An Evaluation of the

Integration of M-learning in Total Reading Approach for Children Plus (TRAC+)

Enhancing Literacy of
Early Grade Students in Cambodia

Dr Grace Oakley, Dr Mark Pegrum, Dr Thida Kheang, & Mr Krisna Seng

ALL CHILDREN READING: A GRAND CHALLENGE FOR DEVELOPMENT

DL4D DIGITAL LEARNING FOR DEVELOPMENT

THE UNIVERSITY OF WESTERN AUSTRALIA

Published by

World Vision, Inc. and Foundation for Information Technology Education and Development, Inc.

World Vision, Inc.
300 I Street NE
Washington, D.C. 20002 USA
All Children Reading: A Grand Challenge for Development (ACR GCD)
www.allchildrenreading.org

Foundation for Information Technology Education and Development, Inc. (FIT-ED)
3/F Orcel II Building
1611 Quezon Avenue
Quezon City 1100 Philippines
Digital Learning for Development
www.dl4d.org

Recommended citation:

Oakley, G., Pegrum, M., Khaeng, T., & Seng, K. (2018). *An evaluation of the integration of m-learning in Total Reading Approach for Children Plus (TRAC+): Enhancing literacy of early grade students in Cambodia.* Washington, DC: World Vision and Foundation for Information Technology Education and Development.

Preface

The Total Reading Approach for Children (TRAC) project was first implemented in Cambodia from 2013 to 2014 by World Education, Inc. (WEI) to improve early grade reading outcomes among Grade 1 and Grade 2 students. This was made possible through a grant from All Children Reading: A Grand Challenge for Development (ACR GCD). ACR GCD, which was launched in 2011 by the United States Agency for International Development (USAID), World Vision, and the Australian Government, is an ongoing series of competitions that leverages science and technology to source, test, and disseminate scalable solutions to improve the literacy skills of early grade learners in developing countries.

End-of-project assessments of TRAC were encouraging: over 90% of performance indicators were successfully achieved. As a result, WEI was awarded follow-on funding by World Vision International – Cambodia to scale up TRAC. Called TRAC Plus (TRAC+), the scale up rolled out in 13 World Vision area development programs in five provinces in Cambodia in December 2014. In Year 1, TRAC+ ran in 170 schools, and continued to work in 138 of the 170 original target schools in Year 2. By the end of the project in September 2017, TRAC+ had directly reached about 20,000 students.

This report presents the findings of an independent evaluation of TRAC+ conducted from February to September 2017 by Dr. Grace Oakley, Dr. Mark Pegrum, and Dr. Thida Kheang—all from the Graduate School of Education, The University of Western Australia—assisted by Cambodian researcher Mr. Krisna Seng. The primary focus of the evaluation was the m-learning component of TRAC+—the use of Aan Khmer, a game-based app developed with funding from ACR GCD to teach Khmer alphabetical principles, vocabulary, and fluency in low resource environments. The evaluation set out to answer the question, "How and to what extent does the integration of m-learning in TRAC+ enhance the literacy of early grade students?" The findings of this study contribute to the body of knowledge on the effectiveness, sustainability, and scalability of m-learning integrated into TRAC+ in the Cambodian primary school context. Equity and efficiency issues were also addressed.

This evaluation was conducted under the Digital Learning for Development (DL4D) project of the Foundation for Information Technology Education and Development (FIT-ED) of the Philippines. As part of the Information Networks in Asia and Sub-Saharan Africa (INASSA) program of the International Development Research Centre (IDRC) of Canada and the Department for International Development (DFID) of the United Kingdom, DL4D aims to improve educational systems in developing countries in Asia through testing digital learning innovations and scaling proven ones. Funding for the evaluation was provided jointly by DL4D and ACR GCD.

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Acknowledgements

Ouk Sreyhoeun. In addition, we would like to thank the school directors, teachers, librarians, literacy coaches, parents, and children who engaged in the impact evaluation, and without whose participation this evaluation would not have been possible.

We would also like to extend our gratitude to the team at Digital Learning for Development (DL4D) and at All Children Reading: A Grand Challenge for Development (ACR GCD), and especially Jill (Kila) Reimer, Education Director of World Vision International – Cambodia, for their support of this evaluation.

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Contents

Acronyms

ACR GCD	All Children Reading: A Grand Challenge for Development
ADB	Asian Development Bank
AR	Augmented Reality
CA	Correct Answer
CCOSC	The Cambodian Consortium for Out of School Children
CFS	Child-Friendly School
CLPM	Correct Letters per Minute
DFID	Department for International Development (UK)
DL4D	Digital Learning for Development
EFA	Education for All
EGRA	Early Grade Reading Assessment
ESD	Education for Sustainable Development
ESP	Education Strategic Plan
ESSP	Education Sector Strategic Program
ET4D	Education Technology for Development
FIT-ED	Foundation for Information Technology Education and Development (Philippines)
FWR	Familiar Word Reading
GSMA	Global System for Mobile Communications Assocation
HU	Higher Use
ICT	Information and Communications Technology/-ies
ICT4D	Information and Communications Technology/-ies for Development
IDRC	International Development Research Centre (Canada)
IRC	International Red Cross
IV	Independent Variable
LCO	Listening Comprehension
LNR	Letter Name Recognition
LPM	Letters per Minute
LU	Lower Use
M4D	Mobiles for Development
MDG	Millennium Development Goal
m-learning	mobile learning

MLit-U	MobiLiteracy Uganda
MoEYS	Ministry of Education, Youth, and Sport (Cambodia)
NEP	NGO Education Partnership
NGO	Non-Governmental Organization
NWR	Non-Word Reading
ORF	Oral Reading Fluency
PB	Program-Based
RCO	Reading Comprehension
RRS	Rapid Response System
SDG	Sustainable Development Goal
SIG	School Improvement Grant
SPSS	Statistical Package for the Social Sciences
SR	Sentence Reading
STAR	School-based Test About Reading
TRAC	Total Reading Approach for Children
TRAC+	Total Reading Approach for Children Plus
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WB	World Bank
WEI	World Education, Inc.
WPM	Words per Minute
WVI	World Vision International
WVI-C	World Vision International–Cambodia

1. Executive Summary

The Ministry of Education, Youth, and Sport (MoEYS) introduced a phonics approach to teaching and learning the Khmer language in primary schools in Cambodia in 2012. To support the MoEYS in improving the reading competencies of early grade children, World Education, Inc. (WEI) was awarded a two-year, USD $300,000 grant under the All Children Reading: A Grand Challenge for Development (ACR GCD) Round 1 global competition to implement the Total Reading Approach for Children (TRAC) project in eight primary schools in two provinces in Cambodia between October 2012 and September 2014. Based on preliminary evidence of promising results, and building upon the ACR GCD partners' interest in scaling promising interventions, World Vision International-Cambodia (WVI-C) directly funded WEI between December 2014 and September 2017 to expand the Total Reading Approach for Children Plus (TRAC+) project to 138 primary schools in five provinces. This study was conducted to evaluate the effectiveness and efficiency of the mobile learning (m-learning) component of the WEI-implemented TRAC+ project. It focused on the value of the *Aan Khmer* ("Read Khmer") app—one of the few mobile solutions awarded under the ACR GCD Round 1 global competition that sought to offer digital gaming to early grade students in low resources settings—as a means of improving the reading of children in Grades 1, 2, and 3.

The study adopted a mixed methods approach, which is considered to be the most effective means of carrying out evaluation research. It was carried out in two main phases. Phase 1 involved using the School Director Survey to develop an understanding of the context within which the TRAC+ project was implemented and to identify 15 schools for a collective case study. Phase 2 involved collecting both quantitative and qualitative data. The quantitative data were gathered through administering two different reading assessments, the Early Grade Reading Assessment (EGRA) and the School-based Test About Reading (STAR), to a sample of students in Grades 1–3 in the 15 selected case study schools. The qualitative data were collected using interviews with school directors, teachers, librarians, literacy coaches, and parents. Focus group interviews were also carried out with peer tutors and students in these schools. Furthermore, several observations of students using the tablets with peer tutors were undertaken.

> Quantitative findings indicate that Grades 2 and 3 children in schools categorized as making higher use of the Aan Khmer app scored significantly higher in some subtasks of the EGRA tests than children in schools with lower use of the app.

Quantitative findings indicate that Grades 2 and 3 children in schools categorized as making higher use of the *Aan Khmer* app scored significantly higher in some subtasks of the EGRA tests than children in schools with lower use of the app. Nevertheless, these results should be treated with caution due to methodological limitations associated with the context.

Qualitative findings revealed positive views of TRAC+, including its m-learning component, among many teachers and students. However, the implementation of m-learning as part of TRAC+ was not necessarily carried out as intended in schools, and a number of issues were identified relating to: the

design of the app itself; the links between the interval testing (also carried out on tablets used for *Aan Khmer* with Grades 1 and 2 children) and the use of the *Aan Khmer* app; staff training; limited involvement of classroom teachers; limited student use of *Aan Khmer*; peer tutoring processes; limited involvement of parents; and the resourcing of TRAC+. The scalability of the project will depend on implementing a responsive design for the app, and increasing its availability through the Google Play store. The sustainability of the project will depend on ongoing and ideally increased funding, training and support for schools. However, both scalability and sustainability might be improved by balancing investment in digital technologies with more investment in traditional analogue resources such as books. Key recommendations emerging from the study are listed in Chapter 8.

The study makes a significant contribution to the body of knowledge on the effectiveness, sustainability, and scalability of m-learning integrated into TRAC+ in the Cambodian primary school context. Indeed, it is the only independent evaluation of the m-learning aspect of TRAC+ in Cambodia, and the only study that has included many associated actors in the project, namely school directors, teachers, librarians, literacy coaches, peer tutors, "struggling students," and parents. The study identified issues relating to the implementation of the m-learning component, leading to recommendations for improvements.

> Both scalability and sustainability might be improved by balancing investment in digital technologies with more investment in traditional analogue resources such as books.

Keywords: mobile learning, m-learning, early literacy, reading, Cambodia, TRAC+

2. Overview of Project

This mixed methods research was conducted to assess the effectiveness, efficiency, scalability, and sustainability of the m-learning component (the *Aan Khmer* app) of the TRAC+ project implemented by WEI in five provinces in Cambodia to improve the reading of children in Grades 1, 2, and 3. This chapter of the report describes the context of the Cambodian education system and the problems the TRAC+ project was designed to address, namely low literacy levels in young children within communities that have low levels of literacy and high levels of poverty, in a country with limited resources and severe shortages of skilled educators. The way in which the TRAC+ project was intended to be implemented is described in some detail.

Later chapters in this report describe how the TRAC+ project, particularly the m-learning component (*Aan Khmer*), has been implemented in practice. The report also indicates the extent to which the *Aan Khmer* app has been beneficial to children's learning. The perspectives of school directors, literacy coaches, teachers, librarians, peer tutors, and children on the usefulness and limitations of the app are described.

2.1 Education in Cambodia

Cambodia's education system has undergone several changes since the colonial period. The immediate post-colonial period in the 1950s witnessed an attempt to promote and expand formal education to reach a wide population in the country (Ayres, 1999, 2003; Bilodeau, 1955). This process was interrupted in the late 1960s when the country suffered a great deal from political instability and armed conflict. Schools were significantly disrupted by widespread armed fighting in the country. This situation became worse during the Khmer Rouge Regime between 1975 and 1979, during which brutal genocide occurred and, it is estimated, at least 1.7 million lives were lost (Ayres, 1999). The formal education system was abolished and school buildings were extensively destroyed during this period.

Following this, there was a period of rehabilitation and reconstruction of the education system, which mainly took place between the early 1980s and the end of conflict in the country in 1998. The focus of the reconstruction was placed on rebuilding basic education infrastructure and associated human resources with particular attention given to establishing administrative bodies, reopening schools, repairing and building schools, and recruiting and training teachers. Several legislative and policy documents were formulated to facilitate the process of education reconstruction. It is important to note that the reconstruction of education was undertaken with considerable support from non-governmental organizations (NGOs) and international multilateral donors such as the International Red Cross (IRC), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the United Nations Children's Fund (UNICEF, from the original abbreviation United Nations Interna-

> The landscape of education in the post-conflict era in Cambodia has been characterized as one of stable development, accompanied by peace and political stability.

tional Children's Emergency Fund), the United Nations Development Programme (UNDP), the World Bank (WB), and the Asia Development Bank (ADB).

The landscape of education in the post-conflict era in Cambodia has been characterized as one of stable development, accompanied by peace and political stability. A more comprehensive approach to education reform has been introduced to accelerate education development, with a special focus on promoting equitable access to education, enhancing education quality, and promoting capacity building and institutionalization (MoEYS, 2014b). This reform not only reflects the political interests of the nation, but also aligns with the global education development movement promoted by the United Nations' (UN) Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), and UNESCO's Education for All goals. This aim is pursued in Cambodia through the commitment to provide free and compulsory primary school education of good quality to all children, regardless of gender and ethnicity (MoEYS, 2003). This is well articulated in key policy documents, including the *Cambodia Millennium Development Goals* and especially the *National Plan for Education for All 2003–2015*.

Figure 1. *Rural scenery, Takeo Province, Cambodia. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

Cambodia's current education system is divided into four academic levels: pre-school education, primary school education, secondary school education (lower and upper), and tertiary education. Pre-school education is not compulsory and caters to children from ages 3–5. Six years of primary school education and three years of lower secondary education make up what is called "basic education" (Grades 1–9) (MoEYS, 2004). While there are no official papers defining compulsory education in the country, the Constitution indicates the State has the duty to provide education to all citizens for at least nine years (Royal Government of Cambodia, 1993). Following the completion of lower secondary school education, students can either enter upper secondary school education or secondary-level vocational and/or technical training schools. Upper secondary education lasts three years (Grades 10–12) and completing this level allows students to continue their education to tertiary level, which can be academic or technical/vocational. It should be noted that the administration of the education system in Cambodia is divided into four levels, namely, the central level (MoEYS), provincial/municipal level (the Provincial Office of Education), district level (the District Office of Education), and school level.

Cambodia has made remarkable progress in promoting universal primary school education since the inauguration of the *National Plan for Education for All 2003–2015* (UNESCO, 2015b). The population of

trained primary school teachers has increased significantly and their academic qualifications have also improved considerably. The number of primary school teachers with upper secondary level education rose from 14.1% to 60.4% between 1999 and 2013 (MoEYS, 2014a). Furthermore, more schools have been built in different parts of the country to expand access to education in rural and remote areas and respond to the growing number of students. There were 7,051 public primary schools in the country in 2014/2015; of these, 5,149 were operated as "child friendly schools" (CFSs) (MoEYS, 2015). The MoEYS introduced the Child Friendly School Policy into the basic education system in the country in 2007 with the objective of promoting the national educational goals, responding to the *Cambodia Millennium Development Goals* and the *National Plan for Education for All 2003–2015*, and achieving the goals and targets of the *Education Strategic Plans* (ESPs) and *Education Sector Support Program* (ESSP) (MoEYS, 2007). The CFS framework for improving education in Cambodia was based on the concept that a school should provide a learning environment that recognizes and nurtures children's basic rights. It focuses on six major dimensions: inclusive education; effective learning; health, safety, and protection of children; gender responsiveness; the participation of children, families, and communities in school operation; and effective and sustainable implementation of the policy (MoEYS, 2007).

At the same time, there has been substantial progress in expanding access to primary school education, with net enrollment increasing from 84% in the school year of 2000/2001 to 97% in the school year of 2012/2013 (MoEYS, 2014a; UNESCO, 2015b). The increase was significant across the country, with many provinces achieving over 90% net enrollment. However, there has been unequal distribution of growth between rural and urban areas. There was a decline in the net enrollment rate in urban primary schools from over 90% in 2004/2005 to slightly below 85% in 2012/2013 (MoEYS, 2014a). Conversely, there has been a considerable increase in primary school enrollment in rural and remote areas, with an increase from 90% to almost 100% in the same period.

> While significant progress has been made in promoting access to primary school education, many school-aged children are still not enrolled in schools in Cambodia. There were at least 57,000 primary school–aged children who did not attend any form of education in 2015.

Achievements have also been made in reducing the repetition rate in primary school education, with a decrease from 28.5% in the school year of 2000/2001 to 10.4% in the school year of 2012/2013 (MoEYS, 2014a; UNESCO, 2015b). There was also a decrease in dropout rates in primary education, with the dropout rate in Grade 6 decreasing by 5.2% between the school years of 2000/2001 and 2012/2013 (MoEYS, 2014a; UNESCO, 2015b). Furthermore, the gender disparity in primary school education has narrowed significantly, with the net enrollment of girls increasing from 80.7% in the school year of 2000/2001 to 97% in the school year of 2012/2013 (MoEYS, 2014a).

While significant progress has been made in promoting access to primary school education, many school-aged children are still not enrolled in schools in Cambodia. There were at least 57,000 primary school-aged children who did not attend any form of education in 2015 (CCOSC, 2015). Many of these children lived in disadvantaged areas with limited access to education, came from low socioeconomic backgrounds, and experienced problematic family issues, ethnicity problems, and physical and intellectual disabilities (Hattori, 2009). Moreover, there is still a lack of such educational infrastructure as

classrooms, basic classroom facilities, libraries, and offices for school directors and teachers in some geographical locations, especially disadvantaged ones. A teacher shortage remains a daunting issue in many disadvantaged primary schools, where teaching is not considered to be an attractive job and working conditions are challenging.

To cope with the shortage of teachers and classrooms, some primary schools recruit contract teachers who may lack both content knowledge and pedagogical preparation; others use double or triple learning shifts. It is important to note that the double learning shift is widely practiced in Cambodia, with the morning shift running from 7–11 a.m. and the afternoon shift running from 1–5 p.m. Some teachers teach both morning and afternoon shifts. Estimates indicate there were 17,035 double shift teachers in 2014, which was equivalent to 38% of the total teaching staff in primary schools (MoEYS, 2015). There are also schools that practice a triple learning shift, allowing even less contact time for individual children in school. While the multiple learning shifts approach helps address the resources shortage, it can have a negative impact on the quality of education because students miss out on some learning activities in school. It can also be problematic if teachers teach more than one shift, as they can suffer from fatigue and have less time for instructional preparation.

A further major challenge for primary school education in Cambodia relates to the quality of education. Learning achievement among primary school students is still low. In 2006/2007, the MoEYS administered standardized tests to assess the performance of primary school students in the Khmer language and mathematics. The results indicated that Grade 3 students achieved an average of 40% for Khmer language questions and 38% for mathematics, while Grade 6 students achieved an average of 68% for Khmer language questions and 53% for mathematics (MoEYS, 2006, 2008). More recent results from the standardized tests administered in 2012/2013 showed there was a significant decrease in achievement in both subjects, with Grade 6 students achieving an average of 45.7% in Khmer and 43.3% in mathematics (MoEYS, 2016). Many influences were identified as contributing to the decline. These included the qualifications of teachers, teachers' pedagogical content knowledge, the teaching and learning environment, the socioeconomic background of students, and attendance rates of students in school. Furthermore, it has been reported that the number of teaching hours delivered in primary schools is 684–760 hours per annum (MoEYS, 2004), which falls below the international recommendation of 850–1000 hours per academic year (UNESCO, 2015c). This situation is further exacerbated by the informal loss of teaching hours. In relation to this, Ang, Colin, and Chhum (2015) reported that on average in the school year of 2012/2013, 27% of teaching hours (50.5 days) were lost due to additional school holidays (for example, closing schools to allow attendance at state events, or sending teachers to supervise teacher trainee exams), teacher absence, and shortened teaching sessions.

2.2 The TRAC+ project

There has been debate among policy makers and educators in Cambodia about how Khmer, the official language of instruction in schools, should be taught. Because the orthography in Khmer is quite complex (as detailed in Chapter 4), learning to read and write is difficult for many children and, indeed, many adults in Cambodia have very low literacy levels. Several approaches to teaching reading and writing have been introduced in primary schools. The first text for teaching reading and writing in Khmer was produced in 1946, based on a phonics approach called *Chet Chhem* (UNESCO, 2015a). This

approach involved reciting and memorizing a chant which combines each consonant (33 consonants) with the 24 vowels of the Khmer language. Abadzi (2013) commented on the approach: "the rhythm of the chant helps consolidate the sequences and the visual letter changes that go with it" (p. 4).

There was a gradual shift toward a "whole language approach" in the 1980s when Cambodia resumed its education system following the collapse of Khmer Rouge in 1979 (UNESCO, 2015a). It was officially introduced in the 1990s and new textbooks were produced accordingly. Whole language approaches, as opposed to skills-based approaches, generally involve teaching literacy in a "top down" manner using whole texts, with an emphasis on making meaning. Children are taught phonics within the context of whole texts instead of separately. A potential problem with this approach is that, if not implemented appropriately, sound-symbol relationships (decoding) may not be taught explicitly and systematically enough. The change to a whole language approach is believed to be the result of advice from foreign experts who may have limited knowledge of the Khmer language. Despite a lack of empirical evidence of the impact of the whole language approach on the literacy skills of primary school children in the nation, there was a consensus among educators that there was a decline in the level of reading and writing abilities in the following two decades (UNESCO, 2015a). As a result, the MoEYS reintroduced a phonics approach to teaching and learning the Khmer language, with a pilot study being implemented in some primary schools in the country; the results of the study were promising (Abadzi, 2013). This approach was eventually implemented in all primary schools in the country in 2012.

Figure 2. *Provincial school where TRAC+ is being implemented, Cambodia. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

In 2012, WEI was awarded USD $300,000 in the ACR GCD global competition—a partnership between USAID, World Vision, and the Australian Government—to implement the TRAC project in Cambodia over a period of two years (October 2012 to September 2014) (for further details, see: allchildren-reading.org/innovators/world-education/). The project adopted an integrated approach to improve the reading skills of children in Grades 1 and 2 in eight rural, semi-urban, and urban primary schools in two provinces, namely, Kampong Cham and Siem Reap. It introduced a range of interventions including reading benchmarks, literacy coaches, a Rapid Response System, peer tutoring, parental engagement, reading toolkits, and m-learning, each of which is explained below:

- Reading benchmarks: A reading benchmark system for the national reading curriculum was jointly developed by WEI and the Cambodian MoEYS. The benchmarks included specific tasks and skills that students should master at designated intervals. The benchmarks entailed regular interval assessments, which allowed teachers and literacy coaches to identify "struggling students" (a term used in the Cambodian context, and understood here as students who have failed an Interval Test) and provide timely, targeted support. There were eight interval tests for Grade 1 students and nine for Grade 2 students.

- Literacy coaches: School-based literacy coaches were recruited and trained to help implement TRAC in each participating school. They were considered as focal actors working closely with teachers to administer the benchmark assessments and the Rapid Response System interventions. In addition, they liaised between schools and community members. Literacy coaches received ongoing support from project staff through regular monthly meetings to improve their technical abilities. They were provided with a small monthly stipend (USD $30 per month).

- Rapid Response System: This system, implemented by literacy coaches, involved peer tutors and parents in the use of a reading toolkit and an m-learning application, *Aan Khmer*, to help struggling students with their reading. The toolkit and m-learning application were aligned with the national curriculum and the TRAC reading benchmark system.

- Peer tutoring: Peer tutors were students in Grades 4–6 who helped struggling students in Grades 1–3 with their reading by using materials from the reading toolkit and/or *Aan Khmer.* They were selected based on their strong reading skills but worked on a voluntary basis. They received a half-day orientation in which they were taught about how to form tutoring groups, and how to use materials from the reading toolkit and tablets. In addition, they attended a monthly meeting to reflect on their work and to further develop their capacity to support struggling students.

- Parental engagement: TRAC aimed to promote the engagement of parents in supporting the learning of their children. Initially, parents were invited to attend a half-day meeting in which they were introduced to the project goals and interventions and discussed ways they could help their children's learning. Parents were encouraged to borrow learning materials from the school library to support their children at home and have the *Aan Khmer* app installed on their smartphones. They were also encouraged to help children at school during study breaks.

- Reading toolkits: A reading toolkit *(Figure 3)* was a box containing 21 different learning games, most of which were simple and could be used by students to improve specific reading skills. The games only focused on one specific reading skill at a time.

- M-learning: An app called *Aan Khmer* was developed to enhance the reading abilities of struggling students. It was one of the few mobile solutions awarded under the ACR GCD Round 1 global competition that sought to offer digital gaming to early grade students in low resources settings. It was game-based early grade reading support software which aimed to promote Khmer alphabetical principles, vocabulary, and fluency.

Figure 3. *The TRAC+ toolkit. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

The TRAC project was completed successfully in 2014, achieving over 90% of its performance indicators during the set timeframe (World Education, 2014). These included increased involvement of school actors in promoting the learning of children; an increased number of teaching and learning materials (1,908 textbooks and 160 mobile devices); improvement in teachers' instructional capacity; indications of improvements in reading scores; and literacy coaches being able to use the Rapid Response System effectively.

With these promising results, and in line with the ACR GCD partners' desire to see innovations scaled, World Vision International-Cambodia (WVI-C) directly funded WEI from December 2014 to September 2017 to expand TRAC with the inclusion of a few additional elements, and renamed as TRAC+. The main aim of TRAC+ is the same as that of TRAC, namely to improve early grade reading. The key changes include:

- The intervention was scaled up from eight primary schools to 138 schools in five provinces, divided into Group A (73 schools), which were supplied with tablets *(Figure 4)* with the *Aan Khmer* app (the "full intervention"), and Group B (65 schools), which received no tablets.

- Digital Interval Tests were introduced at the start of TRAC+ for Grades 1 and 2. The Interval Tests are pre-made formative assessments that track whether children have achieved the benchmark skills/knowledge. The Interval Tests were also introduced for Grade 3, although these Interval Tests are only available on paper.

- TRAC+ includes an intervention for Grades 4–6 in the form of voluntary extracurricular Study Clubs, where students research projects and present them at a school fair, thereby developing hard and soft skills.

- TRAC+ includes leadership and management training in schools. School directors and deputy school directors receive annual training, which is a modified version of the School Management and Leadership curriculum developed under the USAID-funded, World Education-implemented Improved Basic Education in Cambodia project (2009–2014).

Figure 4. *Samsung tablets distributed to schools participating in TRAC+. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

The MoEYS, in collaboration with several NGOs, is in the process of reviewing and revising the Khmer language textbooks for Grades 1–3. It is not clear whether revisions will be major or minor. The revisions will then need to be incorporated into the Interval Tests, but this can be done easily by pushing them out to teachers' tablets when they sync with the server.

There is a Project Exit Strategic Plan for the end of the current project, which involves working with school directors and teachers to ensure future sustainability in schools, and increasing the amount of content by incorporating other NGOs' material onto the tablets.

2.3 The Interval Test app

The Interval Test app (កម្មវិធីពិនិត្យស្ទង់ដំណាក់កាល), aligned with the primary school curriculum implemented by the MoEYS, is intended to be a diagnostic tool used to assess the reading abilities of students, with a focus on five key aspects of reading, including phonemic awareness, phonics, fluency, vocabulary and comprehension. It is currently implemented in Grades 1 and 2 *(Figure 5)*, but there is an indication that soon the Grade 3 benchmark system will be integrated into the test application. For now, the Interval Test app is only compatible with the Android operating system.

Figure 5. *Library set up with tablets for the Interval Test. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

The app requires a Wi-Fi hotspot which connects the teacher's tablet to the students' tablets so that the test items can be delivered in synchrony, with results automatically collated on the teacher's device to provide an overview of responses, and subsequently uploaded to a central server.

The Interval Test app *(Figure 6)* has six key components: testing, test results, results publication, assignment monitoring, retesting, and results comparison. Testing is the initial step in the app, where students register and take the test. Test results show the performance of the students and enable the teacher to identify students with reading difficulties, or students who are not making expected progress. The teacher can see both the average scores for the students in each class, as well as the scores of individual students, including struggling students. Results publication enables the teacher to share the test scores with other relevant teachers who support the students through the assignment of extra learning activities in the toolkit and the *Aan Khmer* app. Another function in the app, called "monitoring assignments of students," enables the teacher to see each student's progress on the assigned learning activities. In particular, the teacher can see who is helping the students learn and what learning activities they have completed. When the students complete their assigned activities, they can be asked to retake the Interval Test; however, this retesting was omitted in the third year of TRAC+ because it was reportedly too time-consuming for teachers. The last component in the app allows comparisons of the test results of each individual student, indicating how much progress they made.

Figure 6. *A screenshot from the Interval Test app (matching the correct word with the picture). Reproduced by permission of WEI.*

2.4 The *Aan Khmer* app

The *Aan Khmer* app (កម្មវិធីអានខ្មែរ) is based on an international template by MoToLi (www.motoli.com), developed by Education Technology for Development (ET4D). The MoToLi app can be customized for different languages. The Khmer version is a co-operation between ET4D, the MoEYS, and World Education (Pegrum, 2014). MoToLi is described as follows by its creators (with reference specifically to MoToLi 2.0, a version developed after *Aan Khmer*):

> *Developed by an international team of technologists, linguists, and educators, MoToLi can be deployed in any phonetic language and is readily adaptable across cultures and curricula.*

> *Through an artful integration of educational features, MoToLi will achieve what gamified learning is best at promoting: enjoyment, autonomy, competence, and social connectedness (MoToLi, n.d.).*

The MoToLi app (see www.motoli.com for more detailed information) is a self-directed app for children aged 5 or older, enabling them to learn reading independently or with peers. The app provides explicit instruction and practice along with some game features but without too many "bells and whistles." It deliberately includes a low level of game features, which the designers view as potentially distracting for young children. It does not include the features of some other digital games, such as rewards, leaderboards, and so on. Later versions do incorporate the ability for children to "win"

Since the app is designed to be used independently by children, or with the help of peers, a teacher is not deemed to be necessary. However some level of teacher involvement is highly desirable to improve the children's learning.

narrated storybooks for them to read on their tablets. The version used in the TRAC+ project was in-stalled on Samsung tablets and had not been optimized for use on mobile phones, so the screens did not resize automatically to fit smaller phone screens.

The pedagogical underpinnings of the MoToLi-based *Aan Khmer* app *(Figure 7)* appear to be grounded in the provision of explicit phonics instruction in a logical sequence, followed by multiple opportunities for children to practice through a variety of interactive activities. This is a skill-building approach to read-ing. Some of the activities are essentially digitized matching games and flashcards, which may assist children to memorize words and letters. At the end of each unit is a "mini-story" containing letters and words covered in the lessons. It is conceivable that children viewing these narrated digital stories may not notice that the story uses letters and words from the lessons. Nevertheless, having opportunities to listen to stories (and read along at the same time) can be advantageous for children in helping them de-velop an interest in reading, an appreciation of narrative structure, and an understanding of "storybook" grammar and vocabulary, as well as giving them a chance to hear what fluent reading sounds like. If there is simultaneous text highlighting and audio narration, children can also learn concepts about print such as directionality. Since the app is designed to be used independently by children, or with the help of peers, a teacher is not deemed to be necessary. However, as the findings of this report will show, some level of teacher involvement is highly desirable to improve the children's learning.

Figure 7. *The welcome/sign-in screen of the Aan Khmer app. Reproduced by permission of WEI.*

The *Aan Khmer* app contains 31 units (see Appendix 1), each of which is made up of three main com-ponents: 1) learning (new content is presented to children); 2) practice (children are presented with three different activities to practice the new content); and 3) a mini-story (the new content is used within a text and presented as a read-along story with audio support). A more detailed example of the contents of one unit is given below:

Example Unit 19: Consonant-Subscript Combination (9) (Figures 8, 9, 10)

a. Learn to read the combination (consonant-subscript combination)
b. Find the initial missing letters
c. Match words with pictures
d. Find paired words
e. Read mini-story (Aunty Trob is a Good Housewife)

Figure 8. *Contents of Unit 19 of the Aan Khmer app. Reproduced by permission of WEI.*

Figure 9. *Mini-story at the end of Unit 19 of the Aan Khmer app. Reproduced by permission of WEI.*

Figure 10. *Mini-story at the end of Unit 19 of the Aan Khmer app (continued). Reproduced by permission of WEI.*

Figure 11. *Progress screen of the Aan Khmer app. Reproduced by permission of WEI.*

Although there are some limitations in the *Aan Khmer* app that has been used in the TRAC+ project, the WEI in Cambodia has permission from MoToLi to make modifications to the app to improve the interface and the instructions. It could also be made more accessible through placing it on Google Play and optimizing it for use on small screens.

It should be noted that MoToLi has also been updated to MoToLi 2.0, with a number of improvements that may benefit *Aan Khmer.* These include:

- Many more levels
- Possibility of wider range of activity types
- Ability to incorporate many teaching videos
- Inclusion of math and writing
- Improvements in design and navigation

The content of the toolkit and the app are very similar so that they complement each other. While the toolkit requires supervision by teachers, literacy coaches and/or peer tutors, the app is designed for self-study (although it can also be used under the supervision of literacy coaches, peer tutors, or even parents, and indeed, it may be advisable to have more teacher involvement in this process).

