

UNDERSTANDING THE POTENTIAL OF DIGITAL INTERVENTIONS TO SUPPORT ENGLISH LANGUAGE LEARNERS IN RWANDA

An investigative report of a tablet-based digital learning suite supporting primary students transitioning to English-based instruction in Kagina, Rwanda

Educational technology has the power to transform learning by improving educational outcomes as well as widening access to quality education for students in developing countries.

According to the World Bank, roughly 250 million disadvantaged children never reach their full potential because they miss out on early learning (2017). In countries with large refugee and immigrant populations or where the language of instruction changes from the student's mother tongue to English, as is the case in Rwanda for example, challenges around access and the quality of education as well as their long-term effects are compounded. In the face a global learning crisis, Kitkit School – a comprehensive tablet-based digital learning solution for early learners - is designed to support Sustainable Development Goal 4 (SDG 4) towards quality education and lifelong learning for all.

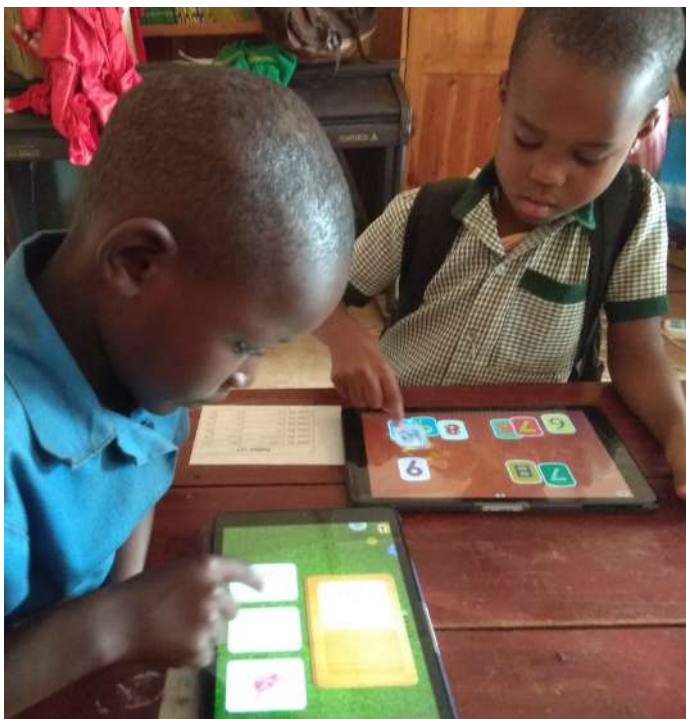
In Rwanda where the pilot tablet-based self-learning session was introduced, most children have not acquired age-appropriate literacy and numeracy skills, which have been considered to be a contributing factor that hampers the achievement of universal and quality primary education. While Rwanda was on pace to achieve near-universal access to primary education in recent years, primary school drop out and repetition have risen while completion and transition to secondary rates have stagnated. According to the Ministry of Education, nearly one third (28.3%) of all primary school children drop out in grade 5 (P5) (MINEDUC, 2015). To

account for this undesirable trend, concerns on the quality of education, and particularly the policy of switching the language of instruction from French to English from P4 adopted in 2008, has been in the center of the discussion. Rwanda's Education Sector Strategic Plan (ESSP) 2013 - 2018 states that teachers in P1-P3 classes should use Kinyarwanda as the mother-tongue language of instruction to help students learn to read, before transitioning in P4 from Kinyarwanda to English. The shift to English was a strategy of the government to facilitate its economical entry into global market, but it has been implemented with limited resources in particular with teacher shortages who has adequate proficiency of English (Williams.T.P, 2017). According to findings from the Ministry of Education, only 15% of primary teachers are proficient to teach in English (MINEDUC, 2009) and it inevitably amplifies the challenges around primary learning across the country.

Where the change is sudden, with inadequate English instruction in the first three grades leaves students ill-prepared to use English at the language of instruction, it is unsurprising that P4 students would face considerable limitations on their learning. Teachers are instructing in a language with which they have limited fluency, while students struggle across subjects due to a lack of basic fluency in the medium of instruction. Per a recent study, increasing repetition and dropout rates in P4 and P5 are likely to have a direct relationship with the change in the language of instruction, including the highest dropout at the end of P5, the year before taking the primary leaving national exam for transition to lower secondary school (Moulton, 2016).

