores than did students in either of the intervention groups.

- The E4K project did not appear to benefit girls and boys differently. When comparing the gains of girls and boys within each intervention group separately, there were no statistically significant differences on any subtasks, which indicates that girls and boys benefitted equally from the E4K project. Secondary findings indicate that when considering the average gains of all girls with all boys combined, regardless of group assignment, girls had statistically significantly greater gains than did boys on all subtasks except listening comprehension. This indicates that there is a gender-based performance gap that the E4K project did not impact.

- Across intervention groups and schools, students spent an average of 920 minutes—or 15.3 hours— in SmartBooks sessions from February to June 2017. The average amount of exposure was higher at intervention AB schools than at intervention A schools: 17.6 hours in SmartBooks sessions compared with 12.9 hours, respectively. Correlation analysis results indicate a weak but statistically significant relationship between minutes of exposure per student to SmartBooks and EGRA gains on all subtasks except the listening comprehension subtask. This indicates that students who had more exposure to SmartBooks tended to have greater gains on all EGRA subtasks except the listening comprehension subtask.

II. Project Description

KAPE, a Cambodian nonprofit organization with extensive experience implementing education projects and conducting research at all levels of the education sector in the country, implemented the E4K project. Its goal was to improve the reading proficiency of Grade 2 and 3 students in Cambodia. KAPE leveraged technology—tablets and the SmartBooks app, which was developed specifically for the E4K project—to deliver content from textbooks approved by the Ministry of Education, Youth, and Sport (MoEYS). It did so in an innovative and interactive way that allowed students to advance through standard reading content at their own pace. The E4K project also delivered training to teachers on DI.

The E4K project had two key intervention components:

1. Converting standard, Khmer reading textbooks to leveled, basal e-books with interactive features that supported students' oral language skill development and were accessible via the SmartBooks app. Students used tablets in their schools' libraries to access the SmartBooks app.

2. Training teachers on DI methodologies and providing the supplemental materials—including furniture and templates for tracking student progress—needed to implement DI in their classrooms. Teachers were instructed to use the DI methodologies and materials to tailor their classroom reading instruction to students' individual needs.

For the first component of the E4K project, digital content came directly from standard Grade 2 and 3 reading textbooks approved by the MoEYS. KAPE collaborated closely with district- and province-level MoEYS staff to create an empirically based readability formula that informed the creation of content at three different reading levels from each textbook passage. MoEYS staff also helped KAPE rewrite passages from the textbooks according to the readability formula. In total, KAPE digitized preexisting textbook content from 24 lessons and created three levels of content for each for a total of 72 e-books. Once the level-appropriate passages were

finalized, KAPE uploaded them onto the SmartBooks app, an interactive platform developed specifically for the E4K project. In their school library and overseen by the librarian(s), students could read the level-appropriate e-books on the app and play digitized games and quizzes that evaluated their reading levels. As students advanced through the passages, games, and quizzes, they could access increasingly difficult texts, allowing them to move from low- to high-complexity content as they improved their reading skills.

The second component of the E4K project related to the creation of DI manuals for Grade 2 and 3 teachers, which were disseminated during a three-day training provided by KAPE. The purpose of the DI component of the E4K project was to supplement the differentiated approach of the SmartBooks app with differentiated classroom instruction. Through DI, KAPE sought to give teachers the tools necessary to help students at different levels advance at a pace appropriate to their abilities. Specifically, KAPE intended to

- Help teachers develop flexible classroom tasks with fluid student groupings that avoided labeling and stigma
- Provide teachers actionable methods and techniques by focusing on assessments and reading benchmarks; give teachers time management, lesson planning, and physical classroom layout instructions so they could implement DI effectively
- Assist teachers in developing individual student profiles and track learning progress over time

During the DI training, teachers received a DI manual developed specifically for the E4K project that included topics on personalized instruction, classroom management, classroom assessment, and curricular materials. By combining teacher training in DI with SmartBooks' differentiated-learning approach, the E4K project gave teachers the tools needed to focus on students' individual needs.

Although implementation of the E4K project was initially planned for the 2015–16 academic year in Cambodia, delays in the development of SmartBooks content—including completion of the content analysis, development of the readability formula, and leveling of the texts—made it necessary to postpone the project's implementation until the 2016–17 academic year. KAPE randomly selected ten schools to participate in the E4K project; five received SmartBooks and DI teacher training materials, and five received only SmartBooks (see Sample). The project was implemented in seven districts in Kampong Cham province and reached more than 450 students in Grades 2 and 3.[4]

III. Research Purpose and Design

The E4K project, part of ACR GCD's efforts in its focus area of mother tongue instruction and reading materials, aimed to improve Grade 2 and 3 students' reading proficiency in Khmer by providing access to standard reading textbooks in an electronic form and by training teachers on DI. The research conducted by STS and KAPE sought to answer the following key research questions specific to the E4K project:

1. Does access to electronic, leveled books via the SmartBooks app improve reading acquisition for Grade 2 and Grade 3 students in Cambodia public school classrooms?

2. Is there any increased effect on reading gains for students who, in addition to having access to the SmartBooks app, have teachers who use differentiated-classroom literacy structures (i.e., DI)?

In addition, EOP research was conducted to answer the following supplemental questions common to all ACR GCD grantees:

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4   KAPE's research design also included five comparison schools, which were located in four districts that were not reached by the intervention.

1. How successful was the rollout of the project?

2. How did the project influence or impact adults' (teachers, parents, community members) knowledge, skills, or attitude regarding their role in helping children read?

3. How did the project influence certain subsets of the student population more than others, based on identifiable contextual factors?

4. How much did the development, implementation, and management aspects of the project cost?

5. Are this project and technology suitable for scaling?

To answer these research questions, KAPE collected EGRA data twice during the project. Baseline data were collected in November 2016, and endline data were collected in June and July 2017. Qualitative, fidelity of implementation (FOI), and cost data were also collected to answer ACR GCD's supplemental questions.

The research design for the E4K project included two intervention groups and a comparison group to answer each of the project-specific research questions and isolate the impact of the DI teacher training on student reading gains.

Sample

KAPE collaborated with district MoEYS representatives to construct a school sampling frame for the E4K project. KAPE requested that MoEYS officials from 17 districts nominate eight well-managed primary schools within their district. Some officials submitted more and some submitted fewer; in total, 122 schools were nominated.

When district MoEYS officials submitted their nominations, they also answered a series of questions including items related to the schools' location, number of students, number and skill of teachers, and infrastructure. KAPE used these answers to specify the E4K project school-selection criteria. The final selection criteria required that participating primary schools should have

• At least one class in Grades 1 through 6

• No multi-grade classes

• No contract teachers in Grades 2 and 3

• A student-teacher ratio of less than 50:1

• Library facilities available for use

• A school director with a history of supporting innovation

After applying these criteria, 90 schools remained in the sampling frame.[5] From the remaining schools, KAPE randomly selected ten schools to be part of the intervention group; five additional schools comprised the comparison group. KAPE then randomly assigned five of the ten intervention schools to group A and five to group AB (Table 1).

Table 1: **Research Design of Project Groups**

Group	Number of Schools
Intervention A: SmartBooks	5
Intervention AB: SmartBooks and DI teacher training	5
Comparison	5

[5] Eighty-one schools met all six criteria, and nine schools were granted exceptions because MoEYS officials requested that these schools be included in the sample frame. KAPE conducted site visits to these schools to ensure they were relatively similar to the schools that met all the selection criteria.

Among the selected intervention and comparison schools, the total student population was 2,337 children in Grades 2 and 3. To reach the target number of students desired for the student sample—750 total students across groups and grades—KAPE randomly selected students. Quotas were established by grade—25 students per grade—but not for gender or age. This resulted in the selection of 50 students from each of the 15 schools—25 students from Grade 1 and 25 students from Grade 2. In total, 750 students were assessed at baseline, and 682 students were assessed at endline. The attrition rate of 9.1 percent was due primarily to student migration over the life of the project.

A breakdown of the research sample by students' grade, gender, and group is provided in Table 2.

Table 2: **EGRA Endline Sample Characteristics**

Group	Grade at Baseline	Girls	Boys	Total: All Students
Intervention A	Grade 2	57	55	112
	Grade 3	63	46	109
	Total	**120**	**101**	**221**
Intervention AB	Grade 2	56	63	119
	Grade 3	58	59	117
	Total	**114**	**122**	**236**
Comparison	Grade 2	61	52	113
	Grade 3	60	52	112
	Total	**121**	**104**	**225**
Total: All groups		**355**	**327**	**682**

STS and World Vision conducted EOP interviews from June 19 to 29, 2017, during endline EGRA data collection (see End-of-Project Interviews). EOP interview details are provided in Table 3.

Table 3: **EOP Interview Sample[6]**

Type of Interview	N	Description
School director	5	Three directors from intervention schools and two from comparison schools
Teacher and librarian	19	11 librarians and five teachers from intervention schools; three teachers from comparison schools
Student	19	19 students from intervention schools
Project management	5	Three KAPE staff members and two app developers
Stakeholders	16	13 MoEYS officials, one USAID/Cambodia staff member, one World Vision Cambodia staff member, and one RTI International staff member
Total	**64**	

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6   Although RTI International was not a participant in the E4K project, it was interviewed as another international nongovernmental organizations implementing an educational project in Cambodia.

STS and World Vision interviewed all school directors, Grade 2 and 3 teachers, and librarians who were available on the day of interviews. Students who were at school on the day of interviews were randomly selected for interviews.

IV. Fieldwork Preparation and Data Collection

EGRA Instrument

KAPE organized an EGRA adaptation workshop from November 2 through 6, 2015, with the goal of reviewing, revising, and adding components to an existing EGRA in Khmer, which was developed in 2010 by the MoEYS in collaboration with the World Bank. Curriculum and literacy experts from the MoEYS and technical experts from World Vision Cambodia and KAPE participated. STS provided technical support during the workshop.

The 2010 EGRA included ten subtasks. As a result of the adaptation workshop, the EGRA developed for the E4K project included seven subtasks: letter name identification, familiar word reading, nonword reading, ORF-sentences, ORF-story, reading comprehension, and listening comprehension. In addition to revising EGRA subtasks, the instrument was piloted, translated into English, and programmed into Tangerine[7] for administration on tablets. The same EGRA instrument was used at baseline and endline.

Institutional Review Boards

Institutional Review Boards (IRBs) are responsible for ascertaining the acceptability of proposed research regarding institutional commitments and regulations, applicable laws, standards of professional conduct and practice, and ethical and societal norms. IRBs examine subject recruitment procedures, proposed remuneration, and the informed consent process. IRBs also evaluate the potential risks and benefits to participants outlined in each protocol.

There are no institutional bodies either within or outside of the Cambodian government that can perform the functions of an IRB. Therefore, KAPE, with Cambodia's national Primary Education Department, determined that the study would take place in accordance with its own Child Protection Policy and be approved and authorized by the Government of Cambodia. The Primary Education Department provided a letter of authorization as a substitute for IRB approval.

Baseline EGRA

The first assessor training took place from November 10 through 14, 2015, after the adaptation workshop. The training consisted of the following activities:

- Reviewing the EGRA principles and gaining a comprehensive understanding of the EGRA instrument components

- Practicing EGRA administration and scoring procedures

- Practicing conducting the EGRA on tablets

- Becoming familiar with the roles and responsibilities of both supervisors and assessors in the field

- Undergoing assessor-accuracy testing[8]

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7   Tangerine is an electronic data collection software designed for use on mobile computers, including netbooks, tablet computers, and smartphones. Its primary use is to enable recording of students' responses in oral early grade reading and mathematics skills assessments, specifically EGRA and Early Grade Mathematics Assessment, and interview responses from children, teachers and principals on home and school context information (http://tangerinecentral.org/).

8   Assessor-accuracy testing is similar to interrater-reliability testing. According to the *EGRA Toolkit (2nd Edition)*, assessor accuracy refers to the testing conducted during training, while interrater-reliability is conducted during operational data collection.

Assessor-accuracy testing is conducted to ensure consistency in scoring among assessors and to measure the degree to which assessors agree in their assessment decisions. At least 90.0 percent consistency is the minimum requirement; this means that at least 90.0 percent of assessors' ratings must be consistent with the list of acceptable responses. All assessors achieved an average greater than 90.0 percent agreement with the list of acceptable responses during the training.

The first round of baseline data was collected from January 5 to 15, 2016. Upon receiving a grant extension, KAPE recognized the need to collect baseline data again for Grade 2 and 3 students during the 2016–17 academic year. An assessor refresher training took place from October 31 to November 1, 2016, prior to the second operational baseline data collection. Most of the assessors had been trained the previous year; the activities conducted were similar to those from the first assessor training and used the same agenda that KAPE conducted, with input from STS. However, because many classrooms were occupied with activities associated with the beginning of the school year, organizers opted not to include in-school practice in this refresher training.

The operational data collection, which served as baseline results in this report, was conducted from November 5 through 28, 2016.

Table 4: **Fieldwork Preparation and Data Collection Timeline**

Task	Dates
EGRA instrument adaptation workshop	November 2–6, 2015
Assessor training	November 10–14, 2015
Baseline EGRA operational data collection (2015–16 academic year)	January 5–15, 2016
Assessor refresher training	October 31–November 1, 2016
Baseline EGRA operational data collection (2016–17 academic year)	November 5–28, 2016
Assessor refresher training	June 15, 16, and 19, 2017
Endline EGRA operational data collection (2016–17 academic year)	June 20–July 4, 2017
EOP interviews	June 19–29, 2017

Endline EGRA

Before endline operational data collection, KAPE held a second assessor refresher training in mid-June 2107. The training included review sessions on the EGRA instrument and administration protocols, and assessor accuracy testing. All assessors reached at least 90.0 percent consistency with the list of acceptable responses. The endline EGRA was conducted from June 20 through July 4, 2017, in the ten intervention schools and five comparison schools.

End-of-Project Interviews

STS and World Vision conducted EOP interviews from June 19 to 29, 2017. The interviews were intended to explore the contextual factors that may have impacted variations in implementation and results among schools and students. They also investigated the potential scalability of the E4K project. EOP interviews were conducted with five groups of project participants: school directors, teachers and librarians, students, project management, and stakeholders.

School directors were interviewed about the teaching context at their schools and challenges faced by teachers and librarians in implementing the E4K project. Teachers and librarians were asked 16 open-ended questions related to the E4K project and its technologies, challenges faced in implementing the project—both the SmartBooks and the DI components—with fidelity, and training and support they received through the project. Students were asked nine open-ended questions related to their use of SmartBooks, engagement in the E4K project, access to technology and e-books, and likes or dislikes about the project.

Project management interviews consisted of 20 open-ended questions related to general information about the E4K project and intervention timeline, characteristics of the implementing organizations, perceptions of project design and implementation quality, and considerations for scalability. KAPE staff members directly involved in the implementation of the E4K project were interviewed, as were the developers from CamAnt who were contracted to design the SmartBooks app.[9]

Lastly, STS and World Vision conducted one-on-one and focus group interviews with stakeholders from the MoEYS, USAID/Cambodia, and other international nongovernmental organizations (INGO) implementing education projects in Cambodia. These interviews focused on understanding the priorities of the MoEYS at the district and province level, types of education projects implemented by other INGOs, and potential for scale-up of the E4K project within the given context.

V. Project Implementation

The E4K project began in January 2015, and ended on July 31, 2017. This section presents implementation challenges, solutions, and successes that help answer the ACR GCD research question: *How successful was the rollout of the intervention?*

Development

The development phase of the E4K project consisted of the development of the SmartBooks app, creation of content—including the e-books, games, and quizzes—to upload onto the app, and construction of the DI materials for teachers in intervention AB schools.

KAPE had previous experience overseeing the production of digital content and apps through the Total Reading Approach for Children (TRAC) project, which was implemented by World Education, Inc. and KAPE under ACR GCD Round 1.[10] As the E4K project focused on higher-order literacy skills, KAPE opted to develop a new app rather than utilize the app developed under TRAC, which targeted pre-reading skills. KAPE contracted CamAnt, a Cambodian company focused on the development of digital content and apps for the education sector, to develop the SmartBooks app. CamAnt began developing the SmartBooks app in April 2015. It released three versions of the app over the life of the project, each with updates and improvements to the previous version. The E4K project team initially planned to have the app tested and finalized by November 2015—meaning the CamAnt team would have about seven months to complete the app, however, the first version of the app was rolled-out in December 2015. The E4K project and CamAnt team then spent several additional months beyond the original schedule to refine and improve the app.

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9   CamAnt is Cambodian company focused on the development of digital content and apps for the education sector. See http://www.camant.com for additional details.

10   TRAC supported MoEYS's phonics-based reading curriculum with a smartphone app that focused on the development of pre-reading skills for students in Grades 1 through 3. See https://allchildrenreading.org/innovators/world-education/ and http://www.worlded.org/WEIInternet/international/project/display. cfm?ctid=na&cid=na&tid=40&id=12281 for more details.

During EOP interviews, CamAnt developers noted that the initial time allocated to the SmartBooks app development and rollout was not sufficient. In the future, they would recommend one year for development and six months for testing. According to CamAnt, the primary challenges with the app's development were the need for constant adaptations and improvements to user experience features and necessary trade-offs due to the design requirements and implementation context. KAPE requested that the CamAnt team include different content specifications in the app, such as text with interactive features, vocabulary pop-up definitions, and reading comprehension exercises. CamAnt determined how to program the interactive elements, animation, audio recordings, highlighted text, and pop-up features. They ensured that student progress could be tracked under individual user accounts, enabling teachers to provide DI to students based on their progression through the SmartBooks app levels.

The developers at CamAnt spent significant time collaborating with KAPE to test and improve content before finalizing it for the SmartBooks app. However, this was a difficult process as it was challenging to render the Khmer words in the text and all content, especially the illustrations, had to be reviewed multiple times. Additionally, CamAnt developers chose a coding language that they had not previously used because they wanted it to be compatible across different hardware and operating systems. However, information on the coding language was limited, which made troubleshooting the app more time-consuming. Another challenge was ensuring an enjoyable user experience within an app as complex as SmartBooks. The content for the texts, games, and quizzes took up large amounts of memory due to the inclusion of audio, illustrations, and animations. This meant that content loaded slowly on the tablet, creating frustration for some users. During pilot testing of the app, each tablet had only one or two user accounts, but after the app was rolled out in schools, each tablet contained eight or more accounts. In some cases, this resulted in delays up to three minutes for a student to log into SmartBooks. This challenge could be mitigated by ensuring that all content was pre-loaded on the tablets or by operating in an area with stronger internet connectivity; if a sufficient internet connection had been available, new content could be loaded as needed.

Overall, the most challenging and time-consuming component of the development phase of the E4K project was the creation of the leveled basal e-books and accompanying illustrations, games, and quizzes. KAPE, in collaboration with Khmer language specialists from the MoEYS, conducted a content analysis of standard textbooks used in Grades 2 and 3 to determine benchmarks from which to establish the three levels of e-books that progressed from low to high complexity as the student learned to read. The content analysis included the identification of key reading acquisition tasks related to core reading skills: phonemic awareness, vocabulary, fluency, and reading comprehension. Diverse reading-acquisition tasks based on these skill areas were identified for each unit within the standard textbooks. Using the content analysis, KAPE Khmer language specialists, MoEYS officials, and education information and communications technology (ICT) specialists developed content for the leveled e-books and coordinated closely with developers and illustrators throughout the process. For each selected unit within the standard textbooks, the team developed reading passages at three reading levels: basic, intermediate, and advanced. In doing so, they considered text difficulty, to reflect reading level; repetitions in word usage, to ensure reinforcement; expansions in letter size; and graduated loading of content, to prevent task overload for students at the most basic reading level.

In tandem with developing the SmartBooks app and content, the E4K project team developed DI manuals and supplementary materials as well as procured and distributed classroom furniture to accommodate the implementation of DI methods. These activities did not present any significant challenges, and the manual was finalized by March 2016.

In EOP interviews, project management noted the challenges and delays during the development phase, particularly in creating the app, e-books, and accompanying content. Because the content analysis was a new process in Cambodia, and because KAPE conducted the analysis in collaboration with the MoEYS, decisions related

to analyzing criteria—such as using syllable count instead of word counts or defining what constitutes a word in Khmer—often took an extended amount of time. Despite these challenges, the E4K project team was satisfied with the final content analysis criteria and process, which they intend to use with the MoEYS in the future.

Implementation

Although implementation of the E4K project was initially planned for the 2015–16 academic year in Cambodia, delays in the development of the SmartBooks content made it necessary to postpone the project's implementation until the 2016–17 academic year. As a result, the E4K project was rolled out in schools immediately following the baseline data collection in November 2016.

During the 2015–16 academic year, KAPE provided an introduction workshop to school directors, teachers, and librarians in implementation schools in anticipation of the project's launch. However, due to the project extension through the 2016–17 academic year, a refresher workshop was held for school directors, literacy coaches, teachers, and librarians on October 27, 2016. The E4K project team provided instructions on using and maintaining tablets, logging students into their SmartBooks account, and providing SmartBooks access and support. Additionally, KAPE conducted a three-day DI workshop from October 19 through 21, 2016, for teachers at the five intervention AB schools. During the workshop, teachers, librarians, and literacy coaches received information on the utility of DI, implementing DI techniques in classrooms, and using evaluations and SmartBooks to supplement their DI instruction. Teachers received copies of the DI manual and supplemental materials to support their implementation of this component of the E4K project.

Feedback from EOP interviews indicated that the implementation of the SmartBooks component in schools was successful. Teachers and librarians confirmed that students received the recommended two sessions with SmartBooks per week, and in some schools, students received additional sessions or could access the tablets during free time. In all schools, students gathered in the library to access the SmartBooks app, and librarians were responsible for managing the hardware, supporting students as they utilized the app, and troubleshooting technical difficulties with the app or tablets. Some teachers and librarians shared that they divided students into two groups and sent one group of students into the SmartBooks sessions at a time, allowing teachers to continue providing instruction to the other group of students. During EOP interviews, some librarians mentioned student absenteeism but did not consider it a major challenge. Some school staff mentioned that they had professional development and planning sessions one week per month; librarians did not provide SmartBooks during those weeks, and therefore students participattd in sessions for only three weeks per month.

When asked their opinion on the SmartBooks' content, teachers responded that they found the electronic content a useful supplement to their classroom instruction. Some noted that the introduction of the SmartBooks app added onto their workload, as they were required to oversee students during sessions or find ways to repeat classroom instructions if students rotated through sessions. Most teachers appreciated that if a student did not understand the lesson in the classroom, he or she could review it again at his or her own pace on SmartBooks. Most believed that the tablets improved their students' reading and that students preferred to study with the tablets. Teachers and librarians noted that students would often have competitions among themselves to advance through the SmartBooks content, which encouraged them to continue using the app. Teachers and librarians also appreciated the differentiated approach, which allowed students to advance through the various levels of e-books at their own pace. Students expressed a lot of excitement over the stars they received in SmartBooks as they advanced through levels—this appears to have been a significant incentive to stay engaged in the content.

Although most teachers and librarians expressed support that the E4K project utilized existing standard textbook content in SmartBooks, some noted that this was a limitation. In most cases, teachers did not allow students to

advance to new lessons in SmartBooks that had not yet been introduced through their classroom instruction. This meant that some students had to repeat the same content on SmartBooks until they reached a new lesson in the classroom. Also, teachers noted that they wished all textbook lessons had accompanying electronic content on SmartBooks, as the interactive and supplementary nature of the e-books helped students advance. Simultaneously, some teachers and librarians felt that students got bored, either by their inability to advance to new lessons in SmartBooks or because the e-book levels were too similar. Many teachers and librarians said they wished that SmartBooks could also include storybooks to allow for variation in e-books and to increase students' engagement. Several teachers mentioned that, when tablets were not being used in the libraries, they brought them into their classrooms to help students follow along with lessons; this underscores teachers' eagerness to leverage technology and digital support during classroom instruction.