The app is intended for use in the following way. First, students are asked to take an Interval Test, which is expected to occur once a month. The Grades 1 and 2 Interval Tests are done using the tablets where these are available, while the Grade 3 test is paper-based. The Interval Test allows for the identification of struggling students, i.e., those who fail a subsection or subsections of the test (with a score of less than 50%). Students are then directed to attempt relevant activities from the toolkit and the *Aan Khmer* app to learn the necessary skills, as identified in the test. They are assigned to work with peer tutors under the direction of literacy coaches. This may take place in the library or a designated classroom. Peer tutoring may occur during break times (typically between 10–15 minutes) or during class time, depending on the school context. Several such peer tutoring sessions are expected to take place between the Interval Test where the struggling student failed a subsection or subsections, and the next Interval Test.

3. Research Objective and Questions

The objective of this research was to conduct an evaluation of the effectiveness, efficiency, scalability, and sustainability of m-learning as part of the WEI TRAC+ project in Cambodian primary schools. In carrying out this objective, young students' access to quality learning experiences was assessed.

For the most part, the researchers have been able to meet the objective. However, in some regards, results should be treated with caution because of the limitations of the assessment instruments used to measure student learning, and because baseline data from which to measure student growth were not available. On top of this, the means by which schools were categorized as making higher use of the tablets and app, as opposed to lower use, were imperfect due to constraints in terms of time and funding, which meant it was not possible to accurately measure the time children spent using the tablets and app in each school.

The central research question examined in this project was:

> *How and to what extent does the integration of m-learning in TRAC+ enhance the literacy of early grade students?*

This question was underpinned by several specific research questions:

1) How are mobile technologies integrated into literacy learning by students, peer tutors, teachers, and parents?

    a. What types of mobile hardware are used, and how?

    b. What forms of mobile connectivity are used, and how?

    c. What types of software (apps, platforms) are used, and how?

    d. How are these integrated into TRAC+?

2) How is the mobile app *Aan Khmer* integrated into TRAC+ by students, peer tutors, teachers, and parents?

    a. What hardware is used to access this app?

    b. What connectivity is needed to download and use this app?

    c. What are the key features of the software (i.e. the app itself)?

    d. How is this app used in the teaching of key elements of literacy, including sound–symbol correspondences, sight words, comprehension, and writing?

3) Are there any significant differences in the literacy improvements in schools with high use of the *Aan Khmer* app compared to schools with little or no use of this app?

4) What aspects of students' literacy, if any, have been improved by use of the *Aan Khmer* app?

5) What conditions have supported students, peer tutors, teachers, and parents in using the *Aan Khmer* app?

6) What challenges have been encountered by students, peer tutors, teachers, and parents in using the *Aan Khmer* app?

7) To what extent did the actual implementation of the *Aan Khmer* app in TRAC+ in schools differ from its planned implementation?

The answers to these questions are detailed in Chapters 6–9, which follow on from Chapter 4 (containing a review of the relevant theoretical literature) and Chapter 5 (giving an overview of the research methodology of this project).

■   ■   ■

4. Review of Literature

This brief literature review covers key theories and research relevant to the TRAC+ project, and to its evaluation in the current report. An overview of the literature on literacy in the early years is followed by an overview of the emerging literature on the pedagogy and evaluation of m-learning.

4.1 Theory of and research on literacy in the early years

In this section of the literature review, theory and research on how literacy is defined and how it might best be taught in the early school years are outlined. This is followed by a critical review of the role of Information and Communications Technologies (ICTs), including mobile learning, in early childhood literacy education.

4.1.1 What is literacy?

The definition of literacy is dynamic and without consensus; however, most traditional definitions encompass reading, writing, speaking, listening, and viewing. Newer definitions of literacy also include the comprehension and creation of multimodal (including digital) texts and critical literacy (Fellowes & Oakley, 2014), while some also include digital literacies (Dudeney, Hockly, & Pegrum, 2013; Pegrum, 2016a). Put simply, the essential underpinning elements of literacy for young children are: oral language ability (phonology, syntax, semantics, and pragmatics); the ability to represent sounds using symbols; the ability to read and write high frequency words with automaticity; the ability to use comprehension strategies to understand a range of text types (including digital texts); and the ability to compose or create texts using a range of modes, such as written words and visuals, for a range of purposes and audiences (Fellowes & Oakley, 2014). It is important to note that many theorists no longer use the term "literacy," but prefer the term "literacies," which reflects the multiplicity of contexts and practices that people engage in during multidimensional literacy events (Mills, 2016).

4.1.2 How does literacy develop and what needs to be taught?

Literacy learning commences when children begin to learn oral language at birth. Children learn about phonemes (sounds in language), syntax (grammar), semantics (meanings), and pragmatics (functions and forms of language in use) from very early in life, through meaningful social interactions with others (Honig, 2007). This knowledge of oral language is foundational to written language.

Success in learning to read and write at school is easier for children who have opportunities to participate in rich home literacy practices; such experiences build understandings about written texts, what they are for, and how they work. Through such home experiences, many young children learn the fundamentals of the "alphabetic principle," or the knowledge that sounds are represented by symbols. Many preschool children also begin to learn how to decode written texts (sound-symbol correspondences), as well as basic concepts about print (such as how to turn pages and the directionality of print). There have been numerous studies on the importance of home environments for early literacy development (see the review by Yu & Daraganova, 2014). Regrettably, in many developing countries, limited or no access to books or other reading materials precludes such print-based literacy experi-

ences in the home, although in some cases adults are now reading aloud to children using texts on their mobile phones (UNESCO, 2014). A program intended to redress such a lack of access to books, cited by UNESCO (2014), is the MobiLiteracy Uganda (MLit-U) program, which is designed to improve early literacy development by providing reading activities for parents and caregivers to perform at home with children. There are many other such programs globally, most of which are funded by NGOs.

Home literacy experiences are important, but it is also true that teachers can make an enormous difference to children's literacy learning through the selection and skillful implementation of appropriate teaching and learning activities (Louden, Rohl, & Hopkins, 2008), even in cases where children come from disadvantaged communities. In terms of what must be taught in the school years to help children become literate with written texts, Konza (2014) extends the five key areas found by the National Literacy Panel (NICHD, 2000) to be crucial to successful literacy learning to include oral language. Konza's "Big Six" comprises oral language, phonemic awareness, letter-sound knowledge, vocabulary, fluency, and comprehension. It is important for any reading program to address these elements. Many theories of literacy learning are "stage theories," where it is believed that literacy develops in phases; however, this developmental perspective is contested. Development is not always predictable because of factors such as features of the language concerned, and individual and contextual factors impacting the learner (Gove & Wetterberg, 2011). A conceptual framework for the development of written literacy for children using alphabetic languages is presented below *(Figure 12)*. (Note that the Khmer writing system is alpha-syllabic, not alphabetic. Please see below for more detail about how this writing system works.) This model represents the development of literacy as a three-stage process. Although it does not incorporate important aspects of literacy such as pragmatics and cognitive processes, the framework aligns with the EGRA, which is used with the TRAC+ project in Cambodia.
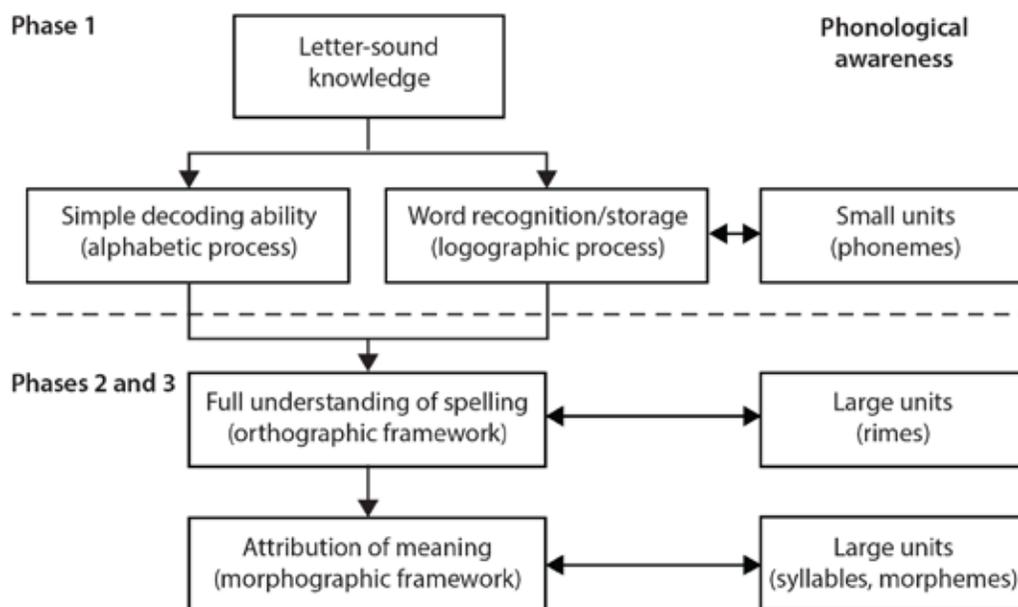
Figure 12. *Three-phase model of reading. Source: Gove, A., & Wetterberg, A. (Eds.). (2011). The Early Grade Reading Assessment: Applications and interventions to improve basic literacy. Research Triangle Park, NC: RTI Press. Reprinted with permission of RTI Press.*

A focus on reading is appropriate in this literature review because of the nature of the study, although it is emphasized that teaching and learning—and the practices of reading and writing—are intimately

interrelated. A comprehensive cognitive model of reading that acknowledges aspects of literacy such as comprehension processes, knowledge about text types and purposes, and knowledge of vocabulary and general conceptual knowledge, has been proposed by McKenna and Dougherty Stahl (2009) *(Figure 13)*. Since this is a cognitive model, it does not explicitly acknowledge the role of sociocultural influences, however.

"Balanced" models of literacy pedagogy posit that it is important to teach skills such as phonics in a systematic and explicit way, although this must be blended with the authentic use of real texts for real purposes, which are relevant and interesting to the children concerned (Pressley, 2006). To implement balanced literacy teaching, the gradual release of responsibility model (Pearson & Gallagher, 1983) is deemed to be useful; teachers help children apply what they have learned through modeled, shared, interactive, guided, and independent practice. Some researchers argue that stand-alone, decontextualized phonics programs not integrated into the classroom reading program are not as effective as phonics teaching within the context of interesting, purposeful, and authentic reading and writing activities (Wyse & Goswami, 2008). However, this is still an area of contention in literacy research and education.

Modified Cognitive Model
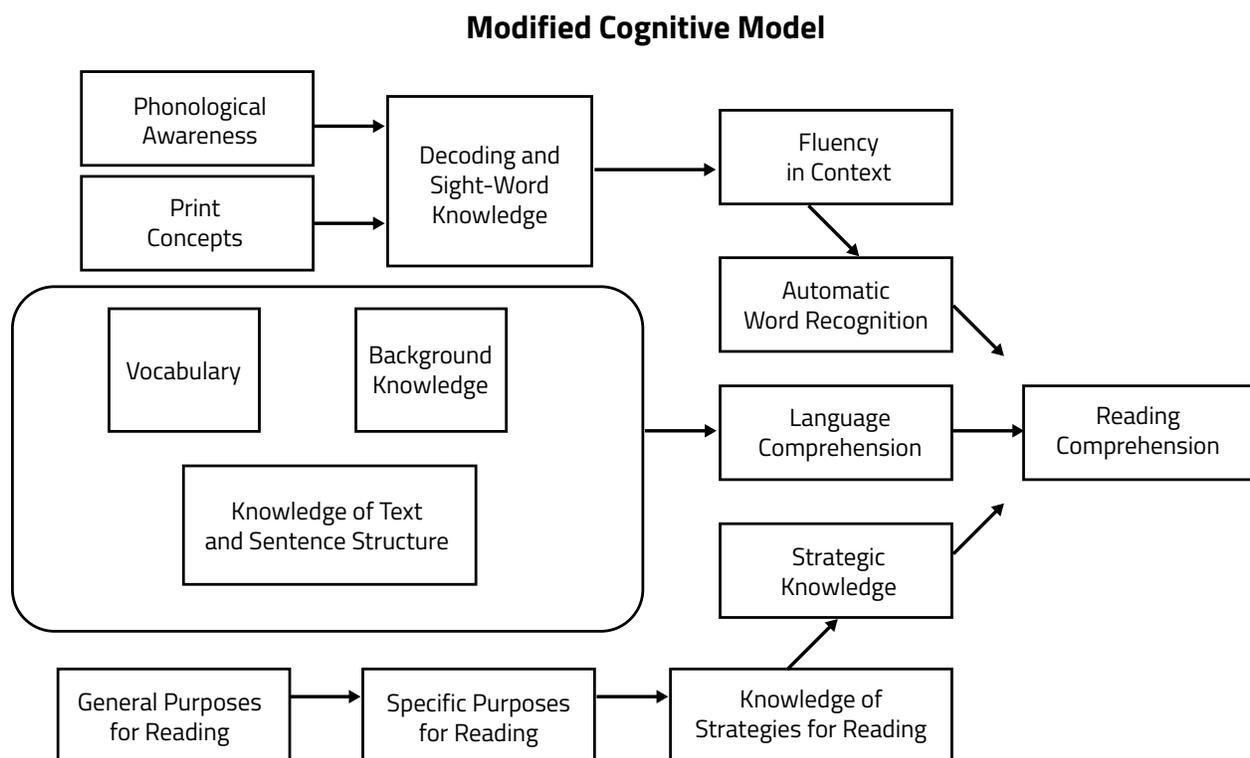
Figure 13. *McKenna & Dougherty Stahl's cognitive model of reading. Source: McKenna, M.C., & Dougherty Stahl, K.A. (2009). Assessment for reading instruction (2nd ed.). New York: Guilford Press. Reprinted with permission of Guilford Press.*

Affective factors are also crucial in the literacy learning process (Ciampa, 2012); if students are not motivated to read and write, and do not feel they have the capacity to become good readers and writers, it is less likely they will succeed. As explained below, ICT-enhanced learning, including games-based learning, can be motivational to children. Such modes of learning are also able to enhance learning because they allow students to learn at their own pace, while providing targeted feedback.

4.1.3 Considerations for the Khmer language

The Khmer language is different from the English language in several ways, which may render some of the research on how to teach phonological awareness and the sound-symbol relationships less relevant. The Khmer writing system is unlike English in that it has a syllabic alphabet and each consonant has two forms—one with an inherent /a/ sound (first series) and one with an inherent /o/ sound (second series) *(Figure 14).*

First series consonant	ក ka [ka:] ខ kha
Second series consonant	គ ko [ko:]

Figure 14. *Khmer consonants. Source: Khmer alphabet. Wikipedia. en.wikipedia.org/wiki/Khmer_alphabet (retrieved 1 August 2017).*

It is not, then, a matter of identifying individual phonemes and representing each phoneme with a grapheme as is the case in English. In the Khmer script, vowels can be represented in more than one way—either as a separate letter (independent vowels), or as a diacritic (dependent vowels) which may be above, below, in front of, after, or around the consonant. Vowels are pronounced differently according to whether the consonant they are attached to belongs in the first or second series. When writing second and subsequent consonants in a consonant cluster, a subscript form of the consonant is used. There are no spaces between words in Khmer written script, but spaces after clauses or sentences. A further aspect that adds to the complexity of learning to read and write Khmer is that many words do not have a standardized spelling. There are numerous other differences between English and Khmer, such as differences in morphology and syntax, but these are beyond the scope of this review.

4.1.4 The role of technology in literacy learning

There has long been a relationship between literacy and technology (Leu, 2000), but in recent years ICTs such as computers and mobile technologies have been increasingly used within and outside schools as sources of texts and as tools for teaching literacy, or as "deliverers of literacy," "sites for interaction around texts," and "mediums for meaning-making" (Burnett, 2010, p. 254). It has been argued that ICTs now have a central role in literacy teaching and learning in the early years (Burnett, 2010), and research around mobile technologies in early literacy learning is emerging. Oakley, Pegrum, Faulkner, and Striepe (2012) documented teachers' uses of mobile technologies to facilitate literacy learning from the early years of school to young adulthood, and found that teachers were using mobile technologies in various ways to further their students' literacy learning. Although some teachers were using "closed" apps (such as spelling and handwriting drills) with underlying pedagogies aligned to behaviorism, many were also using more "open" or generative apps (such as storybook writing apps) in creative ways, often involving collaborative learning and concurrent use of traditional resources and materials such as print books, art materials, and concrete manipulatives.

Touchscreen tablets such as iPads have generated considerable research interest, indicating m-learning potential in several aspects of literacy (Bouvat, Kangas, & Szczech Moser, 2014; D'Agostino, Rodgers, Harmey, & Brownfield, 2015; Milman, Carlson-Bancroft, & Boogart, 2014; Oakley, Howitt, Garwood, & Durack, 2013). Such devices can be motivational to children (Hatherley & Chapman, 2013; Merchant, 2015; Oakley et al., 2013) and can increase oral interaction between children (Falloon & Khoo, 2014; Pegrum, Oakley, Clarke & Sligar, 2013). These devices can also enable multisensory

modes of learning and expression that are in alignment with contemporary early childhood pedagogies such as play-based learning (Marsh, 2004).

Since m-learning devices are small, highly portable, increasingly affordable, and capable of delivering a range of educational experiences due to expanding affordances based on their capability of internet access, they are being used in low income countries around the world to help people who have limited or no access to books to read (UNESCO, 2014; Zelezny-Green, 2014). Such uses are in line with principles such as the six UNESCO Education for All goals, the eight UN Millennium Development Goals and, more recently, the 17 UN Sustainable Development Goals (Pegrum, 2014; UN, n.d.).

The use of games for learning has also received research attention in recent years; this is particularly the case with digital games, and most particularly digital games played on mobile devices. Good games are created using various design principles that foster engagement and learning, and some of which necessitate collaborative learning (N. Whitton, 2012). It should be noted that games may not always be as motivational as intended, especially for those who are not interested in playing games (N. Whitton, 2012). Many games are underpinned by drill-and-practice, behaviorist learning theories that involve rewards and even punishments, and may not be appropriate for higher order thinking processes (P. Whitton, 2012). Effective games may also involve elements of competition, and must use multiple media in effective ways (P. Whitton, 2012). Mobile devices are being used increasingly to deliver educational software with game elements, such as the *Aan Khmer* app.

UNESCO states that "mobile devices constitute one tool—in a repertoire of other tools—that can help people develop, sustain, and enhance their literacy skills" (2014, p. 18). The TRAC+ initiative is one project that aims to improve children's literacy through a repertoire of approaches, including the use of m-learning and, within that context, mobile gaming, which specifically comprises the *Aan Khmer* app (see an overview of the history of the development of the original version of this Cambodian app by ET4D in Pegrum, 2014, pp. 75–77).

4.2 Theory of m-learning

Mobile learning, or m-learning, is learning involving mobile devices; this category most commonly includes mobile handheld devices such as feature phones, smartphones, and tablets, but not portable devices such as laptops (Pegrum, 2014). The latter may be excluded on the basis of Puentedura's (2012) distinction between *portable devices* which are used at Point A, powered down, and moved, then opened up again at Point B, and *mobile devices* which are used at Point A, Point B, and everywhere in between without stopping. New additions to the mobile category include wearable and embeddable devices (Pegrum, 2015; Reinders & Pegrum, 2017), but these go beyond the scope of the current research study.

4.2.1 Establishing agendas

In order to evaluate the nature of mobile learning in a given project, it is essential to begin by establishing the key underpinning agenda or agendas. When surveying current projects and initiatives around the world, it becomes evident that there are at least three major agendas for promoting m-learning, each of which targets different kinds of benefits (Pegrum, 2014). The first agenda involves *transforming teaching and learning* by pushing it in a broadly progressive, usually social constructivist, direction (Pegrum, 2015; Reinders & Pegrum, 2017). The second agenda involves *developing 21st century skills*

connected with the use of new technologies, including creativity and innovation, frequently linked to entrepreneurship (Zhao, 2012), along with skills like critical thinking, collaboration, and communication (Mishra & Kereluik, 2011), and a broad range of digital literacies (Dudeney et al., 2013). The third agenda involves *promoting social justice,* which means providing educational access to traditionally under-served populations. This includes populations in developed countries, such as learners in remote locations, indigenous learners (Wallace, 2013), and learners with special needs or disabilities (Johnson, Adams, & Cummins, 2012). It also includes very large populations in the developing world who may be reached through Information and Communications Technologies for Development (ICT4D) or Mobiles for Development (M4D) projects, some of which place an emphasis on marginalized groups within these populations, notably women and girls (GSMA, 2010). Mobile learning can play an important role here since mobile devices are often more common than books in developing contexts (UNESCO, 2013).

4.2.2 Establishing pedagogies

Once the agenda has been established, it is possible to evaluate the underlying pedagogical approach or approaches. Typically, the first and second agendas are associated with active, collaborative approaches which may take the form of inquiry-based learning or problem-based learning; while the third agenda, because of the often limited affordances of the hardware and software employed, as well as the educational settings in which they are employed, is more often associated with traditional pedagogies such as information transmission and behaviorism (Pegrum, 2014, 2015).
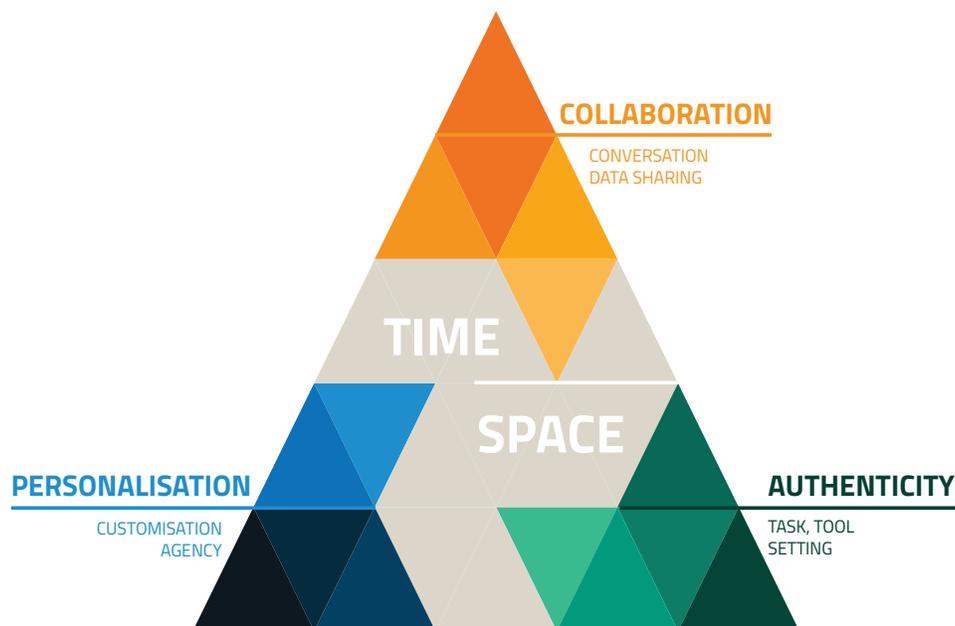
Figure 15. *The iPAC Framework, based on Kearney, Schuck, Burden & Aubusson's (2012) Mobile Pedagogical Framework. Source: Burden & Pegrum (2017). Reprinted by permission.*

One of best-known emerging models of m-learning is the recently renamed iPAC Framework *(Figure 15)*, based on the Mobile Pedagogical Framework (Burden & Kearney, 2017; Kearney et al., 2012), which evaluates three constructs of mobile learning, namely Personalization, Collaboration, and Authenticity. The collaborative aspects of the learning may also be evaluated against a recently proposed digital learning model which distinguishes between weak interaction, where students interact with machines, and strong interaction, where students interact though machines with other people (Clandfield & Hadfield, 2017).

Both of these models have now been mapped to a 3-Level Mobile Learning Framework which takes into account the degree of mobility of the devices, the learners, and the learning experience (Pegrum, 2016b), creating a composite framework *(Figure 16)*. This allows both for a robust evaluation of the pedagogies currently employed in an m-learning initiative, and a consideration of other possible pedagogies which might be added to or layered over the existing pedagogies.

Source: Adapted from Pegrum (2014); Burden & Kearney (2017); Clandfield & Hadfield (2017).
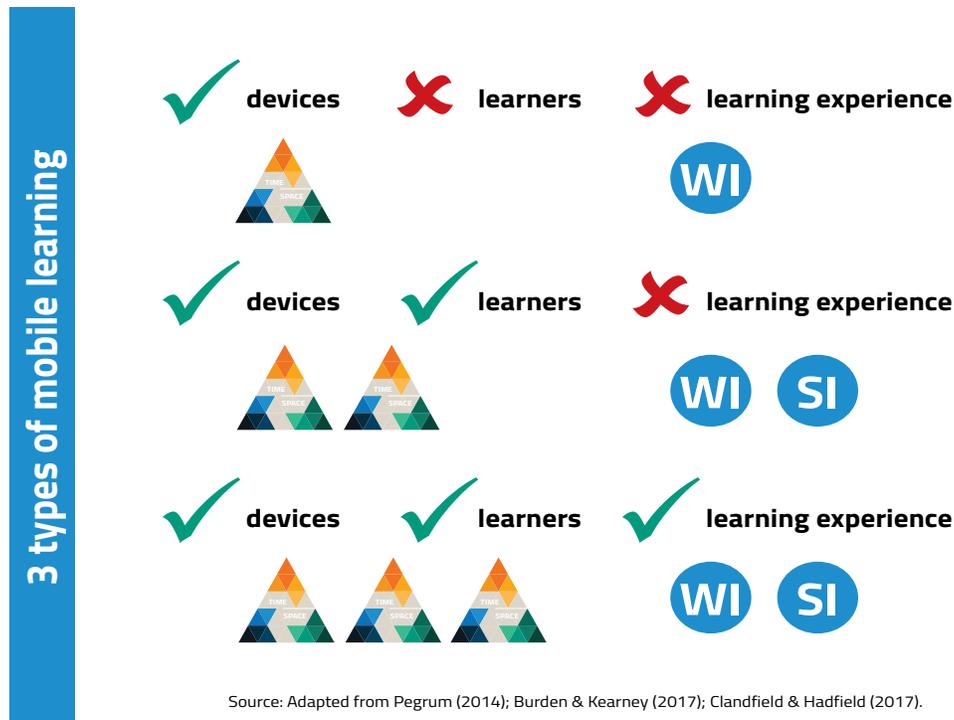
Figure 16. *Mapping of the iPAC Framework and weak/strong interaction model to the 3-Level Mobile Learning Framework. Source: Burden & Pegrum (2017).*

4.2.3 Establishing gaming frameworks

As noted earlier, the use of games for learning has also received research attention in recent years, with good games recognized as having motivational and pedagogical benefits (N. Whitton, 2012). Of late, there has been an upsurge of interest in mobile games in particular (Leaver & Willson, 2016).

Linked to a wider discussion on serious games, used as a way of addressing both workplace challenges and a variety of real-world problems (Dörner, Göbel, Effelsberg, & Wiemeyer, 2016; Feser, 2015; McGonigal, 2011), much has been written about the educational potential of gaming (Baek, Ko, & Marsh, 2014; ELI, 2014; Gee, 2007a, 2007b; Prensky, 2007; White, Sosnik, & Allen, 2015; Young et al., 2012) and gamification (Anderson & Rainie, 2012; Farber, 2014; Gregory et al., 2015; Kapp, 2012). In addition to the motivational benefits highlighted in this literature, pedagogical benefits range from improved knowledge acquisition to the development of 21st century skills and even behavioral change (Boyle et al., 2016; cf. Lee et al., 2016, on critical thinking), though to date there has been less of a research focus on the latter two.

At the pedagogically simpler end of the spectrum, there is a focus on the introduction of game-like principles into learning activities. From a pedagogical perspective, these activities are typically behaviorist drills cloaked in gaming elements (Oakley et al., 2012; Pegrum, 2014); therefore, they are most often attached to the first level of the 3-Level Mobile Learning Framework, with a focus on the Personalization element of the iPAC Framework, and an emphasis on weak rather than strong inter-

action. Such gamified activities are often applied within a broad social justice agenda implemented in developing regions. The gaming elements incorporated might include badges, levels or ranks, and leaderboards (Bristow, 2015).

While these simple games may have both motivational and pedagogical benefits, the potential of mobile gaming extends much further. A growing number of studies report on the use of specifically mobile gaming elements to support learning, typically, once again, with positive effects on student learning and motivation (e.g., Sandberg, Maris, & Hoogendoorn, 2014). Among these studies, a considerable number focus on the connection of mobile augmented reality (AR) with gaming or gamification principles (Antonaci, Klemke, & Specht, 2015; Bacca et al., 2014), including gamified stories (Dunleavy, 2014; cf. Dunleavy & Dede, 2014) and even "exergaming," which incorporates the notion of healthy exercise (Dunleavy, 2014). Here, too, benefits are reported in terms of learning gains as well as motivation (Bacca et al., 2014; Schmitz, Klemke, & Specht, 2012). For the moment, however, such approaches are mainly feasible in well-resourced developed contexts, and as such extend well beyond what might be expected in an app such as *Aan Khmer*, developed for the Cambodian context.

> A growing number of studies report on the use of specifically mobile gaming elements to support learning, typically, once again, with positive effects on student learning and motivation.

■   ■   ■

5. Methodology

This chapter describes the mixed methods research design developed to address the research questions outlined in Chapter 3 of this report.

5.1 Research design

A mixed methods approach was adopted because it is considered to be the most effective means of carrying out evaluation research (Babbie, 2008). The combination of quantitative and qualitative data sources strengthens the veracity of the findings and provides fuller details of the process through which "the program outcomes and impacts are achieved, and how these are affected by the context within which the program is implemented" (Barmberger, 2012, p. 1).

The study was carried out in two main phases. Phase 1 consisted of a situational analysis and overall survey. The aims of the situational analysis were to:

- Develop an understanding of the context in which the TRAC+ project was implemented, and specifically gain an overview of how m-learning was implemented in the 73 Group A TRAC+ schools; and

- Identify 15 schools for the collective case study.

These aims were achieved through the development and administration of a face-to-face School Director Survey.

Phase 2 consisted of a collective case study, alongside the use of the EGRA and the STAR; the latter is a reading assessment used by World Vision International (WVI) globally and is essentially a simplified version of EGRA, with four sub-tests. This phase involved both quantitative and qualitative data. The quantitative data were collected through administering the EGRA and STAR tests to a sample of students in Grades 1–3 in the 15 selected case study schools. The tests focused on students' literacy knowledge, with a specific focus on their reading ability.

The qualitative data were gathered using interviews with school directors, literacy coaches, librarians, teachers, and some parents. In addition, focus group interviews were carried out with peer tutors and students in those schools. Several observations of struggling students using tablets with peer tutors were also carried out. Finally, qualitative data were extracted from the open-ended questions in the School Director Survey.

5.2 Quantitative data collection

Quantitative data were collected during both Phase 1 and Phase 2. In Phase 1, this involved the School Director Survey (see Appendix 2). In Phase 2, the EGRA and STAR reading assessments were administered. These instruments are described in detail below.

5.2.1 Survey of school directors

The 138 schools participating in the TRAC+ project were divided into two different groups—Group A (73 schools) and Group B (65 schools)—across five provinces in Cambodia. The Group A schools had tablets and the *Aan Khmer* app, while the Group B schools did not have the tablets and app, but had the toolkit and all other elements of TRAC+. The school directors of Group A schools (n=73, including 70 males and three females) were invited to participate in the School Director Survey, since these were the schools with access to the tablets and the app.

Face-to-face administration was deemed necessary because the research team was advised that post-al or online surveys would not be successful in the Cambodian context, due to the quality of the postal service, internet issues, and the lack of experience of the participants in completing surveys. All invited school directors were given information letters, asked to sign consent forms, and participated voluntarily.

The survey instrument consisted mostly of Likert scale items, but several multiple-choice questions were included, along with some open-ended questions. This instrument was initially developed in English and subsequently translated into Khmer. It was administered in Khmer, and responses to the open-ended questions were translated into English by the two Khmer-speaking main research-ers. Because of the short timeframe for the study, the survey was not tested for validity, but it was checked for relevance by all four of the main researchers as well as stakeholders in Cambodia.

5.2.2 Implementation of EGRA and STAR

The EGRA was administered to 514 students in Grades 1, 2, and 3 at the 15 selected Group A case study schools. The sample size and sampling procedure (random selection of students) were adopted based on the EGRA guidelines. All parents had the research explained to them in Khmer and signed consent forms. They were made fully aware that participation was voluntary and any who did not wish to participate did not have to do so, although there were no refusals to participate.

The EGRA is primarily aimed at measuring students' knowledge and understanding of literacy and consists of seven subtasks involving: 1) Letter Name Recognition (LNR); 2) Familiar Word Reading (FWR); 3) Non-Word Reading (NWR); 4) Sentence Reading (SR); 5) Oral Reading Fluency (ORF); 6) Reading Comprehension (RCO); and 7) Listening Comprehension (LCO) *(Table 1)*.

The EGRA is administered orally on a one-to-one basis and should take approximately 15 minutes per student. Please refer to the EGRA Toolkit for more details about this assessment, as well as technical adequacy information (globalreadingnetwork.net/resources/early-grade-reading-assessment-eg-ra-toolkit-second-edition). However, there is no formal documentation about the Cambodian version of the EGRA available in English.