To address this challenge, most of the responses of the government and international agencies have focused on equipping teachers by providing capacity-building professional development programs for teachers. The Rwandan English in Action Program (REAP) provided English-language training to teachers during school vacation for more than 88,000 teachers since 2008. Additionally, the Rwanda Education Board under the Ministry introduced a school-based mentorship (SBM) program which sends 1,000 English teachers hired from neighbouring countries like Kenya and Uganda to Rwandan schools to help local teachers. The study concludes, however, the program has been met with mixed results with difficulties recruiting SBM mentors and lack of understanding by head teachers, further impeded by the absence of a monitoring and evaluation system (Wilson, J, 2013 cited in Willian.T.P. 2017). As a consequence, the SBM program was no longer funded in 2016.

In the response to this urgent issue, this case study explores the potential of use of digital-learning technology as an intervention to increase learning outcomes on basic literacy (English) and mathematics for lower primary students in Rwanda. By giving them access to a high-quality tablet-based learning



experience, facilitating self-paced learning, the study aims to find the potential of education technology as a solution to tackle the challenging task of enhancing lower primary student's English capacity in cost-efficient way.

The intervention this study evaluates, utilizing the table-based learning apps call Kitkit School developed by Enuma, was implemented by Good Neighbors (GN), an international NGO which aims to improve the access to quality education in their catchment communities. The intervention, called the Kitkit Session, is designed to provide an extra-curricular opportunity over the course of three months that provides supplementary literacy (English) and math learning support for 684 students enrolled in P1-P3 in the Kagina Primary School located 25km away from Kigali, the capital of Rwanda, from September to December of 2018.

The report presents key findings of the Kitkit session pilot program evaluation:

1. Baseline data reveals very low English literacy levels, even in P3
2. Students demonstrated significant learning gains (Pre-/Post-Assessment Overall Results)
3. Positive correlation of intervention time to higher achievement

As key findings in this study demonstrate, there is promising evidence that the tablet-based learning suite can directly contribute to strengthening children's literacy (English) and math skills even via short-term supplementary interventions. In fact, lower grade students in Rwanda face the dual challenge of mastering basic literacy in Kinyarwanda to "learn to read" as well as building basic proficiency in English to "read to learn", at the same time. Enhancing student's readiness to enter P4 seems urgent and a definite entry point to tackle existing challenges in quality primary learning in Rwanda. This study shows that this intervention provide a compelling solution to tackle these dual tasks and to unleash the potential of digital education for P3 students in particular.

Case study overview

Kitkit Session used to provide basic literacy and numeracy skills

Good Neighbors Rwanda partnered with Enuma, Inc. to equip lower primary school students with basic English literacy and math skills to prepare them for the transition of the language of Instruction from Kinyarwanda to English in Grade 4.

The Kitkit Session targeted children in grades 1 to 3, who were all entitled to attend, though attendance was not compulsory since it was designed as an after-school program.

Kitkit Session allows 1:1 free-play for students

From September to December 2018, 684 students of Kagina Hope School in Rwanda were enrolled for the 25-week Kitkit Session opportunity. The session was offered without any charge. Initially the total number of days for the session was planned for 75 weekdays; however due to holidays and national examination it was only conducted for a total of 62 weekdays.

For three months of the trial, students were given access to Kitkit School daily Monday through Friday. With one tablet available per child, they were ensured to free-play at least 30 minutes per session. The tablets, which include Kitkit's suite of English and math learning games and contents, and e-book library and videos were given to the children from the first day without direct

instruction on how to use, as Kitkit School is designed to be highly intuitive, without the need for guided instruction by adults. A total of 167 tablets were used for 684 enrolled student as the software provides multiple user registration functionality.

It should be noted that the school is operated as a double-shifting system under the government policy, because it considers the effective way to expand access within the constraints of infrastructure, and resources available. Since the Kitkit Session was extra-curricular, students were not mandated to attend. With this freedom to attend, children could come and go they chose.