The use of technology itself appears to have been a motivator for students to engage in reading content. In addition to enjoying the content on SmartBooks, students said in interviews that they liked using the tablets. Students did not express any challenges in learning how to use the tablets, though they did share that sometimes the app crashed or took a long time to load, which they found frustrating. Although teachers and librarians received training from KAPE on how to use and troubleshoot the tablet and app, for many of them it was their first time using such technologies, and they found it hard to adapt to—especially the older teachers. In EOP interviews, many teachers and librarians expressed that they would have liked to receive more training, and others flagged specific challenges with the technology. For example, sometimes the app was moved or deleted by the students, and teachers and librarians did not know how to recover it. In some cases, the app froze—sentences showed up but not the picture or stars were not given out to students when they get the right answer— and students would have to advance to a different lesson for ten or 20 minutes before returning to the original lesson. Battery life on the tablets was poor, necessitating that the librarians charge the tablets often; however, there was not always enough time to charge tablets fully between uses. Although not a frequent occurrence, some tablets broke and were unable to be replaced. Despite the challenges, most teachers and librarians noted that KAPE provided satisfactory technological support, either remotely by phone or in-person.

Based on feedback from project management and teachers, it was evident that the DI component of the E4K project was less successful than the SmartBooks component. Although KAPE intended for all teachers in intervention AB schools to receive training, DI manuals, and furniture to set up reading corners in their classrooms, these were not implemented with complete fidelity. Due to teacher turnover, the E4K project team was not able to train all Grade 2 and 3 teachers on DI, and not all classrooms received the furniture necessary to set up reading corners. In EOP interviews, some teachers stated that the reading corner was helpful to divide students into different reading groups, but most expressed limitations with DI's physical requirements for classrooms. Several mentioned that MoEYS restrictions limited their ability to rearrange furniture in the classrooms to accommodate the reading corners; others shared that they did not use the reading corners because they could not change the classroom for other subjects. Nearly all said the DI teaching strategies were difficult, and that tracking individual students' progress through the profiles was too time consuming.

Program managers were disappointed with the implementation of the DI component of the project. Some of the challenges they cited were the lack of engagement of school directors who were critical of enforcing the implementation of DI; large class sizes; lack of teacher motivation or time to implement new techniques; and short school days. The E4K project team also noted that, due to the significant amount of time invested in the development of the SmartBooks app and content, they were not able to dedicate as much time to the development and monitoring of the DI component. They estimated that three of the schools implemented the DI component with no more than 60.0 percent fidelity and that the other two schools were even less diligent than that. In the future, the E4K project team noted that they would revise the DI manual to make it simpler.

Additional challenges noted by project management included problems with capturing user-dosage data on the app, which, due to a lack of internet connectivity, was not synched to the server and inaccessible. They were also surprised by students' low levels of pre-reading skills in Grades 2 and 3, and they felt that this was a result of auto-promotion of students from Grade 1 even when they did not have the requisite reading skills to advance. In the future, KAPE's project management said they would like to design an app that incorporates pre-reading content from the TRAC app with the SmartBooks app to support students on a wider range of reading skills.

Management

KAPE, a Cambodian nonprofit organization with extensive experience implementing education projects and conducting research at all levels of the education sector in the country, was a competent manager of the E4K project. KAPE staff built strong stakeholder buy-in and engagement from the MoEYS. They also engaged with local Cambodian organizations, such as Thun Thean Seksa and CamAnt, which supported the project's training and technology design. Due to KAPE's strong technical, ICT, and monitoring and evaluation (M&E) capacities, the E4K project team both provided and coordinated technical support on educational content, implementation, and research.

KAPE has implemented a number of other projects in collaboration with the MoEYS throughout Kampong Cham province. The rapport its staff built with district MoEYS officials and school directors helped during the development and implementation phases of the projects. The E4K project managers expressed few management challenges during their EOP interviews, though they did note that stronger buy-in from the MoEYS on the DI component would have allowed for better implementation, as would have stronger supervision by school directors

Fidelity of Implementation

By definition, FOI is the accurate and consistent application of an agreed-upon procedure. FOI research is used to assess the degree to which a project is implemented as intended. Measuring FOI helps implementers and researchers understand and differentiate between what was supposed to happen and what actually happened during the life of a project. When FOI is high and an intervention group experiences gains, then it is possible to associate gains with the intervention; this, in turn, makes it possible to recommend scaling the intervention. FOI research also makes it possible to identify which components of an intervention are most strongly associated with outcomes. When FOI is low and gains are low, it is impossible to know whether the reason for low gains is a poor design or poor implementation. FOI research can also be coupled with M&E to provide feedback to implementers during the project cycle to improve adherence to project design in the case of low FOI.[11]

As part of their projects, all ACR GCD Round 2 grantees conduct FOI research during the implementation period. The primary objectives of FOI for grantees were to

1. Understand what FOI is and why it is important throughout the life of the project

2. Identify essential components, activities, and questions for each phase of project implementation

3. Create relevant, project-specific FOI tools to monitor registrants' adherence to the intervention plan

STS held a series of FOI meetings with each ACR GCD Round 2 grantee to develop project-specific FOI tools and an implementation plan for FOI research. After finishing the FOI sessions, ACR GCD grantees were expected to pilot test their FOI tools and collect data. Grantees were advised to collect a minimum of one round of FOI data; two or more rounds of data collection were considered ideal.

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11   Creative Associates International, Inc. (2015). Fidelity of implementation (FOI) how-to guide (unpublished). Washington, D.C.: USAID.

The collected data serve several purposes:

1. To indicate where revisions in data collection tools were necessary

2. To highlight where improvements in implementation were needed

3. When combined with assessment results, to provide evidence, if possible, that gains were associated with the intervention

KAPE staff involved in the E4K project participated in the FOI meetings in-person and by phone with STS, developed FOI tools, and collected FOI data. The E4K project team also collected student attendance at SmartBooks sessions from librarians. Due to challenges with internet connectivity and the SmartBooks server, the project was not able to capture students' unique usage data from the app. Generally, FOI data were used by the E4K project team as feedback to improve implementation, though select attendance data are included in this analysis (see Key Factors for Success).

VI. EGRA Data Analysis

EGRA data were analyzed using Microsoft Excel and IBM SPSS Statistics. Only students who had data at both baseline and endline were included in the analysis. EGRA subtask results were matched by student and compared by time period to calculate reading gains over the life of the project.[12] Subtasks' mean fluencies and scores are reported, as are standard deviations (SD) and confidence intervals relevant to those mean values.[13] Gain scores were computed as the difference between endline and baseline for each subtask, and student reading performance was evaluated across subgroups of students, including grade and gender. Zero scores[14] were also calculated for all subtasks. Differences in gain scores between groups, grade, and gender were tested for statistical significance using analysis of variance and independent samples t-test analysis.[15] For grade and gender analysis, the differences in gain scores between groups were tested for statistical significance using analysis of variance with Tukey's Honest Significant Difference test for multiple testing.[16] Differences in the proportion of zero scores were tested for statistical significance using chi-square tests.[17] Results with statistically significant differences with p-values less than 0.05 are reported throughout with superscript notations, including asterisks, carets, and hash marks. When results are not statistically significant, it is not possible to assume that there is any difference between the results of students in the intervention or comparison groups.

For each subtask, decision rules were applied to assess whether outliers would need to be removed. For example, if the time remaining for a timed subtask resulted in a fluency rate that was outside a reasonable range, then that student's fluency rate was not included in the analyses. Reasonable ranges for the time remaining were based on multiple factors, including the rate at which letters or words in the language tested are typically read, the distribution—or relative performance—of students in the sample, and the mean fluency rate within and without the outlier data point(s). After consideration of the reasonable ranges in the data, no outliers were removed.

Table 5 provides details on the EGRA subtasks, including how results were calculated.

[12] Because of rounding, mean changes reported may not always equal endline value minus baseline value.

[13] SD describes how much observed values vary from the mean. A smaller SD indicates that most of the values are close to the mean; a larger SD indicates that values are further from the mean. SDs are listed to understand the variability of the scores within the sample. Confidence intervals are indicated by the lines at the top of each bar. Confidence intervals indicate a range of values that is likely to encompass the true value.

[14] Students received a zero score if they were unable to correctly identify a single item on a subtask. In this report, zero scores are shown as the number of students or as the percentage of the total students unable to correctly identify a single item on a subtask.

[15] Analysis of variance is a statistical model that is used to analyze the differences between group means, which helps identify differences in the sample that can be generalized to the population. The independent-sample t-tests compare the difference between the means of two independent groups on the same dependent variable.

[16] Tukey Honest Significant Difference test, or the Tukey-Kramer method, is a multiple comparison test used when intervention and comparison groups have unequal or unbalanced observations.

[17] The chi-square test is a statistical test comparing proportions of students with zero scores that were observed in the data against what was expected.

Table 5: **Subtask and Data Analysis Methods**

Subtask	Type	Description
Letter name identification	Timed	Letter name identification is measured as correct letters named per minute (CLNPM). Letter name identification is a measure of alphabet knowledge and is highly predictive of later reading achievement. Each student had one minute to name up to 100 letters.
Familiar word reading	Timed	Familiar word reading is measured as correct familiar words read per minute (CFWPM). Familiar word reading measures word recognition and decoding. Each student had the opportunity to read up to 50 high-frequency words.
Nonword reading	Timed	Nonword reading is measured as correct "nonwords" read per minute (CNWPM). Nonword reading measures decoding. Each student had the opportunity to read up to 50 one- and two-syllable nonwords.
Oral reading fluency-sentences	Timed	ORF-sentences is measured as correct words read per minute (CWPM). ORF is a decoding and reading fluency measure. Each student had the opportunity to read up to 55 words from eight unrelated sentences.
Oral reading fluency-story	Timed	ORF-story is measured as correct words read per minute (CWPM). ORF is a decoding and reading fluency measure. Each student had the opportunity to read up to 82 words from a single passage. The ORF passage formed the textual basis for the reading comprehension subtask.
Reading comprehension	Untimed	Reading comprehension is measured as the number of correct answers verbally delivered to the assessor based on questions asked about the passage read as part of the ORF-story subtask. Each student had the opportunity to answer up to five questions.
Listening comprehension	Untimed	Listening comprehension is measured as the number of correct answers verbally delivered to the assessor. Listening comprehension is a measure of vocabulary. Each student had the opportunity to answer three questions based on a passage read to them by the assessor.

Considerations

Nonequivalent Groups at Baseline

Although schools were randomly assigned to intervention and comparison groups, results from the baseline assessment presented in Figure 2 show that students who attended schools receiving the E4K project intervention had higher subtask scores than students at schools in the comparison group. Specifically, at baseline, students in intervention A had statistically significantly higher scores on all subtasks except listening comprehension. Additionally, students in intervention AB had statistically significantly higher scores than students in the comparison group on three subtasks: letter name identification, familiar word reading, and nonword reading. There were no significant differences between baseline EGRA scores for students in intervention groups A and AB; students in the intervention groups were comparable at baseline. There were no significant differences across groups on the listening comprehension subtask.

While the main focus of the analysis in this report is gain scores of students across groups, it is important to consider the potential bias introduced into the research design due to students entering with different reading levels. The source of the bias is unknown—student populations may have different characteristics, classrooms or teachers may have different characteristics, or it may result from some other factor. As such, when groups start at significantly different reading levels at baseline, the differences in gains between groups can either be due to the intervention or unknown differences in group characteristics.

VII. EGRA Results

This section presents EGRA results to answer the key research questions posed by the E4K project: *Does access to electronic, leveled books via the SmartBooks app improve reading acquisition for Grade 2 and Grade 3 students in Cambodia public school classrooms?* and *Is there any increased effect on reading gains for students who study with teachers using differentiated-classroom literacy structures (i.e., DI) in addition to having access to the SmartBooks app?*

The following section contains findings by group—intervention A students, who had access to SmartBooks; intervention AB students, who had access SmartBooks and DI teacher training; and comparison group students, who did not have access to the E4K project components—across EGRA subtasks. Results by gender and by grade are also presented.

Overall, all students showed improvements in their literacy skills during the academic year, regardless of their participation in the project. However, **students in both intervention groups showed statistically significant greater gains than students in the comparison group on all subtasks except letter name identification.** Furthermore, there were differences in the performance of students in intervention groups A and AB. Students in intervention A had significantly greater gains than did students in the comparison group on all but one subtask—letter name identification; however, students in intervention AB had significantly greater gains than students in the comparison group on just three subtasks: familiar word reading, ORF-sentences, and ORF-story (Figure 1). Additionally, students in intervention A had significantly greater gains than did students in intervention AB on the nonword reading subtask. However, because students in intervention A were not equivalent to students in the other groups at baseline, the differences in gains may be due to pre-existing differences between the groups (Figure 2).

Figure 3 presents the percentages of students receiving zero scores at endline. **The percentages of students across the three groups receiving zero scores at endline were statistically significantly different on five subtasks: familiar word reading, nonword reading, ORF-sentences, ORF-story, and reading comprehension.** The percentages of students receiving zero scores were comparable across the groups on the letter name identification and listening comprehension subtasks.
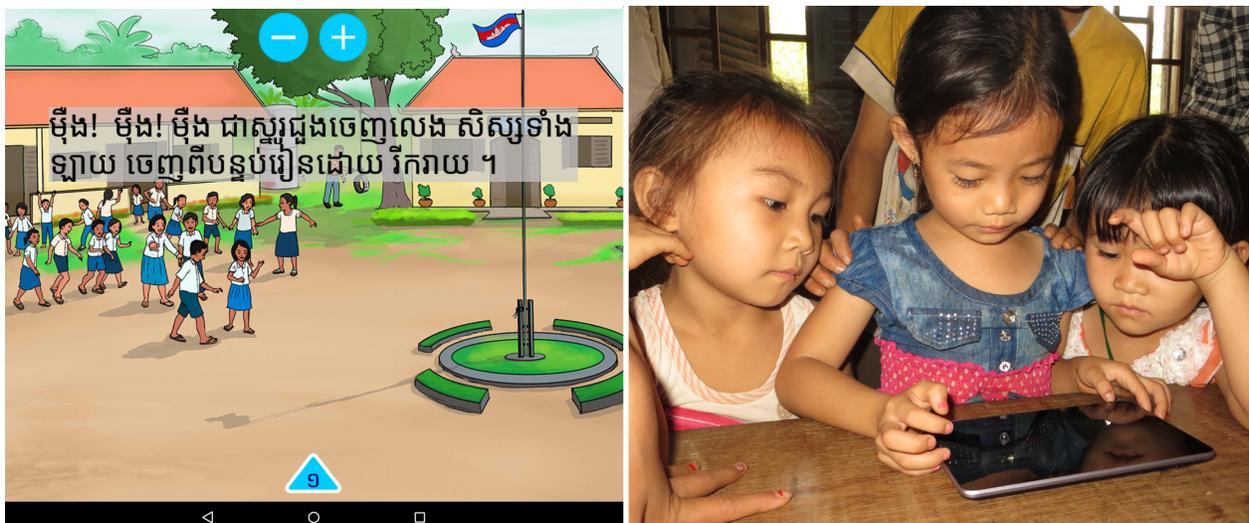
Figure 2: Mean Results by Subtask and Group at Baseline and Endline[18]

Legend:
- Intervention A - Endline
- Intervention AB - Endline
- Comparison - Endline
- Intervention A - Baseline
- Intervention AB - Baseline
- Comparison - Baseline
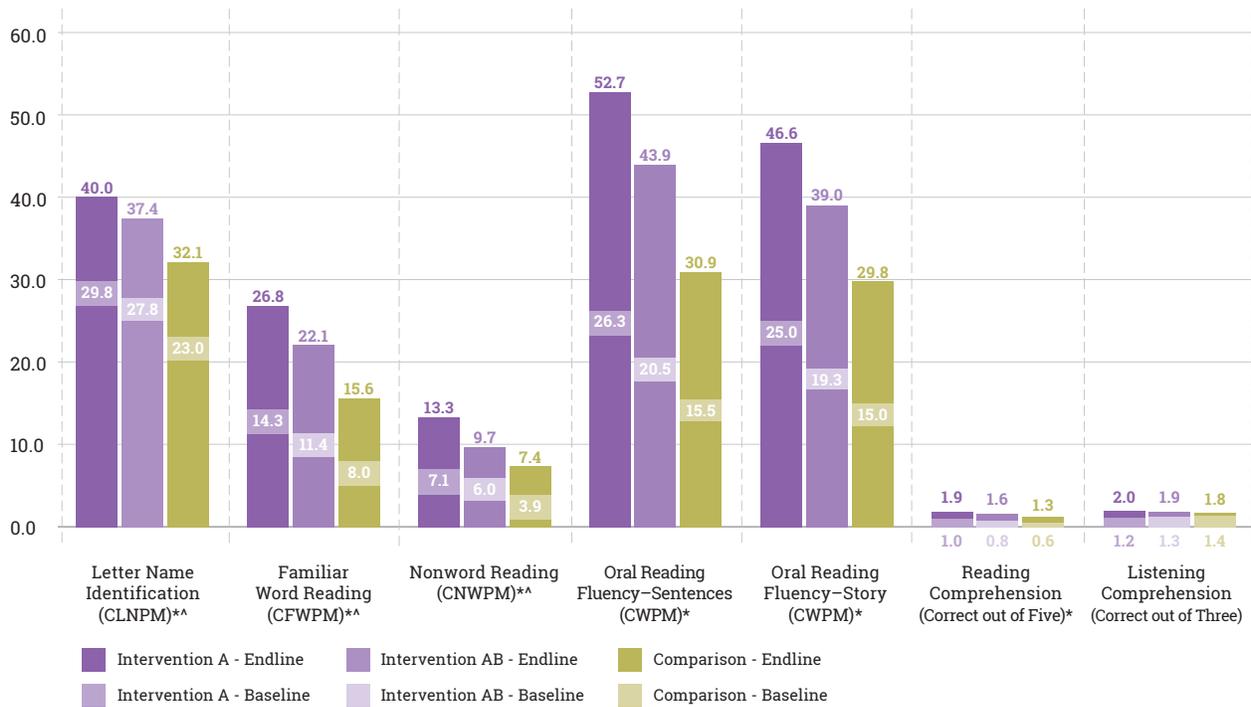
Figure 3: Percentage of Students Receiving Zero Scores by Group at Baseline and Endline (%)[19]

Legend:
- Intervention A - Endline
- Intervention AB - Endline
- Comparison - Endline
- Intervention A - Baseline
- Intervention AB - Baseline
- Comparison - Baseline
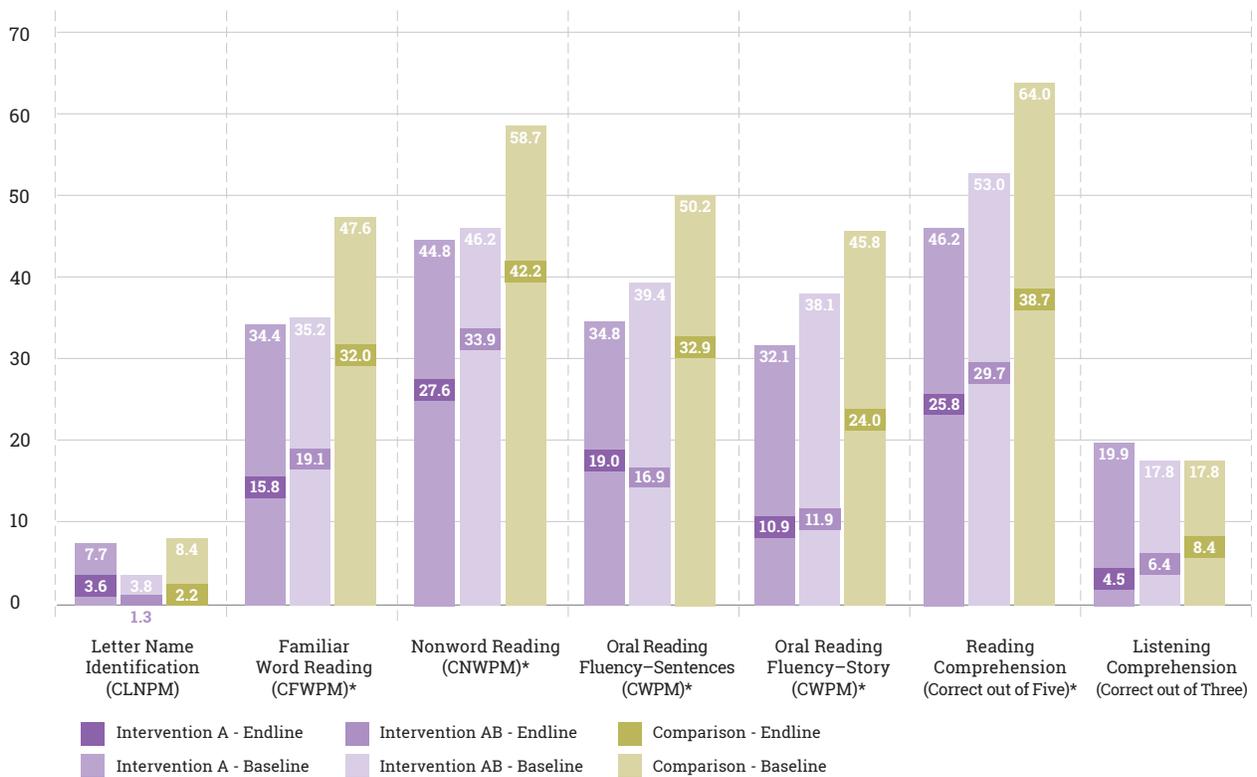
18   An asterisk (*) indicates the baseline score for intervention A students was statistically significantly higher than the baseline score for the comparison group at p<0.05. A caret (^) indicates the baseline score for intervention AB students was statistically significantly greater than the gain for the comparison group at p<0.05. N sizes: All students N=682; Intervention A n=221; Intervention AB n=236; Comparison n=225. The differences in scores across groups at endline were not tested for significance.

19   An asterisk (*) indicates a statistically significant difference in the proportion of zero scores across groups at endline at p<0.05. N sizes: All students N=682; Intervention A n=221; Intervention AB n=236; Comparison n=225.

EGRA Results by Subtask

Letter Name Identification

Letter name identification measures students' knowledge of the alphabet and is predictive of later reading success. For this subtask, students were presented with a stimulus of 100 letters and asked to name as many as they could in one minute. The subtask was discontinued if a student was unable to correctly name any of the first ten letters of the stimulus. Results for this subtask are reported as a fluency rate of CLNPM, and average gain scores for the letter name identification subtask are presented in Figure 4.