Sub-Component	Early Reading Skill	Skill Demonstrated by Student's Ability to	Measure
1. Letter Name Recognition (LNR)	Letter recognition	Provide the name of graphemes, which are presented in random order	Letters per minute (LPM)
2. Familiar Word Reading (FWR)	Alphabetic principle/decoding skills	Use letter-sound correspondence to read a list of familiar words	Words per minute (WPM)
3. Non-Word Reading (NWR)	Alphabetic principle/decoding skills	Use letter-sound correspondence to read a list of non-words	WPM
4. Sentence Reading (SR)	Sentence reading fluency	Read unrelated sentences fluently	WPM
5. Oral Reading Fluency (ORF)	Oral reading fluency	Read a narrative text with accuracy, little effort, and at a sufficient rate	WPM
6. Reading Comprehension (RCO)	Reading comprehension	Respond to literal and inferential questions about the text read	Correct answers (CAs)
7. Listening Comprehension (LCO)	Comprehension	Respond correctly to literal and inferential questions about a text read to the student	CAs

The STAR was administered to 169 students from Grade 3. The main purpose for administering this supplementary test was to compensate for possible limitations in the EGRA. Indeed, the STAR results for the Grade 3 students who took both tests appear to indicate higher literacy levels than the EGRA results. This suggests that the EGRA results for Grades 1 and 2 students may perhaps be understating their literacy knowledge.

The STAR has four subtasks: 1) Letter Naming and Recognition; 2) Familiar Word Reading; 3) Non-Word Reading; and 4) Oral Reading Comprehension. Whereas the EGRA is administered under tightly timed conditions, the STAR allows more time for students to respond. It was only administered to the Grade 3 students as it was not designed for younger children.

5.3 Qualitative data collection

Qualitative data were collected using semi-structured interviews, focus groups, observations, document study, and qualitative data from the School Director Survey. These methods of data collection enable investigation into participants' perspectives and experiences (O'Donoghue, 2007).

5.3.1 Selection of case study schools

From the information given in the School Director Survey, schools were selected according to geographical region and location (urban, rural, or remote) and existing mobile technology use (lower usage of the tablets and *Aan Khmer* app at the school, or higher usage of the tablets and app). One school from the original TRAC pilot was included. All were Group A schools, as resources were not available to send researchers to Group B schools in addition to Group A schools.

As a first step, the selection of case study schools took into account the constraints of time, finances, and accessibility. As a result, 15 schools were selected from five provinces: Banteay Meanchey (six schools), Kampong Thom (one school), Preah Vihear (three schools), Siem Reap (two schools), and Takeo (three schools).

Initially, schools which reported the tablets and app were used for an hour a week or more per student in the School Director Survey were categorized as higher use (HU) schools, and those where the tablets and app were used for less than an hour a week per student were categorized as lower use (LU). However, upon closer investigation when field researchers returned to the schools for the case study data collection, some of the categories were changed for the reasons listed in *Table 2*. Following the re-categorization process, the 15 case study schools comprised 10 HU schools and five LU schools.

Each school was studied as a case, taking into account its situation and context, before a cross-case analysis was conducted to discover similarities/differences between them.

Table 2: *Rationale for categorization of higher use (HU) and lower use (LU) schools (with re-categorized schools highlighted).*

School #	Province	Location	X per Week App Used	Average Minutes per Use	Total Minutes Used per Week	Reason for Change of Category/Qualitative Evidence of Category	Original HU/LU	Re-categorized HU/LU
1	Banteay Meanchey	Rural	5	15	75	The qualitative data collection showed that the literacy coach supervised students 3–4 times a week for 5–10 minutes; peer tutors helped students 5–6 times a week.	HU	HU
2	Banteay Meanchey	Rural	6	15	90	Interviews indicated that students had access to the app 3–4 times a week during their break time of 15 minutes; peer tutors reported helping students 6–7 times a week. The total number of minutes is therefore more likely to be 60.	HU	HU
3	Banteay Meanchey	Rural	7	10	70	The library was found to be small and disorganized. Tablets looked new and barely used. Qualitative data confirmed that students used the app for less than one hour a week.	HU	LU
4	Banteay Meanchey	Rural	5	20	100	The qualitative data collection showed that the literacy coach was carrying out his responsibilities as expected. Interviews confirmed that students used the app more than one hour a week.	HU	HU
5	Banteay Meanchey	Rural	5	20	100	Interviews indicated that students used the app 3–4 times a week for 15 minutes. This shows students may have used the app for 60 minutes a week.	HU	HU
6	Banteay Meanchey	Rural	1	20	20	Interviews indicated that students used the app twice a week for about 15 minutes each time.	LU	LU
7	Kampong Thom	Rural	2	15	30	The qualitative data collection showed high use. The library was well-organized and well-used by the students. The literacy coach and librarian were knowledgeable about the app.	LU	HU

School #	Province	Location	X per Week App Used	Average Minutes per Use	Total Minutes Used per Week	Reason for Change of Category/Qualitative Evidence of Category	Original HU/LU	Re-categorized HU/LU
8	Preah Vihear	Rural	5	20	100	This remote and hard-to-access school had no steady electricity supply to charge batteries. The literacy coach had three different roles and could devote little time to TRAC+. Qualitative data collection indicated that students used the app for less than one hour a week.	HU	LU
9	Preah Vihear	Urban	3	10	30	The qualitative data collection confirmed low use. Tablets looked new and barely used. Teachers lacked knowledge of technology.	LU	LU
10	Preah Vihear	Rural	1	8	8	The qualitative data collection showed high use, as observed on the school visit. The school had a well-organized library, with the literacy coach, librarian, and teachers working to support each other.	LU	HU
11	Siem Reap	Rural	3	20	60	The literacy coach reported supervising students 2–3 times a week; peer tutors reported helping students 6–7 times a week; students reported using the app 2–3 times a week.	HU	HU
12	Siem Reap	Rural	1	20	20	The qualitative data collection showed that students used the app once a week during a break time of 15 minutes.	LU	LU
13	Takeo	Rural	8	10	80	The qualitative data collection showed that the children used the app four times a week during their break time of 15 minutes. The total number of minutes is therefore more likely to be 60 than 80.	HU	HU
14	Takeo	Rural	8	25	200	The literacy coach supervised students 4–5 times a week during break times of 15 minutes; peer tutors reported helping students 2–3 times a week. However, students reported using the app 2–3 times a week. The figure of 200 minutes per week may therefore be an overestimate; 60 minutes may be more likely.	HU	HU
15	Takeo	Urban	2	20	40	The library was well-organized. Interviews with the literacy coach, peer tutors, and students indicated that students used the app for at least one hour a week.	LU	HU

5.3.2 Selection of participants

The purposive selection approach was adopted to choose participants for interviews. It is consistent with a qualitative research design which aims to construct an in-depth understanding of a particular

phenomenon, to uncover socially constructed meanings, and to understand the context within which the phenomenon exists (Hennink, Hutter, & Bailey, 2011). The participants selected for the study included school directors, literacy coaches, librarians, teachers, peer tutors, struggling students, and parents. The inclusion of school stakeholders was based on the assumption that they were involved in the implementation of the TRAC+ project, and it was important to study their perspectives.

The number of participants selected from each school varied, depending primarily on the school location, school size, and availability of participants. In general, the aim was to include the following participants from each school: a school director, a literacy coach, a librarian, two teachers, a group of peer tutors, a group of struggling students (who had failed at least one Interval Test and had been placed in an intervention involving use of the app), and a parent. In some small schools, only one teacher was interviewed. It is important to note that the number of peer tutors and struggling students from each school differed, again depending on their availability. In many schools, parents were not available for interviews. *Table 3* below presents the total number of participants interviewed, along with their geographical locations and roles.

Table 3. *Participants interviewed from each province.*

Provinces	Takeo	Kg Thom	Siem Reap	Banteay Meanchey	Preah Vihear	Total
School directors	3	1	2	6	3	15
Literacy coaches	3	1	2	5	2	13
Librarians	3	1	2	5	2	13
Teachers	6	2	4	11	4	27
Peer tutors (interviewed in focus groups)	18	7	11	42	12	90
Students (interviewed in focus groups)	20	3	9	38	4	74
Parents	0	0	2	2	1	5
Total	53	15	32	109	28	247

5.3.3 Interviews

A semi-structured interview approach was adopted in this research because it is flexible and enables the researchers to interact with the participants and generate an understanding of their perspectives on the issues at hand. It provides participants with freedom to express their views and discuss them with the researchers. According to Bryman (2012), this approach involves a one-on-one conversation between an interviewer and a participant who discuss topics in depth, and it is widely used in qualitative research within the interpretivist paradigm. Adopting this approach, the interviewer and participant ask and answer questions and react to each other's appearance, personality, and identity (Hennink et al., 2011).

In this research, individual semi-structured interviews were carried out with 73 participants who were school directors (n=15, including 14 males and one female), literacy coaches (n=13, including eight males and five females), librarians (n=13, including five males and eight females), teachers (n=27, including 10 males and 17 females), and parents (n=5). The length of each interview differed, ranging from about 15 minutes to more than 60 minutes. An interview schedule was used to guide the inter-

views and to elicit responses from the participants. The interviews were digitally recorded, with permission given by the participants to do so. The interviews were conducted in Khmer. A Khmer-speaking researcher transcribed and translated four early interviews into English for analysis by the research team. A further 40 interviews were transcribed but due to time and budgetary constraints, it was not possible to transcribe and translate all the interviews. With later interviews, the researcher listened to the interview recordings and took notes, subsequently transcribing and translating key passages.

5.3.4 Focus groups

Bryman (2012) describes the focus group discussion technique as a form of interviewing which involves several participants, led by a moderator, discussing a particular set of issues explored in depth. It is primarily concerned with gaining a broad range of perspectives on the topic being investigated. In this report, this technique was employed with peer tutors and struggling students to explore their experiences using *Aan Khmer* and other learning materials promoted by the TRAC+ project, including issues they faced when using them.

The research involved 14 focus group interviews with peer tutors, and 13 focus group interviews with struggling students. This means the interviews were not undertaken in all participant schools due to unavailability of the peer tutors and students. An interview schedule was developed and used by the researchers to guide the discussion and keep it focused on the topics being discussed. The number of participants in each interview varied, ranging from three to 10. The interviews varied in duration, with the shortest lasting about 10 minutes and the longest about 50 minutes.

The interviews were digitally recorded, with permission given by the parents of the participants and the participants themselves. They were conducted in Khmer using the interview schedule, which was translated into Khmer to help the field researchers become familiar with it. The interviews were transcribed and translated into English to begin analysis. Bryan (2012) indicates that transcribing a focus group interview is often more difficult and time-consuming than transcribing an individual interview due to the number of participants who are involved. He also adds that some interviews or some portions of them are sometimes not relevant to the research topic and so there seems little point in transcribing material that will not be helpful. Again, given time and budgetary constraints, not all sections of all focus group interviews were fully transcribed and translated; instead, key passages were selected for transcription and translation.

5.3.5 Observations

Observation was an additional method of data collection adopted in this research. It was carried out with literacy coaches, teachers, peer tutors, and students who were engaging in teaching and learning activities. Observations were undertaken with an observation guide and involved extensive note-taking. According to Hennink et al. (2011), this approach enables the researchers to "systematically observe and record people's behavior, actions, and interactions" (p. 170). In particular, it allows the researchers to produce a detailed description of events taking place. Unfortunately, although it was planned to carry out observations in every case study school, this was often not possible because at the time the research team visited, the tablets were locked away, their batteries were flat, or the students were simply not using them at that point.

5.3.6 Document study

Document study is "a systematic procedure for reviewing or evaluating documents—both printed and electronic (computer-based and Internet-transmitted) materials" (Bowen, 2009, p. 27). The analysis of documents is an unobtrusive method which enables the researcher to learn about the values and beliefs of participants by examining the materials produced by them and others within their contexts (Hesse-Biber & Leavy, 2011). Moreover, it generates knowledge of the background and historical context surrounding a particular phenomenon.

In this research, various relevant documents were reviewed. These included school and TRAC+ documents. This review of documentation provided additional information that enriched what had been learned from semi-structured interviews, focus group discussions, and observations. Furthermore, consulting documents enabled the researchers to keep track of ongoing developments and changes in relation to the project.

5.3.7 Survey of school directors (open-ended responses)

Open-ended responses in the School Director Survey were used to supplement the qualitative data collected at the 15 case study schools. These text-based responses were transcribed and entered into a database by the researchers, and translated by one of the researchers based in Cambodia.

5.4 Data analysis methods

5.4.1 Quantitative data entry

For the School Director Survey, two research assistants who were experienced in data entry completed the data entry process. They received additional training from the researcher based in Cambodia in using the Statistical Package for the Social Sciences (SPSS), the template of the data entry, as well as quality control procedures. To ensure accuracy of the data entered, spot checks were conducted on 5% of the data entered by each research assistant. Data were then reviewed and cleaned. Any errors or unclear information were checked against the original data collection forms.

Similarly to the School Director Survey, because the EGRA and STAR tests were implemented using tablets, the data were consolidated and cleaned by the main researcher based in Cambodia.

5.4.2 Quantitative data analysis

For the School Director Survey, as well as the EGRA and STAR tests, descriptive statistics, frequencies, and cross-tabulations were generated. Some significance tests between variables were performed using inferential statistics testing such as independent t-tests, and multiple linear regression analysis was used to identify other factors that influenced EGRA test scores.

All the quantitative information from the School Director Survey was encoded, categorized, and analyzed in SPSS using descriptive analysis techniques, mainly frequencies.

5.4.3 Qualitative data analysis

Interview and focus group data were analyzed using a flexible thematic analysis approach. This allows researchers to identify and analyze interview passages that are linked by a common theme, and categorize them in order to establish a theoretical framework (Braun & Clarke, 2006). In other words, this

is a process of encoding qualitative data into codes and themes. A theme "contains codes that have a common point of reference and has a high degree of generality that unifies ideas" regarding the phenomenon in question (Vaismoradi et al., 2016). Themes can be generated from prior knowledge and understanding of the phenomenon being studied (deductive or a priori approach) or can emerge from the data (inductive approach). In this study, a priori themes derived from the pre-existing literature on literacy in the early years and mobile learning (covering mobile pedagogical approaches and app evaluation) were used as a starting point. Other themes emerged during the course of data analysis by the research team.

Braun and Clarke's (2006) step-by-step guide to conducting thematic analysis was adopted to analyze the interviews in this research project. They describe this as a process of analysis which involves a constant moving back and forth between the whole data set, the coded data being analyzed, and the analysis of the data being produced. *Table 4* presents a summary of the phases of thematic analysis proposed by Braun and Clarke (2006).

Table 4. *Phases of thematic analysis according to Braun and Clarke (2006).*

Phases	Description of the Processes
Familiarizing oneself with the data	Repeated reading of the data and highlighting meaning units, taking initial notes on ideas and thoughts
Generating initial codes	Producing coding features of the data in a systematic way across the data set
Searching for themes	Sorting different codes into potential themes and collating all relevant coded data within the identified themes
Reviewing themes	Reviewing and redefining the collated themes against the individual interview transcripts and the complete data set and creating a "thematic map" of analysis
Defining and naming themes	Examining the map and organizing themes into a coherent and internally consistent account
Writing the analysis	Choosing examples from the transcribed data to illustrate elements of the themes and respond to the research questions

5.5 Training of field research assistants

5.5.1 Quantitative training

After the tools were developed, training on how to use the data collection instruments was given by the researcher based in Cambodia and one of the researchers from Australia to the 10 Cambodian field researchers (research assistants). All staff were trained in and had a good understanding of the TRAC+ project background and received additional briefings on the project from WVI-C and WEI.

5.5.2 Qualitative training

The field researchers recruited for qualitative data collection came from diverse backgrounds and had a wide range of experience in both qualitative and quantitative research projects. Some of them were involved in the administration of the school surveys in this project. However, training was deemed important to helping them perform their roles effectively. A two-day qualitative training session was facilitated by the researcher based in Cambodia and one of the researchers from Australia. The train-

ing, based in Phnom Penh, started with an introduction to the objectives of the research and the training sessions. This helped everyone become familiar with each other, share their qualitative research experience, and understand the nature of the training. The field researchers were then presented with the roles and responsibilities they were expected to take on in the project, as well as a refresher on qualitative research to help them appreciate what constitutes good research and how they could contribute to achieving this quality.

Because the nature of the study required that the researchers be in face-to-face contact with the participants, it was important that they complied with ethical practices in qualitative research, especially those legally required in Australia. The ethics permissions process and responsibilities required by The University of Western Australia were explained in detail. There was a particular focus on protecting the privacy, confidentiality, and anonymity of the participants, seeking informed consent from the participants before starting the interviews, handling privileged information, and avoiding harm and risk during fieldwork. Researchers were made aware that all participants were to take part on a voluntary basis only and could withdraw from the research at any time without giving a reason, as was explained in the information letters.

Following this, the field researchers were introduced to the interview schedules. These were formulated in English and translated into Khmer to help the researchers better understand them. The facilitators and researchers went through each interview schedule to generate a shared understanding of the content. When an issue or point of confusion was found, a clarification or minor correction was made. In addition, semi-structured interview techniques were practiced during the training session. To help build up the research team's confidence and familiarity with the interview schedules, role plays were carried out using digital recorders. These were observed by the facilitators and feedback was provided to the field researchers.

Since the research involved observations of students using the tablets and apps, the field researchers were oriented as to how to conduct such observations using the observation guide developed for the project. Again, the guide was translated from English into Khmer to help them better understand it. The focus was on how to take notes when observing students using the *Aan Khmer* app. Field researchers were also introduced to the app: what it is, how it works, and issues they might encounter when using it. There was a discussion of literacy terminology so they would be able to understand the activities in the app and the learning of the children.

The training achieved a positive outcome in helping the field researchers develop a good understanding of the project and their roles as qualitative researchers. Equipped with the necessary specific skills and knowledge, the field researchers indicated that they felt confident regarding the expectations and objectives of the research.

5.6 Ethical considerations

Prior to the commencement of the study, ethics approval was sought from The University of Western Australia's Human Research Ethics Committee, as required for all research involving human subjects. Informed consent to participate in the study was obtained at the outset. This involved the creation of information letters explaining the nature and purpose of the research along with matters relating to privacy, confidentiality, and anonymity, and consent forms for those who agreed to participate. Both were translated into Khmer. The information letters and consent forms were distributed to all school

directors, literacy coaches, librarians, teachers, parents, and students involved in the study, with a request to return the signed consent forms to the researchers to indicate willingness to participate. For participants with low literacy levels, information letters and consent forms were read aloud to them by school staff or research assistants. All participants were made fully aware that participation in the study was voluntary and that they could withdraw at any time before publication of the findings, without negative consequences. All data collected and the emerging products of analysis were coded in a manner that protected the anonymity of the participants.

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6. Quantitative Findings

This chapter presents the results of the quantitative data collection and analysis regarding the effectiveness of *Aan Khmer*, focusing on the School Director Survey and the EGRA and STAR test results.

6.1 School Director Survey

A considerable amount of information was collected through the School Director Survey and, as explained in Chapter 5, this was used to inform the selection of the 15 case study schools.
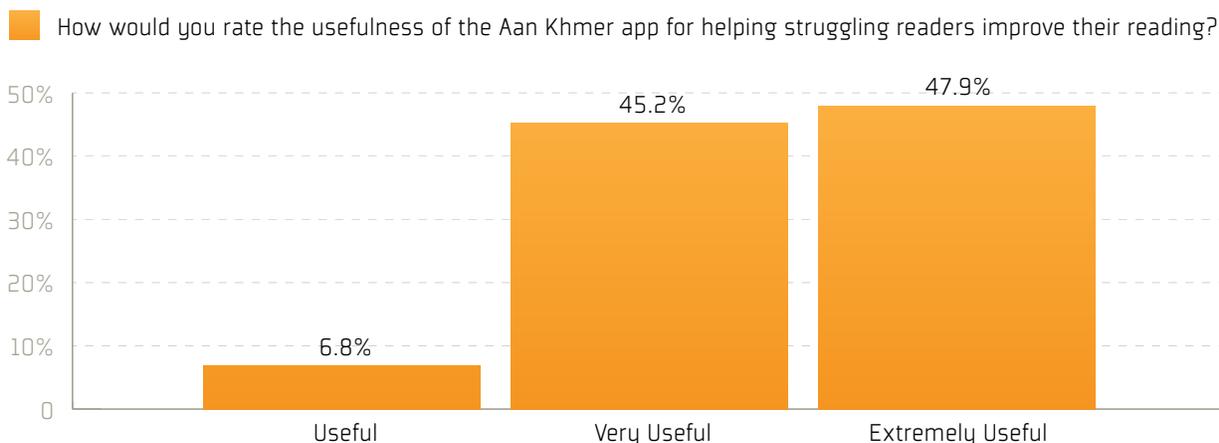
Figure 17. *School directors' ratings of the Aan Khmer app's usefulness.*

It can be seen from *Figure 17* above that school directors overwhelmingly considered the *Aan Khmer* app to be useful in helping struggling students improve their reading.
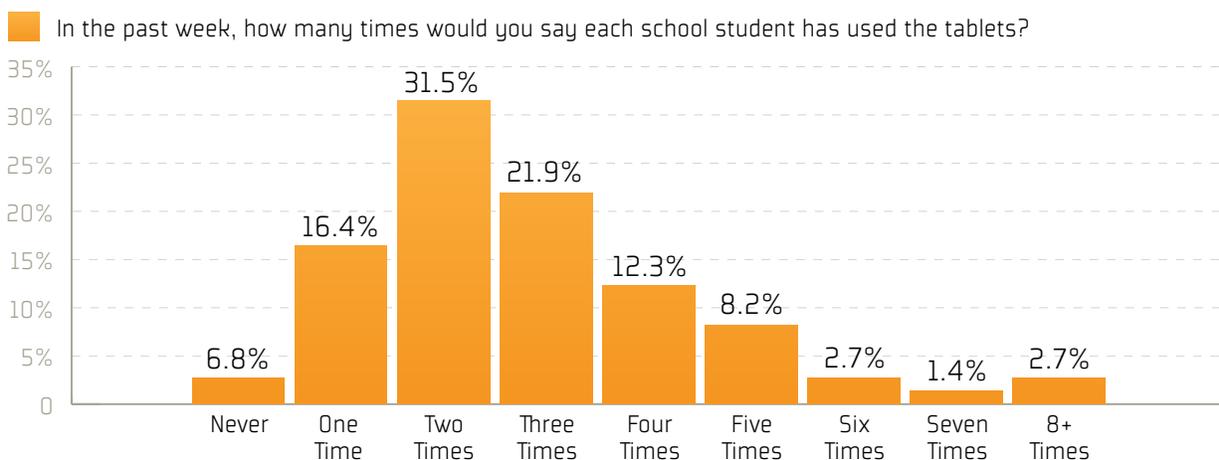
Figure 18. *School directors' estimates of the number of occasions of tablet use per student per week.*

It can be seen in *Figure 18* that according to the school directors' estimates, the majority of students used a tablet two to three times each week, though usage ranged from never to eight or more times a week. It should be noted that this question referred to tablet usage, not specifically to usage of *Aan*

Khmer, and some usage reported here could have been in relation to the monthly Interval Test app. There were no other apps installed on the tablets for students to use.
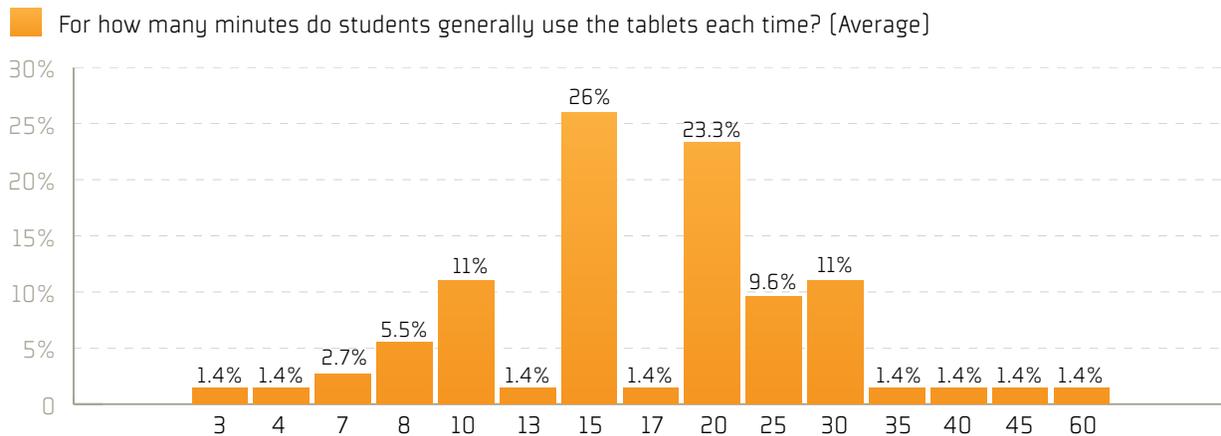
Figure 19. *School directors' estimates of the number of minutes of tablet use per student per occasion.*

Figure 19 shows that according to the school directors, most students used a tablet for 15–20 minutes at a time on average, although this could be as little as three minutes. Again, this question asked about tablet usage in general, and could have involved either the *Aan Khmer* or Interval Test app.
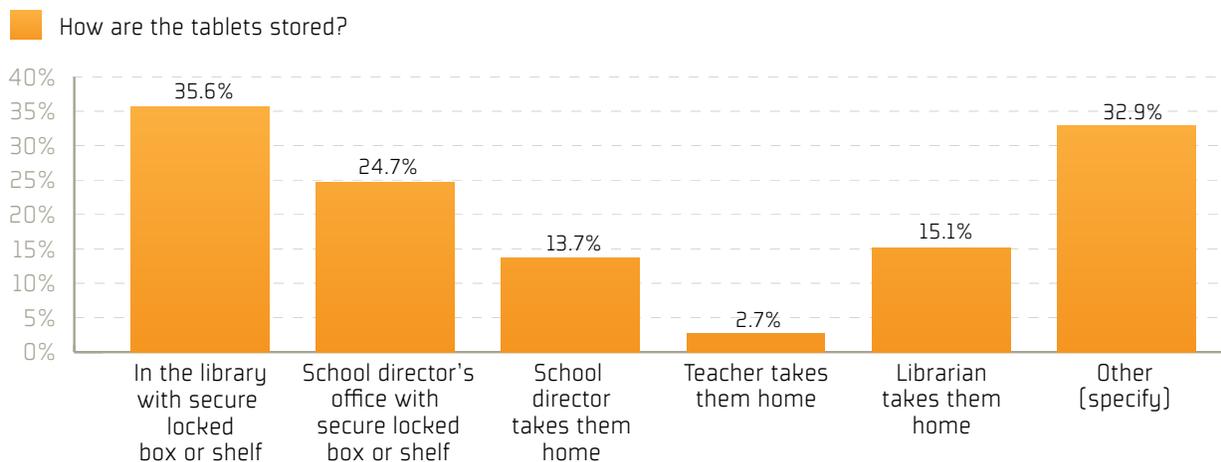
Figure 20. *School directors' information on storage of tablets.*

It can be seen from *Figures 20* and *21* that storage and security of the tablets was perceived as important. They were generally locked up when not in use, and were often taken home by a staff member after school for security reasons, according to the school directors; indeed, most responses in the "Other" category in *Figure 20* involved literacy coaches taking the tablets home.

Figure 21. *Lockable cupboard in school director's office for storing tablets. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

What are the problems that staff and children have encountered when using the Aan Khmer app?

No problems	23.6%
Problems with tablet (such as no power)	18.1%
Problems understanding instructions in the app	18.1%
Problems navigating through the app	11.1%
Problems understanding the concepts being taught	25%
Other (specify)	45.8%
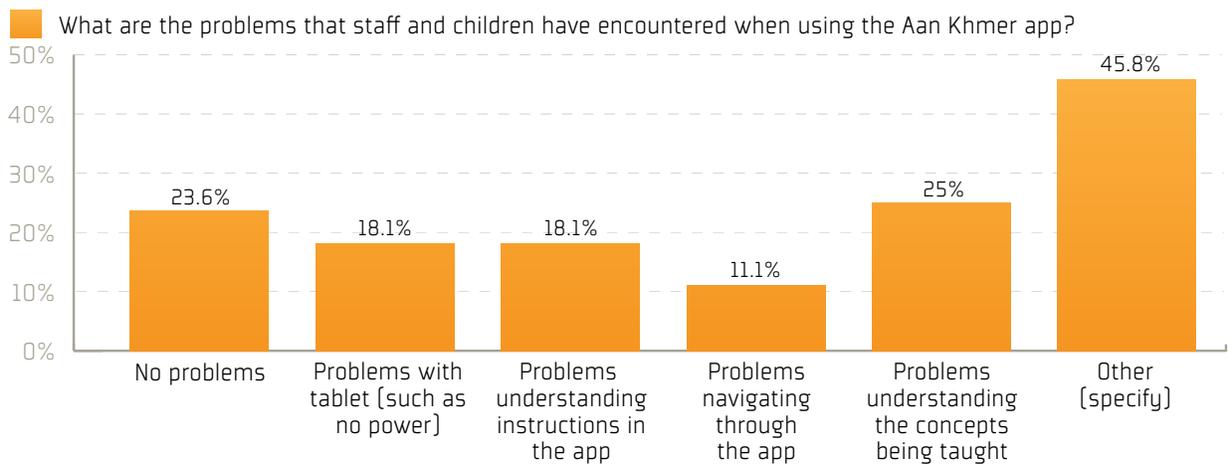
Figure 22. *School directors' opinions on problems encountered by students using the Aan Khmer app.*

Some school directors said no issues had been encountered when using the *Aan Khmer* app, although many reported problems with the tablets, problems with the instructions in the app, problems navigating through the app, and problems for students in understanding the concepts being taught in the app. Further issues identified by the school directors in the 'Other' category included: the slowness of the Wi-Fi (for the Interval Tests); the tablets freezing; the language of the tablets (not the app) being English; the difficulty of activities in the app; the speed of the app; and a mismatch between the words/letters and the pronunciations in the app. There was a strong perception that there was a lack

of technical knowledge and support among school staff, with many school directors reporting they turned to WEI for help when needed.

The suggestions school directors gave in the survey for improvements to the TRAC+ project were directed at training, support, resourcing, and extensions to the *Aan Khmer* app, including:

- More training on the technical aspects of using the tablets, and more technical support in schools for occasions when there are issues with the tablets or Wi-Fi;
- More training for teachers so they can better understand TRAC+;
- Support in encouraging parental involvement;
- More tablets;
- Better stipends for literacy coaches;
- Improvement of the *Aan Khmer* app by including writing instruction;
- Extending TRAC+ to higher grades (not just Grades 1–3); and
- Better communication between the TRAC+ schools and WEI, and between the TRAC+ schools themselves.

6.2 Demographic profiles of students who took EGRA/STAR

Table 5. *EGRA and STAR samples from LU and HU schools.*

		Total		LU		HU	
		N	N %	N	N %	N	N %
Gender of students	Male	248	48.2%	82	49.1%	166	47.8%
	Female	266	51.8%	85	50.9%	181	52.2%
	Row Total	514	100.0%	167	100.0%	347	100.0%
Age of students	Age 5	9	1.8%	4	2.4%	5	1.4%
	Age 6	52	10.1%	14	8.4%	38	11.0%
	Age 7	98	19.1%	33	19.8%	65	18.7%
	Age 8	118	23.0%	30	18.0%	88	25.4%
	Age 9	85	16.5%	32	19.2%	53	15.3%
	Age 10	100	19.5%	33	19.8%	67	19.3%
	Age 11	32	6.2%	9	5.4%	23	6.6%
	Age 12	17	3.3%	10	6.0%	7	2.0%
	Age 13	3	0.6%	2	1.2%	1	0.3%
	Row Total	514	100.0%	167	100.0%	347	100.0%
Grade level of students	Grade 1	167	32.5%	52	31.1%	115	33.1%
	Grade 2	178	34.6%	61	36.5%	117	33.7%
	Grade 3	169	32.9%	54	32.3%	115	33.1%
	Row Total	514	100.0%	167	99.9%	347	99.9%

In total, 514 students from Grades 1–3 in 15 schools from the five target provinces took the EGRA, and the 169 Grade 3 students within this group also took the STAR later the same day *(Table 5)*. Of the students assessed, 48% (or 248) were boys and 52% (or 266) were girls. In terms of grade levels, 32.5% (or 167) students were from Grade 1, 34.6% (or 178) students were from Grade 2, and 33% (or 169) students were from Grade 3. It is important to note that many of the children were older than might be expected—some Grade 3 students were up to 13 years old, for example. The age distribution of students ranged from 5–13, with the median age being 8. It was not possible to identify precisely which children had used the app, though because of the low literacy standards most would have done so.