Daily sessions were held in the library and the cafeteria during the school day, and participating students were given access to Kitkit School either before or after their regular classes. Good Neighbors provided eight sessions per day on average, and students were allocated to elect a specific session. This means all students attended only their registered sessions. In this way, the implementation team ensured every student could be engaged, learning in a 1:1 tablet device arrangement

with user registration tracking their progress in every play log.

Due to limitations of the available space in the school, however, it occasionally resulted in 2-3 hours waiting time for students. For young learners in P1 aged 5-7, the wait might provide an explanation on various degrees of participation rate across grades as we speculate in detail in Findings from the Field, Finding 2.

Roles of Kitkit School session facilitators

Supporting the enrollment of 684 lower primary students, the Kitkit Session was overseen and operated by four 'Kitkit facilitators' employed by Good Neighbors (GN) from the school and surrounding communities. Facilitators were primarily responsible for distributing the tablets to children, but did not intervene with their play.

The facilitators were in charge of the daily administration of the site, including charging 167 tablets, and maintaining the library and cafeteria where the Kitkit Session was held. In addition, 2 staff members

in the GN Rwanda office were responsible for the project management and the collection of data for evaluation.

Enuna, the developers of Kitkit School, provided on-site and remote support. In preparation for implementation, Enuna delivered a 5-day training course for facilitators that covered co-design of the activities, instruction on Kitkit's pedagogy and curriculum, technical capacity-building for software and hardware management, and data collection. It also included an introductory workshop with the school teachers, enumerator training, and on-site pilot administration of EGRA and EGMA assessments.



Evaluation Methodologies

The following field data was collected for project evaluation:

- Play Log data
- Digital literacy and numeracy assessment data
- For a selected sample of students, oral evaluation of literacy and numeracy (EGRA and EGMA)

All play log data of 167 tablets with all 684 registered children are automatically collected through a local server system every two weeks and transmitted to Enuma, Inc. The analysis of play log data provides statistics on play time, game progress, and digital assessment scores.

Digital literacy and numeracy assessments were also conducted during the first (and last) three days of the Kitkit School session as the baseline and endline. Among 684 students, 367 children participated in both pre- and post-tests. The primary purpose of the data collection was to provide information on individual's learning progress for educators, rather than for project evaluation.

For learning progress evaluation, 1:1 oral assessments were carried out both at baseline and endline. These assessments ensured equal participation and detected early progress even for children with insufficient skills to understand the paper-based test. Using the Early Grade Reading Assessment (EGRA) and the Early Grade Mathematics Assessment (EGMA) tools, a randomly selected subgroup of 105 students participated in the test at baseline. At the endline, however, the numbers of students was decreased to 99. Thus, data from the 99 students who took both tests were used for evaluation of the oral assessment. Enumerates were trained for ensuring consistent translation of test administration among facilitators. As such, the pilot of assessment administration was conducted as practiced prior to the baseline.

This case study evaluates the learning outcomes of students by using both play log data and orally assessments.



(Pilot administration of EGRA and EGMA with same-aged children in non-intervention school near community)



(Baseline administration of EGRA and EGMA at the Kaniga primary school)

Using Digital Solutions To Provide Quality Education

The use of technology to support literacy and numeracy acquisition in resource-limited areas had been attracting much attention from governments, international agencies, and NGOs. Research has found that digital technologies can provide an important platform to tackle the challenging task of reaching children who have little or no access to quality education (Gottwald, Morris, Wolf & Galyean, 2017).

However, research on the process and the impact on which of these technologies can improve learning outcomes has been limited in general and shown mixed learning results across regions. For example, in India, a highly significant academic impact was observed through technology-led after-school instructional program, Mindspark. Middle-school students could learn from individually customized content. Both math and Hindi scores increased among students who participated (Muralidharan et al., 2019). Meanwhile, computer-aided instruction (CAI) in Israel had limited impact on the math scores of 4th year students, which could have been due to the higher priority given to CAI could have replaced other school resources, or the time it takes for students and teachers to adjust to CAI may be longer than a year (Angrist and Lavy, 2002). As shown by inconclusive research on the impact of computers on learning, there is a need for improved understanding of how other digital learning solutions can be tailored to best serve students and teachers in low-resource settings, especially in sub-Saharan Africa. Researchers argue that more active and learning attitudes need to be embodied within teaching-learning process as children need to convert information form technology into knowledge (Luckin et al., 2012; Fullan and Langworthy, 2013).