Figure 4: **Average Gain Scores from Baseline to Endline by Group—Letter Name Identification (CLNPM)**[20]
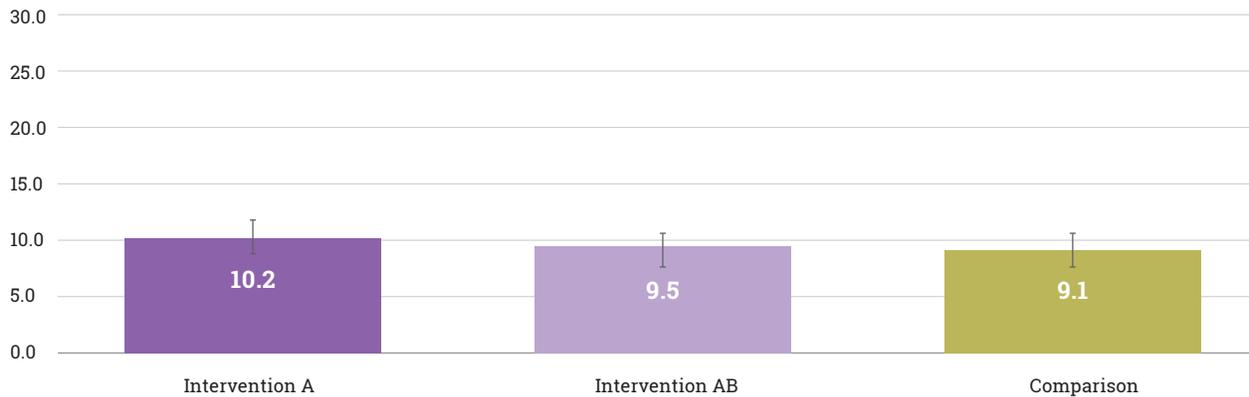
There were no significant differences in the gains across the three groups, meaning that **students in all three groups had comparable gains from baseline to endline on the letter name identification subtask.**

The percentage of students receiving zero scores on the letter name identification subtask at endline is presented in Figure 5. **The percentages of zero scores at endline across three groups were not significantly different, meaning that the proportions of students in intervention A, intervention AB, and the comparison group who were unable to name correctly a single letter name at endline were comparable.**

Figure 5: **Percentage of Students Receiving Zero Scores by Group at Endline— Letter Name Identification (%)**[21]

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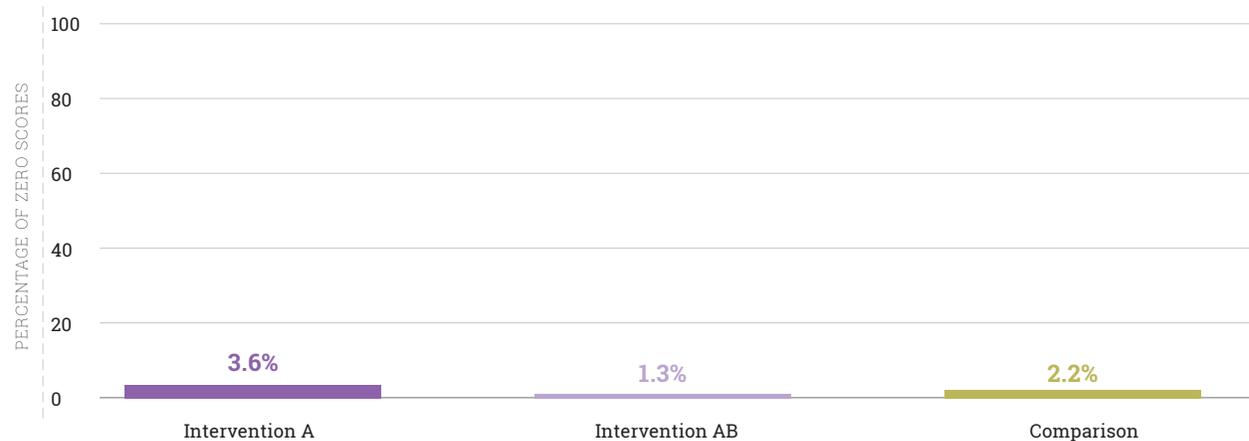
20   The chi-square test of significance indicated that the proportions of students observed receiving zero scores at endline were not statistically significantly different from what was expected in the data for any group. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

21   *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Familiar Word Reading

Knowledge of familiar words and the ability to read them quickly enables a student to read with automaticity—a skill critical to learning to read with fluency and comprehension. In the familiar word reading subtask, students were presented with 50 familiar words and asked to read as many as they could within one minute. The subtask was discontinued if a student was unable to read correctly any of the first five familiar words. Results for this subtask are reported as a fluency rate of CFWPM, and average gain scores are presented in Figure 6.

Students in all groups increased their familiar word reading fluency from baseline to endline. **The gains of students in both intervention groups A and AB were statistically significantly greater than were the gains of comparison group students.** Specifically, students in intervention A were able to read, on average, an additional 12.5 CFWPM, and intervention AB students were able to read, on average, an additional 10.7 CFWPM. Comparison group students read, on average, an additional 7.7 CFWPM. There was no statistically significant difference in the gains obtained by intervention A and intervention AB students.

Figure 6: **Average Gain Scores from Baseline to Endline by Group—Familiar Word Reading (CFWPM)**[22]
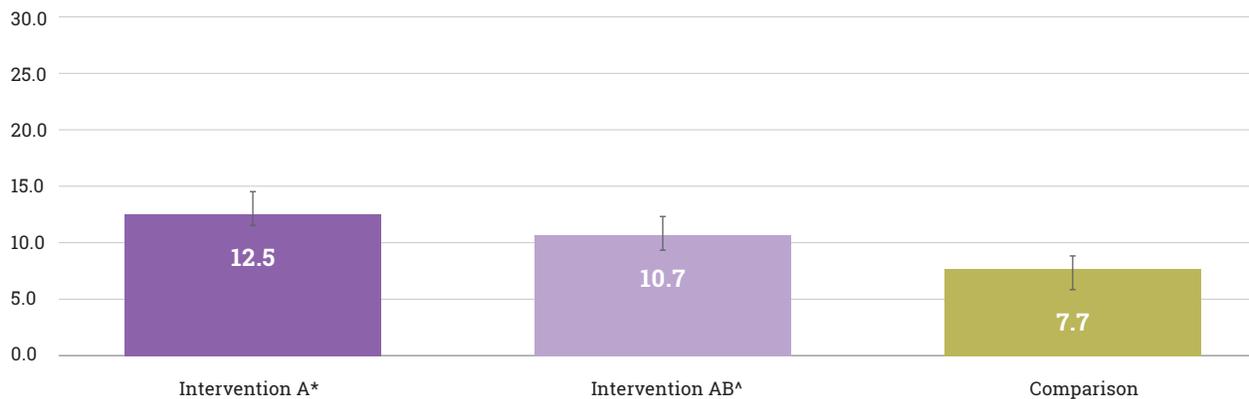
The percentage of students receiving zero scores on the familiar word reading subtask at endline is presented in Figure 7. **The proportions of students unable to correctly read a single familiar word at endline were statistically significantly different across groups.** Specifically, 15.8 percent of students in intervention A received zero scores at endline, 19.1 percent of students in intervention AB received zero scores, and 32.0 percent of students in the comparison group received zero scores. The proportion of students receiving zero scores was higher than expected in the comparison group and lower than expected in both intervention groups A and AB.

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22   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at p<0.05. A caret (^) indicates the gain score for intervention AB students was statistically significantly greater than the gain score for the comparison group at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Figure 7: **Percentage of Students Receiving Zero Scores by Group at Endline—Familiar Word Reading (%)**[23]
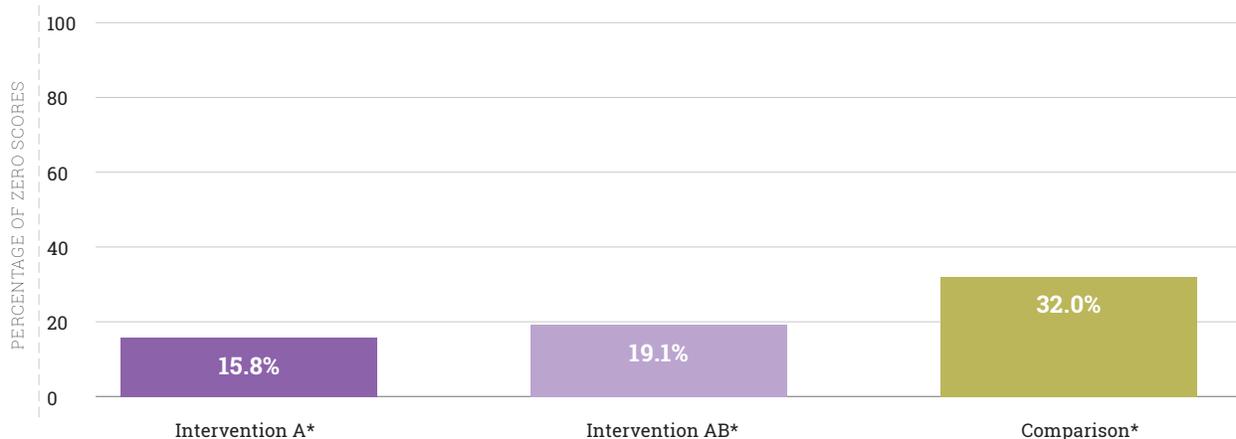
Nonword Reading

The nonword reading subtask measures students' decoding ability by presenting them with words that they would not be able to recognize due to familiarity. Many students in the early grades learn to memorize or recognize a range of familiar words. Thus, to assess their decoding skills, students are presented with invented nonsense words, which requires them to sound out each letter and syllable to decode a word. During this timed subtask, the assessor presented each student with 50 nonwords and asked him or her to read as many as possible in one minute. The subtask was discontinued if a student was unable to read correctly any of the first five nonwords. Results for this subtask are reported as a fluency rate of CNWPM.

Average gain scores for the nonword reading subtask are presented in Figure 8. While students in all groups increased their nonword reading fluency from baseline to endline, **the average gains of intervention A students were statistically significantly greater than the gains of intervention AB and comparison group students.** Students in intervention A read, on average, an additional 6.1 CNWPM. Intervention AB students read, on average, an additional 3.6 CNWPM, and comparison group students read, on average, an additional 3.5 CNWPM. There was not a statistically significant difference between the gain scores of intervention AB and comparison group students.

Figure 8: **Average Gain Scores from Baseline to Endline by Group—Nonword Reading (CNWPM)**[24]
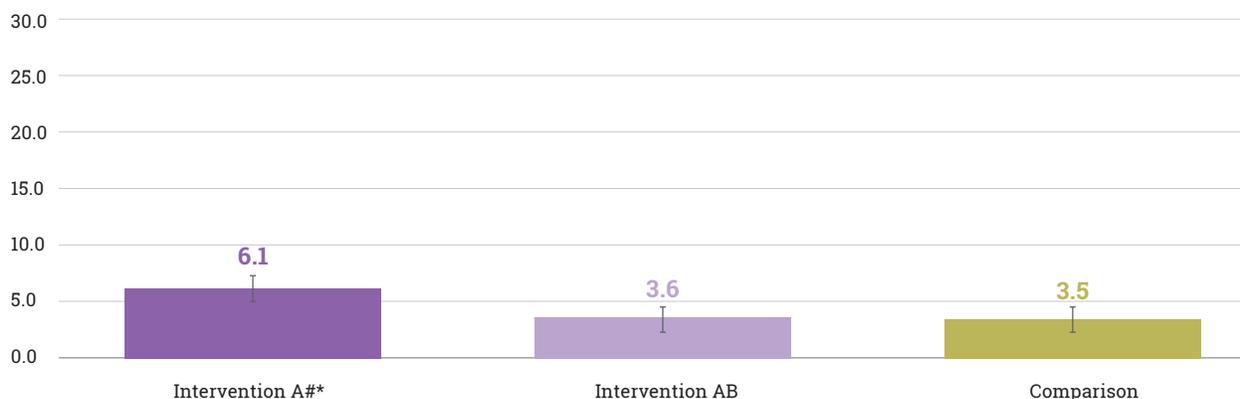
23   An asterisk (*) indicates that the proportion of observed zero scores at endline was statistically significantly different from what was expected in the data at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

24   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at p<0.05. A hash mark (#) indicates the gain score for the intervention A students was statistically significantly greater than the gain score for intervention AB students at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

The percentage of students receiving zero scores on the nonword reading subtask at endline is presented in Figure 9. **Overall, the percentage of students receiving zero scores at endline was statistically significantly different across groups.** Specifically, 27.6 percent of students in intervention A received zero scores at endline, 33.9 percent of students in intervention AB received zero scores, and 42.2 percent of students in the comparison group received zero scores. Furthermore, the proportion of students receiving zero scores was higher than expected in the comparison group and lower than expected in intervention group A.

Figure 9: **Percentage of Students Receiving Zero Scores by Group at Endline—Nonword Reading (%)**[25]
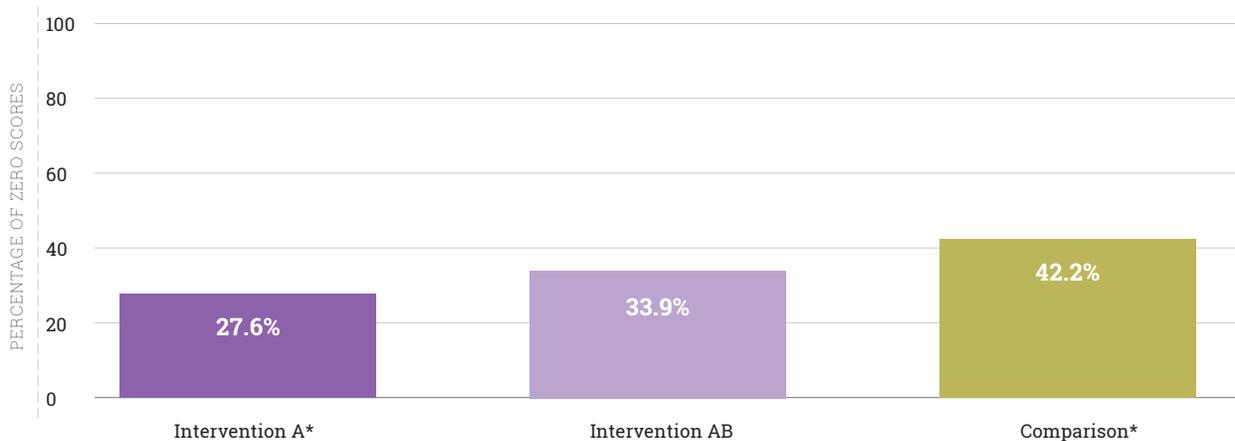
Oral Reading Fluency-Sentences

The ORF-sentences subtask is a measure of overall reading competence.[26] Like the ORF-story subtask, the ORF-sentences subtask measures a student's ability to translate letters into sounds, unify sounds into words, process connections, relate text to meaning, and make inferences to fill in missing information.[27] A student's ORF score is dependent on the foundational skills in the previous subtasks, since individuals need to have some mastery of letter sounds, phonics, and decoding strategies to read fluently. The research indicates that learning to read at a sufficient rate is essential for comprehension and to transition from "learning to read" to "reading to learn." In terms of the acquisition of literacy proficiency in the Khmer language, students are greatly challenged by the preponderance of vowels, consonants, subscripts, and special signs that they need to learn. Thus, students' reading performance can falter until the time that they fully master Khmer orthography rules. Only then can they read with both speed and accuracy.[28] For this EGRA subtask, students were asked to read aloud 55 words in eight unrelated sentences. The subtask was discontinued if a student was unable to read correctly any of the first six words. Results for this subtask are reported as a fluency rate of CWPM.

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25   An asterisk (*) indicates that the proportion of zero scores observed at endline was statistically significantly different from what was expected in the data at p<0.05. The chi-square test of statistical significance indicated that the proportion of students receiving zero scores observed at endline in intervention group AB was not statistically significantly different from what was expected in the data. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

26   ORF-story is the generally accepted measure of CWPM according to EGRA toolkit guidance. ORF-sentences is not a standard subtask but was included in the E4K project EGRA instrument to capture an additional measure of reading fluency prior to comprehension.

27   Hasbrouck, J. and Tindal, G. A. (2006). Oral reading fluency norms: A valuable assessment tool for reading teachers. *The Reading Teacher*, 59: 636–644. doi:10.1598/RT.59.7.3

28   The MoEYS set minimum ORF proficiency standards of 45 CWPM for the lower primary school grades and 100 CWPM for the upper primary grades.

Average gain scores for the ORF-sentences subtask are presented in Figure 10. Students across groups increased their ORF-sentences fluency from baseline to endline, and **the gains of students in both interventions A and AB were statistically significantly greater than the gains of students in the comparison group.** Students in intervention A read, on average, an additional 26.4 CWPM, and intervention AB students read, on average, an additional 23.5 CWPM. Comparison group students read, on average, an additional 15.5 CWPM. The differences in the gains obtained by intervention A and AB students was not statistically significant.

Figure 10: **Average Gain Scores from Baseline to Endline by Group—ORF-Sentences (CWPM)[29]**
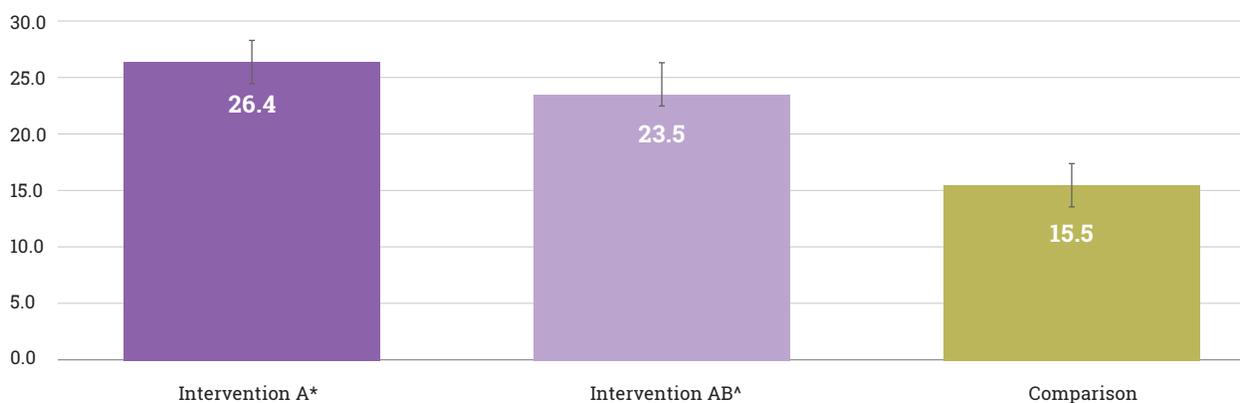
The percentage of students receiving zero scores on the ORF-sentences subtask at endline is presented in Figure 11. **The percentages of students who were unable to read correctly a single word on the ORF-sentences subtask at endline was statistically significantly different across groups.** Specifically, 19.0 percent of students in intervention A received zero scores at endline, 16.9 percent of students in intervention AB received zero scores, and 32.9 percent of students in the comparison group received zero scores. Furthermore, the proportion of students receiving zero scores was higher than expected in the comparison group.

Figure 11: **Percentage of Students Receiving Zero Scores by Group at Endline—ORF-Sentences (%)[30]**
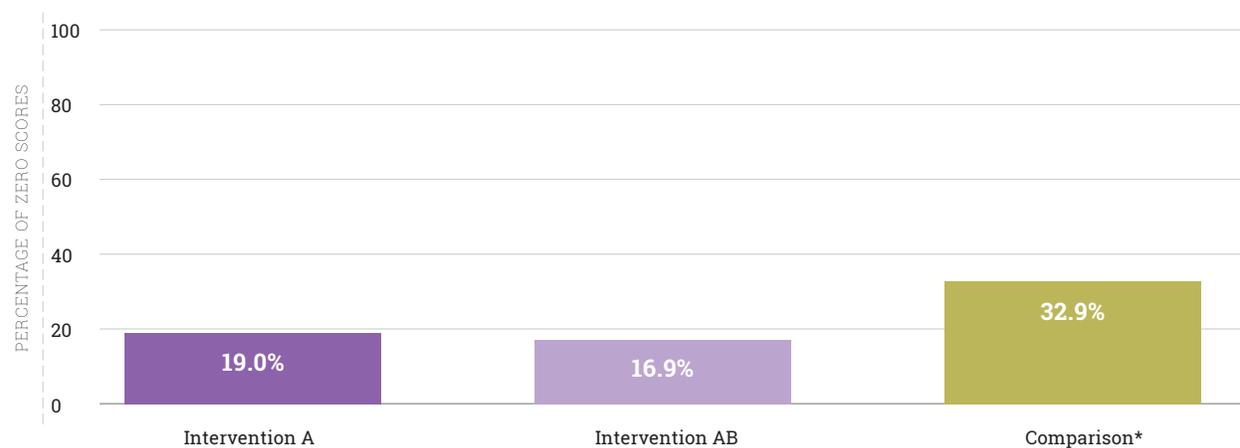
29   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at p<0.05. A caret (^) indicates the gain score for intervention AB students was statistically significantly greater than the gain score for the comparison group at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

30   An asterisk (*) indicates that the proportion of zero scores observed at endline was statistically significantly different from what was expected in the data at p<0.05. The chi-square test of significance indicated that the proportions of students observed receiving zero scores at endline in intervention groups A and AB were not statistically different from what was expected in the data. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Oral Reading Fluency-Story

The ORF-story subtask measures students' overall reading competence. It is the culmination of translating letters into sounds, merging sounds to become words, linking words to become sentences, relating the text to meaning, and making inferences to fill in missing information. A student's ORF-story score is dependent on the skills assessed in previous subtasks since students need to have some mastery of letter sounds and decoding to read fluently. Students had the opportunity to read up to 82 words in the ORF-story passage in one minute. The subtask was discontinued if a student was unable to read correctly any of the first 11 words. Results for this subtask are reported as a fluency rate of CWPM.

Average gain scores for the ORF-story subtask are presented in Figure 12. Though students across groups increased their ORF-story fluency from baseline to endline, **the gains of students in intervention groups A and AB were statistically significantly greater than the gains of comparison group students.** Students in intervention A read, on average, an additional 21.6 CWPM, and students in intervention AB read, on average, an additional 19.7 CWPM. However, comparison group students read, on average, an additional 14.7 CWPM. There was no statistically significant difference in the gains obtained by intervention A and AB students.

Figure 12: **Average Gain Scores from Baseline to Endline by Group—ORF-Story (CWPM)[31]**
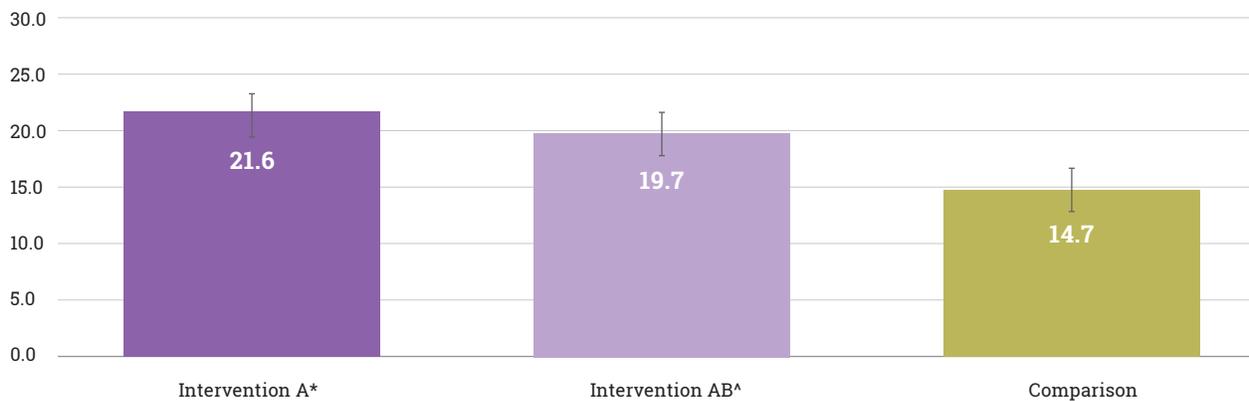
The percentage of students receiving zero scores on the ORF-story subtask at endline is presented in Figure 13. **Overall, the percentage of students receiving zero scores at endline were statistically significantly different across groups.** In interventions A and B, 10.9 and 11.9 percent of students, respectively, were unable to read correctly a single word at endline. In the comparison group, 24.0 percent of students received zero scores. The proportion of zero scores was higher than expected in the comparison group but as expected in the intervention groups.