6.3 EGRA results

In the following section of the report, results from each subtask of the EGRA are presented. Comparisons of scores between LU schools and HU schools are made (independent t-tests). Only *post-intervention results* are given here because baseline data were not available to the researchers for the participating students—although some data existed, there were ethical issues in accessing this material as permissions were not available for children other than those who took the post-test—and therefore student gains were not able to be calculated. It was only possible to collect end line data and compare the mean scores of students in LU and HU schools. This is a limitation of the research, given the many possible confounding factors in the schools.

The EGRA tests were carried out in June and July 2017. Children in Cambodia commence Grade 1 in November, so the Grade 1 children who were in their first year of schooling would only have had approximately eight months of instruction at the time of the EGRA testing carried out for this study. Please refer to Table 1 for a brief description of the purpose and procedure of each EGRA subtask. It is important to remember that subtasks are strictly timed.

6.3.1 EGRA Subtask 1: Letter Name Recognition (LNR)
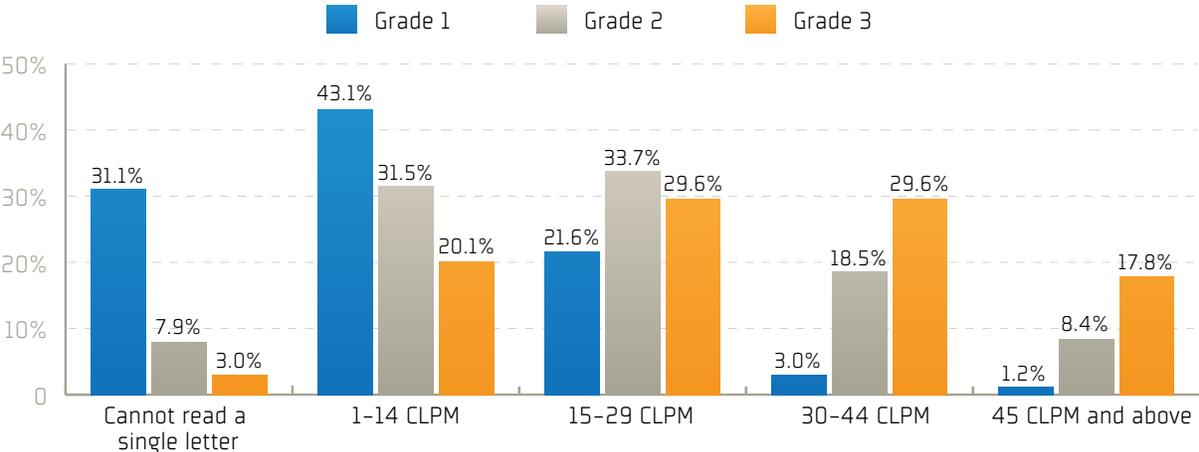
Figure 23. *EGRA LNR results for Grades 1–3, expressed as correct letters per minute (CLPM).*

Just over 31% of students from Grade 1 could not name any letters correctly. The same was the case for 7.9% of students in Grade 2 and 3% of students in Grade 3. The LNR subtask also showed that the largest group of Grade 1 students could correctly identify between 1–14 letters per minute (expressed as correct letters per minute, or CLPM), with the average score being nine letters per minute

(LPM). This does not indicate good progress in learning letters. However, the timed nature of the EGRA may have contributed to these low scores. The largest group of Grade 2 children could correctly identify between 15–29 CLPM, with the average score being 21 LPM. The largest group of Grade 3 children could name between 30–44 CLPM, with the average score being 30 LPM.

We also tested for different scores in LNR by gender *(Table 6):*

- Comparing genders in **Grade 1, there was no significant difference between the genders**.

- Comparing genders in **Grade 2, the mean score for girls** (M=25, SD=17) **was significantly higher than the mean score for boys** (M=17, SD=15), with a significance of p=0.002.

- Comparing genders in **Grade 3, the mean score for girls** (M=33, SD=18) **was significantly higher than the mean score for boys** (M=26, SD=19), with a significance of p=0.01.

Table 6: *EGRA LNR subtask mean scores by gender.*

LNR	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**9**	**10**	**0**	**56**	
Male	87	8	11	0	56	
Female	80	9	10	0	40	NS
Grade 2 (All)	**178**	**21**	**16**	**0**	**80**	
Male	81	17	15	0	56	
Female	97	25	17	0	80	0.002
Grade 3 (All)	**169**	**30**	**19**	**0**	**92**	
Male	80	26	19	0	76	
Female	89	33	18	0	92	0.01
Total	514	20	18	0	92	

Comparing the scores of students at LU schools with those at HU schools using an independent t-test, it was found that **for Grade 1 students, there was no significant difference between the scores of children at LU and HU schools** *(Table 7);* the average score for correctly identified letters per minute was similar between the two groups, namely 7.62 LPM at the LU schools compared to 8.98 LPM at the HU schools, with p>.05. For children in **Grades 2 and 3, however, there was a significant difference between scores at LU and HU schools**; for Grade 2, p<.001, and for Grade 3, p<.05.

Table 7. *EGRA LNR subtask LU/HU comparison.*

Letter Name and Recognition: Letters Read Correctly per Minute (100 Letters)	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
Cannot read a single letter	23.1%	34.8%	9.8%	6.8%	0.0%	4.3%
1–14 LPM	53.8%	38.3%	44.3%	24.8%	27.8%	16.5%
15–29 LPM	21.2%	21.7%	32.8%	34.2%	33.3%	27.8%
30–44 LPM	0.0%	4.3%	11.5%	22.2%	33.3%	27.8%
45 LPM and above	1.9%	0.9%	1.6%	12.0%	5.6%	23.5%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52	115	61	117	54	115
Mean	7.62	8.98	15.05	24.31	25.35	31.90
Std. Deviation	9.688	10.556	12.774	16.994	14.745	20.006
t	-0.795		-3.738		-2.388	
df	165.000		176.000		136.735	
p	0.428		0.000		0.018	
Mean Difference	-1.367		-9.259		-6.544	

In summary, it appears that the *Aan Khmer* app *may* have played a role in assisting children in Grades 2 and 3 to learn letter names.

6.3.2 EGRA Subtask 2: Familiar Word Reading (FWR)

The FWR subtask showed many students from Grades 1–3 were unable to read any words at all. This was especially the case for Grade 1 children. Nearly 90% of Grade 1 students were unable to read a single word correctly (expressed as correct words per minute, or CWPM). This was also the case for 46.6% of Grade 2 students and 32.5% of Grade 3 students *(Figure 24)*.
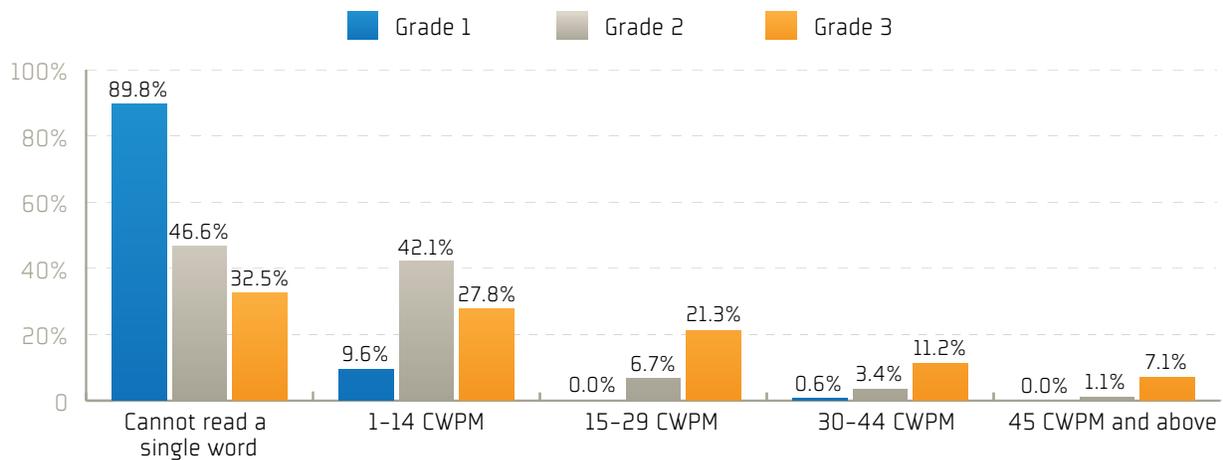
Figure 24. *EGRA FWR results for Grades 1–3, expressed as CWPM (correct words per minute).*

We also tested for different scores in FWR by gender:

- In **Grade 1, there was no significant difference between the genders** *(Table 8).*
- In **Grade 2, the mean score for girls** (M=8, SD=11) **was significantly higher than the mean score for boys** (M=4, SD=8), with a significance of p=0.019.

- In **Grade 3, the mean score for girls** (M=19, SD=16) **was significantly higher than the mean score for boys** (M=10, SD=14), with a significance of p<0.001.

Table 8: *EGRA FWR subtask mean scores by gender.*

FWR	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**1**	**3**	**0**	**38**	
Male	87	1	4	0	38	
Female	80	0	2	0	9	NS
Grade 2 (All)	**178**	**6**	**10**	**0**	**49**	
Male	81	4	8	0	38	
Female	97	8	11	0	49	0.019
Grade 3 (All)	**169**	**14**	**16**	**0**	**50**	
Male	80	10	14	0	50	
Female	89	19	16	0	50	<0.001
Total	514	7	12	0	50	

The mean scores of students from HU schools were higher than for students from LU schools *(Table 9)*. The average score of Grade 1 students in HU schools was 0.76 CWPM compared to 0.13 CWPM in LU schools; however, **for Grade 1 students, there was no significant difference between the two groups** (p>.5). By contrast, **Grades 2 and 3 children in HU schools did significantly better than those in LU schools**. For Grade 2, the average score in HU schools was 7.79 CWPM compared to 3.23 CWPM for LU schools, with a significance of p<.001. For Grade 3, the average score in HU schools was 16.47 CWPM compared to 10.30 CWPM for LU schools, with a significance of p<.05.

Table 9: *EGRA FWR subtask LU/HU comparison.*

Familiar Word Reading: Words Read Correctly per Minute (50 Words)	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
Cannot read a single word	94.2%	87.8%	55.7%	41.9%	37.0%	30.4%
1–14 CWPM	5.8%	11.3%	39.3%	43.6%	33.3%	25.2%
15–29 CWPM	0.0%	0.0%	4.9%	7.7%	22.2%	20.9%
30–44 CWPM	0.0%	0.9%	0.0%	5.1%	5.6%	13.9%
45 CWPM and above	0.0%	0.0%	0.0%	1.7%	1.9%	9.6%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52	115	61	117	54	115
Mean	0.13	0.76	3.23	7.79	10.30	16.47
Std. Deviation	0.627	3.801	5.305	10.871	12.128	16.673
t	-1.704		-3.757		-2.723	
df	127.108		175.417		138.210	
p	0.091		0.000		0.007	
Mean Difference	-1.367		-9.259		-6.544	

In summary, it appears the *Aan Khmer* app *may* have played a role in assisting children in Grades 2 and 3 to learn familiar/high-frequency word recognition.

6.3.3 EGRA Subtask 3: Non-Word Reading (NWR)

This subtask assesses students' ability to decode by asking them to read a series of non-words or nonsense words. This allows decoding skills to be assessed without their sight word knowledge influencing the score. Students are shown 50 non-words on flashcards and must read out as many as they can in 60 seconds.

Overall, children found this task very difficult. Nearly 90% of Grade 1 students were unable to correctly read a single non-word at all (expressed as correct words per minute, or CWPM), and the same was the case for 58.4% of Grade 2 students and 47.3% of Grade 3 students *(Figure 25)*. It should be noted that non-word tests are critiqued by many literacy researchers as being confusing for children, who are not normally asked to read non-words.
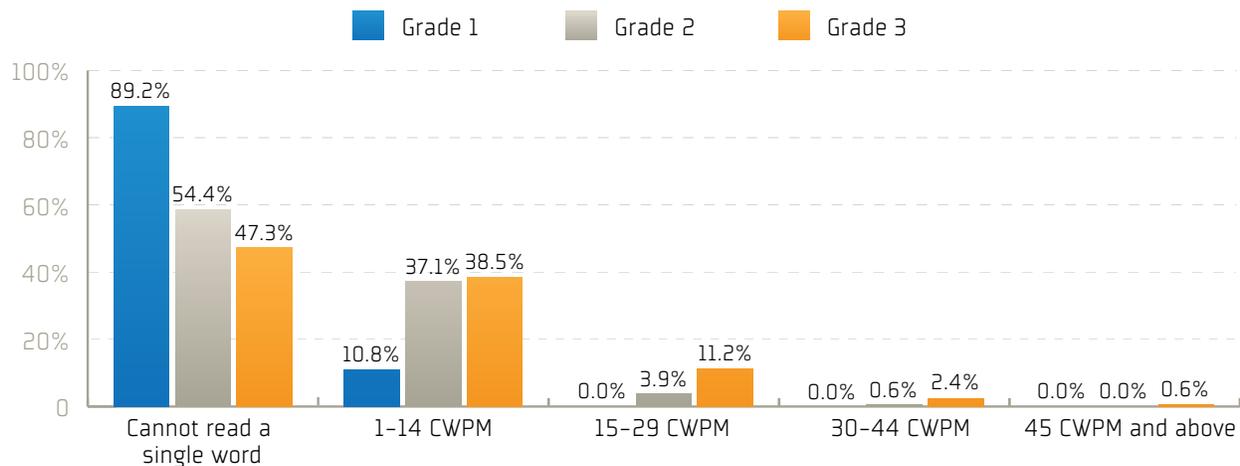
Figure 25. *EGRA NWR results for Grades 1–3, expressed as CWPM (correct words per minute).*

We also tested for different scores in NWR by gender:

- In **Grade 1, there was no significant difference between the genders** *(Table 10).*

- In **Grade 2, there was no significant difference between the genders.**

- In **Grade 3, the mean score for girls** (M=7, SD=10) **was significantly higher than the mean score for boys** (M=4, SD=8), with a significance of p=0.028.

NWR	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**0**	**1**	**0**	**7**	
Male	87	0	1	0	4	
Female	80	0	1	0	7	NS
Grade 2 (All)	**178**	**3**	**6**	**0**	**37**	
Male	81	2	4	0	22	
Female	97	3	6	0	37	NS
Grade 3 (All)	**169**	**6**	**9**	**0**	**46**	
Male	80	4	8	0	36	
Female	89	7	10	0	46	0.028
Total	**514**	**3**	**7**	**0**	46	

The mean scores of students from HU schools were higher than for students from LU schools *(Table 11).* The average score of Grade 1 students in HU schools was 0.33 CWPM compared to 0.17 CWPM in LU schools; however, **for Grade 1 students, there was no significant difference between the two groups** (p>.05). By contrast, **Grades 2 and 3 children in HU schools did significantly better than those in LU schools**. For Grade 2, the average score in HU schools was 3.57 CWPM compared to 1.23 CWPM in LU schools, which was statistically significant at p<.05. For Grade 3, the average score in HU schools was 7.27 CWPM compared to 3.22 CWPM in LU schools, which was statistically significant at p<.05.

Table 11. *EGRA NWR subtask LU/HU comparison.*

| Non-Word Reading: Non-Words Read Correctly per Minute (50 Words)	Grade 1		Grade 2		Grade 3	
	LU	**HU**	**LU**	**HU**	**LU**	**HU**
Cannot read a single non-word	94.2%	87.0%	78.7%	47.9%	63.0%	40.0%
1–14 CWPM	5.8%	13.0%	19.7%	46.2%	33.3%	40.9%
15–29 CWPM	0.0%	0.0%	1.6%	5.1%	3.7%	14.8%
30–44 CWPM	0.0%	0.0%	0.0%	0.9%	0.0%	3.5%
45 CWPM and above	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52	115	61	117	54	115
Mean	0.17	0.33	1.23	3.57	3.22	7.27
Std. Deviation	0.785	1.032	3.149	6.386	5.875	10.186
t	−0.978		−3.278		−3.260	
df	165.000		175.589		160.008	
p	0.329		0.001		0.001	
Mean Difference	−0.157		−2.343		−4.047	

In summary, it appears the ***Aan Khmer*** app ***may*** have played a role in assisting children in Grades 2 and 3 to decode non-words.

6.3.4 EGRA Subtask 4: Sentence Reading (SR)
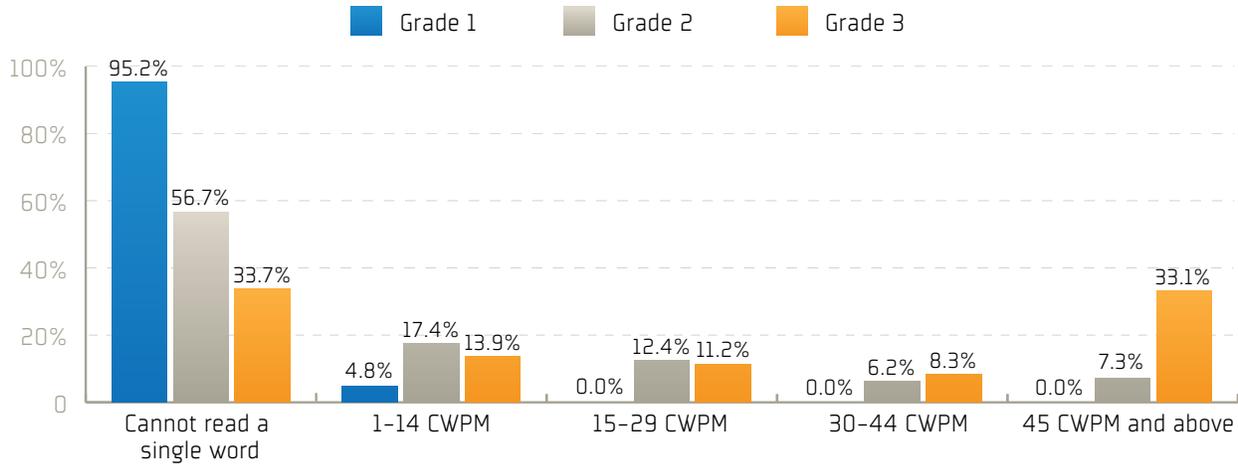
Figure 26. *EGRA SR results for Grades 1–3, expressed as CWPM (correct words per minute).*

The sentence reading (SR) subtask assesses the rate or speed of student reading per minute. Students are given a laminated sheet with eight short sentences containing a total of 57 words to read in 60 seconds.

As in previous subtasks, Grade 1 students found this task difficult. As shown in *Figure 26*, 95.2% of students in Grade 1 could not read a single word correctly. This was also the case for 56.7% of Grade 2 students and 33.7% of Grade 3 students.

We also tested for different scores in SR by gender:

- In **Grade 1, there was no significant difference between the genders** *(Table 12).*

- In **Grade 2, the mean score for girls** (M=13, SD=18) **was significantly higher than the mean score for boys** (M=6, SD=13), with a significance of p=0.006.

- In **Grade 3, the mean score for girls** (M=31, SD=23) **was significantly higher than the mean score for boys** (M=17, SD=22), with a significance of p<0.001.

Table 12. *EGRA SR subtask mean scores by gender.*

| SR	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**0**	**1**	**0**	**12**	
Male	87	0	2	0	12	
Female	80	0	1	0	8	NS
Grade 2 (All)	**178**	**10**	**16**	**0**	**57**	
Male	81	6	13	0	55	
Female	97	13	18	0	57	0.006
Grade 3 (All)	**169**	**24**	**23**	**0**	**57**	
Male	80	17	22	0	57	
Female	89	31	23	0	57	<0.001
Total	514	11	19	0	57	

The mean scores of students from HU schools were higher than for students from LU schools *(Table 13)*. **For Grade 1 students, there was no significant difference between the two groups.** By contrast, **Grades 2 and 3 children in HU schools did significantly better than those in LU schools.** For Grade 2, the average score in HU schools was 12.41 CWPM compared to 4.79 CWPM in LU schools, with a significance of p<.05. For Grade 3, the average score in HU schools was 27.5 CWPM compared to 17.8 CWPM in LU schools, with a significance of p<.05.

Table 13. *EGRA SR subtask LU/HU comparison.*

Sentence Reading Fluency: Words Read Correctly per Minute (57 Words)	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
Cannot read a single word	96.2%	94.8%	75.4%	47.0%	42.6%	29.6%
1–14 CWPM	3.8%	5.2%	9.8%	21.4%	14.8%	13.0%
15–29 CWPM	0.0%	0.0%	9.8%	13.7%	16.7%	8.7%
30–44 CWPM	0.0%	0.0%	3.3%	7.7%	5.6%	9.6%
45 CWPM and above	0.0%	0.0%	1.6%	10.3%	20.4%	39.1%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52	115	61	117	54	115
Mean	0.04	0.36	4.79	12.41	17.80	27.50
Std. Deviation	0.194	1.702	11.118	17.767	20.822	23.929
t	-1.975		-3.507		-2.689	
df	120.432		170.135		118.020	
p	0.051		0.001		0.008	
Mean Difference	-0.318		-7.623		-9.699	

In summary, it appears the *Aan Khmer* app *may* have played a role in assisting children in Grades 2 and 3 to read short sentences.

6.3.5 EGRA Subtask 5: Oral Reading Fluency (ORF)

The oral reading fluency (ORF) subtask aims to assess speed and accuracy (fluency) of oral reading. Students read aloud a short passage of 73 words. As shown in Figure 27, over 92% of students in Grade 1 could not read a single word correctly. This was also the case for 45.5% of Grade 2 students and 27.8% of Grade 3 students.
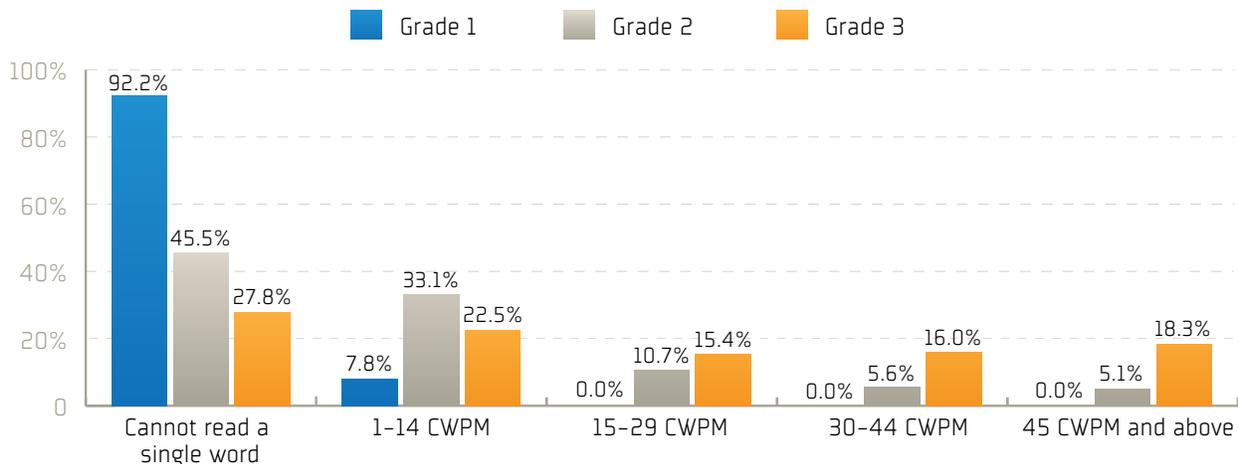
Figure 27. *EGRA ORF results for Grades 1–3, expressed as correct words per minute (CWPM).*

We also tested for different scores in ORF by gender:

- In **Grade 1, there was no significant difference between the genders** *(Table 14)*.

- In **Grade 2, the mean score for girls** (M=12, SD=18) **was significantly higher than the mean score for boys** (M=6, SD=11), with a significance of p=0.014.

- In **Grade 3, the mean score for girls** (M=28, SD=23) **was significantly higher than the mean score for boys** (M=14, SD=20), with a significance of p<0.001.

Table 14. *EGRA ORF subtask mean scores by gender.*

ORF	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**0**	**1**	**0**	**8**	
Male	87	0	1	0	6	
Female	80	0	1	0	8	NS
Grade 2 (All)	**178**	**9**	**15**	**0**	**73**	
Male	81	6	11	0	51	
Female	97	12	18	0	73	0.014
Grade 3 (All)	**169**	**22**	**23**	**0**	**73**	
Male	80	14	20	0	73	
Female	89	28	23	0	73	<0.001
Total	514	10	18	0	73	

The mean scores of students from HU schools were higher than for students from LU schools *(Table 15)*. **For Grade 1 students, there was no significant difference between the two groups.** By contrast, **Grades 2 and 3 children in HU schools did significantly better than those in LU schools.** For Grade 2, the average score in HU schools was 11.56 CWPM compared to 4.13 CWPM in LU schools, with a significance of p<.0.000. For Grade 3, the average score in HU schools was 24.43 CWPM compared to 15.63 CWPM in LU schools, with a significance of p<0.011.

Table 15. *EGRA ORF subtask LU/HU comparison.*

Oral Reading Fluency: Words Read Correctly per Minute (73 Words)	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
Cannot read a single word	96.2%	90.4%	62.3%	36.8%	35.2%	24.3%
1–14 CWPM	3.8%	9.6%	27.9%	35.9%	27.8%	20.0%
15–29 CWPM	0.0%	0.0%	8.2%	12.0%	11.1%	17.4%
30–44 CWPM	0.0%	0.0%	0.0%	8.5%	16.7%	15.7%
45 CWPM and above	0.0%	0.0%	1.6%	6.8%	9.3%	22.6%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52	115	61	117	54	115
Mean	0.19	0.30	4.13	11.56	15.63	24.43
Std. Deviation	1.138	1.156	8.572	17.300	18.828	24.039
t	-0.583		-3.827		-2.586	
df	165		175.663		129.825	
p	0.561		0.000		0.011	
Mean Difference	-0.112		-7.424		-8.805	

In summary, it appears the ***Aan Khmer*** app ***may*** have played a role in assisting children in Grades 2 and 3 to improve their oral fluency.

6.3.6 EGRA Subtask 6: Reading Comprehension (RCO)

In the reading comprehension (RCO) subtask, students are asked five questions about a text. To answer a question, the student must read the sentences in the text. In many cases, children were not able to do this, resulting in low comprehension scores. In this test, if a student cannot read the first sentence of the passage, he or she is not eligible to be asked any questions; if the student can read the first sentence, he or she is eligible to be asked the first question; and if the student can read the second sentence, he or she is eligible to be asked the second question, etc. Only if a student can read the whole passage is he or she eligible to be asked all five questions.
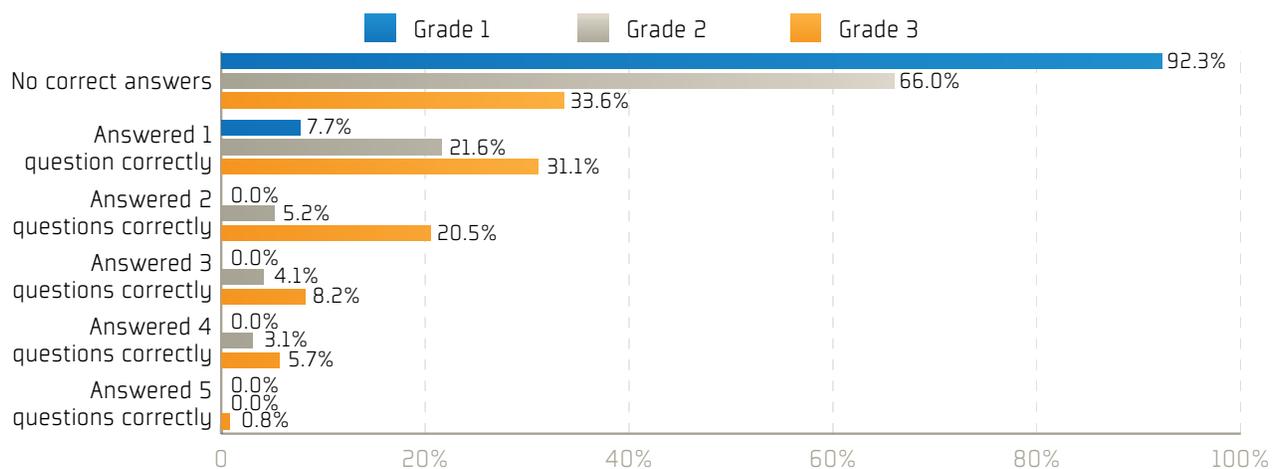
Figure 28. *EGRA RCO results for Grades 1–3, showing the percentages of students able to answer questions correctly.*

In this subtask, as seen in *Figure 28*, the calculation and analysis is based on the percentage of comprehension questions answered correctly by students within a given timeframe of 15 seconds for each question. However, many students in each grade were ineligible to be asked the questions, as seen in *Figure 29*. With the very first question, 92.2% of Grade 1 students, 45.5% of Grade 2 students, and 27.8% of Grade 3 students were ineligible to be asked. Naturally, with later questions the percentages of students who were ineligible to be asked became increasingly higher.
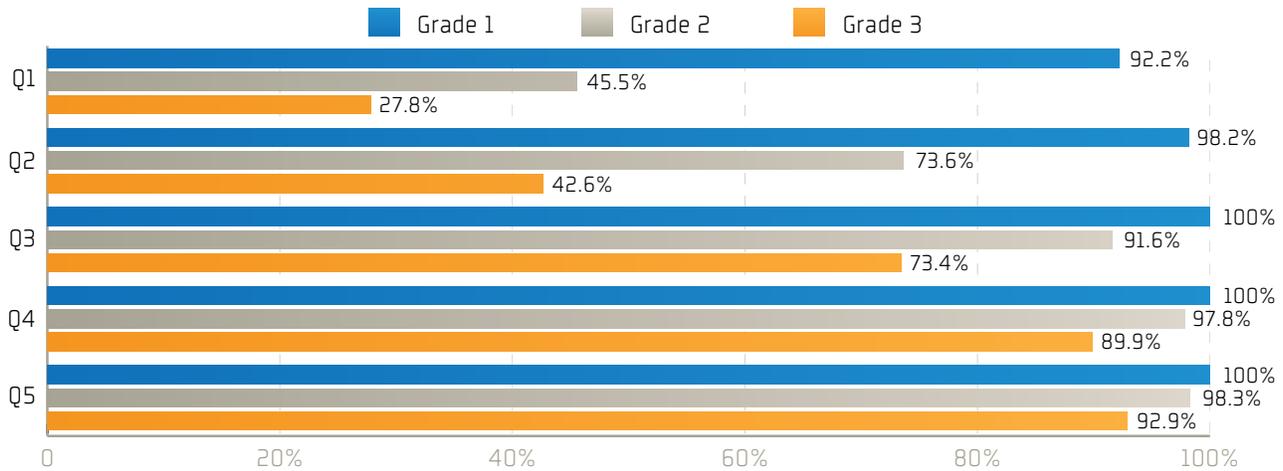
Figure 29. *EGRA RCO results for Grades 1–3, showing the percentages of students ineligible to be asked each of the five questions.*

Among students who were eligible to be asked questions, the average number of correct answers in all grades was very low, standing at 0.08 for Grade 1, 0.57 for Grade 2, and 1.24 for Grade 3 *(Table 16)*.

We also tested for different scores in RCO by gender:

- In **Grade 1, there was no significant difference between the genders.**

- In **Grade 2, there was no significant difference between the genders.**

- In **Grade 3, the mean score for girls** (M=1.51, SD=1.26) **was significantly higher than the mean score for boys** (M=0.84, SD=1.03), with a significance of p=0.002.

Table 16. *EGRA RCO subtask mean scores by gender.*

RCO	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**0.08**	**0.28**	**0**	**1**	
Male	87	0	0	0	0	
Female	80	0.14	0.38	0	1	NS
Grade 2 (All)	**178**	**0.57**	**0.99**	**0**	**4**	
Male	81	0.33	0.68	0	3	
Female	97	0.7	1.12	0	4	NS
Grade 3 (All)	**169**	**1.24**	**1.21**	**0**	**5**	
Male	80	0.84	1.03	0	5	
Female	89	1.51	1.26	0	4	0.002
Total	514	1	1	0	5	

The mean scores of students from HU schools were higher than for students from LU schools *(Table 17)*. For Grade 1, the average score in HU schools was 0.091 compared to zero in LU schools; however, **for Grade 1 students, there was no significant difference between the two groups** (p>.05). For Grade 2, the average score in HU schools was 0.649 compared to 0.304 in LU schools; however, **for Grade 2 students, there was also no significant difference between the two groups** (p>.05). For Grade 3, the average score in HU schools was 1.391 compared to 0.857 in LU schools; **for Grade 3 students, there was a statistically significant difference in RCO scores** (p<.5).

Table 17. *EGRA RCO subtask LU/HU comparison.*

Reading Comprehension: Number of Correct Responses	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
No correct answers	100.0%	90.9%	78.3%	62.2%	51.4%	26.4%
Answered 1 question correctly	0.0%	9.1%	17.4%	23.0%	22.9%	34.5%
Answered 2 questions correctly	0.0%	0.0%	0.0%	6.8%	17.1%	21.8%
Answered 3 questions correctly	0.0%	0.0%	4.3%	4.1%	5.7%	9.2%
Answered 4 questions correctly	0.0%	0.0%	0.0%	4.1%	2.9%	6.9%
Answered 5 questions correctly	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	2.00	11.00	23.00	74.00	35.00	87.00
Mean	0.000	0.091	0.304	0.649	0.857	1.391
Std. Deviation	0.000	0.30151	0.703	1.052	1.08852	1.233
t	−0.41		−1.80		−2.23	
df	11.000		55.258		120.000	
p	0.689		0.077		0.027	
Mean Difference	−0.09		−0.34		−0.53	

**In summary, it appears the *Aan Khmer* app *may* have played a role in assisting children in Grade 3 to improve their reading comprehension.**

6.3.7 EGRA Subtask 7: Listening Comprehension (LCO)

In the listening comprehension subtask, students listen to a short passage read aloud to them and are then asked three questions about the text.