In line with that, tablet-based interventions have gained increased attention. Instead of using technology merely as a tool to gather information, tablet-based interventions enable an individualized learning plan by proving that regionally-tailored and uniquely-integrated hardware and software solutions can help fill critical learning gaps.

In contexts with teacher and resource scarcity, it becomes even more challenging to meet each individual child's unique learning needs. Classroom instruction can be differentiated or scaffolded to better meet the needs of students, but digital solutions offer new ways to tailor learning to address the specific needs of individual children, and can offer students more choice in terms of learning modalities and pace. Still, rigorous evaluation is scarce in both developed and developing countries (Haßler et al. 2015; Hubber et al. 2016). The only peer-reviewed study on a developing country setting is the study by Pitchford, who finds that a tablet program improves early mathematical skills for primary school children in Malawi (2015).

Consequently, this study aims to contribute to these efforts to provide quality education by detailing how a tablet-based educational experience can motivate students to self-learn literacy and mathematical skills as well as provide a foundational intervention for English language learners.

ABOUT KITKIT SCHOOL

Kitkit School was created by the Enuma, Inc. team as a comprehensive early learning solution in response to the 617 million children and adolescents worldwide – six out of ten – who are not reaching minimum proficiency levels in reading and mathematics. Kitkit School is designed as a comprehensive learning platform with game-based Kitkit Learning App, library of books, videos, and songs, and collection of learning tools for support and self-expression. The Kitkit Learning App is composed of interactive educational activities, which allow children to be exposed to high-quality, user-centered educational materials. Currently, Enuma offers Kitkit School in English and Swahili versions, with plans for new languages and contextualization ahead.

The Enuma team created Kitkit School to bring high-quality learning experiences to the children who need them most around the globe. With the needs of children, including those with special needs or without access to resources, at the core of their work, the Enuma team uses user experience and accessible design to engage early learners to gain confidence in early literacy and math. The name Enuma comes from the world enumerate, or to name one by one, to demonstrate the team's dedication to individual and independent learning experience for children.

ABOUT GOOD NEIGHBORS

Good Neighbors (GN) is an international humanitarian development NGO founded in Korea in 1919. It aims to make the world a place without hunger, where people live in harmony. As the name indicates, GN respects the human rights of our neighbors suffering from poverty, disasters and oppression which affect their basic standard of living. GN works to empower the people regardless of race, religion, ideology and beyond geographical constraints; also promotes self-resilience and sustainable development of individuals, families and communities.

The focus of GN projects is children's rights protection, and strengthening global partnership and advocating the rights of the most vulnerable and marginalized in a respectful and effective way. Good Neighbors is currently implementing a ICT-based education project in Bangladesh. The educational projects enhanced opportunity of participation of children through the use of computers and tablet PCs to advocate and raise awareness to children's rights. In addition, with partnership with SBS, one of the largest broadcasting companies in Korea, and Daekyo, an educational service company in Korea, GN is developing educational TV shows in Kiswahili to be aired in Tanzania.

Findings from the field

FINDING 1.

Baseline reveals very low level of English literacy skills, even in P3

Since paper-pencil assessment may be difficult for children with insufficient literacy skills, a random sample of students were orally tested for their reading skills using Early Grade Reading Assessment (EGRA) and Early Grade Mathematics Assessment (EGMA).

In table 1, scores for each subtask have been transformed to be out of 100 total points. This indicates that in terms of literacy subtasks even grade 3 students score less than 20 points out of 100, implicating students are not fully skilled even in basic skills like alphabetic recognition, phonics and decoding. This highlights the need for supplementary education for English comprehension.

Starkly contrasting baseline scores for literacy and mathematics evidence the challenges before students, particularly those in P3, when the language of instruction is English. As seen from the baseline data, student scores reveal much lower literacy proficiency in comparison to the overall baseline scores for math. Scores demonstrate that Grade3 students marked 1.62% to 18.3 % of correct answer on literacy in comparison to their math score of 25.6% ~ 87.6%.