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31   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at p<0.05. A caret (ˆ) indicates the gain score for intervention AB students was statistically significantly greater than the gain score for the comparison group at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Figure 13: **Percentage of Students Receiving Zero Scores by Group at Endline—ORF-Story (%)[32]**
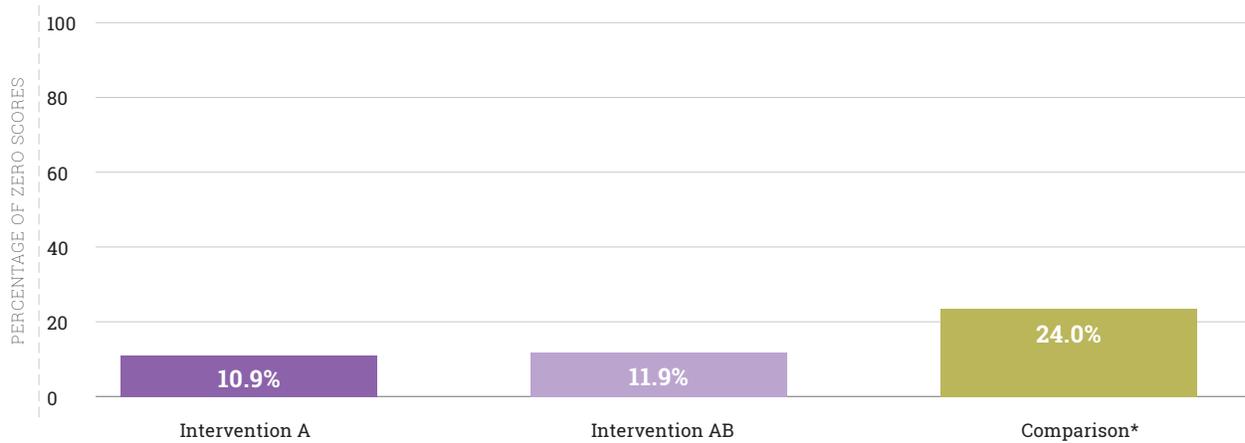
Reading Comprehension

Comprehension is the purpose of reading. Once a child learns the sound-letter relationship and becomes able to decode and read with automaticity, he or she becomes increasingly able to understand the meaning of a text. This subtask assesses that ability.

For the reading comprehension subtask, the assessor removed the passage used in the ORF-story subtask and then asked each student up to five comprehension questions based on what he or she had read. The number of questions asked depended on how many words each student read on the ORF-story subtask. For instance, if a student read just the first ten words, he or she would be asked only the first comprehension question. Similarly, if a student read all words on the ORF-story subtask, he or she would be asked all five questions. Students who received zero scores on the ORF-story subtask also received zero scores on the reading comprehension subtask, because no questions were presented to them. Additionally, any student who could not correctly answer a single reading comprehension question received a zero score on this subtask.

Average gain scores for the reading comprehension subtask are presented in Figure 14. Students across groups increased their reading comprehension scores from baseline to endline, and **the gains of students in intervention A were statistically significantly greater than the gains obtained by comparison group students.** Students in intervention group A correctly answered, on average, 1.0 additional comprehension question at endline than at baseline, compared to 0.6 additional questions correctly answered by students in the comparison group. Intervention AB students correctly answered, on average, 0.8 additional questions at endline than at baseline. There was no significant difference in the gains obtained by intervention A and AB students. Moreover, there was no significant difference in the gains obtained by intervention AB students and comparison group students.

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32   An asterisk (*) indicates that the proportion of zero scores observed at endline was statistically different from what was expected in the data at p<0.05. The chi-square test of significance indicated that the proportions of students observed receiving zero scores at endline in intervention groups A and AB were not statistically different from what was expected in the data. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Figure 14: **Average Gain Scores from Baseline to Endline by Group—Reading Comprehension**[33]
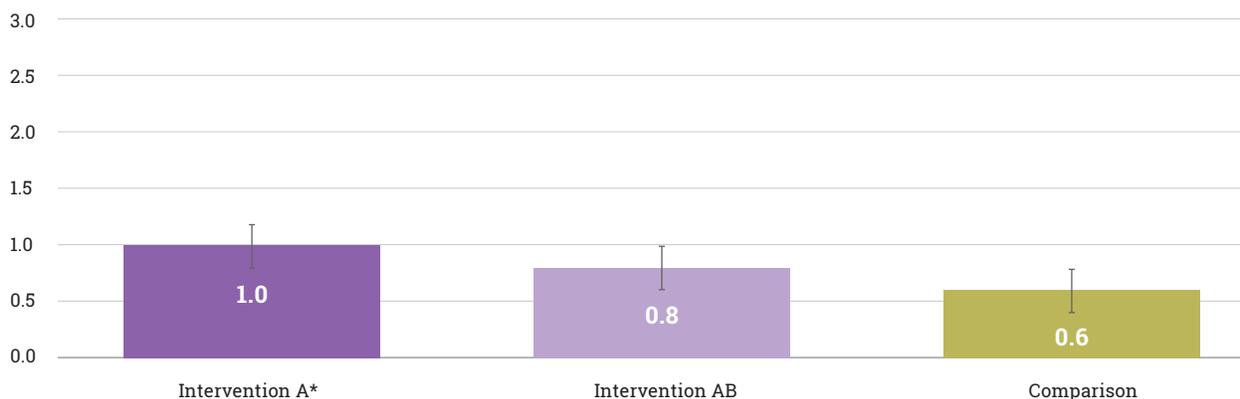
The percentage of students receiving zero scores on the reading comprehension subtask at endline is presented in Figure 15. **The percentages of students who received zero scores on the reading comprehension subtask at endline were statistically significantly different across groups.** Specifically, 25.8 percent of students in intervention A, 29.7 percent of students in intervention AB, and 38.7 percent of students in the comparison group received zero scores on the reading comprehension subtask at endline. The proportion of students receiving zero scores was higher than expected in the comparison group.

Figure 15: **Percentage of Students Receiving Zero Scores by Group at Endline—Reading Comprehension (%)**[34]
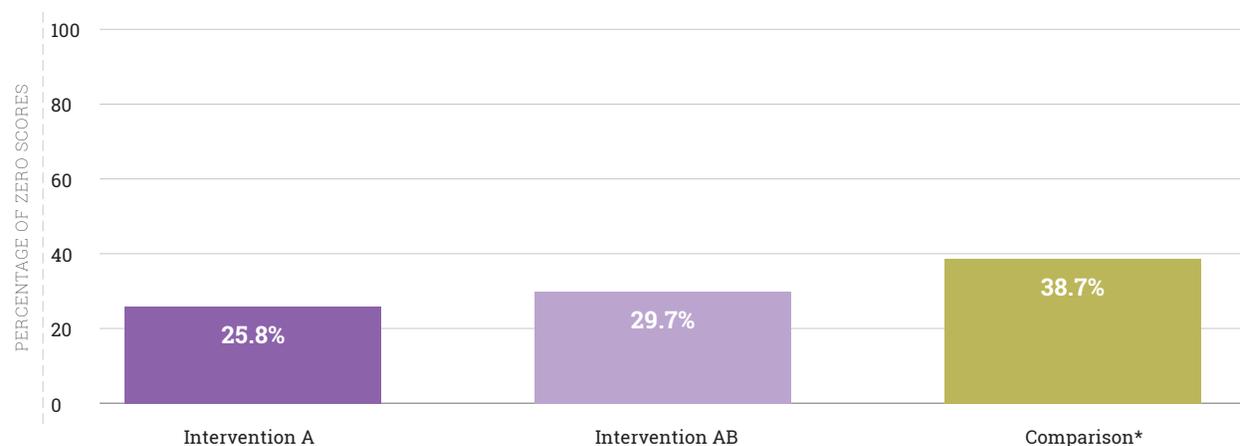
Listening Comprehension

The untimed listening comprehension subtask measures students' ability to comprehend the meaning of a story read to them orally. Students do not need to know how to read to answer listening comprehension questions. As a result, this subtask is an important measure of students' pre-reading abilities because it helps detect obstacles to learning to read, such as limited language proficiency, auditory problems, attention deficit, and other difficulties. In this subtask, the assessor reads a short passage to the student and asks him or her to answer comprehension questions based on what he or she heard. Results for this subtask are presented as the number of questions correctly answered out of five.

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33   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at p<0.05. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

34   An asterisk (*) indicates that the proportion of zero scores observed at endline was statistically different from what was expected in the data at p<0.05. The chi-square test of significance indicated that the proportions of students observed receiving zero scores at endline in intervention groups A and AB were not statistically significantly different from what was expected in the data. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

Average gain scores for the listening comprehension subtask are presented in Figure 16. Though students in across groups increased their listening comprehension score from baseline to endline, **the gains of students in intervention A were statistically significantly greater than the gains of comparison group students.** Intervention A students correctly answered, on average, 0.7 additional listening comprehension questions at endline than at baseline, in contrast to 0.4 additional questions correctly answered by students in the comparison group. Intervention AB students correctly answered, on average, 0.5 additional questions at endline than at baseline. There was no statistically significant difference in the gains obtained by intervention A and AB students. Moreover, there was no statistically significant difference in the gains obtained by intervention AB and comparison group students.

Figure 16: **Average Gain Scores from Baseline to Endline by Group—Listening Comprehension**[35]
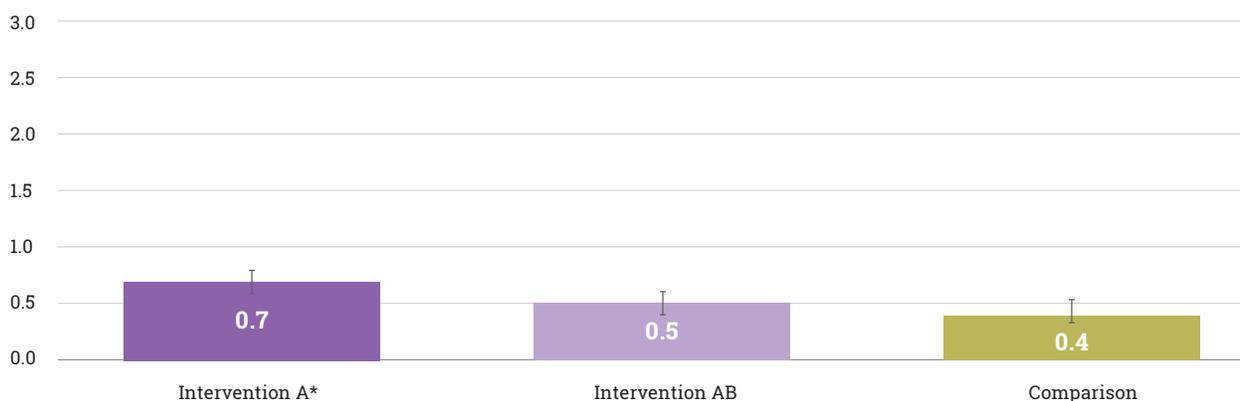
The percentage of students receiving zero scores on the listening comprehension subtask at endline is presented in Figure 17. The proportions of zero scores at endline across the three groups were not significantly different, meaning the proportion of students who were unable to correctly answer a single listening comprehension question at endline were comparable across groups.

Figure 17: **Percentage of Students Receiving Zero Scores by Group at Endline—Listening Comprehension (%)**[36]

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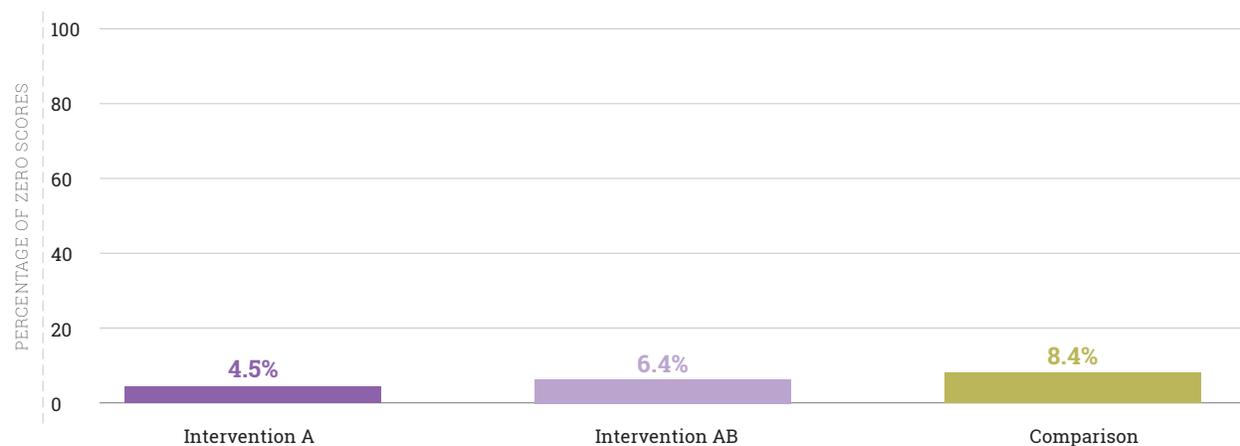
35   An asterisk (*) indicates the gain score for intervention A students was statistically significantly greater than the gain score for the comparison group at $p<0.05$. *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

36   *N* sizes: Intervention A *n*=221; Intervention AB *n*=236; Comparison *n*=225.

EGRA Results by Subgroup

Results in this section answer the ACR GCD supplemental question *How did the project influence certain subsets of the student population more than others based on identifiable contextual factors?* Specifically, the analysis was conducted to understand variation in student performance based on gender and grade.

Gender

Student gains and zero scores were analyzed to determine if there were any differences in performance between girls and boys in intervention A, intervention AB, and the comparison group. As shown in Table 1, 355 girls and 327 boys completed the baseline and endline EGRA. Gain scores for girls and boys are presented by group in Figure 18, and the percentages of girls and boys who received zero scores are presented by group in Figure 19 (see Annex D.9 for detailed results).

Figure 18: **Average Gain Scores from Baseline to Endline by Gender and Group**[37]
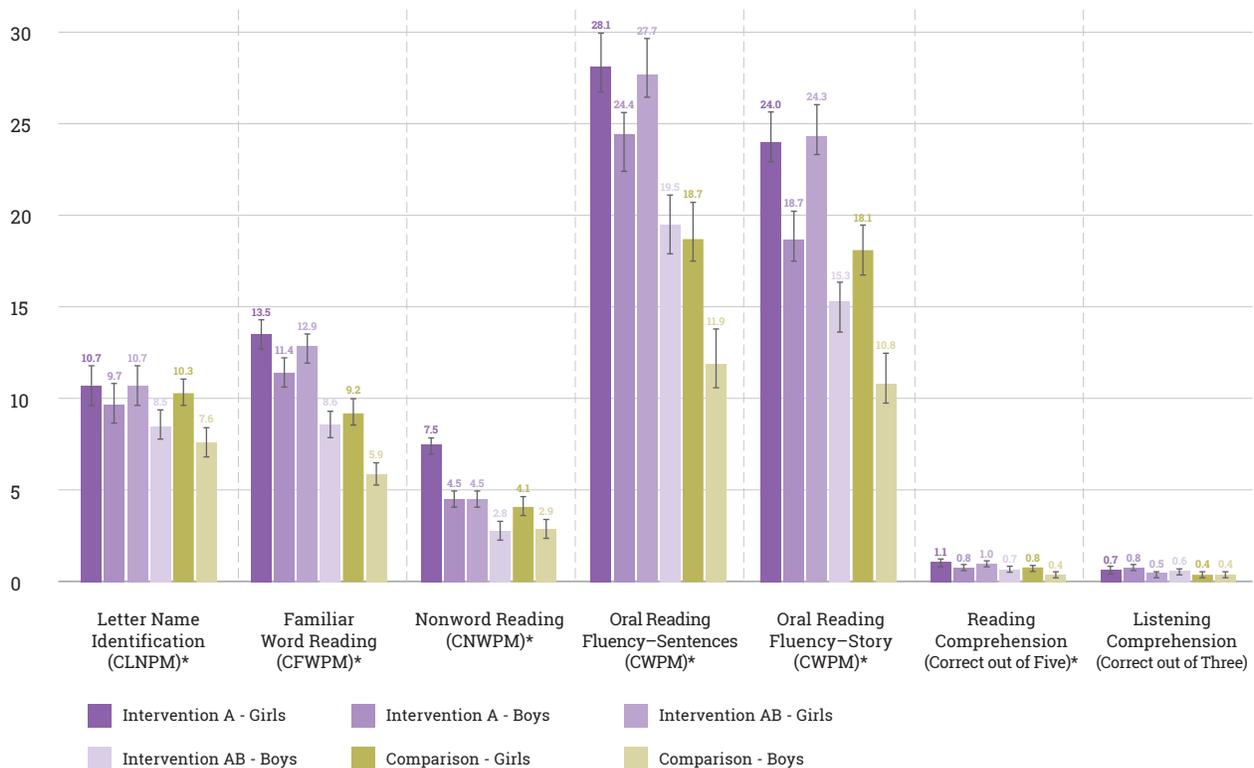
The average gains by gender within the groups—for example, between intervention A girls and boys or intervention AB girls and boys—were not significantly different. This indicates that the E4K project did not appear to benefit girls or boys differently; **in other words, girls and boys within each project group benefitted equally.** When looking across all groups, a secondary finding of the analysis is that, when all groups are combined, girls had statistically significant greater gains on all subtasks than did boys, except on the listening comprehension subtask. There was no statically significant difference between gain scores by gender on the listening comprehension subtask (see Annex Table D.7). This indicates that, overall, girls had greater increases in literacy skills over the academic year than did boys, which suggests an underlying difference in girls' and boys' performances, regardless of group or exposure to the E4K project components.

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[37] An asterisk (*) indicates the subtask gain score for all girls was statistically significantly greater than the gain score for all boys at p<0.05. *N* sizes: Intervention A: Girls *n*=120, Boys *n*=101; Intervention AB: Girls *n*=114, Boys *n*=122; Comparison: Girls *n*=121, Boys *n*=104.

Figure 19: **Percentage of Students Receiving Zero Scores by Gender and Group at Endline (%)** [38]
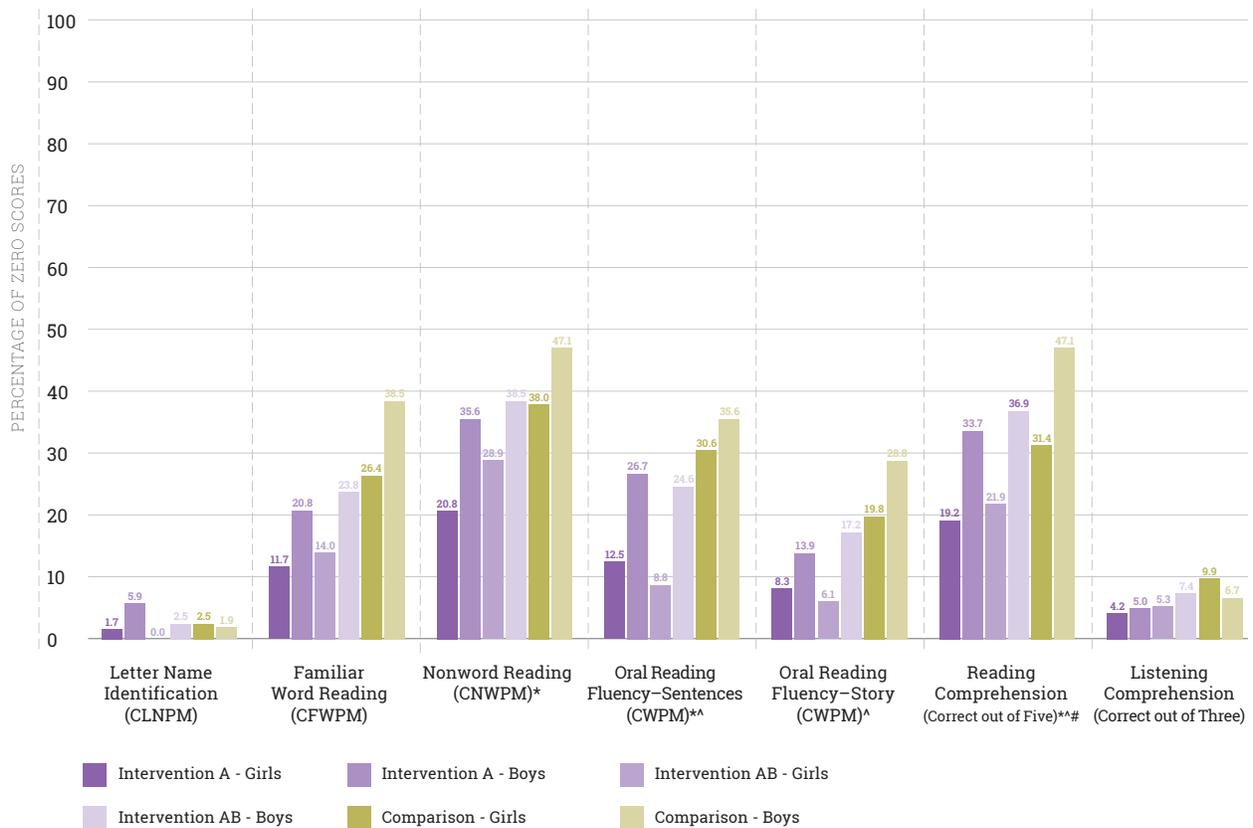
The proportions of girls and boys who received zero scores at endline by group are presented in Figure 20. The proportions of girls and boys within each grade receiving zero scores at endline were comparable on three subtasks: letter name identification, familiar word reading, and listening comprehension. The proportion of intervention A girls who received zero scores was statistically significantly smaller than the proportion of intervention A boys on two subtasks: nonword reading and ORF-sentences. The proportion of intervention AB girls receiving zero scores was statistically significantly smaller than the proportion of intervention AB boys who received zero scores on the ORF-story subtask. Finally, on the reading comprehension subtask, the proportion of girls who received zero scores was statistically significantly smaller than the proportion of boys for all three groups.

Grade

Student gains and zero scores were analyzed to determine if there were any differences in performance between students in Grade 2 and students in Grade 3 within intervention A, intervention AB, and the comparison group. Gain scores for Grade 2 and Grade 3 students are presented by group in Figure 20, and the percentages of Grade 2 and Grade 3 students who received zero scores are presented by group in Figure 21 (see Annex D.8 for detailed results).

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38   An asterisk (*) indicates a statistically significant difference in the proportion of zero scores of girls and boys in intervention A students at $p<0.05$. A caret (^) indicates a statistically significant difference in the proportion of zero scores of girls and boys in intervention AB students at $p<0.05$. A hash mark (#) indicates a statistically significant difference in the proportion of zero scores of girls and boys in each intervention group at $p<0.05$. N sizes: Intervention A: Girls $n=120$, Boys $n=101$; Intervention AB: Girls $n=114$, Boys $n=122$; Comparison: Girls $n=121$, Boys $n=104$.