Most students in Grades 1–3 were able to give at least one correct answer. As shown in Figure 30, only 14.4% of Grade 1 students were unable to give any correct answers, with the percentage standing at 1.7% for Grade 2 students and 2.4% for Grade 3 students. Much of the time, students were able to give two correct answers.
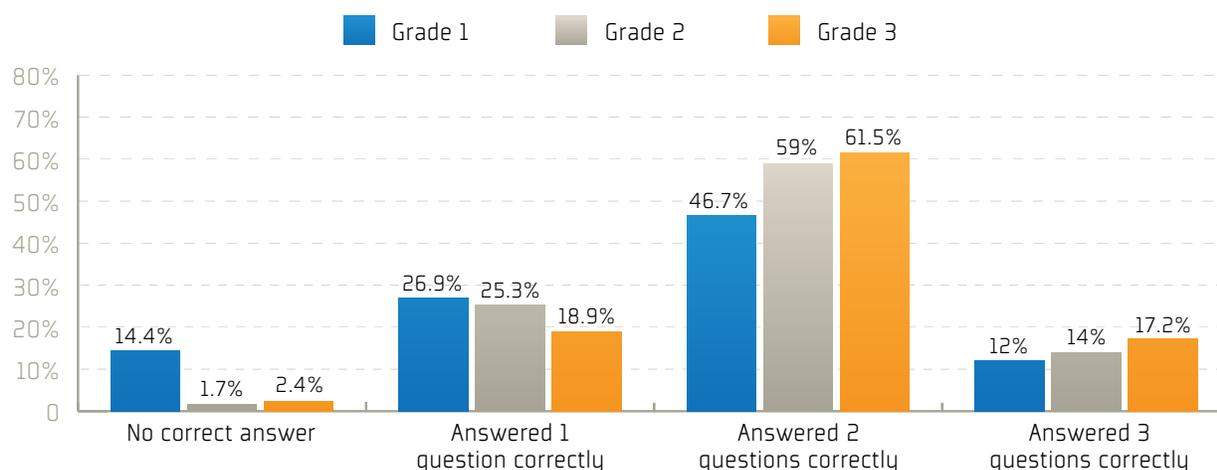
Figure 30. *EGRA LCO results for Grades 1–3, showing the percentages of students who answered questions correctly.*

We also tested for different scores in LCO by gender:

- In **Grade 1, there was no significant difference between the genders** *(Table 18).*

- In **Grade 2, there was no significant difference between the genders.**

- In **Grade 3, there was no significant difference between the genders.**

Table 18. *EGRA LCO subtask mean scores by gender.*

LCO	Count	Mean	Standard Deviation	Minimum	Maximum	P-value
Grade 1 (All)	**167**	**1.56**	**0.88**	**0**	**3**	
Male	87	1.69	0.87	0	3	
Female	80	1.43	0.88	0	3	NS
Grade 2 (All)	**178**	**1.85**	**0.66**	**0**	**3**	
Male	81	1.84	0.68	0	3	
Female	97	1.87	0.66	0	3	NS
Grade 3 (All)	**169**	**1.93**	**0.67**	**0**	**3**	
Male	80	1.9	0.65	0	3	
Female	89	1.97	0.7	0	3	NS
Total	514	2	1	0	3	

The mean scores of students from HU schools were higher than for students from LU schools in Grades 1 and 3, and lower in Grade 2 *(Table 19).* For Grade 1, the average score in HU schools was 1.626 compared to 1.423 in LU schools; for Grade 2, the average score in HU schools was 1.821 compared to 1.918 in LU schools; for Grade 3, the average score in HU schools was 1.991 compared to 1.815 in LU schools. **However, for Grades 1, 2, and 3, there were no significant differences between the groups** (p>.05).

Table 19. *EGRA LCO subtask LU/HU comparison.*

Listening Comprehension: Number of Correct Responses	Grade 1		Grade 2		Grade 3	
	LU	HU	LU	HU	LU	HU
No correct answer	13.5%	14.8%	0.0%	2.6%	3.7%	1.7%
Answered 1 question correctly	36.5%	22.6%	23.0%	26.5%	24.1%	16.5%
Answered 2 questions correctly	44.2%	47.8%	62.3%	57.3%	59.3%	62.6%
Answered 3 questions correctly	5.8%	14.8%	14.8%	13.7%	13.0%	19.1%
	Significance Test		Significance Test		Significance Test	
	LU/HU Comparison for Each Grade					
N	52.00	115.00	61.00	117.00	54.00	115.00
Mean	1.423	1.626	1.918	1.821	1.815	1.991
Std. Deviation	0.80	0.91	0.61	0.69	0.70	0.66
t	-1.381		0.929		-1.595	
df	165.00		176.00		167.00	
p	0.169		0.354		0.113	
Mean Difference	-0.20		0.10		-0.18	

In summary, it does *not* appear the app played a role in assisting children in Grades 1, 2, or 3 to improve their listening comprehension.

6.3.8 EGRA Reading Outcome Modeling

In order to investigate the extent to which factors other than higher or lower app usage may have influenced the students' EGRA scores, multiple regression analysis was carried out, based on several key influential factors.[1] The outcome variable (dependent variable, or DV) is the total score from all seven subtasks of the EGRA, while the independent variables (IVs) are factors that might potentially affect a student's score.

In running the multiple regression analysis, automated entry mode (stepwise) was used. This involved first running the analysis using the variable most highly correlated to the dependent variable in the model. Then the next most correlated variable was included, allowing for the first explanatory variable in the model. Explanatory variables (IVs) were added until no further variables were significant. Using this approach, it was possible to delete a variable that had been included at an earlier step but was no longer significant, given the explanatory variables that were added later.

Two different groups of questions from the School Director Survey were used to predict the outcome. Group 1 included demographic factors such as: 1) student gender **(Q1)**, and 2) student grade level **(Q3)**, as well as learning environment factors such as: 3) parental support **(Q50)**, and 4) ability to borrow books from the school library **(Q18)**. Group 2 included school characteristics such as: 1) school director's education level **(Q11)**, 2) school director's years of experience **(Q13)**, 3) number of teachers in the school **(Q22)**, 4) number of grades in the school **(Q23)**, 5) total number of students at the school **(Q26)**, 6) students' attendance rate **(Q27)**, 7) presence of multi-grade classes **(Q30)**, 8) length of the TRAC+ intervention **(Q4)**, 9) number of tablets provided **(Q35)**, 10) perceived quality of the TRAC+ training **(Q77)**, 11) perceived quality of ICT support **(Q55)**, and 12) number of peer tutors **(Q25)**.

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[1] All the factors or explanatory variables were taken from the School Director Survey in Phase 1.

The overall model *(Table 20)* was significant, with the regression equation of F (8, 457) = 32.27, p<0.0001, and the adjusted R square of .349. The result from multiple regression analysis indicates that 34.9% of the variance in the outcome variable that was measured on the total score of the student EGRA test could be explained by predictors as equal to = −63.309 + 4.1210 Q1 + 8.1710 Q3 + 1.5107 Q50 + 17.782 Q18 + 2.958 Q11 + 11.895 Q30 + 1.9886 Q35 − 0.07226 Q25 *(Table 21)*.

Table 20. *ANOVA and model summary.*

Analysis of Variance					
Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	8	28,616.9	3,577.12	32.27	<0.0001
Error	457	50,653.0	110.84		
Total	465	79,269.9			

Model Summary		
S	R-sq	R-sq(adj)
10.5280	36.10%	34.98%

Table 21. *Model selection details: Hierarchical multiple regression predicting student's EGRA score.*

	Model 1 Coef	P	Model 2 Coef	P	Model 3 Coef	P	Model 4 Coef	P	Model 5 Coef	P	Model 6 Coef	P	Model 7 Coef	P	Model 8 Coef	P	Model 9 Coef	P	Model 10 Coef	P
Constant	-1.851		-28.027		-30.038		-36.075		-39.259		-38.621		-54.330		-54.870		-61.066		-63.309	
Q3	8.0429	0.0000	8.1462	0.0000	8.0781	0.0000	8.1221	0.0000	8.1429	0.0000	8.1709	0.0000	8.1713	0.0000	8.1642	0.0000	8.1541	0.0000	8.1710	0.0000
Q35			1.5028	0.0002	1.5077	0.0001	1.5308	0.0001	1.8020	0.0000	1.4026	0.0011	1.7002	0.0001	1.6544	0.0001	1.9894	0.0000	1.9886	0.0000
Q1					3.9263	0.0001	3.8991	0.0001	3.6696	0.0003	3.7187	0.0002	4.1115	0.0000	4.2194	0.0000	4.1829	0.0000	4.1210	0.0000
Q11							2.179	0.0005	3.957	0.0000	4.271	0.0000	2.684	0.0062	1.971	0.0014	3.335	0.0014	2.958	0.0055
Q4									-1.921	0.0078	-2.044	0.0045	-0.727	0.3495						
Q18											6.073	0.0153	15.832	0.0000	16.624	0.0000	16.281	0.0000	17.782	0.0000
Q30													11.8242	0.0001	12.9631	0.0000	11.3776	0.0001	11.8949	0.0000
Q25																	-0.06468	0.1047	-0.07226	0.0714
Q50																			1.51066	0.1033
Summary Statistics																				
S	11.3284		11.1694		11.0069		10.8735		10.8018		10.7444		10.5674		10.5659		10.5471		10.5280	
R-sq	24.88%		27.13%		29.39%		31.24%		32.29%		33.15%		35.48%		35.36%		35.73%		36.10%	
R-sq(adj)	24.72%		26.82%		28.93%		30.64%		31.56%		32.28%		34.49%		34.51%		34.75%		34.98%	
Cp	77.10		62.94		48.73		37.46		31.91		27.72		13.03		11.91		11.25		10.58	

Gender **(Q1)** was coded as 0 = Male, 1 = Female; student grade level **(Q3)** was represented on a scale of 1 to 3; parental support **(Q50)** was coded 0 = No, 1 = Yes; ability to borrow books from the school library **(Q18)** was coded as 0 = No, 1 = Yes; the school director's education level **(Q11)** was measured on a scale, e.g., 1, 2, 3, 4, 5, 6; the presence of multiple grades **(Q30)** was coded as 0 = No, 1 = Yes; the length of the TRAC+ intervention **(Q4)** was measured on a scale of years; the number of tablets provided **(Q35)** and the number of peer tutors **(Q25)** were measured in units, e.g., 1, 2, 3, 4.

> The second most powerful predictor was the presence of multiple grade classes (Q30). Scores for children in schools with multiple grade classes were on average 11.895 points higher than for children in schools without such classes.

Based on the results in the coefficients table *(Table 22)*, the school policy on whether students were allowed to borrow books from the library to take home for reading **(Q18)** appeared to have a strong effect on the students' EGRA scores. The scores of children attending schools that permitted books to be taken home were 17.782 points higher than those of children attending schools which did not allow borrowing. It should be noted that 94.5% of schools allowed borrowing.

The second most powerful predictor was the presence of multiple grade classes **(Q30)**. Scores for children in schools with multiple grade classes were on average 11.895 points higher than for children in schools without such classes.

Table 22. *Table of coefficients.*

Coefficients: Predicting Student's EGRA Test Score					
Term	**Coef**	**SE Coef**	**95% CI**	**T-Value**	**P-Value**
Constant	–63.309	8.919	(–80.836, –45.782)	–7.10	<0.0001
Q1	4.1210	0.9799	(2.1953, 6.0466)	4.21	<0.0001
Q3	8.1710	0.6041	(6.9839, 9.3581)	13.53	<0.0001
Q50	1.5107	0.9256	(–0.3082, 3.3295)	1.63	0.1033
Q18	17.782	3.447	(11.008, 24.557)	5.16	<0.0001
Q11	2.958	1.061	(0.872, 5.043)	2.79	0.0055
Q30	11.895	2.826	(6.342, 17.448)	4.21	<0.0001
Q35	1.9886	0.4703	(1.0644, 2.9128)	4.23	<0.0001
Q25	–0.07226	0.03998	(–0.15083, 0.00631)	–1.81	0.0714

(Q1) Student gender, (Q3) student grade level, (Q50) parental support, (Q18) ability to borrow books from the school library, (Q11) school director's education level, (Q30) presence of multi-grade classes, (Q35) number of tablets provided, (Q25) number of peer tutors. Note that (Q4) length of the TRAC+ intervention was removed in the process of running the multiple regression analysis, and hence is not shown in this table.

Statistically non-significant values are shown in red.

The third most powerful predictor was the student's grade level **(Q3)**. This may be an artifact of the Cambodian version of the EGRA that was used, as it has been argued that it may not be sensitive enough to measure reading skills in younger children in detail.

The fourth most important predictor was the student's gender **(Q1)**. This is consistent with the results reported earlier, when subtask scores were compared between genders. The multiple regression analysis shows that girls' scores were 4.1210 points higher on average.

6.4 STAR results

The STAR was administered to Grade 3 students only. Its main purpose was to cross-check the EGRA results and compensate for possible limitations in the latter. From the STAR, the students were categorized as follows: 31% non-readers, 24% readers, and 45% readers with comprehension.

Most of the Grade 3 students received higher scores in the STAR than they received in the EGRA, suggesting that perhaps the EGRA may not be sensitive enough to capture students' reading knowledge. It should be noted that there is a slight possibility a practice effect was present since the two (short) tests took place on the same day—first the EGRA and then the STAR—and both tested similar concepts, although, as prescribed in the test guidelines, no feedback was given to students about their correct or incorrect responses.

6.4.1 STAR Subtask 1: Letter Naming Recognition (LNR)

In the STAR Letter Naming Recognition (LNR) subtask, it was found that:

- More than 70% of students could correctly identify 26 letters or more (*Figure 31*), whereas in the EGRA only 53% could read up to 29 letters.

- The mean score for all Grade 3 students tested was 26 letters (*Table 23*).

- The mean score of the students in HU schools was two letters higher than the mean score for the students in LU schools (significance was not calculated because of the small sample size).

- Girls often achieved higher scores than boys, as was the case with the EGRA.

	Cannot read a single letter	1–5 CLPM	6–10 CLPM	11–15 CLPM	16–20 CLPM	21–25 CLPM	26 CLPM and above
N%	0.0%	1.2%	2.4%	4.1%	8.3%	13.6%	70.4%
N	0	2	4	7	14	23	119
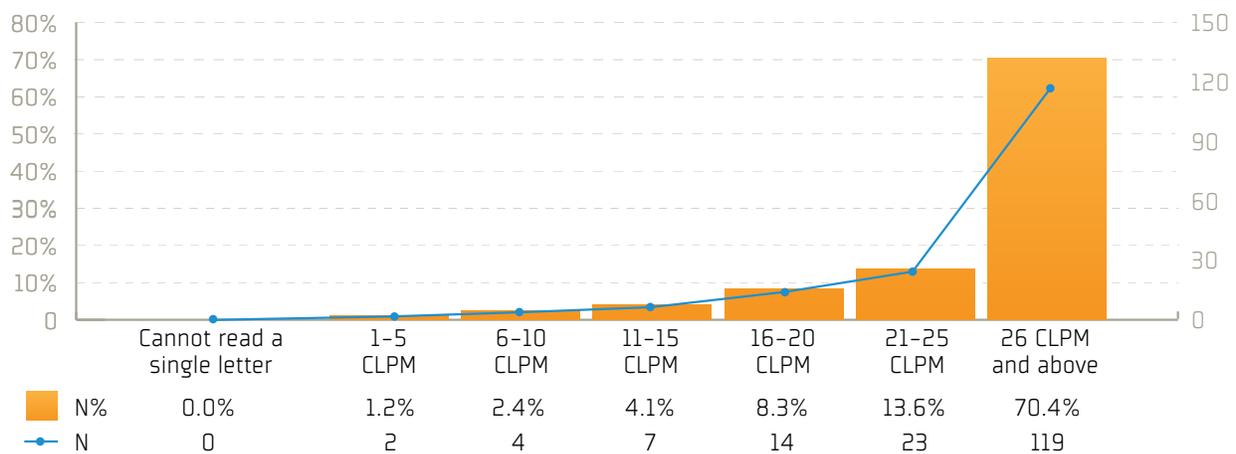
Figure 31. *STAR LNR results for Grade 3, expressed as correct letters per minute (CLPM).*

Table 23. *STAR LNR subtask mean scores by province, LU/HU school, gender, and tier.*

STAR LNRR Subtask		N	Mean	SD	Min	Max
All students		169	26	6	1	30
Province	Takeo	35	26	6	3	30
	Siem Reap	40	27	6	6	30
	Kampong Thom	13	28	4	14	30
	Preah Vihear	27	25	6	7	30
	Banteay Meanchey	54	26	6	1	30
Use of app	LU	54	25	6	1	30
	HU	115	27	6	3	30
Gender of student	Male	82	25	7	1	30
	Female	87	27	5	6	30
Reading comprehension tier	Non-reader	52	20	7	1	30
	Reader	41	28	3	14	30
	Reader with comprehension	75	29	2	20	30

6.4.2 STAR Subtask 2: Familiar Word Reading (FWR)

In the STAR Familiar Word Reading (FWR) subtask, it was found that:

- Nearly 6% of students were unable to correctly identify any words *(Figure 32)*.

- Nearly 60% of the students were able to correctly identify between 9–10 words (with 10 words being the maximum), with a mean score of eight *(Table 24)*.

- For this subtask, there was no difference between students in HU and LU schools.

- Girls often achieved higher scores than boys.

	Cannot read a single word	1–2 CW	3–4 CW	5–6 CW	7–8 CW	9 CW and above
N%	5.9%	5.3%	5.3%	4.1%	20.1%	59.2%
N	10	9	9	7	34	100
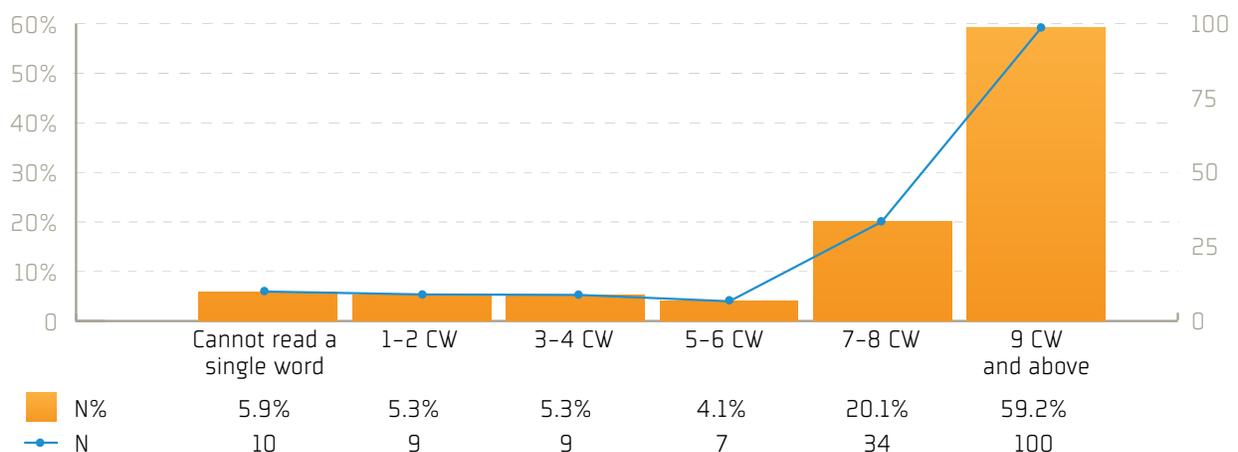
Figure 32. *STAR FWR results for Grade 3, expressed as CW (correct words).*

Table 24. *STAR FWR subtask mean scores by province, LU/HU school, gender, and tier.*

STAR FWR Subtask		N	Mean	SD	Min	Max
All students		169	8	3	0	10
Province	Takeo	35	6	4	0	10
	Siem Reap	40	9	2	0	10
	Kampong Thom	13	9	2	1	10
	Preah Vihear	27	8	2	1	10
	Banteay Meanchey	54	8	3	0	10
Use of app	LU	54	8	3	0	10
	HU	115	8	3	0	10
Gender of student	Male	82	7	3	0	10
	Female	87	9	3	0	10
Reading comprehension tier	Non-reader	52	5	3	0	8
	Reader	41	9	2	3	10
	Reader with comprehension	75	10	1	6	10

6.4.3 STAR Subtask 3: Non-Word Reading (NWR)

In the STAR Non-Word Reading (NWR) subtask, it was found that:

■ Nearly 37% of students correctly identified between 7-8 non-words *(Figure 33)*.

■ The mean score for all students was six non-words *(Table 25)*.

■ The mean score of the students in HU schools was marginally higher than the mean score for the students in LU schools (significance was not calculated because of the small sample size).

■ Girls achieved slightly higher scores than boys.

	Cannot read a single word	1–2 CW	3–4 CW	5–6 CW	7–8 CW	9 CW and above
N%	7.7%	14.2%	11.2%	16.6%	36.7%	13.6%
N	13	24	19	28	62	23
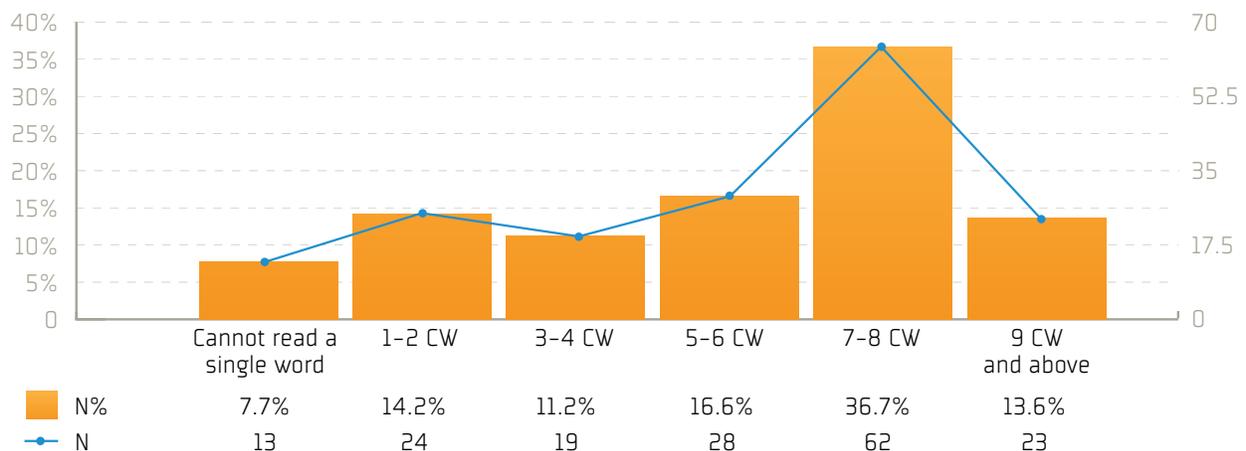
Figure 33. *STAR NWR results for Grade 3, expressed as correct words (CW).*

Table 25. *STAR NWR subtask mean scores by province, LU/HU school, gender, and tier.*

STAR NWR Subtask		N	Mean	SD	Min	Max
All students		169	6	3	0	10
Province	Takeo	35	4	4	0	10
	Siem Reap	40	6	3	1	10
	Kampong Thom	13	6	2	3	9
	Preah Vihear	27	5	3	0	9
	Banteay Meanchey	54	6	3	0	10
Use of app	LU	54	5	3	0	10
	HU	115	6	3	0	10
Gender of student	Male	82	5	3	0	10
	Female	87	6	3	0	10
Reading comprehension tier	Non-reader	52	4	4	0	8
	Reader	41	5	3	1	9
	Reader with comprehension	75	7	2	1	10

6.4.4 STAR Subtask 4: Oral Reading Comprehension (ORC)

In the STAR Oral Reading Comprehension (ORC) subtask, it was found that:

- No students received a zero score *(Figure 34).*

- More than 41% of students were able to correctly answer five out of five comprehension questions.

- The average score was four out of five questions answered correctly *(Table 26).*

- For this subtask, there was no difference between students in HU and LU schools.

- Girls achieved slightly higher scores than boys.

	No correct answer	Answered 1 question correctly	Answered 2 questions correctly	Answered 3 questions correctly	Answered 4 questions correctly	Answered 5 questions correctly
N%	0.0%	9.5%	8.6%	17.2%	23.3%	41.4%
N	0	11	10	20	27	48
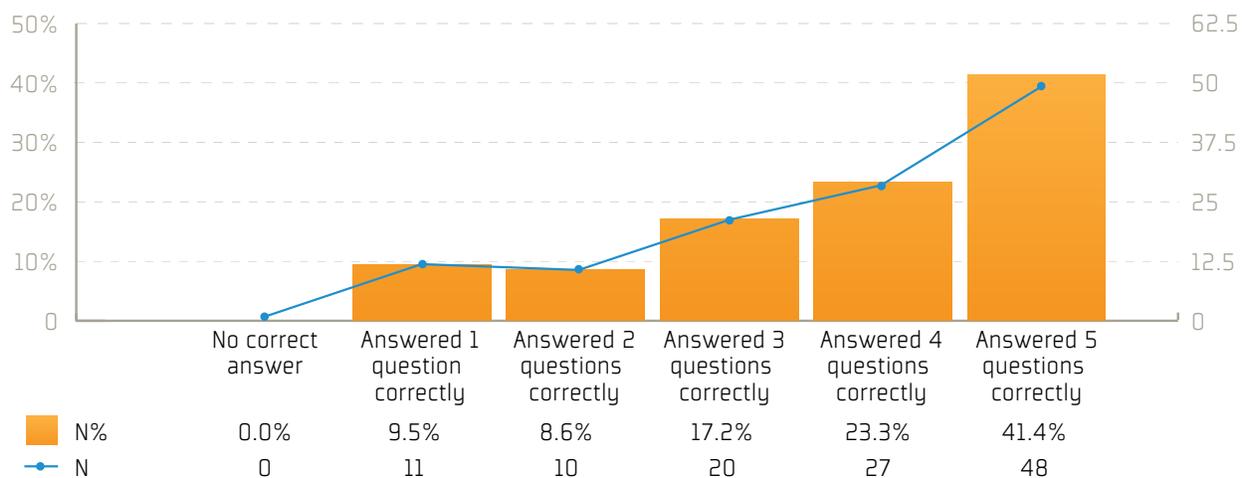
Figure 34. *STAR ORC results for Grade 3, expressed as questions answered correctly.*

Table 26. *STAR ORC subtask mean scores by province, LU/HU school, gender, and tier.*

STAR ORC Subtask		N	Mean	SD	Min	Max
All students		169	4	1	1	5
Province	Takeo	35	5	1	3	5
	Siem Reap	40	4	1	1	5
	Kampong Thom	13	4	1	3	5
	Preah Vihear	27	3	2	1	5
	Banteay Meanchey	54	4	1	1	5
Use of app	LU	54	4	1	1	5
	HU	115	4	1	1	5
Gender of student	Male	82	3	2	1	5
	Female	87	4	1	1	5
Reading comprehension tier	Non-reader	52	-	-	-	-
	Reader	41	2	1	1	3
	Reader with comprehension	75	5	0	4	5

6.5 General trends in the quantitative data

The School Director Survey revealed that directors were generally positive about the *Aan Khmer* app, with just over 93% saying they thought it was very useful or extremely useful for helping struggling readers learn to read. However, they did point out some difficulties associated with training of staff, the availability of technical support, and the storage and organization of the tablets. They also noted that the app itself could be improved to better suit the needs and capabilities of the students.

Even though implementation of the TRAC+ intervention was not always carried out as intended, there appear to have been some positive effects in terms of student learning. Notwithstanding the limitations of the EGRA testing in this study, which are outlined in Chapter 9 of the report, there were significant differences between the reading scores of children in the schools categorized as making higher use (HU) of the *Aan Khmer* app and those categorized as making lower use (LU) of the app, with some of the differences being highly significant.

Taking library books home might have improved reading as children could practice at home; and children in multi-grade classrooms might have been more likely to be grouped according to their abilities rather than simply receiving whole-class teaching.

According to the EGRA results, children in Grades 2 and 3 appeared to benefit more than children in Grade 1. However, it must be noted that the Cambodian EGRA may not have been an appropriate instrument to measure Grade 1 students' reading as it was too difficult for most of them, resulting in a floor effect. A more sensitive test may have shown some differences.

Children in Grades 2 and 3 who were in HU schools had significantly better mean scores than those in LU schools in the following subtests of the EGRA: Letter Name Recognition; Familiar Word Reading;

Non-Word Reading; Sentence Reading; and Oral Reading Fluency. Grade 3 children in HU schools also had significantly higher mean scores than children in LU schools for Reading Comprehension.

Children in Grade 1 showed no significant differences in their mean scores when HU and LU schools were compared. This may have been because of the aforementioned floor effect, or because they had used *Aan Khmer* for a shorter time.

According to the STAR results, children in Grade 3 who were in HU schools did slightly better than those in LU schools in two of the four subtests, but significance was not calculated due to the small sample size.

It is important to note that, while some improvements were found, the overall performance of students as measured in the EGRA and the STAR was not high.

Overall, girls did better than boys in both the EGRA and the STAR tests. This is in line with international trends, whereby girls often outperform boys in literacy in the early years (e.g., OECD, 2014).

Multiple regression analysis indicated that several factors other than the use of the app appeared to influence the EGRA results, with the strongest influences being: children being permitted to take library books home, and schools having multi-grade classrooms. Taking library books home might have improved reading as children could practice at home; and children in multi-grade classrooms might have been more likely to be grouped according to their abilities rather than simply receiving whole-class teaching.

■　　■　　■

7. Qualitative Findings

This chapter outlines the key themes derived from the qualitative data collection and analysis, primarily involving interviews and classroom observations, with some reference made to themes in the relevant critical literature. Following general comments on the TRAC+ project, the Interval Test and *Aan Khmer* apps, and their implementation, the chapter considers the roles of school directors, teachers, librarians, literacy coaches, peer tutors, and parents, as well as the views of struggling students, before concluding with brief comments on scalability and sustainability.

Interviewees are referred to by code letters and numbers to preserve anonymity, but their role is indicated in each case. All direct quotations have been translated from Khmer into English.

Figure 35. *Provincial school where TRAC+ is being implemented, Cambodia. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

7.1 Nature of TRAC+

Many different stakeholders were involved in the implementation of TRAC+ *(Table 27)*. Most staff interviewed were positive about the project and its impact on early grade reading, indicating that it was engaging and motivating for students and led to improvements not only in reading (including knowledge of consonants and vowels) but in related areas such as spelling and pronunciation. Typical comments included:

> I can say that students made significant progress with their reading after they began to use the app. They are able to read and write better than previously. (Teacher A-4)

I observe that the app is not only helpful for students with reading difficulties, but it is also beneficial to normal [sic] students. The app is designed with sounds and pictures which make students learn better. This would enable the students to learn new words faster. (Teacher B-2)

Aan Khmer really helps children learn to read because it is designed with pictures and sounds which enable them to practice and learn better... I have observed that students have progressed with their reading. In the past, students in Grades 1 and 2 did not know how to read properly, and since TRAC+ has been implemented, many of these students, more than 60%, are able to read better. (School Director G-1)

I think Aan Khmer has helped struggling students improve their reading. The app is like a game which is designed with sounds and pictures enabling the students to learn to read better. In particular, learning activities such as matching words, finding words and mini-stories helped them become more confident and competent with their fluency in reading in the classroom ... I noticed that they could understand the Interval Tests better and their scores increased after they used Aan Khmer. (Literacy Coach N-2)

One literacy coach pointed out that the tablets helped students "become independent and ... have a feeling of ownership" of their learning (Literacy Coach A-2). Others emphasized that *Aan Khmer* helped students build up their confidence in participating in reading activities and made them like coming to school. One librarian highlighted:

My observation is that when students are able to read some words or letters, they become more interested in coming to the library to learn. Some students live far away from school, but they manage to visit the library every day. They seem addicted to learning ... I remember helping 12 students with reading difficulties learn to read using Aan Khmer and the toolkit. I helped them by making the learning entertaining and meaningful ... Some of them lived very far away from school (it can take them two hours to travel from home to school) but they came to school to learn with me every day. (Librarian C-3)

When asked what aspects of reading are important for students to become good readers, teachers, librarians, and literacy coaches mentioned the following areas: phonics, vocabulary, reading comprehension, fluency in reading, and consonants and vowels. They added that such areas are promoted in the *Aan Khmer* app.