Without appropriate, effective intervention to support concurrent English acquisition as part of students' literacy development, baseline averages worsen by grade leaving students ill-prepared for the transition to English in P4. Among students tested in P3, there were many children who do not know the alphabet, with comprehension showing a score average of nearly zero. This baseline finding speaks to the urgent and imperative need for improved learner supports for basic English in lower primary grades as well as the challenges facing Rwandan students that contribute to poor completion and high drop-out rates once the language of instruction changes to English in P4.

Table 1 Baseline Averages by Grade on Oral Literacy and Math tests

Sub-tests		Grade 1	Grade 2	Grade 3
Literacy	Letter Name	0.056	1.97	1.62
	Familiar Words	0.357	1.94	9.18
	Invented Words	2.41	6.33	18.4
	Oral Reading Passage	0.178	1.29	10.0
	Reading Comprehension	35.3	1.61	6.62
Mathematics	Number Discrimination Part A	50.3	70.0	87.6
	Number Discrimination Part B	37.6	20.6	75.9
	Addition Level 1	30.3	53.7	71.6
	Subtraction Level 1	28.5	40.5	53.1
	Missing Number	18.4	68.5	45.3
	Addition Level 2	10.6	24.2	42.1
	Subtraction Level 2	10.0	21.9	25.6

FINDING 2.

Students demonstrated significant learning gains (Pre-/Post-Assessment Overall Results)

Table 2 Difference between Endline and Baseline Oral Literacy and Math Tests by Grade

(T-test significance shown as * p < 0.10, **p < 0.05, *** p < 0.01)

Sub-tests		Grade 1	Grade 2	Grade 3
Literacy	Letter Name	2.89***	8.35***	15.3***
	Familiar Words	3.23	12.2***	26.1***
	Invented Words	4.53	19.8***	28.9***
	Oral Reading Passage	1.51	15.3***	35.3***
	Reading Comprehension	-33.8	38.0***	58.4
Mathematics	Number Discrimination Part A	23.8*	22.3***	10.9
	Number Discrimination Part B	27.6***	59.4	13.5
	Addition Level 1	14.6	25.2***	21.0***
	Subtraction Level 1	11.8	21.5***	22.5***
	Missing Number	13.7	-5.65	33.8***
	Addition Level 2	8.82	29.7***	33.8***
Subtraction Level 2	7.06	26.1***	39.1***	

After the 3-month Kikit School extra-curricular session was provided, the same students who participated in EGRA and EGMA in the baseline were tested at the endline. Test result differences between the endline and baseline are shown in Table 2.

Scores from both baseline and endline are out of a total of 100 for each subtask. Thus, for example, 15.3 points increase for the letter name recognition indicates that on average, third grade students scored 15.3 points higher after participating in the Kitkit Session. Also, 35.3 points increase for underading the oral reading passage indicates that on average, third grade students scored 35.3 points higher after participating in Kitkit Session for 3 month. The statistical significance of the difference is represented at three levels, *** for 99% confidence level, ** for 95% and * for 90%. For most of the subtasks with statistically significant increases, findings indicate that the improvement is statistically significant at **99% confidence level**.

Letter name sub-test results improved for all three grades. Second and third grade students showed improvements for several sub-tests of literacy and math tests, including identifying familiar words and invented word, reading words from a reading passage, and addition and subtraction. However, first graders did better on number discrimination, which asked children to identify which number if bigger in a set of two (part A) and a set of four (part B) numbers. This implicates Grade 2 and 3 children are more ready to learn Eglish as a second language while Grade 1 students need to focus more on learning Kinyarwanda as their mother tongue language. This provides lessons on proper designing of targeting for next intervention.

FINDING 3.**Positive correlation of intervention time to higher achievement**

Students spending more time engaged with Kitkit School, particularly students in 3rd grade, were more likely to pass to advanced stages in math and literacy.

On average, students used Kitkit Session for about 756 minutes, while the intended time use was 1230 minutes. The student who fully utilized the opportunity of Kitkit Session played for 2249 minutes.