Figure 20: Average Gain Scores from Baseline to Endline by Grade and Group[39]

Legend:
- Intervention A - Grade 2
- Intervention A - Grade 3
- Intervention AB - Grade 2
- Intervention AB - Grade 3
- Comparison - Grade 2
- Comparison - Grade 3
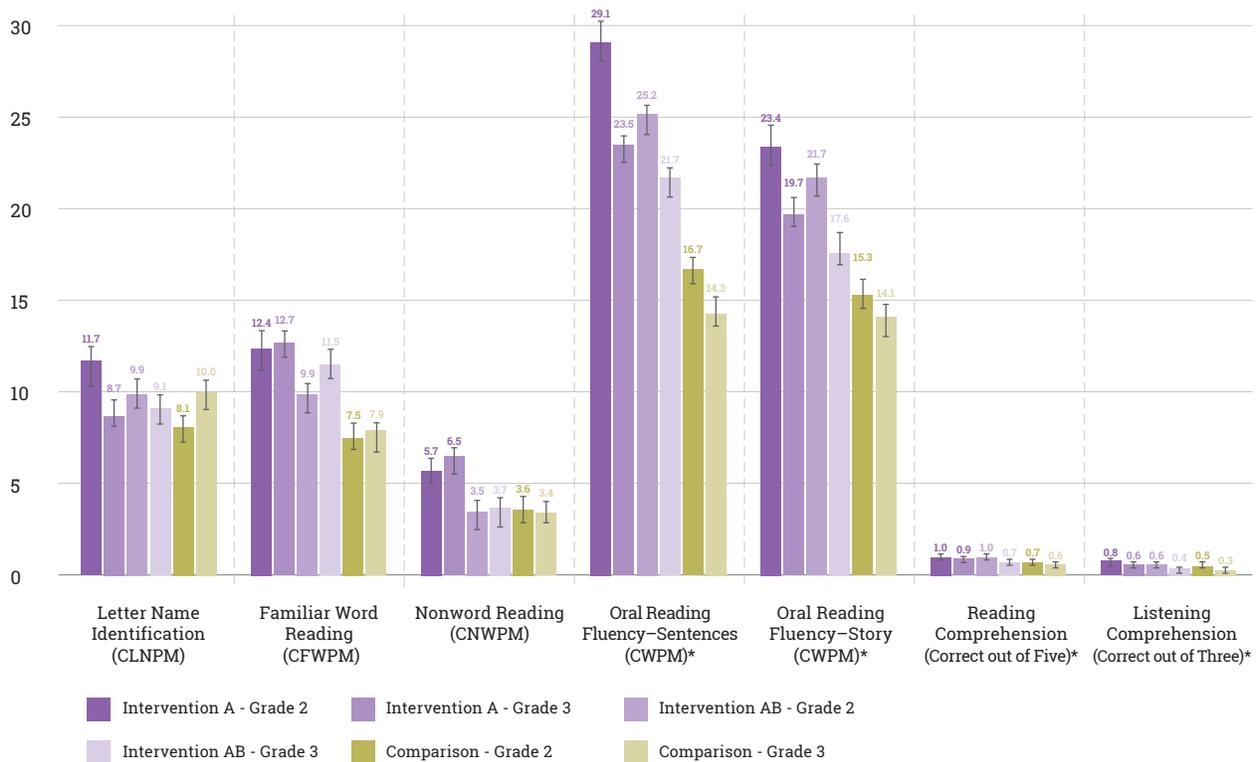
The average gains within the groups did not significantly differ by grade; students in Grades 2 and 3 in each group—intervention A, intervention AB, and comparison—performed comparably. When looking across groups, a secondary finding of the analysis is that Grade 2 students, of all groups combined, had statistically significantly greater gains than did Grade 3 students, of all groups combined, on four subtasks: ORF-sentence, ORF-story, reading comprehension, and listening comprehension (see Annex Table D.9). This indicates that, overall, Grade 2 students had greater increases in literacy skills over the academic year than did Grade 3 students and suggests an underlying difference in Grade 2 and Grade 3 students' performance, regardless of group or exposure to the E4K project components, potentially due to ceiling effects for Grade 3 students.

The percentages of Grade 2 and Grade 3 students who received zero scores at endline are presented by group in Figure 21. Within all groups, there was no statistically significant difference in the proportions of Grade 2 and Grade 3 students who received zero scores at endline; however, within each group, differences were observed. Among intervention A students, the proportion of Grade 3 students who received zero scores was statistically significantly smaller than the proportion of Grade 2 students who received zero scores on three subtasks: letter name identification, ORF-story, and reading comprehension. Among intervention AB students, the proportion of Grade 3 students receiving zero scores was significantly smaller than the proportion of Grade 2 students who received zero scores on the nonword reading and ORF-story subtasks. Among comparison group students, the proportion of Grade 3 students who received zero scores was significantly lower than the proportion of Grade 2 students on five out of seven subtasks.

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39   An asterisk (*) indicates the subtask gain score for all Grade 2 students was statistically significantly greater than the gain score for all Grade 3 students at $p<0.05$. N sizes: Intervention A: Grade 2 $n=112$, Grade 3 $n=109$; Intervention AB: Grade 2 $n=119$, Grade 3 $n=117$; Comparison: Grade 2 $n=113$, Grade 3 $n=112$.

Figure 21: **Percentage of Students Receiving Zero Scores by Grade and Group at Endline (%)** [40]

	Letter Name Identification (CLNPM)*	Familiar Word Reading (CFWPM)^#	Nonword Reading (CNWPM)#	Oral Reading Fluency−Sentences (CWPM)#	Oral Reading Fluency−Story (CWPM)*^#	Reading Comprehension (Correct out of Five)*#	Listening Comprehension (Correct out of Three)
Intervention A - Grade 2	6.3	19.6	28.6	23.2	15.2	33.9	6.3
Intervention A - Grade 3	0.9	11.9	26.6	14.7	6.4	17.4	2.8
Intervention AB - Grade 2	1.7	24.4	39.5	21.8	16.0	34.5	9.2
Intervention AB - Grade 3	0.9	13.7	28.2	12.0	7.7	24.8	3.4
Comparison - Grade 2	2.7	43.4	51.3	42.5	32.7	48.7	9.7
Comparison - Grade 3	1.8	20.5	33.0	23.2	15.2	28.6	7.1

VIII. Key Factors for Success

Results in this section further answer the ACR GCD supplemental question *How did the project influence certain subsets of the student population more than others based on identifiable contextual factors?* Specifically, the analysis was conducted to understand variation in student performance based on their school and the amount of exposure and dosage of the E4K project they received. Results are from the student questionnaire also presented.

Project Exposure and Dosage

Though the E4K project was unable to collect reliable student-usage data from the SmartBooks server due to internet connectivity issues and programming challenges, librarians tracked student attendance at SmartBooks sessions from February to June 2017. Average student usage in minutes by school is presented in Figure 22.[41] On average, across schools, students spent 920 minutes—or 15.3 hours—in SmartBooks sessions at their libraries from February to June 2017. Across intervention A schools, students spent an average of 774 minutes—12.9 hours—in SmartBooks sessions, while students in intervention AB schools spent an average of 1,058 minutes—17.6 hours—in SmartBooks sessions. The highest exposure was at an intervention AB school, where students spent an average of 1,303 minutes—or 21.7 hours—in SmartBooks sessions. The three schools that averaged the lowest number of minutes of exposure were all intervention A schools (see Annex Table G.2).

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40 An asterisk (*) indicates a statistically significant difference in the proportion of zero scores of Grade 2 and Grade 3 students in intervention A at $p<0.05$. A caret (^) indicates a statistically significant difference in the proportion of zero scores of Grade 2 and Grade 3 students in intervention AB at $p<0.05$. A hash mark (#) indicates a statistically significant difference in the proportion of zero scores of Grade 2 and Grade 3 students in the comparison group at $p<0.05$. *N* sizes: Intervention A: Grade 2 $n=112$, Grade 3 $n=109$; Intervention AB: Grade 2 $n=119$, Grade 3 $n=117$; Comparison: Grade 2 $n=113$, Grade 3 $n=112$.

41 Minutes per student were calculated by the number of literacy sessions attended by the student multiplied by the number of minutes per session. The amount of time students actually spent on the app was not available.

Figure 22: **Average Student SmartBooks Dosage by Intervention School (Minutes)**
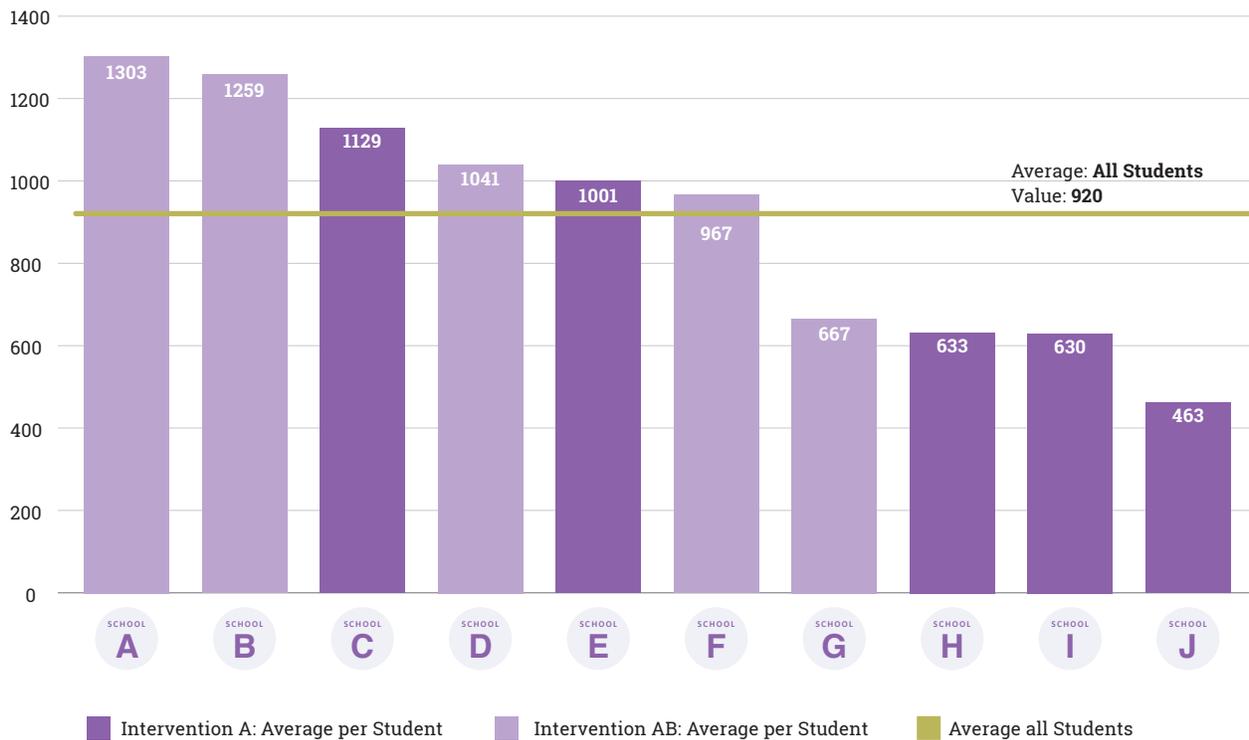
A correlation analysis using student reading outcomes was conducted to determine if there is a relationship between gains and average exposure to the SmartBooks app. **The analysis revealed a weak but statistically significant relationship between minutes of exposure to SmartBooks per student and EGRA gains on all subtasks except listening comprehension; this indicates that students who had more exposure to SmartBooks tended to have greater gains on these subtasks** (see Annex Table E.1).

Student Questionnaire Composites

To better understand the factors that may have influenced changes in students' EGRA scores from baseline to endline, questions from the student questionnaire were compiled into six composites, or groups of questions related to each other. Each composite consists of a series of items related to a specific theme that may have affected students' early grade reading skill acquisition; composites were then assigned a maximum score equal to the total number of items in the composite.[42]

The composites for the E4K project include:

1. Language exposure

2. Socioeconomic status

3. Family reading support

4. Teacher reading support

5. Disposition to reading

6. Engagement in program

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42   Non-responses were given a "0."

Descriptive statistics for the student questionnaire composites are presented in Table 6 (see Annex C for full composite questions, response options, and frequencies). In general, the average composite scores of students in the intervention and comparison groups were comparable.

Table 6: **Average Student SmartBooks Dosage by Intervention School (Minutes)**

Composite	Intervention A			Intervention AB			Comparison			All Students		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Language exposure	214	5.9	0	234	5.9	0	220	5.8	0	668	5.9	0
Socioeconomic status	218	8.1	1.18	230	7.8	1.43	222	7.3	1.64	670	7.7	1.47
Family reading support	221	3.3	1.3	234	3.1	1.51	222	3.1	1.36	677	3.2	1.4
Teacher reading support	218	2.4	0.73	234	2.3	0.74	225	2.5	0.58	677	2.4	0.69
Disposition to reading	221	2.4	0.42	233	2.4	0.53	224	2.4	0.45	678	2.4	0.47
Engagement in program	215	6.7	0.74	228	6.6	1.04				443	6.7	0.91

Students in the intervention groups indicated interest in using SmartBooks. **While only 40.4 percent of students reported reading stories on a phone or tablet before using SmartBooks, 97.1 percent of students in the E4K project reported that they liked using SmartBooks to learn and expressed an interest in continuing to use SmartBooks even after the school year ends.**

The composites and student reading gains were examined to determine if there was a relationship between these composites and student reading outcomes. **The correlation analysis revealed several weak but statistically significant relationships between the composites and gains on reading subtasks** (see Annex Table E.2). Specifically, students with higher scores on the family reading support composite or with higher scores on the disposition to reading composite tended to have greater gains on all subtasks, except the listening comprehension subtask. Also, students with lower scores on the socioeconomic status composite tended to have smaller gains on the familiar word reading, nonword reading, ORF-sentences, ORF-story, and reading comprehension subtasks. Finally, students with higher scores on the engagement with the program composite tended to have greater gains on the letter sound knowledge, familiar word reading, and nonword reading subtasks. While the language exposure and teacher support for learning composites had statistically significant relationships with several subtasks, those relationships were very weak; the correlations had values less than 0.1.

IX. Scalability

Stakeholders are increasingly interested in assessing the scalability of interventions in addition to their results or impacts. To scale up a project means to expand, replicate, adapt, and sustain a successful project in a new geographic area and to reach more beneficiaries over time.[43] ACR GCD grantees have implemented small-scale pilot projects, and an important consideration after each project is the feasibility of replicating or expanding the technology-based innovation and project models to a different or larger population or area.

To inform this decision, STS conducted a scalability assessment guided by the following research question: *Are this project and technology suitable for scaling?* STS used an indirect approach that relies on qualitative descriptions of project performance around seven parameters of sustainability:

- Credibility
- Observability
- Relevance
- Relative advantage
- Ease of transfer and adoption
- Testability
- Sustainability of funding

The seven parameters were adapted from the USAID-funded Scalability Assessment Tool developed by Management Systems International.[44] The tool includes seven sections and 28 questions. STS used data from EOP interviews, EGRA results, literature reviews, and project M&E to assess scalability parameters. These results are meant to inform local program staff, stakeholders, and donors about key considerations before scaling the E4K project's model and technologies to a larger or different beneficiary population.

Credibility

An intervention or innovation must be credible to be supported and taken to scale through either replication or expansion. This aspect of scalability assesses if various stakeholders—including potential adopters, funders, implementers, and beneficiaries—believe that the model has a strong evidence base that may include existing empirical research or anecdotal information.

> **?** **Key Considerations:**
> 1. What evidence was used to develop the intervention?
> 2. What evaluations have been conducted on the intervention?
> 3. In what social contexts does the intervention work?
> 4. What individuals and institutions support the intervention?

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43 Cooley, L., & Linn, J. F. (2014). Taking Innovations to scale: *Methods, applications and lessons.* Results for Development Institute. Washington, D.C. Retrieved from https://www.usaid.gov/sites/default/files/documents/1865/v5web_R4D_MSI-BrookingsSynthPaper0914-3.pdf

44 Cooley, L., & Linn, J. F. (2014). *Taking innovations to scale: Methods, applications and lessons.* Results for Development Institute. Washington, D.C. Retrieved from https://www.usaid.gov/sites/default/files/documents/1865/v5web_R4D_MSI-BrookingsSynthPaper0914-3.pdf

KAPE based the E4K project's literacy innovations on empirical research and field-tested approaches from contexts within and outside of Cambodia. The use of basal e-books to facilitate early grade reading, while relatively new in Cambodia, has been tested in other countries; their success is well-documented. Advantages of basal e-books include systematic and logical sequencing of reading content, smooth transition from emergent to advanced reading, and appropriate tools to assess children based on their reading level.[45] Studies have found that using e-books—with features like audio narration, sound effects, and animation—are effective in helping young children to decode new words and improve reading comprehension.[46] Evidence has indicated that these interactive features can enhance students' motivation to read; the ability to advance at their own pace may build confidence and promote self-learning for students who feel intimidated or shy in the classroom.

As the E4K project is a new implementation model, no evaluations have yet been conducted on the intervention. Although there is limited empirical evidence of the effectiveness of e-books in Cambodia, given that they are new to the country, anecdotal findings from the TRAC project indicate improvements after exposure to the literacy content via an app. KAPE drew from its knowledge of the utility of literacy support through apps in its development of the E4K project.

The E4K project has the potential to be replicated in specific contexts throughout Cambodia. In its pilot year, the project was implemented in urban and rural contexts in the Kampong Cham province. Based on previous experiences with in-school interventions, KAPE chose to implement the E4K project only within well-managed schools; it is not clear to what extent the project could be implemented in schools with less strong management, lack of library space, or lack of librarians. The SmartBooks app can run in both on- and offline contexts and can be operated on tablets or smartphones. In fact, KAPE released selected e-books from the SmartBooks app through the Google Play store, and project management reported more than 4,000 downloads. It is possible that the SmartBooks app could be utilized out of school as a supplement to classroom instruction, though it is unclear if the penetration of mobile devices with enough memory to accommodate the app is sufficient for this to be a viable replication model.[47] Nevertheless, given that Khmer is the language of instruction throughout Cambodia, the project has the potential to be replicated nationally.

The E4K project has wide institutional support; it proved popular with school directors, teachers, and students. KAPE developed the project in collaboration with the MoEYS officials, who noted that the project had the capacity to support learning initiatives in schools. Their support was further solidified by the use of ministry-approved standard content on the app and by the engagement of officials in the content analysis and leveling of e-books. Furthermore, though teachers and librarians expressed that the project added to their workload, they were enthusiastic about the potential of the SmartBooks app as a support for their classroom instruction. School directors supported the intervention, as well.

✓ **Credibility Conclusion**

The E4K project has strong credibility. The intervention was based on evidence from different country contexts of the utility of basal e-books as a way of providing a differentiated learning experience for students developing their reading skills. KAPE leveraged pre-existing relationships with the MoEYS to solidify support for the intervention. Credibility for more widespread scale-up would be strengthened by researching how the SmartBooks app could be used in less well-managed schools.

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45   Kampuchean Action for Primary Education. (2014). *E-books for Khmer (E4K): Using Technology to Create Differentiated Literacy Structures in and out of the Classroom.* (Unpublished proposal for funding)

46   Kampuchean Action for Primary Education. (2014). *E-books for Khmer (E4K): Using Technology to Create Differentiated Literacy Structures in and out of the Classroom.* (Unpublished proposal for funding)

47   The app required 597MB and operating-system version 4.4 or above for Android devices; 703MB for and operating-system version 8.0 or later for Apple devices. See the https://play.google.com/store/apps/details?id=org.kape.smartbooks and https://itunes.apple.com/us/app/khmer-smart-books/id1237059482?ls=1&mt=8 for additional information.

Observability

For an intervention or innovation to be scaled, it should have observable results that show efficacy or impact. Observability of results is key to providing non-technical audiences with proof that an intervention or innovation achieved its intended outcomes and therefore will have positive impacts on beneficiaries.

? **Key Considerations:**

1. Are the results visual and observable?

2. What, if any, is the relationship between results and the intervention?

3. Is there any emotional appeal associated with the evidence?

Results of the first evaluation of the E4K project are promising. EGRA gain scores show that students who had access to the SmartBooks app significantly outperformed their peers across the reading spectrum. Specifically, from baseline to endline, students in intervention A—those who had access to SmartBooks—gained 4.8 CFWPM and 2.6 CNWPM more than students in the comparison group who did not have access to the project's components. Furthermore, intervention A students gained 26.4 and 21.6 CWPM on the ORF-sentences and ORF-story subtasks, respectively, in contrast with gains of 15.5 and 14.7 CWPM on those subtasks by students in the comparison group. Students in intervention AB—who had access to SmartBooks and whose teachers received training in DI—had statistically significantly greater gains on the familiar word reading, ORF-sentences, and ORF-story subtasks. These results indicate an observable relationship between improved early grade reading skills and the E4K project intervention. Given the nonequivalence of groups at baseline, additional research could be conducted to validate the findings of this evaluation and ensure that gains were not a result of intervention students having higher literacy skills at baseline.

It is also unclear what added value the DI training component provided to students in intervention AB schools. Although students in these schools outperformed comparison group students on three subtasks, the average gain scores for intervention AB students were lower than were those for intervention A students on the nonword reading subtask and comparable on the other six subtasks. As KAPE project management noted, FOI of the DI component of the project was low; more research could help explore any potential added value of providing in-person training to teachers on DI.

There is emotional appeal associated with the evidence. School directors, teachers, and librarians anecdotally believed that the project improved students' reading skills. In EOP interviews, teachers and librarians said that they noticed changes in students' participation and engagement in classroom activities, and they reported that students were more social with other teachers and their friends when they were using the tablets. One teacher mentioned that she had seen improvements in students' reading scores on tests they took in the classroom.

✓ **Observability Conclusion**

The observable results of the E4K project support potential scale-up. Students who participated in the intervention had statistically significantly greater reading gains than students who did not, though this impact seems to be mostly associated with the SmartBooks component of the project. Future research could further strengthen the observability and relationship between the E4K project intervention and reading gains by ensuring equivalence of groups at baseline and by strengthening FOI of the DI component.

Relevance

An intervention must be relevant to the context in which it is being implemented to be scalable. It should effectively address a problem that is recognizable and considered important by stakeholders.

? Key Considerations:

1. What is the level of significance of the problem that the intervention is trying to address?
2. Does the intervention address a priority on the policy agenda for potential adopters?
3. Does the intervention address a need felt by the potential beneficiaries?

Evidence indicates a strong need for early grade reading support in Cambodia. A World Bank study from 2012 found that about 26.0 percent of students read below grade level in Grade 1, while other statistics show that only 53.0 percent of Grade 3 students read at grade level.[48,49] While new, standardized textbooks introduced by the MoEYS in the previous academic year appear to improve quality of instruction—and, as a result, early grade reading skills—these initiatives do not fully elevate students to grade level. Quality of education indicators from the Education for All *Global Monitoring Report 2010: Reading the Marginalized* ranked Cambodia 119 out of 129 countries in terms of quality of education and noted that students' dropout rates remain a challenge.[50] National statistics indicate that girls outperform boys across all subjects in the early grades and have lower rates of grade repetition.[51] These findings were corroborated by KAPE's own research through the TRAC project, which observed that girls had higher reading performance than boys.[52]

Early grade reading improvement is a policy priority for the MoEYS and other large donors operating in Cambodia; however, it is unclear to what extent these organizations see ICT as a mechanism to solving the reading skills gap in the country. The MoEYS has focused on quality of education through redesigning curriculum and textbooks—including for Khmer reading instruction—and teacher training. In 2010, the MoEYS, in collaboration with Room to Read and Save the Children, developed materials to populate textbooks for teaching and learning of reading and writing in Khmer in Grades 1 through 3.[53] USAID/Cambodia, RTI International, and World Vision Cambodia are currently focused on improving early grade reading through textbook improvement and teacher and ministry capacity building and training.[54] Although MoEYS officials and school directors noted in EOP interviews the importance of ICT and electronic content, there does not appear to be an official policy regarding the use of technology in primary schools in Cambodia. The STS team observed that there were, at maximum, a few computers per intervention school that are used for administrative purposes only. Schools did not have ICT for student use.

The E4K project approach—introducing standard textbook content in leveled, electronic format—is a novel idea in Cambodia. It is unclear if beneficiaries recognized the relevance or importance of the differentiated approach before implementation. In EOP interviews, school directors articulated the importance of introducing ICT for educational use in their schools, but they did not have funds to procure equipment. School directors, teachers, and librarians all noted that the SmartBooks app provided an opportunity for struggling students to become more engaged in reading and to improve literacy skills; they also expressed that the students were excited about reading due to the interactive nature of the content. Many of the teachers and librarians interviewed shared the desire to have e-books with stories beyond just the standard textbook content to supplement classroom literacy instruction.

48   World Bank, (2012). *Summary report on the early grade reading assistance program in Cambodia,* Phnom Penh: MoEYS.

49   USAID. (2017, July 20). *Our work: Education.* Retrieved from https://www.usaid.gov/cambodia/education

50   United Nations Educational, Scientific, and Cultural Organization. (2010). *Education for all global monitoring report 2010: Reaching the marginalized.* Paris: UNESCO.

51   European Mathematical Information Service (2013) *Education statistics and indicators,* Phnom Penh: MoEYS.

52   Kampuchean Action for Primary Education. (2014). E-books for Khmer (E4K): *Using technology to create differentiated literacy structures in and out of the classroom.* (Unpublished proposal for funding)

53   UNESCO. (2015). *Promising practices in the Asia-Pacific Region: Cambodia early reading and writing.* Bangkok: UNESCO.

54   USAID. (2017, July 20). *Our work: Education.* Retrieved from https://www.usaid.gov/cambodia/education

Relative Advantage

Relative advantage relates to whether the intervention offers an improvement over current or alternative solutions to the problem.