While recognizing the impact the app can have on students' reading, some librarians and literacy coaches pointed out that benefiting from the app also depends on the commitment and attitudes of students. One literacy coach explained:

Aan Khmer is really helpful for students ... However, it also depends on students' attitude to learning. If they work hard, they will be able to progress soon. The problem is that struggling students often pay less attention to their learning. (Literacy Coach O-2)

Staff members were also very positive about the fact that the project meant there were more teaching and learning resources available to them and their students in schools, and that teachers learned new ways of teaching while librarians were trained to manage the library resources effectively.

Students were found to be eager to use both the toolkit and the *Aan Khmer* app, and in some schools this encouraged them to come to the library, which was a common location for students to access

these. In the School Director Survey it was reported that 69 (94.5%) out of 73 schools allowed parents and students to borrow learning materials to take home, and one school allowed the tablets to be taken out of school. Moreover, 37% percent of school directors indicated that at least some parents had the *Aan Khmer* app installed on their smartphones, with the estimated number of parents in each case varying from one to 30 depending on the school context and parental background. The struggling students said their reading had improved as a result of using *Aan Khmer*.

> The struggling students said their reading had improved as a result of using *Aan Khmer*.

The staff members who were best informed about TRAC+ were, unsurprisingly, the literacy coaches. In many cases, the role of literacy coach was taken on by staff with other roles, including school directors, teachers, and librarians. Many school directors who were not literacy coaches were found to have only a very general overview of the project; similarly, teachers who were not literacy coaches were mostly familiar with the Interval Test app (which they administered once a month) and were unfamiliar with the *Aan Khmer* app.

Table 27. *Key components and roles in the TRAC+ project*

Benchmark Assessments	Rapid Response System (RRS)	School-Level Implementation
Interval Tests are administered by teachers and/or literacy coaches to identify 'struggling students' (those who fail an Interval Test).	The RRS is implemented to improve the reading of struggling students. This includes: • Literacy coaches assigning peer tutors to supervise the learning of struggling students using *Aan Khmer* and/or materials from the toolkit. • Literacy coaches promoting parental engagement in supporting the learning of their children at home and at school using materials from the toolkit and if possible *Aan Khmer*.	• School directors oversee the implementation of the project but may have limited hands-on involvement. • Teachers work with literacy coaches to administer Interval Tests, identify struggling students, and send them to engage in extra learning activities. • Librarians work with literacy coaches and sometimes teachers to develop learning schedules for struggling students and support them in the library. • Literacy coaches are in fact the lynchpin of the project and work with school directors, teachers, librarians, peer tutors and parents to implement the project. • Peer tutors are selected from Grades 4–6 and trained by literacy coaches on how to use *Aan Khmer* and toolkit materials to support the learning of struggling students. • Parents are informed about their children's learning difficulties by literacy coaches and encouraged to support the learning of their children at home and at school.

Indeed, one fundamental problem found was that many teachers—and even some school directors—who were not literacy coaches were very unclear on the distinction between the Interval Test app and the *Aan Khmer* app. It was noted that when asked about the latter, they often responded with reference to the former. This is most likely because, apart from their initial TRAC+ training, many teachers encounter only the Interval Tests on a regular basis, with the use of *Aan Khmer* left to literacy coaches.

Staff members were generally positive about the initial TRAC+ training they had received, which most described as having lasted three days. They indicated that the training helped them perform their jobs properly. Several literacy coaches and teachers suggested the training could be longer, and refresher training could occur more often. Others wished that training could occur closer to their workplaces.

Interestingly, many staff members indicated that a whole community effort is needed to help improve students' learning, with typical comments as follows:

> It is important that all concerned stakeholders get involved in the implementation of the project in order to make it a success. These include school directors, teachers, literacy coaches, community members, commune council, and parents. (School Director A-1)

> Establishing a good relationship with community members and having them involved in this project is very important to make this project a success. (Teacher A-4)

> I suggest that the school director, classroom teachers, and the literacy coach need to work very closely together to make TRAC+ a success, and those who are already part of the project should not be removed if there is a new project introduced … The school directors establish a strong relationship with community members, making sure that they are well-informed of what is happening in school and especially the learning of children. If there are problems, both school and community members should jointly resolve them. (Librarian C-3)

A number of suggestions were proposed to improve the implementation of TRAC+. One suggestion related to providing more support both financially and technically to literacy coaches to help them perform their roles effectively. It was suggested that literacy coaches should be independent individuals who are not teachers, librarians, or school directors, so they are more available to carry out their responsibilities. Another suggestion was directed toward promoting more engagement of teachers in the project and especially in supporting the learning of struggling students. In this regard, interviewees suggested, more training should be provided to teachers to help them better understand the project and their roles in the project. Some staff thought the impact of the project was limited by the fact that the tablets were only available to a small number of students, and often only for short periods. It was suggested by some that the project ought to be extended to Grades 4–6. A further suggestion to improve the implementation of TRAC+ related to addressing the issue of limited teaching and learning resources in schools. Many believed that more tablets and other learning resources are needed to promote the learning of the children. Furthermore, it was suggested that attention should be paid to addressing issues relating to technological aspects of the app as well as the electricity supply and internet connectivity.

Recommendation: Consider highlighting the need for clear communication and joint coordination among all staff in the implementation of TRAC+, including ensuring that staff members are aware of the differences between the Interval Test and *Aan Khmer* apps. This should include maintaining regular communication about the project, the Interval Test, *Aan Khmer,* the toolkit, and students' use of these. In some contexts, it may be that the involvement of fewer staff would facilitate better communication and coordination.

7.2 Design of Interval Test and *Aan Khmer* apps

The Interval Test *(Figure 36)* is a diagnostic and progress monitoring tool, while *Aan Khmer* is a learning tool. *Aan Khmer* may be seen as an educational project which, in respect of the 3-Level Framework of Mobile Learning introduced in Chapter 4, is linked to a social justice agenda in the sense of making use of available hardware and infrastructure to extend students' learning opportunities.

In line with the research literature about mobile educational apps, it can be observed that students appear motivated and engaged when involved in activities on the tablets. However, although there is evidence of positive responses to the multimedia and gamification elements, there is also some evidence that students are not always clear on the instructions for activities, and may be just playing or guessing rather than responding in such a way as to improve learning.

Figure 36. *Student taking an Interval Test in the school library. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

As might be expected in this kind of educational project, the underlying pedagogies are very traditional. Students are relatively passive in the first listening stage (where they simply repeat sounds) and the final mini-story stage (where they may read along with the sentences in the story), and are only active in the second puzzle stage. The underlying pedagogy is explicit teaching of skills (especially in the first stage) and drill-and-practice (especially in the second stage). While this is common in educational apps, and is not without merit at foundational stages of learning—particularly when students are learning to master specific skills—there are no stages which support any kind of social constructivist pedagogy, incorporating elements like communication and collaboration (e.g., if students were asked to discuss answers or stories), or communication and creativity (e.g., if students were asked to generate their own language). A major disadvantage is that children are not asked to write any letters or words they have been exposed to in the app. There is a strong reciprocal relationship between learning to read and learning to write, and this is not capitalized on within the app, nor is it capitalized on by classroom teachers in terms of building on children's *Aan Khmer* learning.

When asked about improvements to *Aan Khmer*, most teachers, librarians, and literacy coaches stated that the content and approach are already suitable. This may partly reflect the common use of traditional pedagogical approaches in their everyday teaching; and/or their primary focus on the surface-level multimedia and gaming elements rather than the underlying pedagogy; and/or their lack of familiarity with the app, especially in the case of teachers, as they may never have used it themselves apart from their initial training. Common suggestions for content mostly involved adding more of it. However, the bulk of suggestions for improvement were related to navigation of the interface.

It was also observed by some interviewees that there are certain features of traditional Khmer learning that are not well-replicated in the Interval Test and *Aan Khmer* apps. For example, consonants and vowels are traditionally separated in the learning of Khmer, but they occur together in the apps; and students are traditionally taught to say "Letter A," "Letter B," and so on, but in the apps they only encounter "A," "B," etc. It may not be possible to change this, however, given that the apps are in part template-driven, and such alterations could cause issues with timing. It should be mentioned that this issue also occurs with the EGRA and the STAR.

Recommendation: Consider improving *Aan Khmer* by upgrading the navigability, adding more content, building in more communication, collaboration, and creativity, and incorporating a writing component. Some teachers recommended improvements to the mechanics of the interface; for example, there are usually at least two clicks needed to proceed, and it is not always intuitive how to move to the next stage. Other teachers suggested that more content and stories are needed within the app because students may otherwise find themselves repeating the same content over and over. It would be valuable to incorporate more communicative and creative activities which require students to actively produce language, not necessarily within the app itself but perhaps in collaboration around the app, and it would be useful to specifically encourage writing practice.

7.3 Implementation of Interval Test and *Aan Khmer* apps

The Interval Tests were widely perceived as providing teachers with a helpful diagnostic assessment of students' learning, linked to the MoEYS curriculum, and allowing interventions to be made to support struggling students. However, it was extensively reported that they present both administrative and technological challenges.

Administratively, it is often necessary to repeat the Interval Tests three or four times with each grade, because there are not enough devices to test all the students simultaneously in grades that have high enrollments. In TRAC+, schools received between 14 and 21 tablets. It was reported in many interviews that at least one tablet in each school was out of order and could no longer be used. One literacy coach explained:

> There are 17 tablets in this school, but three of them no longer work, making it more difficult to manage them to meet the needs of the children. Also, the test has to be administered several times so students are usually divided into various groups due to the limited number of tablets and this can greatly interrupt the learning of the children. I doubt if it is worth using such technology (the Interval Test app and Aan Khmer app) to help children learn given the problems we have had. (Literacy Coach G-2)

The Grade 3 Interval Tests, which are paper-based, present an even greater administrative burden in terms of manual marking. Some literacy coaches commented that the paper-based test did not help students much, explaining that because they were sitting next to each other, this created an opportunity for students to copy answers from each other easily. Some said it may not be worth administering this test because the results may not be accurate. Tests taken on tablets were viewed as more reliable.

Technologically, it was frequently reported that, apart from tablets which no longer worked, there were issues with a lack of electricity supply and uncharged batteries, potentially affecting use of both the Interval Test and *Aan Khmer* apps. One school director commented on the electricity issue as follows:

> One major problem in my school is that there is an inadequate electricity supply to charge the tablets. In the past, we paid the teachers of Grades 1 and 2 to take the tablets home and charge them. We did this for a year until there was a complaint that I should not allow the teachers to take the tablets out of school and that there was inappropriate management of the tablets in the school. Thus, I decided to collect all the tablets back from the teachers and asked the literacy coach to take care of them. Later, we purchased a mobile battery charger, but it did not provide enough energy to support all 14 tablets. This resulted in an inability to utilize the tablets effectively. To be frank, we haven't used the tablets at all this month. (School Director F-1)

It was found in the survey of school directors that 50% of the TRAC+ schools relied on government electricity, about 29% used a private mini grid, and others used solar systems and batteries. There was an indication that in schools where access to electricity was very limited, the Interval Tests for Grades 1 and 2 were frequently conducted using paper.

Figure 37. *Students taking an Interval Test on tablets in a classroom. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

Moreover, for the Interval Test *(Figure 37)*, a Wi-Fi hotspot connection is required to connect the teacher's tablet to the students' tablets so the test items can be delivered in synchrony, with results subsequently being automatically collated on the teacher's device to provide an overview of answers, and eventually being uploaded to a central server. If the connection fails during the test—which is

not unusual given the low amount of electricity available in some settings—the test must be started again from the beginning. One literacy coach commented on this matter:

> *Often, there was a problem with the Interval Test app, that it stopped working when the test was almost done. I don't know exactly what the problem was… It may have been caused by a poor internet connection. When this happens, the test has to be restarted. Many students have complained about this problem and expressed a feeling of frustration, wanting to leave the classroom. (Literacy Coach G-2)*

While it is difficult to see how this issue can be addressed, it may become less severe in the future as electricity and Wi-Fi access slowly improve.

Further issues exist around the need to standardize test givers' delivery practices, as well as students' test-taking practices. Moreover, the linking of the Interval Tests to *Aan Khmer* may not be structured in the way it was intended—with students not being sufficiently directed to work on particular activities in *Aan Khmer*, and instead choosing whichever sections they wish—and limited use of the latter may be reducing the overall impact of the intervention.

There was considerable variation among schools in the length of time struggling students were able to spend using the toolkits and the *Aan Khmer* app. It is important to note that while the app was intended for struggling students, in many schools it was accessible to all groups of students. For example, it was revealed in the survey that more than 86% of TRAC+ schools opened access to *Aan Khmer* to all groups of learners. The survey indicated that at least 42% of the schools allowed students to use *Aan Khmer* during their break times of 10–15 minutes, 22.5% scheduled library time for students to use the app, 16.3% allocated shift time for students to use the app, and others allowed students to use the app during instructional time.

In schools where *Aan Khmer* was used solely or primarily during the 10–15-minute breaks, it was regularly reported that by the time both the peer tutors and struggling students had arrived and begun work, they often had little time left to focus on the app—perhaps as little as five minutes. Additionally, there was a general concern regarding students using the tablets during their break times, namely, that they often spent too much time playing with the tablets and toolkits, and returned to class very late. One teacher explained the situation as follows:

> *Students often use the tablets during their study breaks which are between 10 and 15 minutes. They enjoy using the tablets because they find them entertaining and often forget that it is time to get back to class. Some students return to class after 30 minutes. This interrupts classroom learning time. I don't think the students should be allowed to access the tablets during the break times. There should be a separate time, for example on Thursday, allocated for using the app. (Teacher B-2)*

In a small number of HU schools where struggling students were taken out of regular classes to work with peer tutors as a kind of intervention activity, it was found that students generally spent far longer working on the *Aan Khmer* app—perhaps up to 40 minutes or even an hour. This would seem preferable in targeting change.

Findings also indicated concern among school directors, literacy coaches, librarians, and teachers regarding safekeeping and management of the tablets in schools. Many interviewees were concerned there is no safe place to keep the tablets, and wondered who should be responsible if tablets get

stolen. Some school directors indicated they did not want to get involved in managing the tablets, fearing that they might be held accountable if something went wrong. At least one report of a stolen tablet was confirmed due to the lack of secure storage at school, and some tablets were damaged from unintentional scratching or dropping. In many schools the tablets are kept in a lockable safe or cupboard (see Figure 21 in Chapter 6), and in others they are taken home or distributed to teachers, literacy coaches, and school directors to manage. Typical comments on this matter included:

> *Initially, there were 15 tablets in this school, but now we have only 13 tablets. One of them was out of order and returned to World Education, and the other one was stolen. In the past, I asked relevant teachers to keep some tablets and charge them, but because of the loss, I decided to collect all the tablets from them and I kept them myself. (Literacy Coach F-2)*

> *Because of security reasons, I can't leave the tablets at school. It occurred in the past that someone broke into the school office to steal some office items. Learning from this, I decided to hand the tablets to each relevant teacher to keep them, and I asked them to give the tablets to their students to use during the breaks. There are 19 tablets in this school, which are distributed to the teachers as follows: I keep four tablets, each of the two teachers of Grade 1 has five tablets, and a teacher of Grade 2 holds five tablets. Therefore, I do not need to go around and pass the tablets to them during the breaks. They already know the number of struggling students in their class and can just hand the tablets to them during the breaks. (Literacy Coach J-2)*

Furthermore, school directors widely expressed their concerns regarding the sustainability of this project, explaining that it would be difficult if their schools were left on their own to continue implementing the project without support from an international organization. In particular, they highlighted that schools do not have the technical and financial capacity to support this project, given that the tablets would require updates and would be costly to maintain. In addition, some literacy coaches who are financially supported by the project said they would have to consider whether to continue in their roles if support ends. Many have heavy workloads, and if they were paid only by commune councils, their allowances would be lower and payments irregular.

Recommendation: Consider delivering the Interval Tests in a more standardized way. Literacy coaches and teachers were observed delivering Interval Tests in very different ways. There were variations in the time spent familiarizing students with the hardware and software prior to commencement of the real test (which is important because regular students may otherwise use the tablets little, if at all). There were also variations in the extent to which questions were asked in a leading way and/or hints and clues were provided; in the time allowed for student responses; and in one case it was even observed that when all the children in a particular group chose the wrong response to a test item, the test giver deleted the results and offered the whole group the chance to redo the question. Moreover, it was observed in several classes that students were sharing answers and otherwise helping each other during the Interval Tests. This undermines the reliability of these tests as diagnostic instruments, limiting the value of the feedback provided to teachers. Greater standardization could be achieved through more training for literacy coaches and teachers.

Recommendation: Consider creating digitized Interval Tests for Grade 3. This would deal with the lack of standardization of timings of test items in the paper test, as well as the time-consuming administrative and marking burden that falls to teachers. It is noted that plans are reportedly in place to digitize the Grade 3 tests.

Recommendation: Consider making a more structured link between the Interval Tests and _Aan Khmer_. In reality, usage of the _Aan Khmer_ app is not as structured as it should be. When students do poorly on a section of the Interval Test, they should be directed to a particular section of the app, but often students just use any part they like.

7.4 Role of school directors

School directors have the responsibility for overseeing the implementation of TRAC+ in their schools, but there was some variation in how hands-on their contact was with the project. Some had only a general overview of the project, with minimal interaction with the literacy coach, librarian, teachers, and parents, admitting they were too busy with their office work and out-of-school duties. One school director commented on the situation as follows:

> _It is hard for me to manage my time to actively engage in this project (TRAC+). Often, I cannot manage to meet with classroom teachers and literacy coaches ... I get stuck in my office all day when there is a lot of work on my table. I have not done a good job with the technical aspects of this project. (School Director C-1)_

However, some school directors were regularly involved in meeting and working with the literacy coach, teachers, parents, community members, and students. These school directors viewed the implementation of the project, and especially the support of struggling students, as a joint effort. One school director shared his involvement in TRAC+ as follows:

> _My involvement in TRAC+ in this school is that I oversee its overall implementation. I am responsible for making sure that Interval Tests are administered according to the testing schedule and that struggling students are identified and supported accordingly ... Basically, I work closely with the teachers, literacy coach, and librarian. When classroom teachers complete lessons that require students to take the Interval Test, they inform the literacy coach and myself. Then, we organize the test for the students. The test allows us to keep track of their learning progress and especially enables us to know which subtests they fail ... After that, we assign the students who fail the test to take extra learning activities (using material from the toolkit and Aan Khmer) ... We work with the librarian to organize the learning schedule for the struggling students. We also organize meetings with parents every one or two months to inform them about their children's learning and ask for their support ... Also, we assign peer tutors to support the learning of the students. (School Director G-1)_

It is important to note that some deputy school directors appear to have more involvement in and understanding of TRAC+ than school directors, given that within the school structure deputy school directors are assigned to supervise teaching and learning.

School directors were particularly positive about having their schools selected for participation in the project, seeing that it would bring more teaching and learning resources to their schools and have a positive impact on the learning of the children. Some school directors indicated it was a joint decision among school-level stakeholders, including representatives of school support committees, to take on TRAC+. They hoped it would change the perceptions of some parents and community members regarding learning and help promote learning achievements. However, some directors indicated they were unsure how their schools had been chosen, suggesting that this may not have been a fully consultative process.

School directors reported that they received training in relation to school leadership and management and especially their roles in the implementation of TRAC+, focusing on the overall objectives of the project, reading benchmarks and assessments, conducting Interval Tests, and ways of helping struggling students with their reading. In general, they found the training helpful. Some suggested that the training should be held more often, at least three times a year, and that it should last longer than three days. Some school directors, especially senior ones, indicated they were still unfamiliar with the use of technology, especially the Interval Test and *Aan Khmer* apps, and were not confident with some technical aspects of the project.

While recognizing the contribution of the TRAC+ project to improving teaching and learning in their schools, many directors pointed out possible improvements. One common response related to building the pedagogical capacity of teachers. For instance, one school director explained:

> *One way to improve the implementation of this project is that more attention needs to be paid to helping teachers improve their teaching capacities through providing them with up-to-date instructional approaches. Teachers use the same ways of teaching which do not have a significant impact on the learning of children. (School Director G-1)*

Other school directors commented that the training should focus on helping teachers develop a good understanding of how to administer Interval Tests, and to use reading benchmarks and *Aan Khmer*. Further suggestions related to the recruiting and training of literacy coaches: school directors suggested the literacy coaches should not be recruited from within the teaching staff at the school; rather, it was stated that the literacy coaches should be independent individuals with enough time to support the implementation of the project and the learning of the children. Another common response related to addressing the shortage of teaching and learning materials, including tablets and toolkits. Some suggested the project be expanded to include Grades 4, 5, and 6.

7.5 Role of teachers

It was widely reported in the interviews that teachers' involvement in TRAC+ relates to conducting Interval Tests, identifying struggling students, sending them to attend extra reading activities, and using learning materials from the toolkit to support activities in their classes. Unless they were also literacy coaches, they generally did not get involved in using *Aan Khmer* to teach struggling students to read, though some were asked to help the literacy coach supervise the students using *Aan Khmer* in their individual classrooms.

Teachers indicated that they were content with the training they had received about their part in the implementation of TRAC+, with a specific focus on how to use reading benchmarks and how to conduct Interval Tests, which were their main responsibilities in the project. They stated that the training helped them perform their roles and assist their students in learning to read. This was a typical comment on this matter:

> *The training helped me perform my job in relation to the implementation of Interval Tests and reading benchmarks. In particular, it helped build up my confidence in using the toolkits, the app (the Interval Test app) and reading benchmarks to teach students to read. (Teacher B-2)*

While they appreciated the value of the Interval Tests as diagnostic tools, and the value of the toolkit and *Aan Khmer* as interventions for struggling students, many teachers found the implementation of some aspects of TRAC+ to be a burden which took time out of their lesson preparation time. This was perceived as a particular challenge in schools with a shortage of teachers, because they were often assigned to take more than one class, and they felt it had a negative impact on the quality of their instruction. Contract teachers sometimes struggled as well, as indicated in the following comment:

> One challenge I faced is that I (as a contract teacher) lacked pedagogical preparation. I found it hard to teach children to read because the way reading is taught these days differs from what I experienced. In this case, I asked for help from other teachers who are good at teaching reading. (Teacher C-5)

Senior teachers indicated that they sometimes struggled with the technology. It was stated in some interviews that teachers who were struggling technologically did not like to speak up about this during initial training, leading to a suggestion that more time could be spent helping less technologically confident teachers try out the apps during training.

Notwithstanding the possible benefits that might accrue from teachers further developing their pedagogical and/or technological skills, the perceived additional burden without effective compensation resulted in a reticence on the part of some to cooperate in the implementation of the project. It was mentioned in many interviews that teachers did not collaborate closely with literacy coaches to administer the Interval Tests or support the follow-up learning interventions for struggling students, leaving the literacy coaches to do the job alone. One school director commented on this issue:

> There is a concern about the lack of involvement of teachers in TRAC+. Some teachers did not carry out the expected responsibilities properly, and did not pay enough attention to helping struggling children learn. They neglected their roles. (School Director F-1)

In some cases, tensions arose between teachers and literacy coaches when coaches approached teachers for help with the administration of the tests and with supporting the struggling students. It is important to note that, unlike the literacy coaches, the teachers were not paid for their involvement in TRAC+.

As indicated previously, the number of tablets available in each school is between 14 and 21, depending on school size. In large classes it is necessary to administer Interval Tests over multiple lessons, which is very time-consuming and interrupts instructional time and children's learning. Unfortunately, it is not possible to change this without more tablets. However, it may be possible to address the issue that the paper-based Interval Test for Grade 3 is particularly time-consuming to administer and mark. There was also a concern that teachers had difficulties using the tablets to administer the tests due to their unfamiliarity with the tests, though they had received some training in this area. This suggests there is a need to train teachers how to administer the tests properly.

As noted earlier, one fundamental problem that emerged frequently in the interviews was that many teachers are very unclear on the distinction between the Interval Test app and the *Aan Khmer* app. When asked about the latter, they often responded with reference to the former. It would be helpful for them to be given clearer guidance on the distinction, and to be encouraged to take a greater interest in how *Aan Khmer* can complement their classroom teaching and their use of the Interval Test app.

Recommendation: Consider ways to provide more opportunities for hands-on use of the tablets during training of teachers, and consider teaching them ways to integrate the children's _Aan Khmer_ activities with other classroom-based activities. Teachers would benefit from more guidance on the technological and pedagogical aspects of the project, and indeed on its administrative procedures. They also would benefit from developing a clearer conception of the distinction between the Interval Test and _Aan Khmer_ apps.

Recommendation: Consider ways to encourage teachers to create more of a feedback loop between the Interval Tests and _Aan Khmer_. For a truly integrated strategy, teachers must consider not only how the Interval Tests determine which students undertake intervention work with the toolkits and _Aan Khmer_ after or outside class, but also how this intervention work might have a bearing on their classroom teaching and their students' classroom performance. While _Aan Khmer_ can be used for independent study, its effective integration into students' learning and TRAC+ in general depends on close teacher involvement. To a large extent, the app was not integrated tightly with any other teaching and learning activities, but rather was used in a decontextualized manner, which is not ideal for promoting learning in young children. More needs to be done to integrate use of the app with other learning activities and materials.

7.6 Role of librarians

Librarians' main responsibilities in TRAC+ include working with the literacy coaches and teachers to administer Interval Tests and support the learning of struggling students, developing library timetables for the students to come and visit, coordinating the work of peer tutors in supporting the struggling students through the toolkits and _Aan Khmer_, helping parents choose appropriate learning materials to support their children at home, keeping records of resources (including toolkits and tablets) in the library, and ensuring the library environment is conducive to learning.

It was widely reported that librarians play a crucial role in supporting the literacy coaches in administering Interval Tests. This is because in many schools the tablets are placed in the library during the day for students to use. Moreover, librarians work closely with the literacy coaches to organize learning schedules for the students and support their learning. In many cases, librarians are informed of the number of struggling students from each grade, the learning activities assigned to them, and the names of the supervising peer tutors. Once they have all the necessary information, librarians can create a timetable for the learning of struggling students, and ensure the toolkit and tablets are available for them. Some librarians go beyond this to assign learning activities they consider more suitable for the students' needs and levels. One experienced librarian explained the situation as follows:

> _I am actively involved with the TRAC+ project. My main responsibility is to help struggling students learn to read using Aan Khmer and especially materials from the toolkits. These students are in Grades 1, 2, and 3 … Basically, I am given a list of students who failed the test and the games (learning activities) that they need to play with. Often, I find that the assigned game is far too difficult for the students to learn. In this case, I have to change the game to suit their actual learning ability. However, I need to find out what the problem is. I ask them to take a written test in the library so that I can identify their problem. Based on the result, I assign a new learning activity to them. (Librarian C-3)_

Some librarians reported that they helped parents of struggling students select suitable learning materials for their children to use at home and even worked with some parents to help children learn at school during the study breaks. However, the number of parents involved in this way was very small.

Overall, librarians felt very positive about TRAC+ due to the fact that there were additional resources in their libraries, and that their libraries were to some extent beginning to function as hubs of digital and game-based learning. Through the Interval Test results, librarians could offer targeted help to struggling students, as one pointed out:

> One positive experience with TRAC + is that students have to take Interval Tests which enable us to monitor their learning progress better. It is not a guess but a scientific way of measuring learning progress. This allows us to find a way to help students with learning difficulties effectively and on time. (Librarian C-3)

In schools where all groups of students were allowed to access *Aan Khmer*, there was some indication that regular students—those with no particular reading difficulties—may have benefited from using the app even more than the struggling students. One librarian from such a school made the following comment:

> My observation is that regular students appear to have benefited more from the toolkit and the tablets than the students with reading difficulties. This is because the struggling students usually use easy games and they keep playing the same games over and over, while regular students often try different games, especially the more difficult ones. For example, games relating to complicated words and sentences (mini-stories) are often played by regular students and this means that they can strengthen their reading ability. Easy games such as lotto and basic consonant and vowel games are used by the struggling students. It seems that they do not learn much from the games. Importantly, those struggling students are not really focused on their learning activities. They just play around. (Librarian B-3)

While overwhelmingly optimistic about TRAC+, the librarians raised several issues regarding its implementation. One main concern was that some librarians had taken on additional roles as literary coaches or teachers, making it hard for them to find a balance between their roles, and constraining their ability to perform their jobs as librarians. This problem could be critical for new librarians with limited training and experience. Further issues existed around a lack of communication among librarians, teachers, literacy coaches, and school directors in coordinating and monitoring the learning of struggling students. The following example was given by one librarian:

> Each peer tutor was assigned to help a number of struggling students on a scheduled basis. They followed their assigned schedules. The practice was that the peer tutors had to be present at their assigned times even if no students showed up. As the librarian, I could do nothing if a classroom teacher and literacy coach did not send struggling students to the library. Once again, to make this project a success, it is important that teachers, the literacy coach, librarian, and school directors work collaboratively. I am very happy to do my best to assist those students to learn to read. I have a number of ways to help them. (Librarian C-3)

In general, librarians were content with the training they received because it helped them perform their jobs better, including learning new ways of managing the library and helping children learn to read. There was considerable variation, however, in the amount of training the librarians in the study had received. While most had received training for their roles as librarians as well as their specific roles in TRAC+, some newly appointed ones were not well informed about the expectations for their participation in the project. Some librarians were not able to provide sufficient support to struggling students who visited the library, and some failed to communicate with literacy coaches and teachers about students' learning. Furthermore, it was reported that there were frequent changes of librarians in some schools, and this created difficulties in finding replacements and then helping them familiarize themselves with their roles in the project.

7.7 Role of literacy coaches

Literacy coaches play a pivotal role in TRAC+. They are essentially the lynchpin of the project in each school, with a key coordinating position. The dedication of the staff members who have taken on this role is apparent. They may have a number of responsibilities in the project, ranging from administering Interval Tests to dealing with parents of struggling students. One literacy coach in the study accurately described the roles and responsibilities as follows:

> I work with the teachers of Grades 1–3, keeping them informed of the Interval Test schedule and asking for their cooperation in administering the test. We identify struggling students based on the test results and we provide them with support accordingly. Basically, I inform the parents of struggling students about the learning of their children and ask them to borrow learning materials from the library to support their children at home. I sometimes organize a meeting with them at school. At the same time, I print out the names of the students and share them with their teachers and the librarian so that they know about this and help them out as they are supposed to do. I also give the names to peer tutors in order for them to support the learning of these students during the second study breaks … During the breaks I go around and ask the peer tutors to come and help the students in the library. The problem is that these students sometimes do not show up and in this case I have to go and find them.

When they are ready to start working on the tablets it is about time to resume the classroom learning because the break is only 15 minutes ... Actually, we also allow them to use the tablets in some classroom hours, for example, social science ... I sometimes help my students use learning materials in toolkits which are left in each classroom. (Literacy Coach J-2)

It is clear from the above quote that one major responsibility of literacy coaches can be the adminis-tration of Interval Tests, which take place once a month. This is often realized through working with classroom teachers and librarians to organize the tests, identify struggling students, and support their learning. Literacy coaches reported considerable variation in how much support they gave to the students. Some assigned learning activities and peer tutors, and then left it to the librarians to manage the learning schedules. Others went beyond this to closely watch and support students using *Aan Khmer* and toolkit materials. There was also variation in how often they were directly involved in supporting the learning of struggling students, ranging from around two to five times a week. It was apparent that many literacy coaches paid more attention to helping students from Grades 1 and 2, leaving Grade 3 students to be supervised by peer tutors and in some cases to work on their own. They indicated that they often spent more time helping students at the beginning of the school year because peer tutors were still learning their jobs.

Figure 39. *Peer tutor working with a student under direction of the literacy coach, using toolkit resources and the Aan Khmer app. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

In addition, literacy coaches are responsible for recruiting and training peer tutors to supervise the learning of struggling students. While there was variation in how they trained peer tutors to take up this role, the focus was often mainly on familiarizing them with *Aan Khmer* and the toolkit materials, and explaining that they should not use any punishments with the students under their supervi-sion. There was little or no emphasis on the pedagogical aspects of the peer tutors' roles. Literacy

coaches widely agreed that peer tutors play a crucial role in supporting the implementation of TRAC+. Some viewed peer tutoring as a win-win strategy for both peer tutors and students, explaining that peer tutors not only support the learning of struggling students, but also improve their own reading in the process *(Figure 39)*.

Nevertheless, some literacy coaches indicated that the involvement of peer tutors in TRAC+ remained limited, further elaborating that some peer tutors were not very actively involved in the project and others did not carry out their roles as expected. Some literacy coaches explained that the lack of involvement of peer tutors was partly due to classroom teachers who often did not send them as scheduled to support the struggling children.

> Some viewed peer tutoring as a win-win strategy for both peer tutors and students, explaining that peer tutors not only support the learning of struggling students, but also improve their own reading in the process.