As shown in Figure 1, second and third grade students' use was more evenly distributed than first grade students.

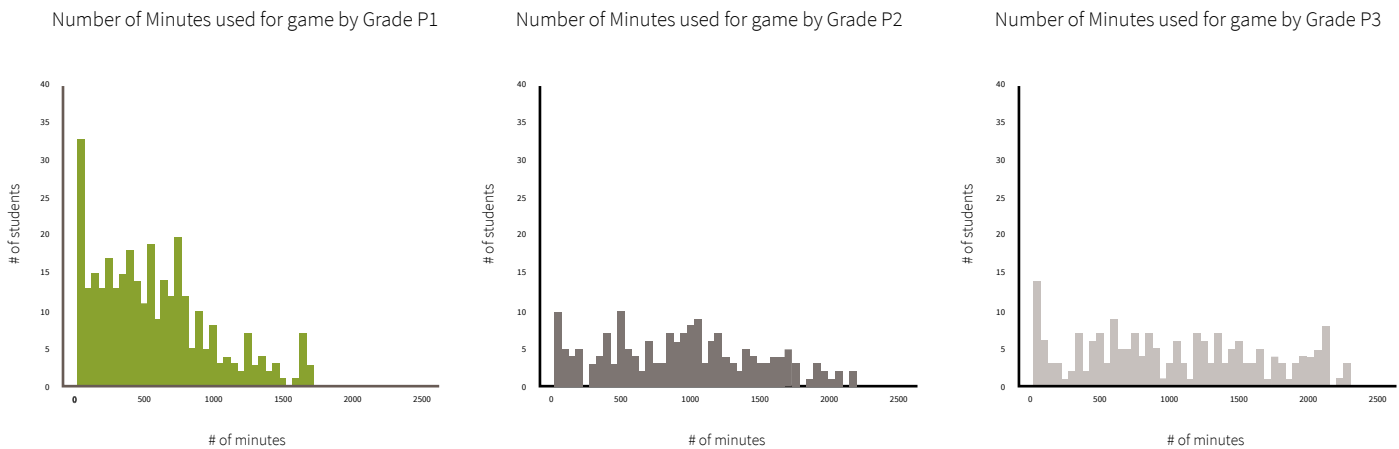


Figure 1. SEQ Figure \^ ARABIC 1 Number of Minutes on Kitkit Session by Grade



In the key part of Kitkit School, students encounter over 2200 activities across Literacy and Numeracy. In each Egg Course, it contains up to 30 learning Sessions. And Sessions includes 4-6 activities. When children complete all the Egg Course, Sessions and Learning Activities in each Literacy and Numeracy Coop, they will have mastered the curricular content in Kitkat system, and built basic English and mathematics skills and concepts.

Kitkit School also provides a built-in Assessment. Each Course includes a Post Test at the end of all the Sessions. This is an Assessment to make sure users have mastered the curricular content in the Course. If they succeed in this Assessment, their last Creature will get a crown, and the next Egg Course will be unlocked. These serve to inform about user's progress with curriculum at different points in the Course.