? **Key Considerations:**
1. How adequate are the current solutions for the problem?
2. Is this intervention more effective than the current solution?
3. Is this intervention more effective than other innovative models established?

As mentioned in the previous section, many donors and INGOs in Cambodia are focused on improving early grade reading through teacher capacity building or updating curriculum and textbooks. There is evidence that these approaches have positive outcomes: after the introduction of new standard textbooks in 140 schools in 2010, a 2012 EGRA showed improved reading skills.[55] However, it is unclear if these approaches benefit all students equally. In fact, given the proportion of students in Grades 1 and 3 who still read below grade level, it is possible that teacher-level approaches do not contribute to equal improvements for students of different reading abilities.

If this is indeed the case, the E4K project model has the capacity to effectively complement MoEYS and donor-supported interventions. Class sizes in Cambodia are large, with many classrooms having a student-to-teacher ratio of more than 50 to one. In these contexts, it is difficult for teachers to provide a learning experience that fits all students' needs. The differentiated approach of the E4K project—both through SmartBooks and training in DI—provides teachers with the tools to give students an individualized learning experience appropriate for their level and pace of advancement. A key advantage of the SmartBooks app over existing solutions is its multi-modal approach, which allows for students to read and listen, thus supporting their ability to pronounce new words.

Although some INGOs, such as Room to Read, focus on producing reading content for primary students, and others, like Aide et Action International, are producing apps to encourage pre-reading and foundational reading skills, there does not appear to be another organization in Cambodia that is combining technology, DI, and basal e-books. One of the E4K project's key relative advantages is its ability to complement in-class instruction and give students the ability to learn at their own pace. Given the lack of empirical evidence on the efficacy of other innovative models, it is unclear if the E4K project results in better reading outcomes for primary school students; however, the results of this evaluation indicate that exposure to the intervention produce statistically significantly greater reading gains than access to classroom instruction and standard print textbooks alone. The E4K project team noted that to better support all students' reading levels, the SmartBooks app could also include activities and materials that focus on pre-reading skills development.

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55   UNESCO. (2015). *Promising practices in the Asia-Pacific region: Cambodia early reading and writing.* Bangkok: UNESCO.

✓ **Relative Advantage Conclusion**

The E4K project model, particularly the SmartBooks app, is a strong complement to current solutions and approaches to early grade reading skills development in Cambodia. There is a multitude of other interventions in Cambodia that focuses on different skills development and different levels of the education system, and KAPE has developed a model that supports these existing approaches in an innovative way. Although the E4K project may not be a substitute for current solutions, it has the capacity to contribute to more equitable improvements for primary school students of different reading levels.

Ease of Transfer and Adoption

Ease of transfer and adoption relates to whether the characteristics and components of the intervention lend themselves to being adopted by organizations other than the original implementer. This parameter of scalability looks at how complex or resource-heavy an intervention is, as well as whether specific elements of the intervention may be deemed inappropriate or unattractive to other implementers.

? **Key Considerations:** [56]

1. What is the level of technical sophistication of the components and activities of the intervention?
2. What is the level of complexity of the intervention?
3. What level of supervision and monitoring is needed?

The development of the E4K project required high levels of technical expertise in literacy, Khmer language, and information technology. KAPE leveraged its internal capacity in these areas and partnered with MoEYS officials and Cambodian app developers to create the e-books and the SmartBooks app. This was an intensive process that required significant investments of time and resources and, ultimately, delayed the rollout of the implementation. Given that the app is stable and that the e-books are now uploaded, it is likely that adoption by a different organization would require less technical expertise. If, however, an adapter decided to incorporate textbook content from grades other than Grades 2 or 3, the organization would need to consider the lessons learned by KAPE during the development of new content and app updates, and budget time and resources accordingly. In EOP interviews, some teachers and librarians expressed discomfort with technology and noted that they would have liked more intensive training on how to use and troubleshoot the tablets. Students, however, did not appear to have any trouble learning how to use the tablets and app. In the case of replication of the model, organizations should take into account Cambodian teacher's low-ICT literacy levels, particularly those who have been in the profession for a number of years.

The SmartBooks component of the E4K project is relatively straightforward. The project only required that teachers and librarians offer two SmartBooks sessions per week to Grade 2 and 3 students. These educators had the ability to offer the sessions at the time that worked best for their instruction timetables. As schools did not receive one tablet per student, but rather one tablet per every four or five students, some librarians organized students into groups who rotated turns with the app. In other schools, teachers sent small groups of students to the library to use the app. When they finished, teachers sent another group of students from the same class to the library for their turn. This flexibility allowed each school to adapt this component of the project to fit their needs. No major challenges in delivering the SmartBooks sessions were reported.

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[56]   In the original tool, this section includes 11 questions. This analysis includes the questions deemed most relevant for the intervention model and context.

In contrast, the DI component of the project is complex to implement, as noted by KAPE project management and teachers. Project management and teachers expressed that the DI manual was lengthy and complicated. In EOP interviews, teachers said that the reading corners and training on DI allowed them to understand students' different reading levels and create different reading groups; however, they expressed limitations with the physical DI requirements for their classroom, as the MoEYS did not allow them to change the layout of furniture for other classroom subjects. Nearly all teachers said the DI teaching strategies were difficult and that tracking individual students' progress through the profiles was too time-consuming. The E4K project team recognized that modifications to the DI component would be needed prior to replication or scaling.

During the pilot year of the E4K project, the KAPE team provided intense levels of supervision, M&E, and troubleshooting. The E4K project team provided support and technical assistance to teachers and librarians on the app and the tablets throughout the project, due to programming bugs as well as low levels of ICT literacy among teachers and librarians. Furthermore, because of poor connectivity and the inability to capture individual user data on the server, KAPE had to monitor students' progress manually, through attendance taken by librarians and site visits to schools. The E4K project team also provided follow-up support to teachers in intervention AB schools who were having difficulties implementing the DI component of the project, or for new teachers who were not trained at the beginning of the project. Although it is likely that a new organization would have to provide some supervision, M&E support, and troubleshooting if the model were to be replicated, these levels would be lower than during the pilot year of implementation, particularly if the app were to be further improved.

✓ **Ease of Transfer and Adoption Conclusion**

The SmartBooks component of the E4K project could be relatively easy to transfer and adapt to a new organization, particularly if the new implementer did not require new content or add grade levels to the app. Supervision and M&E requirements for the SmartBooks component could also be lowered if efforts are made to strengthen the functionality of the app and improve the server's ability to capture student usage data in real time. The DI component of the project, however, was complex for KAPE to implement and for teachers to adopt. As a result, this component should be revised prior to adoption, replication, or scaling.

Testability

The testability parameter examines how easy it is for organizations to pilot the intervention on a small scale before full adoption. Testability assesses whether potential adopters would need to commit significant resources or time to test the model if they chose to pilot it in a new context.

? **Key Consideration:**

1. Can the model be tested on a limited scale?

The E4K project—specifically the SmartBooks component—could easily be tested on a limited scale before full adoption. The language of instruction throughout Cambodia is Khmer, and standard textbooks have been adopted nationally. Because of this, the SmartBooks app and its content are applicable throughout the 24 provinces of the country. Furthermore, this component does not require large investments in ICT infrastructure or technology; the primary cost would be the procurement of tablets to distribute in schools. If the DI component were to be tested again on a small scale, a potential adopter would most likely need to invest significant resources and time to test the approach and work with school administration to create buy-in.

Although replication of the E4K project in new areas of Cambodia would be relatively time- and cost-efficient, if the model were to be introduced into new languages, an adopter would have to invest heavily in developing new content and updating the app

✔ Testability Conclusion

Parts of the E4K project model—namely, the SmartBooks component—would not require significant investment in resources or time to pilot in a new context within Cambodia. However, if an adopter were to replicate the DI component or introduce the model into a new language, significant investments in development and piloting would be needed.

Sustainability of Funding

Sustainability of funding refers to how cost effective the intervention is and whether there are funds available to scale the intervention, either through government or other organizations.

? Key Considerations:

1. Is the model more cost-effective than other solutions?
2. What kind of funding commitment is required to scale the model?
3. Is there any potential for internal revenue from the model (i.e. service fees)?

No comprehensive cost-effectiveness analysis was conducted on the E4K project; instead, a cost analysis was performed to answer the supplemental research question *How much did the development, implementation, and management aspects of the project cost?* A cost analysis is often a component of scalability assessments, as it helps decision makers and stakeholders understand the feasibility of replication with given budgetary constraints. Because ACR GCD grantees implement new approaches, they often allot significant financial resources to developing new materials that could be used on a recurring basis. To better understand the funding requirements of the E4K project, a cost analysis was conducted to present the total cost of the intervention and to clarify the investments that would be needed for project replication or scale-up.

USAID guidance on conducting cost analyses on early grade reading projects suggests that the "ingredients method"[57] be used to calculate costs in the following categories:

- Management and associated technical costs
- Development costs
- Implementation costs

Project staff completed a costing template with guidance from World Vision and STS. Costs were outlined based on the activities from the project work plan, and each expenditure was classified based on the three categories listed above. The analysis used invoiced costs from the beginning of the project in fiscal year 2015 through June 30, 2017.

Table 7 provides a detailed breakdown of costs by category based on the E4K project's activities.[58,59]

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[57]   RTI International. (2015). Measurement and research support to education strategy goal 1: Early grade reading costing template and guidance. Washington, D.C.: USAID. Retrieved from http://pdf.usaid.gov/pdf_docs/PBAAF458.pdf

[58]   The total grant amount for the E4K project was $325,403, which included $25,476 in matching funds contributed by KAPE. As of June 30, 2017, the project had invoiced $305,244 and had $20,160 remaining in its budget.

[59]   Matching funds contributed by KAPE are included in the cost analysis.

Table 7: **Cost Analysis**[60]

Activity	Management	Development	Implementation
Activity 1: Conduct content analysis		$ 4,925	$ -
Activity 2: Develop interactive basal book		$ 13,534	$ -
Activity 3: Baseline testing and follow-up surveys		$ 9,542	$ 41,556
Activity 4: Develop and implement workshops for ICT usage in literacy		$ 37,020	$ 47,786
Activity 5: Differentiated classroom literacy structure established and in use		$ 12,948	$ 20,891
Total	$ **117,041**	$ **77,969**	$ **110,234**
Percentage of total (%)	**38.3**	**25.5**	**36.1**

The management category includes costs that are not directly related to implementation and are likely to vary widely based on who is overseeing the implementation of the intervention. **Management costs for the E4K project represented 38.3 percent of the costs expended** and included the cost of maintaining the project office in Kampong Cham; personnel salaries and expat costs associated with non-technical work; travel, lodging, and per-diem costs for technical consultants; and other indirect rates and fees.[61]

Development includes the costs related to the development of materials, survey instruments, programs, and other content that would not need to be redeveloped in the scale-up of a project. **The development costs for the E4K project represented 25.5 percent of the costs expended.** The major expenses within this category were associated with the development of the SmartBooks app, the content analysis, and the development of materials for the DI component of the project. These costs are one-off expenditures that would not be incurred if a project were implemented again with the same content.

The implementation cost category is arguably the most relevant for stakeholders who are considering scaling up a project or intervention. This category includes all of the recurrent activities and costs that would need to be expensed should the project be replicated, including: materials printing and distribution, training, M&E, events and presentations, workshops, and human resources activities. **For the E4K project, implementation costs represented 36.1 percent of the total project cost.** The primary costs within this category were related to the rollout of the SmartBooks app in schools and the training of teachers on DI, as well as a collection of M&E and EGRA data.

Projects sometimes benefit from in-kind services, institutional support, or preexisting relationships with stakeholders or governments that may provide the project with tangible benefits, although it may be difficult or impossible to monetize the costs. Examples of this include local volunteers, strong capacity or support from a large nongovernmental organization, or relationships with local governments that could ease logistics and procedures. Although KAPE did not receive any notable in-kind contributions that are excluded from the cost analysis, KAPE's strong technical capacity and longstanding relationships with the MoEYS should be considered as tangible benefits that may not be as accessible to potential adopters.

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60   Due to rounding, total sums may not equal the addition of each subpart.

61   Management costs may be inclusive of a 17.0% flat fee charged for Negotiated Indirect Cost Recovery Agreement.t

> ✓ **Scalability of Funding Conclusion**
>
> Management costs for the PCL project represented a larger proportion of the overall cost of the project than implementation or development costs. More rigorous cost and impact data should be collected to understand better the cost effectiveness of the model.

X. Conclusions

KAPE implemented the E4K project to increase Grade 2 and 3 students' reading proficiency in Khmer by providing standard reading textbook content in electronic, leveled, e-book formats. The SmartBooks app and tablets gave students the opportunity to learn through a differentiated approach, advancing through the e-books, games, and quizzes at a pace appropriate for their level and rate of learning. The project also provided training, materials, and furniture to teachers so they could incorporate DI techniques during classroom literacy instruction.

Certain components of the E4K project were more successful than others. Namely, SmartBooks appears to have helped students strengthen their skills across the reading spectrum; however, there were implementation challenges with the DI component, and findings suggest low uptake of the techniques in teachers' classrooms. Nevertheless, there is potential for replication and scale-up; observable results, credibility of the model with key stakeholders, and the ability of the project to be rolled out to other schools in Cambodia provide strong arguments for the scalability of the SmartBooks app.

The following are lessons that should be considered for any future interventions incorporating components of the E4K project.

Lessons Learned

> 📖 **There is potential for projects that use technology to deliver standard textbook content in leveled and interactive electronic formats.**

Although KAPE utilized existing content from MoEYS-approved textbooks, the team offered an innovative technology-based approach that provided students with a differentiated approach to learning. The E4K project team created three levels for each book. In addition, by adding games and quizzes to assess student achievement, the project gave students the opportunity to advance at their own pace. This innovative approach, which was previously untested, was supported by the MoEYS, school directors, and teachers who found the project to be a strong support to classroom literacy instruction. This innovative approach could also be explored outside of the Cambodian context in places where large class sizes limit teachers' ability to provide individualized instruction to students.

> ⚖️ **Scale-up of initiatives like the E4K project is particularly feasible if strong relationships are forged with ministries of education.**

KAPE capitalized on its preexisting relationship with the MoEYS, involving MoEYS officials in many steps of the project—including sample selection, content analysis, and book leveling. By ensuring MoEYS buy-in from the start of the project, KAPE was able to gain support for its implementation approach in the schools. Interestingly, MoEYS officials did not appear as supportive of the DI techniques in the classroom—some teachers said they were not able to change furniture set-up because of district MoEYS restrictions—which may indicate a preference for an approach that does not encroach upon established classroom instruction. Projects may find success in effectively engaging ministries by providing complementary reading supports to students that build upon standard instruction or teaching practices.

Projects should invest in successfully tracking dosage through technology.

The E4K project anticipated capturing and utilizing student dosage and game and quiz results through the SmartBooks app. However, technical challenges—including server issues and poor internet connectivity—limited their ability to access these data. Instead, the team relied on manual attendance records that, although useful, were not as accurate in assessing the relationships between students' SmartBooks dosage and reading outcomes. Furthermore, teachers were unable to easily use student performance on the SmartBooks app as a way to offer differentiated learning opportunities in the classroom. These tracking challenges, which have proven common across pilot technology projects for ACR GCD Round 2 grantees, could be addressed in future projects by allotting sufficient time to test and roll out technologies and providing easier ways for student-performance data to be used by projects and by teachers.

Research limitations—specifically, nonequivalence of groups at baseline—can hinder the ability of projects to demonstrate their impact conclusively.

Because intervention students performed better at baseline, it is not possible to conclusively state that their gains were the result of exposure to the project. Researchers and implementers should ensure strong dialogue during the research design and sample selection process, and assess comparability of groups based on observable characteristics prior to data collection.

Approaches that require significant deviations from standard teaching practices may be difficult for teachers to adopt.

As part of the E4K project, KAPE introduced teachers to techniques and tools to provide DI in their classroom. Although feedback from teachers indicated that they saw the potential in providing a differentiated learning experience for students of varying reading levels, the majority of teachers felt that the approaches were too time consuming, too challenging, or not in adherence to teaching requirements from school directors or MoEYS officials. The E4K project team recognized the complexity of the DI component of the project and also the need for school directors to be both highly supportive of these types of approaches and engaged in monitoring teacher adoption of the new practices. To alleviate these challenges, KAPE could explore ways of better engaging teachers in the use of SmartBooks, perhaps by encouraging teachers to use the app during classroom instruction.

Projects, such as the E4K project, that are given sufficient time to pilot their technology and improve upon its functionality can provide a better user experience—and greater impact.

The E4K project initially allocated seven months to developing the SmartBooks app and its content; however, there were significant delays in the development of these two elements of the project that necessitated a grant extension through an additional academic year. Although users and project management noted that there were still some bugs in the software during the implementation period, user experience was greatly improved as a result of KAPE having sufficient time to test and refine the technology component. App developers on the E4K project recommended a timeframe of one year to develop a quality app plus six months to test and finalize it.

Annexes

Annex A: **EGRA Instrument**

Enumerator Name	

Date and Time

Date	
Time	

ID

ID	

School Location

LID	
SchoolName	
InterventionType	
Cluster	
Commune	
District	
Province	

Consent

សួស្តី ខ្ញុំឈ្មោះ_____ហើយខ្ញុំរស់នៅ_____ ខ្ញុំចង់បុករប់បុអូន នូវព័ត៌មានខ្លះៗពីខ្លួនខ្ញុំ (ចំនួនសមាជិកគ្រួសារ ចំណង់ចំណូលចិត្ត ចំនួនមិត្តភក្តិៗល�។)

១. តើបុអូនឈ្មោះអ្វី ? តើបុអូនមានបងបុអូនប៉ុន្មាននាក់ ? (រង់ចាំសិស្សឆ្លើយតប បើសិស្សមិនឆ្លើយតប សូមស្ទូរទៅសំណួរទី២)។

២.តើបុអូនចូលចិត្តធ្វើអ្វីខ្លះនៅពេលបុអូននៅក្រៅសាលារៀន ?

សូមអានខាណុខខាងក្នុងមខ្ញុយពូដីមួបីទ្បួលហានការយល់ព្រមពីសិស្ស

ថ្ងៃនេះខ្ញុំចង់ដឹងអំពីសមត្ថភាពអានរបស់បុអូន ។ ប៉ុន្តែបុអូនអាចបដិសេធហានបើសិនមិនចង់ចូលរួម ។ យើង និងលេងលុបដែងអំណានជាមួយគ្នានាៗ ខ្ញុំនឹងខ្លុយបុអូនអានតួអក្សរ ពាក្យ លុបៈនិង រឿងខ្លីៗ។ ខ្ញុំនឹងកំណ ត់រយៈពេលដែលបុអូនត្រូវអានតាមផ្នែកនីមួយៗ។ លុបដែងអំណាននេៈមានរយៈពេលបុរហាលែពី២០ទៅ៣០នាទី ។ នេៈមិនមែនជាការប្រឡង ដាក់ពិន្ទុ ឬចំណាត់ថ្នាក់អ្វីទេ។ ជាថ្មីមួងទ្បៀតបើបុអូនមិនចង់ចូលរួម បុអូនអាចបរាប់ខ្ញុំហាន។ រាល់សំណួរដែលខ្ញុំសួរ បុអូនអាចមិនឆ្លើយក៏ហាន បើបុអូនមិនដឹង ឬមិនចង់ឆ្លើយ ។ តើបុអូនមានអ្វីចង់សួរខ្ញុំបួទ? តើយើងអាចចាប់ផ្តើមហានហើយឬនៅ ?

តើបុអូនយល់ព្រមដែរឬទេ ? ☐

Student Information

SID	
OID	
Name	
Sex	
Age	
BOD	
Grade	
Grade Name	

QIRR

គឺនេះជាIRRមនែដងែរឬទេ? (សូមចាប់ដៃគូរធ្លុចIRRមួយថ្ងៃងៃម្តែតង)

☐ ហទឬបាស   ☐ ទរ

Letter Name Version A

បង្ហាញបញ្ជីគ្នាអក្សរដល់សិស្ស។ ប្រាប់សិស្សថាទំព័រនេះមានពុយញជន: ស្រៈនិស្ស័យ និងស្រៈពេ្ញតួ ។ ប្ដូអូនគូរអានតួអក្សរនេះខ្ញុំយៗ ចុហាស់ៗ និងខ្ញុំយហានច្បី៍ន តាមដលែអាចធ្វើ៍ទៅហាន ។

ឧទាហរណ៍ៈ

បីអក្សរ រ គូរអាន រ មិនមនែអានថា អក្សរ រ ទៅ។

សាកល្បងអនុវត្ត: ប្រាប់ខ្ញុំញ៍៍នៅគ្នាអក្សរ "ៗ" នេះ

បីសិស្សអានគូរ សូមថា លុអ បីសិស្សអានខុស សូមអានខ្ញុំយសិស្សស្តាប៍ិញ៕។

សាកល្បងមួយ៍ៀ្ត: ប្រាប់ខ្ញុំញ៍៍នៅគ្នាអក្សរ "ខ" នេះ

បីសិស្សអានគូរ សូមថា លុអ បីសិស្សអានខុស សូមអានខ្ញុំយសិស្សស្តាប៍ិញ៕។

គីប្ដូអូនដឹងពីអ្វីដលែគូរផ្ដីវ៍ហើយឬទៅ ?

នៅពេលដលែខ្ញុំញ៍ិនិយាយថា "ចាប់ផ្ដើម" សូមអានគ្នាអក្សរខ្ញុំយហានច្បី៍នតាមដលែអាចធ្វើ៍ទៅហាន។ ខ្ញុំញ៍ិនិងស្តាប់ប្ដូអូន នៅពេលប្ដូអូនកំពុងអាន។ សូមប្រាប់ខ្ញុំញ៍ពីគ្នាអក្សរទាំងនេះ ជាយចាប់ផ្ដើមនៅទីនេះនិងបន្តតាមរ៍ៀបនេះ។ [ចង្ធុលទៅគ្នាអក្សរ ដល់ប្ដូងនៅលើជួរដកេបន្ទាប់ពីខឧទាហរណ៍និងបន្តចង្ធុលគ្នាអក្សរបន្តដល់ចុងនបែន្ទាត់ដំប្ដូង] ។ រួចរាល់ ? ចាប់ផ្ដើម

ល	ន	ឈ	ច	អ	ភ	ខ	ំៃ	ឈ	ភ
ព	យ	ល	ៗ	ឈ	ៈ	ឌ	ក	ខ្ឌ	ព
ៗៈ	ជ	ៈ	ខ	ៀ	បំ	៑	ង	ណ	ប
បំ	ៀ	គ	ំៃ	ច	ត	ត	ៗៈ	ំៃ	ខ
ជ	ទ	ម	ធ	គ	ស	ញ	ឈ	ទ	េ
រ	ៗ	ច់	ញ	ៀ	យ	រ៍	ស	យ	ប
ៀ	ំៃ	ពុ	ត	ឡ្ឌ	ក	អ	ហ	ច	ង
ខ្ឌ	រ៍	ធ	ជ	ន	ៗ	៸៎	ឆ	ឆ	ណ
ៗ	ខ្ឌ	ប្ឌ	ៈៈ	ជ	េ	ៈៈ	ៗ	ជ	ៗ
ម	រ៍	ខ	ៗ	ជ	យ	ឡ្ឌ	៸៎	៑	ហ

Familiar Word Reading Version A

បង្ហាញបញ្ជីពាក្យដល់សិស្សៗ។ ប្រាប់សិស្សថានេះជាបញ្ជីពាក្យដលែគួរអាន។ ប្រអូនគួរអានពាក្យនេះ ខ្លួយៗ
ច្បាស់ៗ ដាយមិនគួរផ្ដុំ និងបូរកេបទ។

ឧទាហរណ៍៖ ពាក្យ "ឆ្មា" គួរអានថា ឆ្មា តម្លៃតង។

សាកល្បងអនុវត្ត: ប្រាប់ខ្ញុំនៅពាក្យ "ផ្សារ" នេះ

បីសិស្សអានគួរ សូមថា លួអ បីសិស្សអានខុស សូមអានខ្លួយសិស្សសុគាបើញ។

សាកល្បងមួយឡៀត: ប្រាប់ខ្ញុំនៅពាក្យ "ព្លួក" នេះ

បីសិស្សអានគួរ សូមថា លួអ បីសិស្សអានខុស សូមអានខ្លួយសិស្សសុគាបើញ។

តើប្រអូនដឹងពីអ្វីដលែគួរផ្ដវើហើយឬទៅ?