Another important responsibility of literacy coaches relates to engaging community members and especially parents of struggling students in supporting their children's learning. Literacy coaches reported that they informed the parents of the students with reading difficulties about the progress of their children and ways of supporting them through both written and verbal communication. They often invited the parents to attend a meeting at school, updated them with their children's test results, and encouraged them to borrow learning materials. Many reported that while the number of parents attending school meetings increased, few parents took the opportunity to borrow learning materials to help their children at home, and even fewer parents came to help children at school. It was a challenge to engage parents in supporting the learning of their children due to poverty levels, limited literacy skills, and busyness with work. One literacy coach explained:

> It is very difficult to ask some parents to come to school and even more difficult to ask them to borrow learning materials from the toolkit to help their children at home. I have to emphasize to them many times the importance of using these materials to support their children. Many parents did not want to borrow learning materials from school to support their children at home because they were afraid that they might damage the materials and that they would be asked to pay for the damage ... Some parents are illiterate and they don't know how to use the materials to support their children (Literacy Coach G-2)

Some literacy coaches visited the parents of struggling students at home, especially those living in distant communities and those with limited involvement in schools. The purpose of such visits was again to inform parents about the learning of their children and seek their support. Some brought learning materials from the toolkits when visiting the parents, hoping to lend these to them after explaining how they could help in the learning of their children. One literacy coach shared her experience as follows:

> I organize meetings with parents of struggling students at school, and I visit those who did not come to the meetings. I bring along learning materials when I go to see them. I teach them how to use the materials and encourage them to borrow them to support the learning of their children at home ... I also talk to them about what has been happening in school, especially relating to the learning of their children, and what they could do to help their children learn. (Literacy Coach C-2)

Literacy coaches said they had received training for their roles before and after starting their jobs. There was considerable variation in the number of training sessions they had received, depending on the length of their service. Training sessions, they said, had lasted from one to three days, with a primary focus on orienting them to their responsibilities in TRAC+ and the implementation of the Interval Tests and *Aan Khmer*. One literacy coach stated:

> *The training lasted three days, with the first two days focusing on the theoretical aspects of the Aan Khmer app and Interval Test app and the last day focusing on the technical aspects. They (trainers) showed us how the tablets worked, including how to turn them on and off, how to adjust the sound, how to start the apps, and how to use the apps. They also taught us how to conduct Interval Tests. (Literacy Coach A-2)*

There is also follow-up training once a year before the start of the school year, which involves reviewing the responsibilities of literacy coaches, how to use the tablets, and issues of concern, along with an overview of the progress of the TRAC+ project. While acknowledging the usefulness of the training they received, many literacy coaches indicated it was too short, allowing limited time for them to grasp the content. Some admitted they were not able to understand some parts of the training.

It became apparent in the interviews that some literacy coaches lacked knowledge of the technology and especially how to use the Interval Test and *Aan Khmer* apps. Some new literacy coaches, especially those with less than one year of experience, had received limited training, while others did not receive any training, hampering their ability to deliver the expected results. Among the more experienced literacy coaches, some senior staff members were still unfamiliar with the technology. One senior literacy coach shared her experience:

> *I am not familiar with using the Interval Test app and Aan Khmer app. In particular, I do not know how to use the app to support the learning of the students … Also, I do not know how to connect the tablets to the internet (Wi-Fi). (Literacy Coach F-2)*

Many literacy coaches expressed frustration when they encountered problems in their jobs and did not know how to approach them, though they were able to contact staff from World Education for help.

A fundamental issue with TRAC+ is that the literacy coaches are paid a low stipend (and on an irregular basis if it is paid by the commune council), which led many to resign early in the project, and has discouraged others from taking on such a role. The result is that often a school director, teacher, or librarian is taking on the literacy coach role as an additional, paid set of responsibilities. Some school directors indicated they had struggled to find someone to fill the role, elaborating as follows:

> *It is too much for a literacy coach to handle all the work of TRAC+ in this school, given the number of students we have. I requested two literacy coaches for this school so they could help each other. When there was only one literacy coach, he had to work till 12 or 1 p.m. (instead of finishing the morning shift at 11 a.m.). He once came to me to resign from this job because he could no longer take it … I encouraged him to continue in his job for the sake of the children. (School Director C-1)*

> *One of the problems we face in implementing TRAC+ in this school relates to recruiting a literacy coach. No one was interested in the job when we announced it, due to the poor remuneration. One of our teachers volunteered to take on the job because he wanted to help the children learn. This is a sacrifice. (School Director D-1)*

It was widely indicated in the interviews that the literacy coaches who are associated with another position have struggled to find a balance between the two. In particular, they were unable to manage their time to support students with learning difficulties. One literacy coach who also teaches Grade 6 shared his experience:

> *If I have to carry out all the responsibilities required for a literacy coach, it may not be possible given that I am also a classroom teacher and that I have some family business to attend to. As the literacy coach, for example, I am supposed to provide full support for struggling students, but I do not have enough time to do so because I have other responsibilities to fulfill and the financial support for the work is very limited. Actually, I have tried my best to allocate some of my time for this work. (Literacy Coach D-2)*

Another literacy coach who holds two additional roles as the deputy school director and librarian in a remote school added:

> *I don't have enough time to support the learning of struggling students. I work as the deputy school director, librarian and literacy coach. I have a lot of work to handle. Often, I do not submit my report to World Education on time because I have to complete other reports including PB (program-based budgeting) and SIG (school improvement grant). I asked the teachers of Grades 1 and 2 to take over this role (literacy coach), but no one was interested. Actually, I did not want to take on this role either, but the school director strongly encouraged me to take it on. I am really tired of carrying so many responsibilities. (Literacy Coach F-2)*

In brief, because of its centrality to the project, the role of literacy coach should be better recognized; at the same time, those in this role should be invited to take on slightly more responsibility for clarifying certain aspects of TRAC+ to their colleagues, and further structuring and standardizing the implementation of the project. In particular, literacy coaches could be asked to provide more training and support to peer tutors as the latter engage in guiding struggling students' learning.

Recommendation: Consider ways to clearly recognize the commitment of the school staff involved with the project. In the current setup of the project, it is important to recognize the commitment of the literacy coaches, many of whom have taken on the role in addition to their existing duties, and for a relatively modest financial reward. Given that it is often difficult to find individuals to take on the literacy coach role—and given that it may not be possible to increase stipends, or indeed maintain them at current levels in the future—an alternative would be to divide their roles among librarians and Grades 1–3 teachers, resulting in less work for each individual and perhaps facilitating greater communication and coordination. Indeed, the presence of literacy coaches may be one of the reasons for the limited involvement of teachers in many schools. Nonetheless, dividing literacy coaches' roles among other staff would certainly have workload implications for those involved, and it would be important to recognize the commitment of these staff members to their roles.

7.8 Role of peer tutors

The peer tutors support the work of the literacy coach in each school. Generally from Grades 4–6, these students have been identified based on their strength in reading and their reliability, with some schools nominating students, and others seeking volunteers. In some cases, where a school has two shifts, these older students who would normally attend in the afternoon must attend in the morning

to help the younger students. Sometimes, peer tutors set up appointments with the students they are assigned to supervise after school hours outside the school.

Peer tutors are trained by the literacy coaches on how to use the toolkits and the tablets, including tips for helping younger students; for example, they are typically told not to use any punishments with younger students, but to be as encouraging as possible. However, there was little evidence of any pedagogical training in how to support or guide younger students, rather than simply correcting them or providing answers for them *(Figure 40)*. For example, as one literacy coach explained regarding the training she provides to peer tutors:

> *Well, I did not give them much advice or help. I asked them to come to the library and helped them understand the app and the games. After the demonstration, I asked them to play with the app and toolkits so that they could become familiar with them. Then, they are ready to go out and help younger students. (Literacy Coach A-2)*

Figure 40. *Peer tutor guiding a student to choose correct answers in the Aan Khmer app. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

While the capability to teach—that is, to explain to, rather than correct, younger students—should ideally be part of their skill set, it is recognized that even with training this would be difficult for peer tutors who themselves are still quite young. At the same time, being placed in a mini-teaching role could have benefits for the peer tutors' own literacy skills.

There was variation in how often peer tutors worked with struggling students. In some schools, peer tutors might work with the students two or three times a week, and in other schools they might supervise the students up to six or seven times a week. In any given session, they might supervise one or more struggling students. Some peer tutors reported that struggling students preferred to work with the toolkits as they found *Aan Khmer* difficult to use. They said that it was often difficult to get Grades 1 and 2 students to follow instructions, with the younger students wanting to just play, using sections of the app other than those set for them, guessing answers in the app, or copying answers from peers.

It was reported by some peer tutors that they received limited training on how to use *Aan Khmer* and the toolkit to support struggling students, and that they had difficulty understanding some complicated activities in *Aan Khmer*, including long sentences and some mini-stories. Some admitted they found it challenging to explain these to struggling students (Peer Tutors Focus Group N-6). These issues not only hampered their ability to fulfill their roles, but demotivated them somewhat.

One major problem with peer tutoring raised in the interviews was that it could be difficult to manage peer tutors and keep them active in their roles after a period of time. A certain number of peer tutors were usually recruited and trained at the beginning of the school year to support the learning of struggling students, depending on the perceived needs of the school; however, very often only a small number continued to engage in their work after a few months and it was not easy to find replacements, adding more work for other peer tutors. One literacy coach stated that: "we recruited about 25 peer tutors to guide struggling students; however, only seven or nine of them actually do a proper job" (Literacy Coach D-2).

A further issue with peer tutoring is that it normally takes place during the study breaks for about 10–15 minutes, which does not allow enough time for peer tutors and students to complete the assigned tasks properly. Moreover, younger students frequently wanted to eat snacks or play with their classmates during these breaks and did not show up, or showed up late, for their scheduled appointments, with peer tutors often having to take time to go and look for the students assigned to them. The role of peer tutors was simpler when, as in some schools, meetings took place during class time rather than break time, so that absenteeism was not an issue, and they could work with struggling students for longer periods.

Many interviewees said there was limited space for peer tutoring to take place, and it was frequently interrupted by other students. Survey responses indicated the library was the most common place for students to use *Aan Khmer* (41.6% of the time), followed by a classroom (28.3%), and the playground (16.9%). Several school directors and literacy coaches suggested a separate space for struggling students to engage in their extra learning activities so that peer tutors and literacy coaches would be able to support them better and without interruptions or disturbances.

Recommendation: Consider providing peer tutors with training on how to guide struggling students. The peer tutoring sessions were observed to be largely silent, with little verbal communication between students. Peer tutors were seen pointing struggling students to the correct answers on many occasions, and even answering for them. In some cases, struggling students appeared not to fully understand the instructions and/or the content. It is essential that peer tutors receive training, most likely from literacy coaches, on how to guide and explain, rather than answering on behalf of struggling students. Moreover, wherever possible, peer tutors should only supervise one struggling student at a time. Peer tutors are still young themselves and many are already having difficulties with their guiding roles.

7.9 Role of parents

One major aim of TRAC+ was to involve community members and especially parents of students with learning difficulties in supporting children in learning. This was promoted through organizing school/parent meetings and visiting parents at home. In general, the literacy coach at each school sent a letter to invite the parents of struggling students to attend a school meeting following the identification of these students. Through this meeting, the literacy coach, sometimes accompanied by the school director or a teacher, informed the parents about their children's learning, and introduced learning support materials from the toolkit and/or *Aan Khmer*.

Parents were encouraged to borrow materials to work with their children at home. Some parents took up the offer to borrow materials from the toolkit, while a few even had the *Aan Khmer* mobile app loaded onto their own smartphones (though it currently lacks a responsive design and may be difficult to read on smartphone screens). A small number came to school to help the children with their learning during the study breaks. One librarian described parental involvement at school as follows:

> Some parents come to help their children at school. Last year, five parents of children came to help students learn to read in the library during the study breaks. They used the toolkit to help them. A few parents came to borrow the tablets to help their children at home, but we did not lend the tablets to them for security reasons. Also, some parents had the app installed on their smartphones so that they could support their children's learning at home. However, not many parents own a mobile device. (Librarian A-3)

In some schools, however, it was in fact possible for parents to borrow tablets to take home and support their children's learning overnight, picking up the tablets in the evening and returning them in the morning.

Several parents indicated they helped their children learn to read and write at home. Some parents did this once or twice a week while others did it almost every day. Some parents with busy schedules and/or limited education tended to leave their children on their own, while others relied on older children in the family to support younger ones. Furthermore, many parents kept in regular contact with their children's classroom teachers to maintain an overview of their learning and intervene when needed. One parent of a Grade 2 student explained:

> I have noticed that my son has improved in his reading. Earlier this year, he was not able to read properly and he can read better now. His teacher has informed us about his studies and asked us to help him with his learning at home. I help him learn to read when I am home, especially after my business hours. I am busy. I manage to help him a few times a week and each time lasts about 20 minutes. Sometimes my husband helps him out a few times when I can't manage it. (Parent C-9)

When asked if they knew about the existence of TRAC+ and *Aan Khmer* at school, most parents said they had not been informed about it. When they were presented with the *Aan Khmer* app and shown how it works, many displayed significant interest in the app, asking if they could have it installed on their mobile devices. They seemed to believe it could be of help with their children's learning.

Overall, while recognizing that parental involvement in education has increased in recent years and that parents play an important role in improving the learning of their children, school directors, teach-

ers, librarians, and literacy coaches conceded that such involvement remains limited. Some parents never attended any school meetings and knew little about what was happening in school. In the survey, 28.8% of school directors indicated that parents never came to school to watch or help their children learn with *Aan Khmer*, 45.2% stated that parents rarely came to school, 24.7% said that parents sometimes came to school, and only 1.4% reported that parents frequently came to school to participate with their children.

Several factors leading to a lack of parental involvement were identified in the interviews. The first relates to poverty. Cambodia is one of the poorest countries in the world, ranking 143 out of 188 countries in the Human Development Index (UNDP, 2016), with 18.9% of its population living in poverty, meaning they earn less than USD $1.25 per day (Ministry of Planning, 2014). It was apparent in some settings that poverty has constrained parents' engagement with their children's education. Due to their poor economic circumstances, many parents were unavailable for school meetings and were frequently not at home to support the learning of their children. One literacy coach from a disadvantaged school made the following comment:

> *Many students in this school—it could be more than 60% of the school population—have problems with their learning, especially reading ... One major influence relates to the low economic situation of their parents. Most parents in this community rely on subsistence agriculture and they do not have time to get involved in supporting the learning of their children. Often, they go farming somewhere out of the community and stay there for 10 to 15 days. Some bring their children with them when going farming. These children are mainly in Grades 1 and 2 because they are still very young and need to be taken care of, so they are taken away with their parents ... Only a small number of Grades 1 and 2 students usually show up in class during farming season. (Literacy Coach F-2)*

A second factor commonly mentioned in the interviews was parental migration. While there are several reasons why Cambodians migrate, the reason stated most often in the interviews was a search for employment opportunities. Some parents left their children at home with relatives. This could lead to irregular attendance at school, possibly resulting in poor learning achievement and even dropout. For example, one literacy coach indicated that children whose parents were not around were often absent from school and showed little progress on their Interval Tests (Literacy Coach J-2).

A third factor frequently mentioned was the low educational attainment of many parents. The Ministry of Planning (2012) reported that the adult literacy rate in Cambodia was approximately 77% in 2010, being highest in Phnom Penh and other urban areas. Literacy levels in rural and remote areas are thus lower than in urban areas. This was evident in interviews where some parents from disadvantaged settings were found to have low education levels and to be unable to provide much home support for their children's learning. Like-

> Some parents from disadvantaged settings were found to have low education levels and to be unable to provide much home support for their children's learning. Likewise, some guardians, notably grandparents, admitted they were unable to support children's learning due to their own limited educational backgrounds.

wise, some guardians, notably grandparents, admitted they were unable to support children's learning due to their own limited educational backgrounds. Literacy coaches commented on the situation as follows:

> *About 50–60% of invited parents came to attend school meetings. In the past, many parents attended the meetings, but the number has decreased over time. This is because many parents are minimally literate and said they did not know how to help their children. Some parents migrated to the city or Thailand, leaving their children with the grandparents to take care of ... The problem is that many grandparents do not know how to read and write, and when their grandchildren asked them for help with their learning, they could not provide any. That was the reason many of them stopped attending school events or meetings. (Literacy Coach O-2)*

> *Some parents do not understand the value of education, paying less attention to the learning of their children. Whenever I invite them to a school meeting, they never show up. It is really difficult to get them to come to school for a meeting ... I am the one who goes out to invite parents to attend a school meeting and I feel really pressured when I have to do so. Some parents even said that education is not important. However, I kept inviting them again and again, and some of them eventually came to a meeting. (Literacy Coach F-2)*

7.10 Views of struggling students

Struggling students, as noted in Chapter 2, are students in Grades 1–3 who fail one or more subsections of the Interval Test and are assigned extra learning activities using the toolkit or *Aan Khmer*. Literacy coaches reported that students from different grades performed poorly in different subsections of the test. One commented as follows:

> *Struggling students in different grades failed different subsections of the Interval Test. In general, Grade 1 students are often poor in recognizing letters and syllables, Grade 2 students generally fail the subsection on reading comprehension ... and Grade 3 students do not perform well in the subsection on reading sentences. (Literacy Coach K-2)*

Although struggling students were assigned to use materials both from the toolkit and *Aan Khmer* to improve their reading skills, they made more use of the former than the latter. There was a great deal of variation in the number of times students used *Aan Khmer*, ranging from one to six times a week, depending on the school context. It appears the students in smaller schools had more opportunities to use *Aan Khmer* than their counterparts in larger schools, as tablets were more readily available to them.

Aan Khmer was the only m-learning reading app that students used at school, though some also used it at home. Approximately 37% of school directors reported in the survey that at least some parents had the *Aan Khmer* app installed on their own mobile devices to support their children's learning at home; and, as mentioned earlier, some schools allowed parents to borrow tablets overnight. Other students used *Aan Khmer* at home because their parents were school directors, teachers, librarians, or literacy coaches who took the tablets home for safekeeping.

Struggling students said using *Aan Khmer* helped improve their reading and complemented their classroom activities in relation to sounds, consonants, and vowels. However, as with school direc-

tors, teachers, and peer tutors, there was some confusion as to the distinction between the Interval Test and *Aan Khmer* apps; students were unclear about their differing and distinct purposes. One unexpected finding was that some students said they preferred using the Interval Test app to the *Aan Khmer* app, possibly seeing the former as being more like a game with a score (despite the inclusion of certain gamification elements in the form of puzzles in *Aan Khmer*).

As discussed earlier, it was sometimes difficult to get struggling students to pay attention to their assigned activities during school breaks, because they wanted to eat or play with their classmates. This caused inconvenience for peer tutors and literacy coaches, as one coach commented:

> *Many peer tutors are in Grade 5 and their study breaks are after those of students in Grades 1 and 2. The students go and play with their friends during study breaks and this is a challenge for peer tutors because they have to go and look for the students they are going to supervise. As the literacy coach, I have to help them look for those students. (Literacy Coach O-2)*

It was widely reported by literacy coaches, teachers, and peer tutors that some students experienced difficulties with the instructions on how to use the *Aan Khmer* app, often just wanted to play with it, and sometimes even exited the app or switched off the tablet accidentally. One peer tutor commented:

> *It is difficult to teach younger students to learn to read using the tablets because they do not pay enough attention to their assignment and they find it difficult to follow the instructions. For example, I asked them to play their assigned game, but they ignored my instructions. They just wanted to play any games that they liked ... Some students seemed lazy. They did not want to play the game at all. (Peer Tutor B-3)*

Interviewees occasionally mentioned that the accents heard in the Interval Test and *Aan Khmer* sounded different from those of local people, making it harder for students to understand. Students also found the time allowed in the timed Interval Tests very limited, reporting that they could not complete all the test sections; and, similarly, there was an indication in the interviews that some learning activities in *Aan Khmer* were difficult for students to complete, with students not being able to keep up with the reading speed of the app, leading them to become somewhat demotivated. Typical comments included:

> *Some learning activities in Aan Khmer can be far beyond the learning ability of many students. It can be fine for those few outstanding ones ... For example, during learning activities involving consonant-subscript combinations—which are often presented in long sentences—it can be really difficult for the students to keep up with the reading speed. This can discourage them from learning. I think the activities should be broken down into shorter ones, allowing the students enough time to practice. (Literacy Coach D-2)*

> *Some learning activities in Aan Khmer can be too hard for some struggling students to complete and this can discourage them from learning. These students are often from low socio-economic backgrounds and their parents pay less attention to their education. Some of them are not around. (School Director M-1).*

Recommendation: Consider introducing *Aan Khmer* only in Grade 2. It may not be effective for students in Grade 1 to use the app as they may lack the necessary foundational skills to learn from it. The EGRA scores in Grade 1 would also suggest that these students gained limited benefits from its use.

Figure 41. *Student taking an Interval Test in a classroom. Photo by Mark Pegrum, 2017. May be reused under CC BY-SA 4.0 license.*

7.11 Scalability and sustainability

Given the generally positive responses of staff, students, and parents to TRAC+, it is important to consider future scalability and sustainability. The following recommendations emerge from the data collected, as reported both in Chapter 6 (focusing on quantitative data) and Chapter 7 (focusing on qualitative data).

Recommendation: Consider incorporating responsive design into the *Aan Khmer* app. Currently, the app does not reformat itself for different-sized screens, and some text is unreadable on smartphones. It should be based on a responsive design which automatically configures itself for different devices, even if there is a recommended minimum screen size. There are reportedly plans in place to do so.

Recommendation: Consider making the *Aan Khmer* app available in Google Play. Rather than needing to be manually installed, the app should be made available in Google Play. It would be easier for teachers and parents to download and experiment with it, helping to scale up its use. There are reportedly plans in place to do this, once the app size has been reduced to fit within the Google Play size limit.

Recommendation: Consider balancing the current investment in digital technologies with more investment in analogue resources such as books. While small improvements have been seen in early grade students' literacy skills, overall levels remain low. This makes any incremental improvements insufficient. Moreover, even when tablets are supplied, there are issues with electricity, connectivity, and maintenance. Given the results of the multiple regression analysis—which show beneficial effects from students being allowed to borrow library resources and from being taught in multi-grade classes—it may be worth exploring whether a wider range of strategies, in combination, could make the project more effective. This could, in turn, contribute to its scalability and sustainability.

■ ■ ■

8. Implications and Recommendations

The quantitative results of this study, obtained from the EGRA and STAR instruments, indicate that there may have been small but significant improvements in most aspects of reading for Grade 2 and especially Grade 3 children in schools in which there was higher use (HU) of the *Aan Khmer* app as compared to schools with lower use (LU) of the app. It should be stressed that the low results of Grade 1 students in both HU and LU schools may be partly attributable to the insufficient sensitivity of the EGRA test. However, these test results should be viewed with a degree of caution as there were many limitations in the study, particularly the quantitative parts, as detailed in Chapter 9 of this report. Multiple regression analysis showed that many factors apart from the use of the app influenced the EGRA results, with the strongest predictors of higher results being: children being permitted to take library books home, and schools having multi-grade classrooms. Thus, it cannot be claimed that use of the app was the only factor that might account for higher EGRA and, in some cases, STAR scores.

Qualitative findings indicate that TRAC+, including its m-learning component, was viewed positively by many school directors, teachers, librarians, and literacy coaches, as well as struggling students themselves. Nevertheless, it is apparent that TRAC+ was not running as intended in many instances, and major challenges surfaced in the School Director Survey and the interviews. These included issues with the design of the app, and the structural links between the use of the Interval Tests and the *Aan Khmer* app. More staff training was needed, including clarification of the distinction between the Interval Tests and *Aan Khmer*, and more systematic cooperation was required between classroom teachers and literacy coaches in seeking to monitor and consolidate students' learning. Students in many schools only accessed *Aan Khmer* briefly during break times, and played random games rather than their assigned games on the tablets. Peer tutors faced difficulties in having struggling students follow their instructions and often provided answers rather than guiding the learning of the students under their supervision. Despite the best efforts of literacy coaches and other staff, there was limited parental and community involvement. The resourcing of TRAC+ was also limited, in terms of hardware, connectivity, and sometimes electricity supply, but also in terms of the pivotal literacy coach positions which were often difficult to fill in view of the low stipends received for taking on multiple responsibilities.

Because of the challenges identified in the qualitative components of the study, it is perhaps not surprising that literacy learning through use of the *Aan Khmer* app appeared limited. If the issues with implementation could be addressed, and the app modified in some regards, it is possible that increases in children's literacy levels through the integration of m-learning could be enhanced. To this end, a list of key recommendations has been extracted from Chapter 7 and is presented below.

The following are our key recommendations for the improvement of the m-learning aspects of TRAC+.

RECOMMENDATION ON NATURE OF TRAC+:

Recommendation 1: Consider highlighting the need for clear communication and joint coordination among all staff members in the implementation of TRAC+, including ensuring that staff members

are aware of the differences between the Interval Test and *Aan Khmer* apps. This should include maintaining regular communication about the project, the Interval Test, *Aan Khmer*, the toolkit, and students' use of these. In some contexts, it may be that the involvement of fewer staff would facilitate better communication and coordination.

RECOMMENDATION ON DESIGN OF AAN KHMER APP:

Recommendation 2: Consider improving *Aan Khmer* by upgrading the navigability, adding more content, building in more communication, collaboration, and creativity, and incorporating a writing component. Some teachers recommended improvements to the mechanics of the interface; for example, there are usually at least two clicks needed to proceed, and it is not always intuitive how to move to the next stage. Other teachers suggested that more content and stories are needed within the app because students may otherwise find themselves repeating the same content over and over. It would be valuable to incorporate more communicative and creative activities which require students to actively produce language, not necessarily within the app itself but perhaps in collaboration around the app, and it would be useful to specifically encourage writing practice.

RECOMMENDATIONS ON IMPLEMENTATION OF AAN KHMER & INTERVAL TESTS:

Recommendation 3: Consider delivering the Interval Tests in a more standardized way. Literacy coaches and teachers were observed delivering Interval Tests in very different ways. There were variations in the time spent familiarizing students with the hardware and software prior to commencement of the real test (which is important because regular students may otherwise use the tablets little, if at all). There were also variations in the extent to which questions were asked in a leading way and/or hints and clues were provided; in the time allowed for student responses; and in one case it was even observed that when all the children in a particular group chose the wrong response to a test item, the test giver deleted the results and offered the whole group the chance to redo the question. Moreover, it was observed in several classes that students were sharing answers and otherwise helping each other during the Interval Tests. This undermines the reliability of these tests as diagnostic instruments, limiting the value of the feedback provided to teachers. Greater standardization could be achieved through more training for literacy coaches and teachers.

Recommendation 4: Consider creating digitized Interval Tests for Grade 3. This would deal with the lack of standardization of timings of test items in the paper test, as well as the time-consuming administrative and marking burden that falls to teachers. It is noted that plans are reportedly in place to digitize the Grade 3 tests.

Recommendation 5: Consider making a more structured link between the Interval Tests and *Aan Khmer*. In reality, usage of the *Aan Khmer* app is not as structured as it should be. When students do poorly on a section of the Interval Test, they should be directed to a particular section of the app, but often students just use any part they like.

RECOMMENDATIONS ON ROLE OF TEACHERS:

Recommendation 6: Consider ways to provide more opportunities for hands-on use of the tablets during training of teachers, and consider teaching them ways to integrate the children's *Aan Khmer* activities with other classroom-based activities. Teachers would benefit from more guidance on the technological and pedagogical aspects of the project, and indeed on its administrative procedures. They also would benefit from developing a clearer conception of the distinction between the Interval Test and *Aan Khmer* apps.

Recommendation 7: Consider ways to encourage teachers to create more of a feedback loop between the Interval Tests and *Aan Khmer*. For a truly integrated strategy, teachers must consider not only how the Interval Tests determine which students undertake intervention work with the toolkits and *Aan Khmer* after or outside class, but also how this intervention work might have a bearing on their classroom teaching and students' classroom performance. While *Aan Khmer* can be used for independent study, its effective integration into students' learning and TRAC+ in general depends on close teacher involvement. To a large extent, the app was not integrated tightly with any other teaching and learning activities, but rather was used in a decontextualized manner, which is not ideal for promoting learning in young children. More needs to be done to integrate use of the app with other learning activities and materials.

RECOMMENDATION ON ROLE OF LITERACY COACHES:

Recommendation 8: Consider ways to clearly recognize the commitment of the school staff involved with the project. In the current setup of the project, it is important to recognize the commitment of the literacy coaches, many of whom have taken on the role in addition to their existing duties, and for a relatively modest financial reward. Given that it is often difficult to find individuals to take on the literacy coach role—and given that it may not be possible to increase stipends, or indeed maintain them at current levels in the future—an alternative would be to divide their roles among librarians and Grades 1–3 teachers, resulting in less work for each individual and perhaps facilitating greater communication and coordination. Indeed, the presence of literacy coaches may be one of the reasons for the limited involvement of teachers in many schools. Nonetheless, dividing literacy coaches' roles among other staff would certainly have workload implications for those involved, and it would be important to recognize the commitment of these staff members to their roles.

RECOMMENDATION ON ROLE OF PEER TUTORS:

Recommendation 9: Consider providing peer tutors with training on how to guide struggling students. The peer tutoring sessions were observed to be largely silent, with little verbal communication between students. Peer tutors were seen pointing struggling students to the correct answers on many occasions, and even answering for them. In some cases, struggling students appeared not to fully understand the instructions and/or the content. It is essential that peer tutors receive training, most likely from literacy coaches, on how to guide and explain, rather than answering on behalf of struggling students. Moreover, wherever possible, peer tutors should only supervise one struggling student at a time. Peer tutors are still young themselves and many are already having difficulties with their guiding roles.

RECOMMENDATION ON STRUGGLING STUDENTS:

Recommendation 10: Consider introducing *Aan Khmer* only in Grade 2. It may not be effective for students in Grade 1 to use the app as they may lack the necessary foundational skills to learn from it. The EGRA scores in Grade 1 would also suggest that these students gained limited benefits from its use.

RECOMMENDATIONS ON SCALABILITY & SUSTAINABILITY:

Recommendation 11: Consider incorporating responsive design into the *Aan Khmer* app. Currently, the app does not reformat itself for different-sized screens, and some text is unreadable on smartphones. It should be based on a responsive design which automatically configures itself for different devices, even if there is a recommended minimum screen size. There are reportedly plans in place to do this.

Recommendation 12: Consider making the *Aan Khmer* app available in Google Play. Rather than needing to be manually installed, the app should be made available in Google Play. It would be easier for teachers and parents to download and experiment with it, helping to scale up its use. There are reportedly plans in place to do this, once the app size has been reduced to fit within the Google Play size limit.

Recommendation 13: Consider balancing the current investment in digital technologies with more investment in analogue resources such as books. While small improvements have been seen in early grade students' literacy skills, overall levels remain low. This makes any incremental improvements insufficient. Moreover, even when tablets are supplied, there are issues with electricity, connectivity and maintenance. Given the results of the multiple regression analysis, which show beneficial effects from students being allowed to borrow library resources and from being taught in multi-grade classes, it may be worth exploring whether a wider range of strategies, in combination, could make the project more effective. This could, in turn, contribute to its scalability and sustainability.

■   ■   ■

An Exploration of the Integration of the Reading and Digital Reading Approach for Children Plus

9. Conclusion

The inclusion of an m-learning component (the *Aan Khmer* app) in the overall TRAC+ project was generally viewed positively by school staff and students, who said it has been useful in helping children learn to read. However, it is impossible to say with certainty that the app led to better EGRA and STAR results because of limitations in the study design, which are outlined below.

In terms of technological factors, the *Aan Khmer* app was run on Samsung tablets in schools with limited technical support. Although Wi-Fi is not needed to run the *Aan Khmer* app, it is needed to run the Interval Test, and unreliable Wi-Fi and school networks were often problematic. There were also problems in charging batteries in some schools, and issues relating to secure storage of the tablets.

The *Aan Khmer* app itself mainly focuses on symbol-sound knowledge and word identification, although children are exposed to sentences and also a narrated digital story at the end of each module. The app does not have many of the game features that are known to motivate students (this was a deliberate choice of the designers, who wanted to minimize distractions). Some participants in the study commented that the app was challenging for students to use because the instructions were difficult to follow, the content was difficult to understand, or the activities were difficult to complete. Some limitations of the earlier software have now been addressed by MoToLi in a later version of their app but have not yet been built into *Aan Khmer*.

As described in detail in this report, the m-learning aspect of TRAC+ was not always implemented as intended. This was often related to shortages of resources and training. However, even if the m-learning aspect had been implemented as intended, limited integration with classroom teaching and learning activities and authentic, meaningful literacy activities might still have restricted its effectiveness. The recommendations in the previous chapter may help to improve future implementation and effectiveness.

9.1 Limitations of the study

The quantitative results should be treated with caution because of several design limitations in the study. First, resources were not available to study both Group A and Group B schools. Second, within Group A, the allocation of schools into HU/LU categories was based initially on School Director Survey responses and then corroborated as far as possible using qualitative data. Because of time and resource limitations in this study, there was no scientific counting and measurement of the amount of app use in schools. Some of the schools categorized as either HU or LU may not have been significantly different from each other in terms of time spent on the app. In a future study, the quality of time using the app should be assessed as well as the quantity. This would involve longer periods of observation.