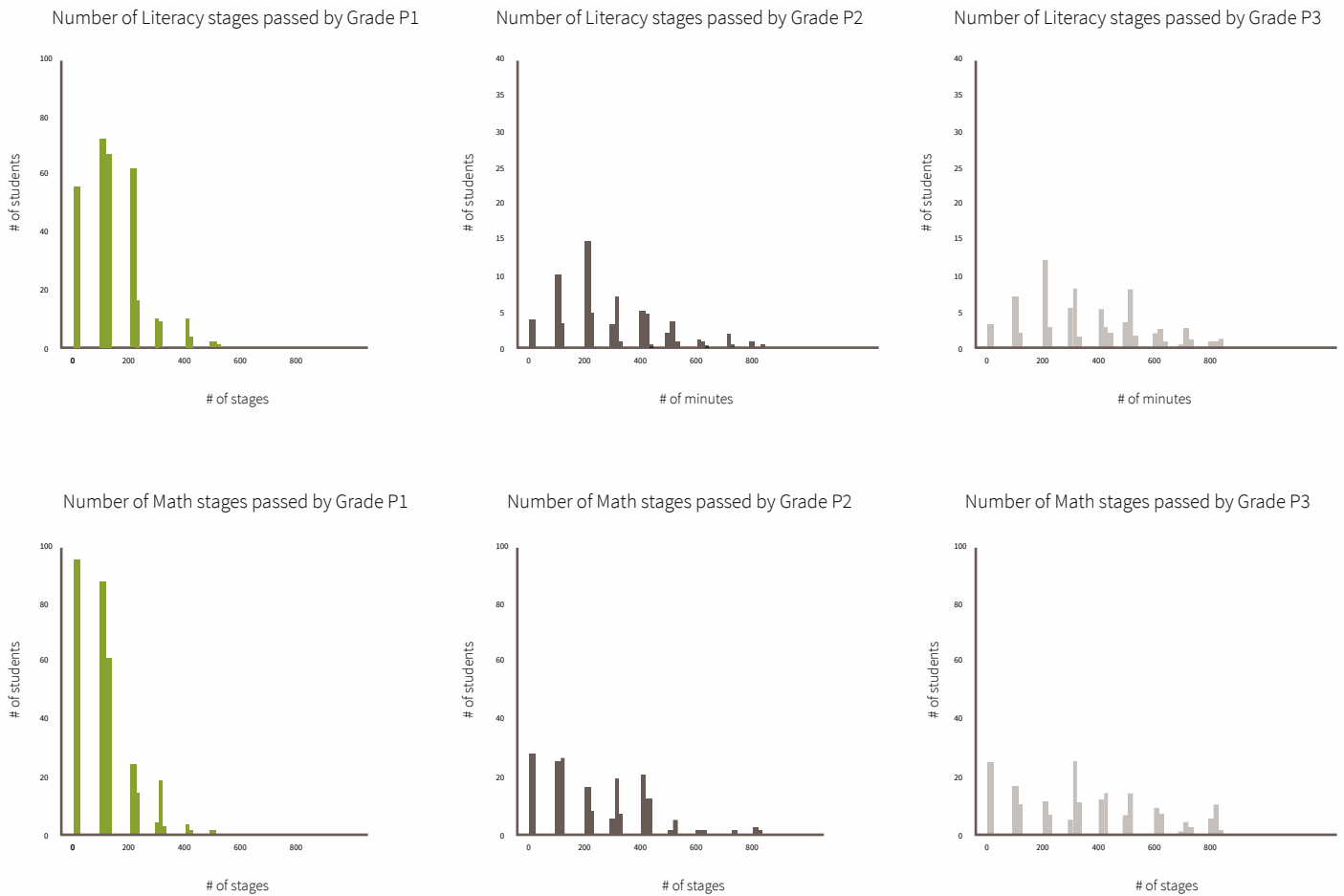


Figure 2. SEQ Figure \^ ARABIC 2 Number of Literacy (top) and Math (bottom) Stages Passed by Grade

In the case, how far students are able to advance in the Kitkit School curriculum for literacy and math lessons are shown in Figure 2. Stages range from 100 to 800, which is referred to as Egg Course 1 to 8 within the Kitkit curriculum. While first grade students do not pass beyond 500 (Egg Course 5) for both literacy and math lessons, fewer second and third grade students stayed in level 0 and greater number of second and third grade students reached level 800 (Egg Course 8). On average, first grade students remain in Egg Course 1 for both literacy and math, while second and third grade students reach Egg Course 2 for literacy and math.

As different level-progress data show, tablet-based 1:1 learning solution enables individualized learning path by reflecting each child's unique learning capabilities and needs. For English as a second language learner, first grade student may need to be paced slowly while third grade could be fast. This implicates the need of reconsideration on design of targeting of the intervention as English learning support program.

FINDING 4.

More improvement when students take-up intended use time

Students were divided into two groups, by using the intended time spent on Kitkit Session as the cutoff, 1230 minutes. For each set of boxplots in Figure 3 and 4, the left boxplot is based on the students who played the Kitkit less than the intended time, while the right boxplot is based on the students who used it more than the intended time. While the orange line indicates the median of the distribution of students' scores on math

or literacy subtask, the blue line represents the average score. Among math subtasks, students who used Kitkit Session more than the cutoff time, scored 9 points higher on average (Figure 3). Among literacy subtasks, students improved most on identifying the letter name, scoring 30 points higher for those who used more than the cutoff time (Figure 4).