នៅពេលដលែខ្ញុំនិយាយថា "ចាប់ផ្ដើម" សូមអានពាក្យខ្លួយហានចំរឹនគាមដលែអាចផ្ដវើទៅហាន។ ខ្ញុំនឹងស្តាប់បុ្រអូន
នៅពេលអ្នកំពុងអាន។ សូមប្រាប់ខ្ញុំពីពាក្យទាំងនេះ ដាយចាប់ផ្ដើមនៅទីនេះនិងបន្តគាមរបៀបនេះ។ [ចង្អុលទៅពាក្យដំ
ប្លូងនៅលីជួរដកេបន្ទាប់ពីឧទាហរណ៍និងបន្តចង្អុលពាក្យបន្តដល់ចុងនបែន្ទាត់ដំប្លូង] ។ រួចរាល់? ចាប់ផ្ដើម

គ្រូបង្រៀន	លី	កុមារ	ជំនួយ	ការងារ
ទុំ	បុគ្គលិក	ទាហាន	រូបបធម៌	ញ៉ាំ
គូរ	ធរធារ	អាកាសចរណ៍	ទំនរ	សាលា
កំបិត	ល្បបងៃ	ប៉ុរពៃណី	អាកាស	គំន្ូរ
ជុំ	ប្ុស្សី	សន្តិភាព	ទា	មន្ទីរពទេ្យ
កាៈ	ម៉ុទសេ	សាងសង់	សុខភាព	ថ្ទៃទាំ
ម៉ុសៅ	គំនិត	រ៉ាយ៉ាប់	ជិៈ	បណ្ណាល័យ
អំណាន	ស្ៀវភៅ	ព្ុយាយាម	មាតុភូមិ	ចៈ
ពៈ	ស្ុរ៉ៃ	គ្ុរសារ	ខ	ផ្ុទៈ
ជដរ	ដ៉ីរ	គា	ថ្ណៃក្សា	ម៉ៃ

Time Remaining	
Autostop?	☐

Non-Word Reading Version A

បង្ហាញបញ្ជីមិនមនៃពាក្យដល់សិស្សៗ ឬរាប់សិស្សថានេះជាបញ្ជីមិនមនៃពាក្យដលេត្លួរអាន។ ឬអូនត្លួរអានវា ឱ្យបឌួៗ ចុ្ហាស់ៗ ដាយមិនត្លួរផ្តេស នឹងបុរេកបទ។

ឧទាហរណ៍៖ ពាក្យ "ឆុមសៃ" ត្លួរអានថា ឆុមសៃ តម្មៃតង។

សាកល្បងអនុវត្ត៖ ប្ហុរាប់ខ្ញុំនៅពាក្យ "ងុស" នេះ

បីសិស្សអានត្លួរ សូមថា លុអ បីសិស្សអានខុស សូមអានឱ្យយសិស្សសុតាបរិញ្ញ។

សាកល្បងម្លួយទៀត៖ ប្ហុរាប់ខ្ញុំនៅពាក្យ "តុ្អ្ម" នេះ

បីសិស្សអានត្លួរ សូមថា លុអ បីសិស្សអានខុស សូមអានឱ្យយសិស្សសុតាបរិញ្ញ។

គីឬអូនដឹងពីអ្វីដលេត្លួរផ្តុវីហើយ្លបុ្ទ?

នៅលេដលេខ្ញុំនិយាយថា "ចាប់ផ្តគីម" សូមអានពាក្យឱ្យយហានច្ហុរីនតាមដលេអាចផ្តុវីទៅហាន។ ខ្ញុំនឹងស្ហុតាប់ឬអូន នៅលេឬអូនកំពុងអាន។ សូមប្ហុរាប់ខ្ញុំនពីពាក្យទាំងនេះ ដាយចាប់ផ្តគីមនៅទីនេះនិងបន្តតាមរបៀបនេះ៖ [ចង្អុលទៅពាក្យដំ ឬុងនៅលើជ្ជុរដកេបន្ទាប់ពីខទាហារណ៍និងបន្តចង្អុលពាក្យរបន្តដល់ចុងបែន្ទាត់ដំឬុង] ។ រួចរាល់? ចាប់ផ្តគីម

ងុ	តគាយ	ផ្តនា	ផ្លុរវៃ	កាហ៊ាត
ដំឡ្ពា	ដាញ	វទ្ឡោ	ក្ុសប	សសៀ
កំណិត	ខុសរ	ខសៃ	វតិល	ងៀុត
ឱ្ប	គិ	កឺស	ដីច	គ្លុង
ឈិស	ហ្ឫហាតៃ	ញ៉បៃ	កាផៅ	ច្ុន
ឱៀង	ចុស	គីឡ្ពាញ	យុ្មម	រឡ្ពៃតៃ
ឈុក	ដដោល	អាហាញ	ចំណ់ៃ	បនៃ
ផ្ជៀច	ខុ្មះ	លំណាំង	ហ៊ាំ	នលេ
ញៀ	តាញ	ច្ឡៀុង	ទម៉ៅ	ផ្តុអ៉ៃ
ល្ុស	ឈជ្ថ្	មម៊ីង	ឈន់ធា	អំណចៃ

Time Remaining	
Autostop?	☐

Oral Reading Fluency Sentences A

នេះជាល្បះខ្លីៗ។ ខ្ញុំចង់ឱ្យបុអ្នអានឱ្យពូ្ Tនិងច្ហាស់ៗ។

ឧទាហរណ៍៖ សិស្សនៅសាលារៀន។

សាកល្បងអនុវត្ត៖ សូមអានឥល្ុបនេះឡ្ើងវិញ។

បីសិស្សអានត្ុូវ សូមថា ល្អ បីសិស្សអានខុស សូមអានឱ្យសិស្សសុតាបើវិញ។

នៅពេលដែលខ្ញុំនិយាយថា "ចាប់ផ្តើម" សូមអានល្ុបឱ្យហានច្ុរ័នតាមដល៍េអាចផ្ុរ៉ីទៅហាន។ ខ្ញុំនឹងស្ុតាប់បុអ្ន នៅពេលបុអ្នកំ្ពុងអាន។ សូមបុ្រាប់ខ្ញុំពីល្ុបទាំងនេ។ ដាយចាប់ផ្តើមនៅទីនេះនិងបន្តតាមរៀបនេះ។ [ចង្អុលអុលទៅពាក្យនៃ ល្ុបៈដំបូងនៅលើជួរដេកបន្ទាប់ពីឧទាហរណ៍និងបន្តចង្អុលពាក្យបន្តដល់ចុងបៃបន្ទាត់ដំបូង] ។ រួចរាល់ ? ចាប់ផ្តើម

ប្ូណា	ទទួល	រាក់ទាក់	មិត្ត	យ៉ាំង	វិករវាយ។
គ្ូរីរ៉ស់	ហាលៃ	ដញៀ	គ្ុនា	ក្ុនុង	ទឹក
បឹងៗ។	វាលស្ុរ៉ែ	ភ្ូមិ	យឺង	មាន	ព៌ណ៍
ខៀ្រ	ស្ុ៊រ៉ងាត់ៗ។	សិស្ស	កំពុង	អាន	ស្៉ៀភៅ
ក្ុនុង	បណ្ឌ៉ណាល៍យៗ។	សុខ	ផ្ើក	ទ៊ឹក	ឆៅ
ទ៊ីប	វា	ឈឺ	ពះៗ។	សុភ៊ី	ភ្ុ៊ញ៉ាក់
ព៊ី	ដំណកេ	រ្ូច	ទៅ	ហាត់	ប្ុរ៉ណាៗ។
សាលារៀន	ខ្ញុំ	ជា	សាលា	កុមារ	មត្ើ៉ៗ។
ខ្ញុំ	គារព	ស្ុ៊រ៉ឡ្ាញ	ម្ុតាយ	ឆ៌ឱុក	ខ្ញុំ
ណាស់ៗ។					

Time Remaining

Autostop? ☐

Oral Reading Fluency Story A

បង្ហាញសិស្សសនៅអត្ថបទរឿង រូចប្រាប់៖

នេះជារឿងខ្លីៗ។ ខ្ញុំចង់ឱ្យបុអ្ននអានឱ្យឮៗ និងចូរហាស់ៗ។ នៅពេលអានចប់ ខ្ញុំនឹងសួរបុអ្នន ៤ ៥ សំណួរអំពីអ្វីដែល បុអ្ននហានអាន។ គឺបុអ្ននយល់ពីអ្វីដែលលោគ្រូវផ្ដើរហើយបុទៅ? នៅពេលខ្ញុំនិយាយថា "ចាប់ផ្ដើម" សូមអានអត្ថបទឱ្យហានចូរីនតា មដលៃអាចផ្ដូវីទៅហាន។ ខ្ញុំនឹងស្ដាប់បុអ្នន ពេលបុអ្ននកំពុងអាន។ រួចរាល់ ? ចាប់ផ្ដើម

ថ្នុងម្ចើយ	សុភី	ហន	ទូល	ស្ពវាយទុំ	មួយ	ល្ពអើ
ទៅ	លក់	ង	ផ្ដសារៗ។	មកដល់	៣ក់កណ្ដាល	ផ្ដល្ពវ
នាង	ហន	ឈប់	សម្ពរាកៗ។	ស្ពវា	ក៏	ល្ពច
សី	ស្ពវាយ	អស់	ប្លន	ប្ដរាំៗ។	សុភី	ទៅ
មុខ	ក៏	ជួប	គា	គា	ក៏	ល្ពច
សី	ស្ពវាយទុំ	វា	អស់	ខ្ញុល:ទ្យៀតៗ។	នាង	ទៅ
មុខទ្យៀត	ជួប	សរៈ	សរៈ	ក៏	ល្ពច	សី
ស្ពវាយទុំ	រហ្លួត	អស់	ពី	ល្ពអើៗ។	សុភី	ទៅ
មុខទ្យៀត	ក៏	យ័ញ	ដ៏វី	មួយ	ផ្ដអើល	បុក
ដើមក្ដរូចៗ។	សុភី	ភ័យ	ណាស់	ហើយ	បន្ត	ដំណើរ
ដល់	ផ្ដសារៗ។	សុភី	ដាក់	ល្ពអើ	ចុះ	ស្ពរាប់តវី
លាន់	មាត់ៈ	"អូ!	ផ្ដល្ពក្ដរូច!	ម៉ចេអីចឹង!"។		

Time Remaining

Autostop? ☐

Reading Comprehension Story A

ឥឡូវ ខ្ញុំសូមសួរបូអូន ៤ ៥ សំណួរអំពីសាច់រឿងដែលបូអូនហានអាន ។ សូមពុយាយាមឆ្លើយសំណួរតាមដែលបូអូន អាចទៅផ្ដើរហាន ។ រួចរាល់ ? ចាប់ផ្ដើម

១.គឺពលេចញេពីផ្ដទេ សុភីយកអ្វើទៅលក់ឯងផ្ដសារ ? (ចម្ងលើយគ្ដឺមគ្ដរៈ ផ្ដលស្ដេវាយ/សុវាយទុំ/សុវាយ)

☐ គ្ដឺមគ្ដរ	☐ មិនគ្ដឺមគ្ដរ	☐ មិនឆ្លើយ

២. គឺអ្វើហានកើតឡ្បើងនៅពេលសុភីឈប់សម្ងរាកនៅពាក់កណ្ដាលផ្ដល្ងវ ?
(ចម្ងលើយគ្ដឺមគ្ដរៈ សុវាល្ងចសីសុវាយ/សុវាសីសុវាយ/សុវាល្ងចសីសុវាយអស់ប្ដនបុរាំ)

☐ គ្ដឺមគ្ដរ	☐ មិនគ្ដឺមគ្ដរ	☐ មិនឆ្លើយ

៣. គឺមានសត្ដអ្វើផ្ដសងេងទ្បើតល្ងចសីសុវាយសុភី កុវាពីសត្ដសុវា ? (ចម្ងលើយគ្ដឺមគ្ដរៈ សត្ដវគា និងសវៈ/សត្ដគា/សត្ដសវៈ)

☐ គ្ដឺមគ្ដរ	☐ មិនគ្ដឺមគ្ដរ	☐ មិនឆ្លើយ

៤.ហាតុអ្វើហានជាសុភីក័យ ? (ចម្ងលើយគ្ដឺមគ្ដរៈ ខ្ងលាចសត្ដដ៏រ/ខ្ងលាចដ៏រដញ/ខ្ងលាចសត្ដដ៏រកត់បុក/ខ្ងលាចដ៏រជាន់)

☐ គ្ដឺមគ្ដរ	☐ មិនគ្ដឺមគ្ដរ	☐ មិនឆ្លើយ

៥.គឺសុភីដឹងចាសត្ដទាំងនាៈល្ងចផ្ដលស្ដេវាយសីដផ្ដប្ដទ? ពុវាៈអ្ដើ ?
(ចម្ងលើយគ្ដឺមគ្ដរៈ ទៈ/មិនដឹងទៈ ពុវាៈនាងទ�ិបតភ្ងេញាក់ផ្ដអីលពលេដាក់ល្ងអ៊ចុៈនៅផ្ដសារ (ឆ្ងលើយតម្ងយគឺខុស))

☐ គ្ដឺមគ្ដរ	☐ មិនគ្ដឺមគ្ដរ	☐ មិនឆ្លើយ

Listening Comprehension Story A

សូមបុរាប់សិស្សថា ខ្ញុំនឹងអានអត្ថបទនេះ ហើយបុ្អូនគួរស្តាប់ដាយយកចិត្តទុកដាក់។ ពេលអានចប់ ខ្ញុំនឹងសួរសំណួរខ្លះ ហើយបុ្អូនគួរផ្លើយសំណួរឱ្យបានត្រឹមត្រូវតាមតអែនផ្ញវៈវិហាន។ តើបុ្អូនយល់ថាត្រូវផ្ញើអ្វីចុះហាស់ ហើយ ?

អត្ថបទ

សុខ និងតារាជាមិត្តល្អនឹងគ្នា។ ពួកគេមោនអាយុបុ្រាំមួយឆ្នាំដូចគ្នា ។ ពួកគេតែងតែលេងជាមួយគ្នារៀងរាល់ថ្ងៃ។ ថ្ងៃ មួយ សុខឃើញតារាទៅសាលារៀន វាក៍សុំម្តាយទៅរៀនផងវៈ។ ក្រោយមក ពួកគេក៏នាំគ្នាទៅរៀនយ៉ាងសបុ្បហាយរីករាយ។

១. តើសុខ និងតារាគួរជាអ្វីនឹងគ្នា ? (ចម្លើយគួរមគួរវៈ មិត្ត/មិត្តល្អ/មិត្តគួរមជុ្ញនាក់)		
☐ គួរមគួរវ	☐ មិនគួរមគួរវ	☐ មិនផ្លើយ
២.ហាតេុអ្វីរីសុខហានចូលរៀន ? (ចម្លើយគួរមគួរវៈ សុខសុំម្តាយទៅរៀន/សុខចង់ទៅរៀន/ចង់ទៅរៀន)		
☐ គួរមគួរវ	☐ មិនគួរមគួរវ	☐ មិនផ្លើយ
៣.ហាតេុអ្វីហានជាសុខ និងតារាមានអារម្មណ៍សបុ្បហាយរីករាយ ? (ចម្លើយគួរមគួរវៈ នាំគ្នាទៅសាលា/ហានទៅរៀនជាមួយគ្នា)		
☐ គួរមគួរវ	☐ មិនគួរមគួរវ	☐ មិនផ្លើយ

Annex B: Student Questionnaire

Part 1 - Questions 1-6

1. តើនៅសាលា លោកគ្រូ/អ្នកគ្រូ ដែលនិយាយ(ភាសាខ្មែរ) ទាក់ទង់ប្អូនដៃបួទ?
   (At school, does your teacher speak to you in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

2. តើនៅសាលា មិត្តរបស់ប្អូនដែលនិយាយ(ភាសាខ្មែរ) ជាមួយប្អូនដៃបួទ?
   (At school, do your friends speak to you in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

3. តើនៅសាលា ប្អូនដែលនិយាយ(ភាសាខ្មែរ) ជាមួយមិត្តភ្ញម់ច្នាក់ដៃបួទ?
   (At school, do you speak to your friends in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

4. តើនៅផ្ទះ ប្អូនដែលនិយាយ(ភាសាខ្មែរ) ជាមួយបងប្អូនរបស់ប្អូនដៃបួទ?
   (At home, do you speak to your siblings in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

5. តើនៅផ្ទះ ប្អូនដែលនិយាយ(ភាសាខ្មែរ) ជាមួយមនុស្សសធំ(បង,ឪពុកម្តាយរបស់ប្អូន)ដៃបួទ?
   (At home, do you speak to the adults in your home in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

6. តើនៅសាលា មានសៀវភៅរឿង ទស្សនាវដ្តី ឬកាសែតជាភាសាខ្មែរដៃបួទ?
   (At school, are there books or magazines/newspapers in Khmer?)

   ☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨៨. មិនឆ្លើយ

Part 2 - Questions 7-16

7. គីនៅផ្ទះរបស់បុអូន មានវិទ្យុ *(radio)* ដែរឬទេ? *(At your house, do you have a radio?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

8. គីនៅផ្ទះរបស់បុអូន មានទូរទស្សន៍ ដែរឬទេ? *(At your house, do you have a tv?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

9. គីនៅផ្ទះរបស់បុអូន មានទូរសព្ទ ដែរឬទេ? *(At your house, do you have a telephone/mobile phone?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

10. គីនៅសាលា បុអូនដែលនិយាយ(ភាសាខ្មែរ) ជាម្ចួយមិត្តស្រមថ្នាក់ដែរឬទេ? *(At your house, do you have electricity?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

11. គីនៅផ្ទះរបស់អូន មានបង្គន់ ដែរឬទេ? *(Do you have a toilet inside your house?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

12. គីនៅផ្ទះរបស់បុអូន មានកង់ឬម៉ូតូ ដែរឬទេ? *(At your house, do you have a bicycle or motorcycle?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

13. គីនៅផ្ទះរបស់បុអូន មានឡាន គាយន្ត គូឬតា ឬត្រាក់ទ័រ ដែរឬទេ?
    (At your house, do you have four wheeler (a car, truck, 4x4, tractor)?)

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

14. គីម្សិលមិញ បុអូនចំណាយពេលវេលាជួយធ្វើការងារផ្ទះ(លាងចាន, មីលគា, ហកខាអារ)ច្រីនប៉ុណ្ណោ?
    (Last night, how much time did you spend on household chores (at home)?)

☐ ០. គ្មាន ☐ ១. ម្ចួយចំនួន ☐ ២. ច្រីន ☐ ៨៨៨. មិនឆ្លើយ

15. គីម្តាយបុអូនអាចអាន(ភាសាខ្មែរ) ដែរឬទេ? *(Can your mother read in Khmer?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

16. គីឪពុកបុអូនអាចអាន(ភាសាខ្មែរ) ដែរឬទេ? *(Can your father read in Khmer?)*

☐ ១. ហទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

Part 3 - Questions 17-20

17. តើនៅផ្ទះទៅមានអ្នកណា (ឪពុកម្តាយ, បងប្អូន, ជីដូនជីតា) អានរឿងឱ្យបុ្អូនស្តាប់ ?
    (Does someone from home (parent, sibling, grandparent) read stories to you?)

    ☐ ១. ហៗ/ចាស ☐ ០. ទ�}} ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

18. តើនៅផ្ទះទៅមានអ្នកណា (ឪពុកម្តាយ, បងប្អូន, ជីដូនជីតា) ជួយធ្វើកិច្ចការសាលារបស់បុ្អូន ?
    (Does someone from home (parent, sibling, grandparent) help you with your school work?)

    ☐ ១. ហៗ/ចាស ☐ ០. ទ} ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

19. តើបុ្អូនអានសៀវភៅរឿងជាមួយក្រុមគ្រួសារបុ្អូននៅផ្ទះទៅញឹកញាប់ប៉ុណ្ណាដង ?
    (How often do you read with a family member at home?)

    ☐ ២. រាល់ថ្ងៃ ☐ ១. ម្តងម្កាល ☐ ០. មិនដែល ☐ ៨៨៨. មិនឆ្លើយ

20. តើនៅផ្ទះទៅមានអ្នកណាតែងតែជួយបុ្អូន អានឬធ្វើកិច្ចការសាលា ? ((ចម្លើយលើសពីមួយ)
    At home, who most often helps you with your reading or your homework?)

    ☐ ១. ឪពុកម្តាយ ☐ ២. បងប្អូន ☐ ៣. សមាជិកគ្រួសារដទៃទៀតដូចជាជីដូនជីតា

    ☐ ០. ពុំមានអ្នកណាជួយខ្ញុំទាល់តែសោះ ☐ ៨៨៨. មិនឆ្លើយ

Part 4 - Questions 21-26

21. តើបុ្អូនចូលចិត្តអាន (សៀវភៅ) នៅផ្ទះដែរឬទ�{} ? *(Do you like reading at home?)*

    ☐ ១. ហៗ/ចាស ☐ ០. ទ} ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

22. តើបុ្អូនចូលចិត្តអាន (សៀវភៅ) នៅសាលាដែរឬទ} ? *(Do you like reading at school?)*

    ☐ ១. ហៗ/ចាស ☐ ០. ទ} ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

23. តើនៅសាលា បុ្អូនអាន (សៀវភៅ) ដាយស្ងាត់ស្ងៀមម្នាក់ឯងញឹកញាប់ប៉ុណ្ណាដង ?
    (At school, how often do you read books quietly by yourself?)

    ☐ ២. រាល់ថ្ងៃ ☐ ១. ម្តងម្កាល ☐ ០. មិនដែល ☐ ៨៨៨. មិនឆ្លើយ

24. តើនៅសាលា លោកគ្រូ/អ្នកគ្រូ (បណ្ណារក្ស) ចូលណាប់សួរបុ្អ្នអំពីអ្វីដែលបុ្អ្នកំពុងអានដែរឬទេ?
(At school, does your teacher ask you questions about what you are reading?)

☐ ១. បាទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

25. តើនៅសាលា លោកគ្រូ/អ្នកគ្រូ (បណ្ណារក្ស) ដែលចូលណាប់ជួយបុ្អ្ន ពេលបុ្អ្នអានមិនកើតដែរឬទេ?
(Does teacher help you when you are unable to read something?)

☐ ១. បាទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

26. តើនៅសាលា លោកគ្រូ/អ្នកគ្រូ (បណ្ណារក្ស) ឱ្យបុ្អ្នសរសេរហានញឹកញាប់ប៉ុណ្ណា?
(How often does your teacher ask you to write in school?)

☐ ២. រាល់ថ្ងៃ ☐ ១. មុ្តងមុ្កាល ☐ ០. មិនដែល ☐ ៨៨៨. មិនឆ្លើយ

Part 5 - Questions 27-35

27. តើបុ្អ្នហានប្រើប្រាស់កម្មវិធីសៀវភៅឆ្លាតក្នុងចាប់ពុលតែហានញឹកញាប់ប៉ុណ្ណា?
(How often do you use the SmartBooks app?)