Third, there was a lack of baseline data available to the researchers to use in calculating student gains. There were no data available to show whether schools in which children achieved higher end line EGRA and STAR scores might have had higher baseline scores (although this is unlikely for Grade 1 students in Cambodia, who typically know very little about reading upon entering school). A fourth limitation, related to the third, is that there may be unknown factors that influenced the EGRA results.

It was found through multiple linear regression that many factors appeared to have had an impact on the EGRA results, with the strongest predicting factors being schools that permitted children to take home books from the library, and schools with multi-grade classrooms.

Fifth, the Cambodian version of the EGRA that was used in this study (as the only test available for Grades 1 and 2 children) is known to have limitations. For example, it does not seem to be fine-grained enough to capture the reading knowledge of young children, hence there were many extremely low scores among the Grade 1 children tested. Further, the EGRA does not assess important foundational skills for reading such as concepts about print and vocabulary knowledge. Additionally, the EGRA does not align directly with the skills taught in the TRAC+ intervention. TRAC+ directly aligns only with sub-tasks 1–3 of the EGRA (although non-words are not taught). Subtasks 4–6 of the EGRA are indirectly addressed, i.e., the reading skills directly addressed in TRAC+ may contribute to improved learning outcomes on these subtasks.

Sixth, the School Director Survey was a self-report survey of the school directors. Some of their responses were based on estimates, and it was not possible for researchers to verify many of the responses.

There were also limitations associated with the qualitative part of the study. For logistical reasons it was not possible to carry out a large number of observations. More observations of children using the apps in schools were planned, but the field team was unfortunately unable to complete all of these because when researchers arrived on site, they encountered issues such as libraries being closed, tablets being inaccessible, no students being scheduled to use the tablets, peer tutors not being present, or tablet batteries being flat.

Seventh, another limitation was that only one researcher did the translations for the qualitative analysis, although some spot checking and discussion with the other Khmer speaking researcher was performed. As is always the case with translation, some meanings may have been lost or slightly changed in the process.

9.2 Significance of the study

Despite the limitations outlined above, the study is significant in that it is the only independent evaluation of the m-learning aspect of TRAC+ in its large-scale rollout in Cambodia, and the only study that has involved interviewing a significant number of school directors, teachers, librarians, literacy coaches, peer tutors, struggling students, and parents. This part of the research has led to the identification of several issues relating to the implementation of the m-learning component, leading in turn to recommendations for improvements when considering the hardware and software development issues involved in a digital literacy application, and the operationalization and uptake of a digital application across multiple stakeholders. The study has also revealed that the project participants involved are generally very supportive of TRAC+ and the *Aan Khmer* app and would like to see continued use of the app and tablets.

10. Project Information and Outputs

The first conference presentation to report on this study was entitled as follows:

Oakley, G., Pegrum, M., Kheang, T., & Seng, K. (2017). *M-learning in TRAC+ to enhance the literacy of early grade students in Cambodia.* 7th Annual m-Education Alliance Symposium: Future-Proofing Technology for Education in International Development, Washington, DC, 5–6 October 2017.

A publication in an open access journal is envisaged.

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■ ■ ■

Appendices

Appendix 1: Structure of *Aan Khmer* Units

FEATURES (*AAN KHMER* APP)

Front Page—Registration (Guest or New User)

Table of Contents

1. Dependent Vowels

   a. Dependent vowels (learn to pronounce vowels)

   b. Match dependent vowels with the sound

   c. Pair dependent vowels

   d. Find dependent vowels (listen to the sound and find it)

   e. Dependent vowels (learn to read dependent vowels with pictures)

2. Consonants

   a. Consonants (learn to pronounce consonants)

   b. Match consonants with the sound

   c. Pair consonants

   d. Find consonants (listen to the sound and find it)

   e. Consonants (learn to read consonants with pictures)

3. First Series of Consonants

   a. First series of consonants (learn to pronounce first series of consonants)

   b. Find first series of consonants (according to the sound)

   c. Match words with pictures

   d. Find paired words

   e. Mini-story *(Short Lion)*

4. Second Series of Consonants

   a. Second series of consonants (learn to pronounce second series of consonants)

   b. Find words with a different sound

   c. Match words with pictures

   d. Find paired words

   e. Mini-story *(Cow and Duck)*

5. Diacritical Marks (thmenh kandor)

   a. Diacritical marks (presented with consonants and dependent vowels)

   b. Choose words according to the sound type

   c. Match words with the sound

   d. Find paired words

   e. Mini-story *(Diacritical Marks [thmenh kandor])*

6. Diacritical Marks (trei sabt)

   a. Diacritical marks (presented with consonants and dependent vowels)

   b. Choose words according to the sound type

   c. Match words with the sound

   d. Find paired words

   e. Mini-story *(Diacritical Marks [trei sabt])*

7. Supplementary Consonants (First Series)

   a. Supplementary consonants (learn to spell)

   b. Match words with pictures

   c. Match words with pictures (multiple words)

   d. Match words with the sound

   e. Mini-story *(Kak is a Hard-Working Boy)*

8. Supplementary Consonants (Second Series)

   a. Supplementary consonants (learn to spell)

   b. Form correct words

   c. Match words with pictures

   d. Match words with the sound

   e. Mini-story *(Animals Dance and Grandmother Dances)*

9. Independent Vowels

   a. Independent vowels (learn to pronounce independent vowels)

   b. Match words with pictures

   c. Choose words according to the sound type

   d. Find paired words

   e. Independent vowels (presented with pictures)

10. Subscript Consonants

    a. Subscript consonants (learn to pronounce subscript consonants)

    b. Match subscript consonants to the sound

    c. Find paired words

    d. Choose subscript consonants according to the sound

    e. Subscript consonants (presented with pictures)

11. Consonant-Subscript Combination (1)

    a. Consonant-subscript combination (learn to read the combination)

    b. Choose words according to the sound

    c. Match words with the sound

    d. Find paired words

    e. Mini-story *(Animals are Performing)*

12. Consonant-Subscript Combination (2)

    a. Consonant-subscript combination (learn to read the combination)

    b. Find words with a different sound

    c. Find words according to the sound type

    d. Find paired words

    e. Mini-story *(Snail is Scared)*

13. Consonant-Subscript Combination (3)

    a. Consonant-subscript combination (learn to read the combination)

    b. Find words according to the sound

    c. Find paired words

    d. Match words with the sound

    e. Mini-story *(Krum and Kreng)*

14. Consonant-Subscript Combination (4)

    a. Consonant-subscript combination (learn to read the combination)

    b. Find words with a different sound

    c. Find paired words

    d. Match words with the sound

    e. Mini-story *(Bear and Khleach)*

15. Consonant-Subscript Combination (5)
    a.   Consonant-subscript combination (learn to read the combination)
    b.   Find words with a different sound
    c.   Find paired words
    d.   Match words with the sound
    e.   Mini-story *(Chrib is a Good Boy)*

16. Consonant-Subscript Combination (6)
    a.   Consonant-subscript combination (learn to read the combination)
    b.   Find words according to the sound type
    c.   Match words with pictures
    d.   Find paired words
    e.   Mini-story *(Smart Cat)*

17. Consonant-Subscript Combination (7)
    a.   Consonant-subscript combination (learn to read the combination)
    b.   Match words with the sound
    c.   Find paired words
    d.   Find words according to the sound
    e.   Mini-story *(Bat is Wondering)*

18. Consonant-Subscript Combination (8)
    a.   Consonant-subscript combination (learn to read the combination)
    b.   Find words that begin with the sound pronounced
    c.   Choose words according to the sound type
    d.   Listen and find words
    e.   Mini-story *(Chhly's Goal)*

19. Consonant-Subscript Combination (9)
    a.   Consonant-subscript combination (learn to read the combination)
    b.   Find the initial missing letters
    c.   Match words with pictures
    d.   Find paired words
    e.   Mini-story *(Aunty Trob is a Good Housewife)*

20. Consonant-Subscript Combination (10)

    a.   Consonant-subscript combination (learn to pronounce the combination)

    b.   Find words according to the sound type

    c.   Match words with pictures

    d.   Listen and find words (according to what is pronounced)

    e.   Learn how to read sentences using the consonant-subscript combination

21. Consonant-Subscript Combination (11)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words with a different sound

    c.   Match words with pictures

    d.   Listen and find words (according to what is pronounced)

    e.   Mini-story *(Elephant Hunter)*

22. Consonant-Subscript Combination (12)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type

    c.   Match words with the sound

    d.   Find paired words

    e.   Mini-story *(Thnou has a Toothache)*

23. Consonant-Subscript Combination (13)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Match words with pictures

    c.   Match words with the sound

    d.   Find paired words

    e.   Mini-story *(Kampruk is Joining a Running Competition)*

24. Consonant-Subscript Combination (14)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type (consonant-double subscript combination)

    c.   Match words with pictures

    d.   Listen and find words (according to what is pronounced)

    e.   Mini-story *(Aunty Pioy is an Obedient Daughter)*

25. Consonant-Subscript Combination (15)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Match words with pictures

    c.   Match words with the sound

    d.   Find paired words

    e.   Mini-story *(Pril has a Stomach Bug)*

26. Consonant-Subscript Combination (16)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type (consonant-double subscript combination)

    c.   Match words with pictures

    d.   Find paired words

    e.   Mini-story *(A Burning Scarf)*

27. Consonant-Subscript Combination (17)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type (consonant-double subscript combination)

    c.   Match words with pictures

    d.   Find paired words

    e.   Mini-story *(Prey Mlur Market)*

28. Consonant-Subscript Combination (18)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type

    c.   Match words with pictures

    d.   Listen and find words (according to what is pronounced)

    e.   Mini-story *(Watching a Drama)*

29. Consonant-Subscript Combination (19)

    a.   Consonant-subscript combination (learn to read the combination)

    b.   Find words according to the sound type (consonant-double subscript combination)

    c.   Choose words according to the sound

    d.   Match words with pictures

    e.   Mini-story *(Uncle Sna Visits His Hometown)*

30. Consonant-Double Subscript Combination (1)

    a.   Consonant-double subscript combination (learn to read the combination)

    b.   Complete letters at the beginning and end of the word

    c.   Match words with the sound

    d.   Listen and find words (according to what is pronounced)

    e.   Mini-story *(Smart Toads)*

31. Consonant-Double Subscript Combination (2)

    a.   Consonant-double subscript combination (learn to read the combination)

    b.   Find words beginning with double subscripts

    c.   Find letters/words according to the sound type

    d.   Complete letters at the beginning and end of the word

    e.   Mini-story *(Grilled Fish)*

TRAC+ EVALUATION: SCHOOL DIRECTOR SURVEY

Respondent agreed to be interviewed (after reading the consent form)	Yes	1		Survey reference	
	No	2			
Interviewer ID				Signature of data collection assistant	

Only for data encoder	Name	Signature	Date
Data entry staff			
Supervisor			

INSTRUCTIONS FOR DATA COLLECTION ASSISTANT

- ✓ This form is to be completed by the school director/school principal.
- ✓ Please ensure there is only one answer to each question, unless otherwise indicated.
- ✓ Arrange a quiet place to speak.
- ✓ Confirm that the interviewee meets the inclusion criteria.
- ✓ Read the Information Letter and Consent Form and invite him or her to sign.
- ✓ If consent is given, commence the survey.

SCHOOL INFORMATION

This section is to be completed for each school visited.

1	Date of interview	Date: Month: Year:		
2	Time interview commenced			
3	Time interview ended			
4	School name			
5	School address			
6	Type of location (urban/rural)	Urban	1	
		Rural	2	
7	Type of school (Group A)	Group A	1	

SCHOOL DIRECTOR PROFILE

8	Name of respondent		
9	Gender of respondent	Male	1
		Female	2
10	Age of respondent		

Appendix 2. School Director Survey

11	Highest qualification	Lower Secondary Education	1
		Upper Secondary Education	2
		Bachelor Degree	3
		Master Degree	4
		Doctoral Degree	5
		Other (specify)	6
12	How long have you been the school director at **this school**?		
13	In **total**, how long have you been a school director (at this school and at other schools)?		
14	What kind of training did you receive for your role as school director? (Circle all that apply)	Program budgeting	1
		Leadership and management	2
		Transparency	3
		Accountability	4
		Monitoring and evaluation	5
		School implementation grant	6
		Other (specify)	7

SCHOOL CHARACTERISTICS AND ENVIRONMENT			
15	What kind of electricity supply does the school have? (Circle all that apply)	No electricity	1	
		Solar system	2	
		City/government electricity	3	
		Private mini grid	4	
		Battery (but not related to solar)	5	
		Other (specify)	6	
16	Does the school have a library?	Yes	1	
		No	2	Skip to Q19
17	If **yes**, what kind of library does your school have? (Read out the possible options)	A separate building	1	
		A room within a building	2	
		Corner of School Director's office	3	
		Corner/back of classroom	4	
18	Does the library allow students to borrow books to take home?	Yes	1	
		No	2	
19	Do children have access to a community library (not in the school)?	Yes	1	
		No	2	
20	Is there an internet connection at the school?	Yes	1	
		No	2	Skip to Q22
21	If the school has Wi-Fi connectivity to the TRAC+ devices, please rate this connectivity on a scale from 1 to 6: 1 = very poor (hardly ever connects to devices); 2 = poor (connects to devices some of the time); 3 = average (connects to devices most of the time); 4 = good (connects to devices almost all of the time without a problem); 5 = very good (connects to devices all of the time without a problem); 6 = excellent.	Very poor	1	
		Poor	2	
		Average	3	
		Good	4	
		Very good	5	
		Excellent	6	

SCHOOL STATISTICS

22	How many teachers are there at the school?				
23	How many grades does the school have?				
24	How many literacy coaches are working with children at this school?				
25	How many TRAC+ peer tutors are there at the school?				
26	How many students are enrolled in the school in total?				
27	27a. On average, what is the attendance rate at the school for girls?				
	27b. On average, what is the attendance rate at the school for boys?				
	27c. How much does the attendance rate vary by season?	Not at all	1		
		A little	2		
		Some	3		
		A lot	4		
28	Number of students and class size			Number of classes:	
	28a. How many Grade 1 students are there at the school? (Total enrollment [T] + female enrollment [F])	T:_____/ F:_____			
	28b. How many Grade 2 students are there at the school? (Total enrollment [T] + female enrollment [F])	T:_____/ F:_____			
	28c. How many Grade 3 students are there at the school? (Total enrollment [T] + female enrollment [F])	T:_____/ F:_____			
29	What percentage of students from each Grade 1–3 at the school has reading difficulties (i.e., has difficulty passing the reading assessments)?	Grade 1			
		Grade 2			
		Grade 3			
30	Are there any multi-grade classes in your school?	Yes	1		
		No	2		

TRAC+ OPERATION

31	When did the TRAC+ project commence at your school?			
32	Who manages/oversees the TRAC+ project at your school? (Circle all that apply)	Me, as school director	1	
		Literacy coach	2	
		Librarian	3	
		Teacher	4	
		World Vision staff	5	
		World Education staff	6	
		School support committee	7	
		Other (specify)	8	
33	Please describe your role in relation to TRAC+.			
34	Who decided that this school would get involved in the TRAC+ project, and why?			

TABLET AND APP USAGE				
35	How many TRAC+ tablets are there in the school?			
36	Among the tablets provided by the TRAC+ project, how many are still working?			
37	How many other tablets are there in the school?			
38	How are the tablets stored? (Circle all that apply)	In the library in/on securely locked box or shelf	1	
		In the library in/on non-secure box or shelf	2	
		In school director's office in/on securely locked box or shelf	3	
		In school director's office in/on non-secure box or shelf	4	
		School director takes them home	5	
		Teacher takes them home	6	
		Librarian takes them home	7	
		Other (specify)	8	
39	Which students are allowed to use these tablets? (Circle all that apply)	Students who struggle with reading (i.e., those who have difficulty passing the reading assessments)	1	
		Students who do not struggle with reading (i.e., those who do not have difficulty passing the reading assessments)	2	
40	For the students who use the tablets, what grade(s) are they from? (Circle all that apply	Grade 1	1	
		Grade 2	2	
		Grade 3	3	
		Grade 4	4	
		Grade 5	5	
		Grade 6	6	
41	Who else does the school allow to use the tablets for the purpose of learning to read? (Circle all that apply)	Librarian	1	
		Teacher	2	
		School director	3	
		Students from nearby community who study at another school	4	
		Other (specify)	5	
42	In the past week, how many times would you say each student has used the tablets?	Never	1	
		One time	2	
		Two times	3	
		Three times	4	
		Four times	5	
		Five times	6	
		Six times	7	
		Seven times	8	
		Eight times or more	9	
43	For how many minutes do students generally use the tablets each time? (minimum, average, and maximum)	Minimum		
		Average		
		Maximum		

44	In what time slots do the students use the tablets? (Do not read out the answers) (Circle all that apply)		Struggling Students	Non-struggling students	
		Break time	1	1	
		Class study time	2	2	
		Library time	3	3	
		Shift time	4	4	
		Other times	5	5	
45	What is the physical location in the school where the children use the tablets? (Circle all that apply)	Classroom	1		
		Library	2		
		Playground	3		
		Other (specify)	4		
46	Do the children use the TRAC+ tablets outside the school? (i.e., in other places)	Yes	1		
		No	2	Skip to Q48	
		Don't know	99	Skip to Q48	
47	If **yes**, where do they use them? (Circle all that apply)	Home	1		
		Neighbor's house	2		
		Friend's house	3		
		Rice field	4		
		Other public place	5		
		Other (specify)	6		
48	Do any of the children have the *Aan Khmer* app installed on their own or their parents' devices?	Yes	1		
		No	2	Skip to Q50	
		Don't know	99	Skip to Q50	
49	If **yes**, approximately how many?				
50	Do parents come to the school to help/watch their children use the *Aan Khmer* app?	Never	1		
		Rarely	2		
		Sometimes	3		
		Often	4		
51	Do the children use the TRAC+ or other tablets to access any reading apps other than *Aan Khmer?*	Yes	1		
		No	2	Skip to Q53	
		Don't know	99	Skip to Q53	
52	If **yes**, please name the apps (List all the apps, one in each row provided)		1		
			2		
			3		
			4		
			5		

53	What are the problems that staff and children have encountered when using the *Aan Khmer* app? (Circle all that apply)	No problems	1	
		Problems with tablet (such as no power)	2	
		Problems understanding instructions in the app	3	
		Problems navigating through the app	4	
		Problems understanding the concepts being taught	5	
		Others (please specify)	6	
54	What sort of ICT technical support is there at the school to help staff with computer, tablet, internet, Wi-Fi, or printing problems?			
55	Please rate the ICT technical support that is available at the school.	Very poor	1	
		Poor	2	
		Average	3	
		Good	4	
		Very good	5	
		Excellent	6	
56	Do staff members at the school use any forms of ICT for teaching purposes other than the tablets supplied as part of the TRAC+ project?	Yes	1	
		No	2	Skip to Q58
		Don't know	99	Skip to Q58
57	If **yes**, what forms of ICT do the staff members use (e.g., desktop computers, laptops, smartphones)?	Desktop	1	
		Laptop	2	
		Smartphone	3	
		Tablet/iPad	4	
		Other (specify)	5	
58	How many staff at the school do you estimate have smartphones for personal use?	76%-100%	1	
		51%–75%	2	
		26%–50%	3	
		25% or fewer	4	
		None	5	
		Don't know	99	
59	Do children use any forms of ICT **at school** other than the tablets supplied as part of the TRAC+ project?	Yes	1	
		No	2	Skip to Q62
		Don't know	99	Skip to Q62
60	If **yes**, what forms of ICT do the children use (e.g., desktop computers, laptops, smartphones)?	Desktop	1	
		Laptop	2	
		Smartphone	3	
		Tablet/iPad	4	
		Other (specify)	5	

61	If **yes**, how often do they use them on average?	Once a year	1	
		Twice a year	2	
		Once a month	3	
		Once a fortnight	4	
		Once a week	5	
62	Do children use any forms of ICT (such as desktop computers, laptops, smartphones) **outside school** other than the tablets supplied as part of the TRAC+ project?	Yes	1	
		No	2	Skip to Q65
		Don't know	99	Skip to Q65
63	If **yes**, what forms of technology do the children use?	Desktop	1	
		Laptop	2	
		Smartphone	3	
		Tablet/iPad	4	
		Other (specify)	5	
64	If **yes**, how often do they use them?	Once a year	1	
		Twice a year	2	
		Once a month	3	
		Once a fortnight	4	
		Once a week	5	
65	How would you rate the usefulness of the *Aan Khmer* app for helping **struggling readers** improve their reading?	Not useful	1	
		Slightly useful	2	
		Useful	3	
		Very useful	4	
		Extremely useful	5	
66	How would you rate the usefulness of the *Aan Khmer* app for helping **non-struggling readers** improve their reading?	Not useful	1	
		Slightly useful	2	
		Useful	3	
		Very useful	4	
		Extremely useful	5	
67	Please provide some explanation for your rating in the previous question (**struggling readers**).	Please provide some explanation for your rating in the previous question (**non-struggling readers**).		

PEER TUTORS				
68	What grade are the peer tutors from?	Grade 1	1	
		Grade 2	2	
		Grade 3	3	
		Grade 4	4	
		Grade 5	5	
		Grade 6	6	

69	Based on what criteria were the peer tutors selected? (Please list in order of importance, with one reason in each row provided)		1	
			2	
			3	
			4	
			5	
			6	
			7	
70	On average, how long do you think each peer tutor spends (per week) tutoring?			Minutes
71	What training have the peer tutors received? (Please write down each kind of training received with one example in each row provided)		1	
			2	
			3	
			4	
			5	

72	How useful was each type of training? Why do you think this? (Please write your answers below in each row provided)	Not at all useful	Slightly useful	Useful	Very useful	Extremely useful
		1	2	3	4	5
		1	2	3	4	5
		1	2	3	4	5
		1	2	3	4	5
		1	2	3	4	5

73	How are the peer tutors supported in their TRAC+ responsibilities?

LITERACY COACHES				
74	Who are the literacy coaches who work at your school? (Circle all that apply)	Retired teachers	1	
		Community members	2	
		Youths from World Vision/Area Programs	3	
		Other (specify)	4	
75	Based on what criteria were the literacy coaches selected? (Please list in order of importance, with one reason in each row provided)		1	
			2	
			3	
			4	
			5	
			6	
			7	
76	How much time each week do the literacy coaches spend with each student?			Minutes

	OVERALL ABOUT THE PROJECT			
77	The TRAC+ team provided training for the staff and peer tutors at the school to help them use the tablet and the *Aan Khmer* app. As a whole, what do you think was the quality of this training?	Very poor	1	
		Poor	2	
		Average	3	
		Good	4	
		Very good	5	
		Excellent	6	

78	In your opinion, how could the TRAC+ project be improved?

79	What do you/does your school plan to do with the tablets when the TRAC+ project is finished?

Appendix 3. Interview Questions for Case Study Schools

TRAC+ INTERVIEW QUESTIONS

Teachers

Date of interview: _____ Start: _____ End: _____

Interviewee's name: _____ Name of school: _____

Interview location: _____ Interviewer's name: _____

Introduction

- Purpose of the interview

- Assuring anonymity and confidentiality

- Seeking authorization/permission to record the conversation in order to have an accurate account of what is said

Background Information

1. Tell me about yourself—name, role, and what grade you teach.

2. When did you become a teacher in this school?

3. Do you teach children to read using the *Aan Khmer* app? If yes, when did you start using the app?

4. Do you hold any other post as well as this one (e.g., literacy coach, deputy school director, secretary)?

5. What training did you receive before the implementation of the app? How long did the training last and who/which organization provided the training?

6. What training/support have you received since the implementation of the app?

Teachers' Work and Experiences with the *Aan Khmer* App (and the TRAC+ Project)

7. Please describe your role/responsibility specifically in relation to the implementation of the *Aan Khmer* app in this school.

8. Do you think the *Aan Khmer* app has helped the children in your class learn to read? If so, how has it helped? How do you know this?

9. Which children has it helped (e.g., children with reading difficulties, other children)?

10. What would you like to change about the app, and how could it be changed?

11. What would you like to change about the way the app is used by the children?

12. How does the app fit in with your classroom teaching? (Do you follow up on the app activities with other classroom activities? How?)

13. What aspects of reading does the app help children learn (e.g., decoding, sight words, speed, accuracy, etc)?

14. What aspects of reading does the app not address?

15. Are there any other areas of literacy that the app has helped the children with, such as writing? If yes, can you tell me more about this?

16. How do you assess or monitor the progress of the children's reading abilities? How often?

17. How does the app complement other TRAC+ materials such as the toolkit?

18. How would you rate the training you received on using the app? (Rate from 1 to 5, with 5 being the highest score.) Can you explain why you gave this rating?

19. How could the training be improved?

20. Can you tell me about any problems children have when using the app to learn to read?

21. Have you ever had any problems using the app to teach children to read? If yes, what are they? How are the problems solved?

22. What are the positive experiences you have had with the implementation of the app?

23. What are the negative experiences you have had with the implementation of the app?

24. What role, if any, do parents play in helping their children to use the app?

25. In your opinion, is there anything that the school leadership could do to improve the impact of the TRAC+ project?

Closing Remarks

- Do you have anything you can add before we end our conversation? Is there anything you think we haven't spoken about in relation to the app?

Interview Comments

- Any other important points: _____

- Themes/issues to follow up in next interview: _____

TRAC+ INTERVIEW QUESTIONS

Librarians

Date of interview: _____ Start: _____ End: _____

Interviewee's name: _____ Name of school: _____

Interview location: _____ Interviewer's name: _____

Introduction

- Purpose of the interview

- Assuring anonymity and confidentiality

- Seeking authorization/permission to record the conversation in order to have an accurate account of what is said

Background Information

1. Tell me about yourself – name and role/position in this school.

2. When did you start working as a librarian in this school?

3. Do you hold any other post as well as this one (e.g., teacher, literacy coach, deputy school director, secretary)?

4. Have you received any training in relation to your work as a librarian? If yes, what training? Who/which organization provided the training?

5. Have you received any training specifically in relation to the implementation of the *Aan Khmer* app in this school? If yes, what training? Who/which organization provided the training?

Librarians' Work and Experiences with the *Aan Khmer* App (and the TRAC+ Project)

6. Please describe your role/responsibility specifically in relation to the implementation of the *Aan Khmer* app in this school.

7. Do you think the *Aan Khmer* app has helped the children learn to read? If so, how has it helped?

8. In your opinion, which children has it helped (e.g., children with reading difficulties, other children)? How do you know this?

9. What would you like to change about the app, and how could it be changed?

10. What would you like to change about the way the app is used by the children?

11. What aspects of reading does the app help children learn (e.g., decoding, sight words, speed, accuracy, etc)?

12. What aspects of reading does the app not address?

13. Are there any other areas of literacy that the app has helped the children with, such as writing? If yes, can you tell me more about this?

14. How does the app complement other TRAC+ materials such as the toolkit?

15. How would you rate the training you received on using the app? (Rate from 1 to 5, with 5 being the highest score.) Can you explain why you gave this rating?

16. How could the training be improved?

17. What are the positive experiences you have had with the implementation of the app?

18. What are the negative experiences you have had with the implementation of the app?

19. What role, if any, do parents play in helping their children to use the app?

20. In your opinion, is there anything that the school leadership could do to improve the impact of the TRAC+ project?

Closing Remarks

- Do you have anything you can add before we end our conversation? Is there anything you think we haven't spoken about in relation to the app?

Interview Comments

- Any other important points: _____

- Themes/issues to follow up in next interview: _____

TRAC+ INTERVIEW QUESTIONS

Literacy Coaches

Date of interview: _____ Start: _____ End: _____

Interviewee's name: _____ Name of school: _____

Interview location: _____ Interviewer's name: _____

Introduction

- Purpose of the interview

- Assuring anonymity and confidentiality

- Seeking authorization/permission to record the conversation in order to have an accurate account of what is said

Background Information

1. Tell me about yourself—name, highest educational qualification, and what you do in this school.

2. When did you become a literacy coach? How?

3. What post did you hold before this one?

4. Do you hold any other post as well as this one (e.g., deputy school director, teacher, management staff member in the school, school community representative)?

5. What training did you receive before your appointment as a literacy coach? How long did the training last and who/which organization provided the training?

6. What training/support have you received since your appointment as a literacy coach?

Literacy Coaches' Work and Experiences with the *Aan Khmer* App (and the TRAC+ Project)

7. In your role as the literacy coach in this school, what key activities characterize your day-to-day, weekly and monthly schedule?

    - Prompts: administration of Interval Tests, administration of the *Aan Khmer* app, dissemination of toolkit materials, organizing parent meetings

8. Please describe your role/responsibility specifically in relation to the implementation of the *Aan Khmer* app in this school.

9. Can you tell me about the children you tutor to learn to read (what grade they are in, and their reading ability)?

10. How many times per week do you tutor them to learn to read? How much time do you spend on helping them per time?

11. Do you think the *Aan Khmer* app has helped the children you tutor to learn to read? If so, how has it helped? How do you know this?

12. What aspects of reading does the app help children learn (e.g., decoding, sight words, speed, accuracy, etc)?

13. What aspects of reading does the app not address?

14. Are there any other areas of literacy that the app has helped the children with, such as writing? If yes, can you tell me more about this?

15. What would you like to change about the app, and how could it be changed?

16. What would you like to change about the way the app is used by the children?

17. What comments would you like to make about the role the peer tutors play?

18. How do you assess or monitor the progress of the children's reading abilities? How often?

19. How does the app complement other TRAC+ materials such as the toolkit games?

20. How would you rate the training you received on using the app? (Rate from 1 to 5, with 5 being the highest score.) Can you explain why you gave this rating?

21. How could the training be improved?

22. Have you ever had any problems using the app to teach children to read? If yes, what are they?

23. In your opinion, is there anything that the school leadership could do to improve the impact of the TRAC+ project?

Closing Remarks

- Do you have anything you can add before we end our conversation? Is there anything you think we haven't spoken about in relation to the app?

Interview Comments

- Any other important points: _____

- Themes/issues to follow up in next interview: _____

TRAC+ INTERVIEW QUESTIONS

Peer Tutors

Date of interview: _____ Start: _____ End: _____

Interviewee's name: _____ Name of school: _____

Interview location: _____ Interviewer's name: _____

Introduction

- Purpose of the interview

- Assuring anonymity and confidentiality

- Seeking authorization/permission to record the conversation in order to have an accurate account of what is said

Peer Tutors' Work and Experiences with the *Aan Khmer* App (and the TRAC+ Project)

1. Tell me about yourself—your name and which grade you are in.

2. When did you become a peer tutor? How did you become a peer tutor?

3. Do you hold any other post as well as this one (e.g., student council member, club representative)?

4. What training did you receive before your appointment as a peer tutor?

5. What training have you received since your appointment as a peer tutor?

6. How many times each week do you do peer tutoring? How long each time?

7. How do you help the younger children learn to read using the app? Which grade(s) are they in?

8. Do you ever have problems with the app? What are they? Who helps you fix these problems?

9. Do you have any other problems with peer tutoring? What are they? Who helps you fix these problems?

10. Who helps you to be a good peer tutor? How do they do this?

11. What aspects of reading in the app do you think are difficult for students to learn? Why?

12. What aspects of reading in the app do you think are easy for students to learn? Why?

13. If you could change anything about the app, what would it be? Why would you change it?

Closing Remarks

- Do you have anything you can add before we end our conversation? Is there anything you think we haven't spoken about in relation to your work as a peer tutor or the app?

Interview Comments

- Any other important points: _____
- Themes/issues to follow up in next interview: _____

TRAC+ INTERVIEW QUESTIONS
Students

Date of interview: _____ Start: _____ End: _____

Interviewee's name: _____ Name of school: _____

Interview location: _____ Interviewer's name: _____

Introduction

- Purpose of the interview

- Assuring anonymity and confidentiality

- Seeking authorization/permission to record the conversation in order to have an accurate account of what is said

Students' Experiences with the *Aan Khmer* App

1. Tell me about yourself—your name and which grade you are in.

2. When did you first learn how to use the *Aan Khmer* app?

3. How did you learn how to use the app? Who taught you how to use it? (If more than one person, who was the best at teaching you? Why?)

4. What do you like most about using the app? Why?

5. What do you like least about using the app? Why?

6. When you use the app, how do you know what game to play?

7. Do you think playing the games in the app has helped you to improve your reading? In what ways do you think the app helps you learn to read? What parts of your reading does the app help you with?

8. Who helps you when you are using the app?

9. How do they help you?

10. Where do you use the app?

11. Do you ever use the app at home or anywhere outside school? If yes, do you receive any help from someone when using the app outside school? If yes, from whom and how?

12. How many times each week do you use the app? How long each time?

13. Have you ever had any problems using the app? What are they?

14. Can you tell me about the other games that you use to help you learn to read? Which do you find the most helpful—the toolkit games or the app? Why do you think that?

15. Do you think using the app helps you with your reading when you go back to the classroom and do other activities? Can you tell me more about this?

16. Do you think using the app helps you with your writing? If yes, how does it help?

Closing Remarks

- Do you have anything you can add before we end our conversation? Is there anything you think we haven't spoken about in relation to the app?

Interview Comments

- Any other important points: _____
- Themes/issues to follow up in next interview: _____