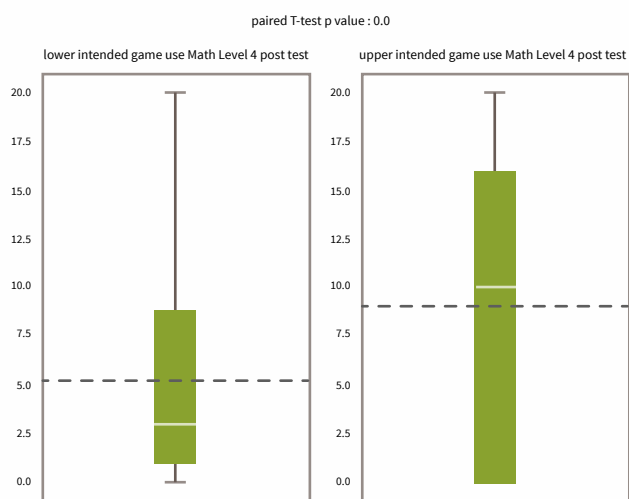


Figure 3 Boxplot of Score Improvement on Math Subtask Missing Number

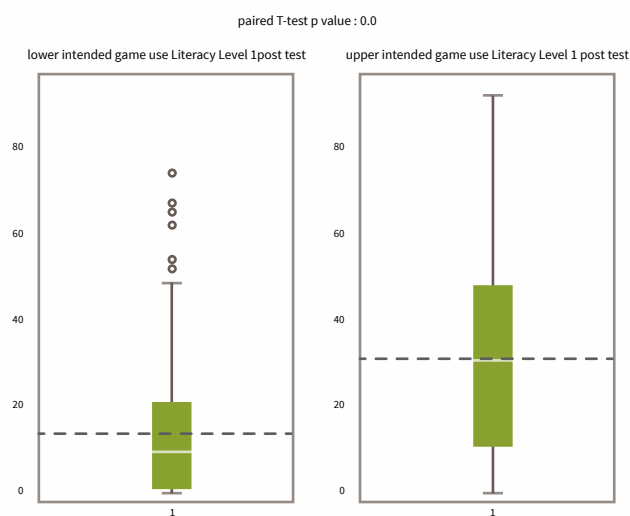


Figure 4 Boxplot of Score Improvement on Literacy Subtask Letter Name

Summary & Recommendations

THE POTENTIAL OF DIGITAL INTERVENTIONS TO SUPPORT SIGNIFICANT LEARNING GAINS AND IMPROVED ACCESS AND ENGAGEMENT FOR STUDENT

Whether digital learning solutions, beyond the provision of digital educational hardware, can deliver improved education experiences for children in low-resource settings is a practical and urgent challenge to be addressed to achieve sustainable development.

Although Kitkit Session was provided as a voluntary extra-curricular activity, it is promising that students actually used it to learn literacy and math skills. Surprisingly, students in higher grades seem to be more engaged with the solution; while third grade students played Kitkit School for 1003 minutes on average, second grade students used it for 905 minutes on average and first grade students for 515 minutes. If GN and Enuma are interested in the second round of the trial, analyzing peer effects of using Kitkit School and the role of facilitators and teachers in the take-up of Kitkit School may be useful to better understand why there are

such differences across grades. Moreover, oral test results indicate that second and third grade students improve on many literacy and math subtasks. Whether these improvements are correlated with specific games within Kitkit School tasks will also be helpful so that teachers have students repeat tasks they need practice in. Digital test results indicate that first grade students spent the least amount of time on KitKit Session, and thus, understanding whether there are social, cultural, or institutional barriers for them to participate also needs attention.

One caveat to consider about this case report is that results provided here are limited to process evaluation, due to the absence of a comparison group. For future plans to scale up this project, it is recommended that the partners utilize a phase-in design to assign treatment and comparison groups of students.

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