☐ ២. រាល់ថ្ងៃ ☐ ១. ពីរទៅបី ក្នុងមួយសប្តាហ៍ ☐ ០. មិនដែលចូលបណ្ណាល័យ ☐ ៨៨៨. មិនឆ្លើយ

28. តើបុ្អ្នចូលចិត្តរឿងក្នុងកម្មវិធីសៀវភៅឆ្លាតដែរឬទេ? *(Do you like the stories you read on SmartBooks?)*

☐ ១. បាទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

29. តើការអានរឿងតាមក្នុងកម្មវិធីសៀវភៅឆ្លាតមានភាពងាយស្រួលដែរឬទេ? *(Is reading stories on SmartBooks easy?)*

☐ ១. បាទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

30. តើការស្តាប់រឿងក្នុងកម្មវិធីសៀវភៅឆ្លាតងាយស្រួលដែរឬទេ? *(Is listening to stories on SmartBooks easy?)*

☐ ១. បាទ/ចាស ☐ ០. ទេ ☐ ២. មិនដឹង ☐ ៨៨៨. មិនឆ្លើយ

31. តើបុ្អ្នធ្វើលំហាត់ក្នុងកម្មវិធីសៀវភៅឆ្លាត ហានផ្តការប៉ុន្មាន? *(Are the quizzes on SmartBooks easy?)*

☐ ១. ផ្តកាយ១ ☐ ២. ផ្តកាយ២ ☐ 3. ផ្តកាយ៣ ☐ ០. អត់ផ្តកាយ ☐ ៨៨៨. មិនឆ្លើយ

32. តើប៉ុន្មានអាចចូលប្រើកម្មវិធីសៀវភៅហនដាយខ្លួនឯង ?
(តើប៉ុន្មានប្រើចាប់ប៉ុលតែលងប៉ុន្មាន ? ហើយដឹមប៉ីលងគួរវ៉ធ្វើវ៉ដុចម្តេច ?)

☐ ១. ភាគច្រើន ហទ/ចាស   ☐ ០. ភាគច្រើន ទេ   ☐ ២. មិនដឹង   ☐ ៨៨. មិនឆ្លើយ

33. តើប៉ុន្មានធ្លាប់អានរឿងតាមចាប់ប៉ុលតែ ឬទូរសព្ទមុនប្រើកម្មវិធីសៀវភៅឆ្លាតជដរ៉ូទ ?
(Have you read stories on a phone or tablet before SmartBooks?)

☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨. មិនឆ្លើយ

34. តើប៉ុន្មានចូលចិត្តរៀនតាមកម្មវិធីសៀវភៅឆ្លាតក្នុងចាប់ប៉ុលតែដរ៉ូទ ?
(Do you like using SmartBooks to learn?)

☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨. មិនឆ្លើយ

35. តើប៉ុន្មាននឹងបន្តប្រើប្រាស់កម្មវិធីសៀវភៅឆ្លាតតទៅមុខទៀតដរ៉ូទ ?
(Do you want to continue using SmartBooks even though the school year is over?)

☐ ១. ហទ/ចាស   ☐ ០. ទេ   ☐ ២. មិនដឹង   ☐ ៨៨. មិនឆ្លើយ

Annex C: **Student Questionnaire Results and Composites**

Table C.1: **Language Exposure Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
At school, does your teacher speak to you in Khmer?	No	7	3.2	10	4.3	6	2.7
	Yes	213	96.8	225	95.7	218	97.3
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
At school, do your friends speak to you in Khmer?	No	7	3.2	7	3.0	2	0.9
	Yes	212	96.4	228	97.0	222	99.1
	Don't know	0	0.0	0	0.0	0	0.0
	No response	1	0.5	0	0.0	0	0.0
At school, do you speak to your friends in Khmer?	No	2	0.9	2	0.9	0	0.0
	Yes	218	99.1	233	99.1	222	99.1
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	2	0.9
At home, do you speak to your siblings in Khmer?	No	2	0.9	3	1.3	1	0.4
	Yes	216	98.2	232	98.7	222	99.1
	Don't know	0	0.0	0	0.0	0	0.0
	No response	2	0.9	0	0.0	1	0.4
At home, do you speak to the adults in Khmer?	No	4	1.8	4	1.7	2	0.9
	Yes	215	97.7	231	98.3	220	98.2
	Don't know	0	0.0	0	0.0	1	0.4
	No response	1	0.5	0	0.0	1	0.4
At school, are there books, magazines, or newspapers in Khmer?	No	2	0.9	2	0.9	27	12.1
	Yes	215	97.7	232	98.7	197	87.9
	Don't know	0	0.0	0	0.0	0	0.0
	No response	3	1.4	1	0.4	0	0.0

Table C.2: **Socioeconomic Status Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
At your house, do you have a radio?	No	100	45.2	119	50.6	115	51.1
	Yes	121	54.8	116	49.4	109	48.4
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	1	0.4
At your house, do you have a TV?	No	9	4.1	16	6.8	32	14.2
	Yes	212	95.9	218	92.8	192	85.3
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	1	0.4	1	0.4
At your house, do you have a telephone or mobile phone?	No	10	4.5	6	2.6	6	2.7
	Yes	210	95.0	228	97.0	218	96.9
	Don't know	0	0.0	0	0.0	0	0.0
	No response	1	0.5	1	0.4	1	0.4
At your house, do you have electricity?	No	10	4.5	19	8.1	35	15.6
	Yes	211	95.5	215	91.5	190	84.4
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	1	0.4	0	0.0
Do you have a toilet inside your house?	No	26	11.8	42	17.9	77	34.2
	Yes	195	88.2	193	82.1	148	65.8
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
At your house, do you have a bicycle or motorcycle?	No	2	0.9	2	0.9	7	3.1
	Yes	219	99.1	233	99.1	218	96.9
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
At your house, do you have four-wheeler (car, truck, 4x4, or tractor)?	No	123	55.7	137	58.3	152	67.6
	Yes	98	44.3	98	41.7	73	32.4
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
Last night, how much time did you spend on household chores?	None	12	5.4	12	5.1	9	4.0
	Some	167	75.6	180	76.6	186	82.7
	A lot	40	18.1	42	17.9	29	12.9
	No response	2	0.9	1	0.4	1	0.4

Table C.2: **Socioeconomic Status Composite (continued)**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
Can your mother read in Khmer?	No	23	10.4	37	15.7	37	16.4
	Yes	198	89.6	198	84.3	184	81.8
	Don't know	0	0.0	0	0.0	4	1.8
	No response	0	0.0	0	0.0	0	0.0
Can your father read in Khmer?	No	23	10.4	37	15.7	45	20.0
	Yes	197	89.1	195	83.0	176	78.2
	Don't know	1	0.5	2	0.9	4	1.8
	No response	0	0.0	1	0.4	0	0.0

Table C.3: **Family Reading Support Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
Does someone from home (parent, sibling, grandparent) read stories to you?	No	57	25.8	76	32.3	69	30.7
	Yes	164	74.2	158	67.2	155	68.9
	Don't know	0	0.0	1	0.4	1	0.4
	No response	0	0.0	0	0.0	0	0.0
Does someone from home (parent, sibling, grandparent) help you with your school	No	42	19.0	65	27.7	53	23.6
	Yes	179	81.0	170	72.3	170	75.6
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	2	0.9
How often do you read with a family member at home?	Never	27	12.2	41	17.4	37	16.4
	Sometimes	151	68.3	139	59.1	157	69.8
	Everyday	43	19.5	54	23.0	30	13.3
	No response	0	0.0	1	0.4	1	0.4
At home, do you usually not get help with reading or homework?	No	185	83.7	183	77.9	190	84.4
	Yes	36	16.3	52	22.1	35	15.6
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
At home, do one or both parents help you with your reading?	No	80	36.2	85	36.2	99	44.0
	Yes	141	63.8	150	63.8	126	56.0
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0

Table C.3: **Family Reading Support Composite (continued)**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
At home, do your brother or sister help you with your reading?	No	111	50.2	135	57.4	126	56.0
	Yes	110	49.8	100	42.6	99	44.0
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0
At home, do other family member (grandparents, aunts, uncles) help you with your reading?	No	200	90.5	217	92.3	189	84.0
	Yes	21	9.5	18	7.7	36	16.0
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	0	0.0	0	0.0

Table C.4 : **Teacher Reading Support Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
At school, does your teacher ask you questions about what you are reading?	No	53	24.0	62	26.4	42	18.7
	Yes	166	75.1	170	72.3	183	81.3
	Don't know	0	0.0	3	1.3	0	0.0
	No response	2	0.9	0	0.0	0	0.0
Does teacher help you when you are unable to read something?	No	25	11.3	26	11.1	14	6.2
	Yes	193	87.3	207	88.1	211	93.8
	Don't know	1	0.5	1	0.4	0	0.0
	No response	2	0.9	1	0.4	0	0.0
How often does your teacher ask you to write in school?	Never	10	4.5	16	6.8	4	1.8
	Sometimes	106	48.0	107	45.5	108	48.0
	Everyday	105	47.5	112	47.7	113	50.2
	No response	0	0.0	0	0.0	0	0.0

Table C.5 : **Disposition to Reading Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
Do you like reading at home?	No	9	4.1	17	7.2	12	5.3
	Yes	212	95.9	217	92.3	213	94.7
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	1	0.4	0	0.0
Do you like reading at school?	No	7	3.2	8	3.4	9	4.0
	Yes	214	96.8	226	96.2	215	95.6
	Don't know	0	0.0	0	0.0	0	0.0
	No response	0	0.0	1	0.4	1	0.4
At school, how often do you read books quietly by yourself?	Never	26	11.8	43	18.3	36	16.0
	Sometimes	165	74.7	154	65.5	158	70.2
	Everyday	30	13.6	38	16.2	31	13.8
	No response	0	0.0	0	0.0	0	0.0

Table C.6: **Engagement in Program Composite**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
How often do you use the SmartBooks app?	I don't visit the library	1	0.5	2	0.9	0	0.0
	A few days each week	210	95.5	224	95.3	0	0.0
	Every day	8	3.6	8	3.4	0	0.0
	No response	1	0.5	1	0.4	0	0.0
Do you like the stories you read on SmartBooks?	No	2	0.9	1	0.4	0	0.0
	Yes	216	98.2	230	97.9	0	0.0
	Don't know	1	0.5	3	1.3	0	0.0
	No response	1	0.5	1	0.4	0	0.0

Table C.6: **Engagement in Program Composite (continued)**

Questions	Response Options	Group					
		Intervention A		Intervention AB		Comparison	
		Frequency	%	Frequency	%	Frequency	%
Is reading stories on SmartBooks easy?	No	12	5.5	7	3.0	0	0.0
	Yes	206	93.6	223	94.9	0	0.0
	Don't know	2	0.9	3	1.3	0	0.0
	No response	0	0.0	2	0.9	0	0.0
Is listening to stories on SmartBooks easy?	No	5	2.3	14	6.0	0	0.0
	Yes	213	96.8	215	91.5	0	0.0
	Don't know	2	0.9	4	1.7	0	0.0
	No response	0	0.0	2	0.9	0	0.0
Do you use SmartBooks on your own?	Mostly No	21	9.5	21	8.9	0	0.0
	Mostly Yes	199	90.5	207	88.1	0	0.0
	Don't know	0	0.0	6	2.6	0	0.0
	No response	0	0.0	1	0.4	0	0.0
Have you read stories on a phone or tablet before SmartBooks?	No	127	57.7	139	59.1	0	0.0
	Yes	91	41.4	93	39.6	0	0.0
	Don't know	1	0.5	2	0.9	0	0.0
	No response	1	0.5	1	0.4	0	0.0
Do you like using SmartBooks to learn?	No	5	2.3	6	2.6	0	0.0
	Yes	215	97.7	227	96.6	0	0.0
	Don't know	0	0.0	1	0.4	0	0.0
	No response	0	0.0	1	0.4	0	0.0
Do you want to continue using SmartBooks even though the school year is over?	No	2	0.9	7	3.0	0	0.0
	Yes	216	98.2	226	96.2	0	0.0
	Don't know	0	0.0	1	0.4	0	0.0
	No response	2	0.9	1	0.4	0	0.0

Annex D : EGRA Descriptive Statistics and Additional Tables

Table D.1: **Letter Name Identification (CLNPM)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	29.8	1.3	7.7%	40.0	1.4	3.6%	10.2	0.8
Intervention AB	236	27.8	1.1	3.8%	37.4	1.3	1.3%	9.5	0.7
Comparison	225	23.0	1.1	8.4%	32.1	1.2	2.2%	9.1	0.7
Total: All students	**682**	**26.9**	**0.7**	**6.6%**	**36.5**	**0.8**	**2.3%**	**9.6**	**0.4**

Table D.2: **Familiar Word Reading (CFWPM)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	14.3	1.2	34.4%	26.8	1.6	15.8%	12.5	0.7
Intervention AB	236	11.4	1.0	35.2%	22.1	1.3	19.1%	10.7	0.6
Comparison	225	8.0	0.7	47.6%	15.6	1.1	32.0%	7.7	0.6
Total: All students	**682**	**11.2**	**0.6**	**39.0%**	**21.5**	**0.8**	**22.3%**	**10.3**	**0.4**

Table D.3: **Nonword Reading (CNWPM)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	7.1	0.7	44.8%	13.3	1.0	27.6%	6.1	0.5
Intervention AB	236	6.0	0.6	46.2%	9.7	0.8	33.9%	3.6	0.4
Comparison	225	3.9	0.4	58.7%	7.4	0.6	42.2%	3.5	0.4
Total: All students	**682**	**5.7**	**0.3**	**49.9%**	**10.1**	**0.5**	**34.6%**	**4.4**	**0.3**

Table D.4: **ORF−Sentences (CWPM)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	26.3	2.4	34.8%	52.7	2.9	19.0%	26.4	1.5
Intervention AB	236	20.5	1.9	39.4%	43.9	2.5	16.9%	23.5	1.4
Comparison	225	15.5	1.7	50.2%	30.9	2.2	32.9%	15.5	1.3
Total: All students	**682**	**20.7**	**1.2**	**41.5%**	**42.5**	**1.5**	**22.9%**	**21.8**	**0.8**

Table D.5: **ORF−Story (CWPM)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	25.0	2.1	32.1%	46.6	2.5	10.9%	21.6	1.2
Intervention AB	236	19.3	1.7	38.1%	39.0	2.1	11.9%	19.7	1.1
Comparison	225	15.0	1.4	45.8%	29.8	2.0	24.0%	14.7	1.1
Total: All students	**682**	**19.8**	**1.0**	**38.7%**	**38.4**	**1.3**	**15.5%**	**18.7**	**0.7**

Table D.6: **Reading Comprehension (Correct out of Five)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	1.0	0.1	46.2%	1.9	0.1	25.8%	1.0	0.1
Intervention AB	236	0.8	0.1	53.0%	1.6	0.1	29.7%	0.8	0.1
Comparison	225	0.6	0.1	64.0%	1.3	0.1	38.7%	0.6	0.1
Total: All students	**682**	**0.8**	**0.0**	**54.4%**	**1.6**	**0.1**	**31.4%**	**0.8**	**0.0**

Table D.7: **Listening Comprehension (Correct out of Three)**

Group	n/N	Baseline			Endline			Gain from Baseline to Endline	
		Mean	SE	Zero Score (%)	Mean	SE	Zero Score (%)	Mean	SE
Intervention A	221	1.2	0.1	19.9%	2.0	0.1	4.5%	0.7	0.1
Intervention AB	236	1.3	0.1	17.8%	1.9	0.1	6.4%	0.5	0.1
Comparison	225	1.4	0.1	17.8%	1.8	0.1	8.4%	0.4	0.1
Total: All students	**682**	**1.3**	**0.0**	**18.5%**	**1.9**	**0.0**	**6.5%**	**0.6**	**0.0**

Table D.8: **Average Gain Scores by Group and Gender**

Subtask	Intervention A						Intervention AB						Comparison					
	Boys			Girls			Boys			Girls			Boys			Girls		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
Letter name identification (CLNPM)	120	10.7	1.1	101	9.7	1.0	114	10.7	1.0	122	8.5	1.0	121	10.3	0.9	104	7.6	1.0
Familiar word reading (CFWPM)	120	13.5	1.0	101	11.4	1.1	114	12.9	0.9	122	8.6	0.8	121	9.2	0.9	104	5.9	0.8
Nonword reading (CNWPM)	120	7.5	0.7	101	4.5	0.7	114	4.5	0.7	122	2.8	0.5	121	4.1	0.5	104	2.9	0.5
ORF-sentences (CWPM)	119	28.1	2.0	101	24.4	2.2	114	27.7	2.0	122	19.5	1.9	120	18.7	2.0	104	11.9	1.5
ORF-story (CWPM)	120	24.0	1.6	101	18.7	1.6	114	24.3	1.7	122	15.3	1.3	121	18.1	1.7	104	10.8	1.2
Reading comprehension (correct out of five)	120	1.1	0.1	101	0.8	0.1	114	1.0	0.1	122	0.7	0.1	121	0.8	0.1	104	0.4	0.1
Listening comprehension (correct out of three)	120	0.7	0.1	101	0.8	0.1	114	0.5	0.1	122	0.6	0.1	121	0.4	0.1	104	0.4	0.1

Table D.9: **Average Gain Scores by Group and Grade**

Subtask	Intervention A						Intervention AB						Comparison					
	Grade 2			Grade 3			Grade 2			Grade 3			Grade 2			Grade 3		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
Letter name identification (CLNPM)	112	11.7	1.1	109	8.7	1.0	119	9.9	1.1	117	9.1	0.9	113	8.1	0.9	112	10.0	1.0
Familiar word reading (CFWPM)	112	12.4	1.1	109	12.7	1.0	119	9.9	0.9	117	11.5	0.9	113	7.5	0.9	112	7.9	0.8
Nonword reading (CNWPM)	112	5.7	0.7	109	6.5	0.8	119	3.5	0.6	117	3.7	0.6	113	3.6	0.6	112	3.4	0.5
ORF-sentences (CWPM)	112	29.1	2.4	108	23.5	1.7	119	25.2	2.2	117	21.7	1.8	113	16.7	2.0	111	14.3	1.6
ORF-story (CWPM)	112	23.4	1.8	109	19.7	1.4	119	21.7	1.7	117	17.6	1.4	113	15.3	1.7	112	14.1	1.4
Reading comprehension (correct out of five)	112	1.0	0.1	109	0.9	0.1	119	1.0	0.1	117	0.7	0.1	113	0.7	0.1	112	0.6	0.1
Listening comprehension (correct out of three)	112	0.8	0.1	109	0.6	0.1	119	0.6	0.1	117	0.4	0.1	113	0.5	0.1	112	0.3	0.1

Table D.10: **Zero Scores by Group and Gender at Endline**

Subtask	Group					
	Intervention A		Intervention AB		Comparison	
	Girls	Boys	Girls	Boys	Girls	Boys
	n=120	n=101	n=114	n=122	n=121	n=104
Letter name identification	1.7	5.9	0.0	2.5	2.5	1.9
Familiar word reading	11.7	20.8	14.0	23.8	26.4	38.5
Nonword reading	20.8	35.6	28.9	38.5	38.0	47.1
ORF–Sentences	12.5	26.7	8.8	24.6	30.6	35.6
ORF– Story	8.3	13.9	6.1	17.2	19.8	28.8
Reading comprehension	19.2	33.7	21.9	36.9	31.4	47.1
Listening comprehension	4.2	5.0	5.3	7.4	9.9	6.7

Table D.11: **Zero Scores by Group and Grade at Endline**

Subtask	Group					
	Intervention A		Intervention AB		Comparison	
	Grade 2	Grade 3	Grade 2	Grade 3	Grade 2	Grade 3
	n=112	n=109	n=119	n=117	n=113	n=112
Letter name identification	6.3	0.9	1.7	0.9	2.7	1.8
Familiar word reading	19.6	11.9	24.4	13.7	43.4	20.5
Nonword reading	28.6	26.6	39.5	28.2	51.3	33.0
ORF–Sentences	23.2	14.7	21.8	12.0	42.5	23.2
ORF– Story	15.2	6.4	16.0	7.7	32.7	15.2
Reading comprehension	33.9	17.4	34.5	24.8	48.7	28.6
Listening comprehension	6.3	2.8	9.2	3.4	9.7	7.1

Annex E : **Correlation Analysis Results**

Table E.1: **Project Exposure and EGRA Subtask Gains Correlation Analysis Results**

	Mean	1	2	3	4	5	6	7	8
1. Letter sound knowledge (CLSPM) gain	9.9	---							
2. Familiar word reading (CFWPM) gain	11.6	---	---						
3. Nonword reading (CNWPM) gain	4.8	---	---	---					
4. Oral reading fluency sentence (CWPM) gain	24.9	---	---	---	---				
5. Oral reading fluency story (CWPM) gain	20.6	---	---	---	---	---			
6. Reading comprehension (Correct out of five) gain	0.9	---	---	---	---	---	---		
7. Listening comprehension (Correct out of three) gain	0.6	---	---	---	---	---	---	---	
8. E4K SmartBooks exposure (minutes)	919.7	.154**	.102*	.093*	.114*	.157**	.149**	-0.066	---

N=452; * sig. at $p<.005$; ** sig. at $p<.001$

Table E.2: **Composite and EGRA Subtask Gains Correlation Analysis Results**

	Mean	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Letter sound knowledge (CLSPM) gain	9.6	---												
2. Familiar word reading (CFWPM) gain	10.3	---	---											
3. Nonword reading (CNWPM) gain	4.4	---	---	---										
4. Oral reading fluency sentences (CWPM) gain	21.8	---	---	---	---									
5. Oral story reading fluency (CWPM) gain	18.7	---	---	---	---	---								
6. Reading comprehension (correct out of five) gain	0.8	---	---	---	---	---	---							
7. Listening omprehension (correct out of three) gain	0.6	---	---	---	---	---	---	---						
8. Language exposure composite	5.9	0.041	.088*	0.070	.095*	.080*	.097*	0.009	---	---	---	---	---	---
9. Socioeconomic status composite	7.7	0.058	.241**	.182**	.226**	.178**	.119**	0.008	---	---	---	---	---	---
10. Family reading support composite	3.2	.100**	.168**	.136**	.171**	.163**	.150**	0.031	---	---	---	---	---	---
11. Teacher reading support composite	2.4	0.069	0.073	.076*	0.052	0.051	0.058	-0.057	---	---	---	---	---	---
12. Disposition to reading composite	2.4	.108**	.215**	.170**	.186**	.168**	.138**	0.053	---	---	---	---	---	---
13. Engagement with project composite	6.7	.108*	.105*	.108*	0.088	0.081	-0.004	-0.058	---	---	---	---	---	---

N=678; * sig. at p<.005; ** sig. at p<.001

Annex F : EGRA Reliability Results

Table F.1: **Reliability Results for EGRA Instrument at Baseline**

Subtask	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Letter name identification (CLNPM)	0.809	0.911
Nonword reading (percent correct)	0.9380	0.891
Nonword reading (CNWPM)	0.823	0.912
ORF-sentences (CWPM)	0.917	0.891
ORF-story (CWPM)	0.950	0.893
Reading comprehension (correct out of five)	0.886	0.901
Listening comprehension (correct out of three)	0.327	0.952
	EGRA Coefficient Alpha	**0.921**

Table F2: **Reliability Results for EGRA Instrument at Endline**

Subtask	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Letter name identification (CLNPM)	0.836	0.918
Nonword reading (percent correct)	0.927	0.899
Nonword reading (CNWPM)	0.809	0.916
ORF-sentences (CWPM)	0.885	0.907
ORF-story (CWPM)	0.954	0.896
Reading comprehension (correct out of five)	0.875	0.906
Listening comprehension (correct out of three)	0.308	0.957
	EGRA Coefficient Alpha	**0.927**

Annex G : **Additional Results**

Table G.1: **E4K SmartBooks Dosage Descriptive Statistics by Intervention Group**

Intervention Group	n/N	Mean (minutes used throughout the project)	SD
Intervention A	220	774.0	270
Intervention AB	232	1057.9	258
All intervention students	**452**	**919.7**	**299**

Table G.2: **E4K SmartBooks Dosage Descriptive Statistics by School and Intervention Group**

School	Intervention Group	Mean (minutes used throughout the project)
School A	AB	1303
School B	AB	1259
School C	A	1129
School D	AB	1041
School E	A	1001
School F	AB	967
School G	AB	667
School H	A	633
School I	A	630
School J	A	463