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Does Reading-While-Listening Enhance Students' Reading Fluency? Preliminary Results from School Experiments in Rural Uganda

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Abstract
Although studies on the effects of Reading While Listening (RWL) to audiobooks on students' reading fluency is limited, the available emerging literature consistently demonstrates its favourable contribution to improve reading fluency. Since improving fluency is an important instructional goal of primary schools, understanding the role of RWL to audiobooks in improving reading fluency is essential. The goal of the study was to assess the impact of RWL to audiobooks on reading fluency. To achieve this goal, we conducted a randomized controlled experiment using forty six students enrolled in grade 3 at Hadassa Primary School in rural Mbale, Uganda.The significance of the study underscores the current inefficiencies within classrooms globally and the ease with which simple interventions can be implemented to improve fluency. Limitations of the study are discussed.
Keywords: Reading While Listening (RWL); reading fluency; randomized control trial; The Walking School Bus; Uganda; audiobook

1. Introduction

The Walking School Bus literacy and reading program has been developing a comprehensive audiobook program called "SiMBi." This is a mutually beneficial program that provides greater incentive for students in Higher Income Countries (HICs) to actively engage in reading out loud while simultaneously positively impacting literacy overseas (Chase et al., 2009).

The rationale for this program comes from two primary underpinnings:

1. Many students around the world from all socioeconomic backgrounds lack interest and incentive to read (OECD, 2012). At the same time, many students from Lower Income Countries (LICs), lack access to educational material which is necessary to inspire literacy (OECD, 2012).
2. With advances in technology, the way in which people learn and process information is quickly changing and has allowed for improved learning outcomes. For example, it is now understood that reading and listening simultaneously strengthens memory. It also reduces distraction while reading and enables English Language Learners (ELL) students to grasp proper annunciation (Bird, 2002).

Recognizing the abovementioned, we developed The Walking School Bus reading application, "SiMBi". Walking School Bus volunteers read and record chapters of books in the public domain, and make them readily available to students in our partnered communities through audio recordings. Volunteers choose the book and record the chapters. These recordings are then sent to our partnered schools around the world with the attached PDF's available in the reading application. Students in our partnered schools will have the opportunity to listen and read simultaneously. This works as a great teaching tool, helps to cultivate proper English pronunciation, reading fluency, comprehension and hence knowledge acquisition (Vidal, 2011). Additionally it fosters peer-to-peer community and generosity. As volunteer readers, we gain the motivation to read as it has the added benefit of connecting us to and contributing to communities in developing countries. We also gain the practical skills of reading aloud, deepening our students' understanding of the texts through vocal techniques, tone, and verbal processing.

2. Primary Education in Uganda: Brief sectoral context and challenges

The government of Uganda considers education a basic human right but recognizes the need to close the gender-

literacy gap as well as raise fluency rates to the 90th percentile (Okuni, 2004). Participating in education is also viewed as part of the solution to reducing poverty. The government is dedicated to providing equitable access to quality and affordable education to all Ugandans. The Ugandan education system provides four levels of education, starting with an initial non-compulsory pre-school phase of Early Childhood Development for 3-5-year-olds managed by the private sector; which is followed by seven years of free and compulsory primary education for 6- 12-year-olds; four years of post-primary education and training for 13-16-year-olds followed by two years of advanced secondary education; and tertiary and university education. 2009-10 to 2014-15.

The Ministry of Education (MoE) is responsible for the development of policies and policy guidelines on education, setting standards, developing the curriculum, provision of instructional materials, construction of basic school facilities and for monitoring standards through supervision and assessment.

The education sector in Uganda is constrained by many challenges. These include a high level of teacher and student absenteeism, weak school level management structures, inadequate availability of learning materials, and large class sizes (Wandega, 2002). A major issue is also the availability of teachers in disadvantaged areas and a lack of accommodation for teachers in rural, hard to reach areas. Specifically, in primary and pre-primary levels, enrolment is low and has shown only a modest rise in recent years. The Education Sector Strategic Plan (ESSP) 2004-2015 pointed out that as a critical concern: "Primary schools were failing to provide sufficient Ugandan children with literacy, numeracy and basic life skills" (Uganda Education Sector Plan, 2013). Furthermore, a number of factors have been identified by the Ugandan Education Sector Plan (2013) as causes of the low quality in primary education. These are summarized below:

a) High level of absenteeism of head teachers, teachers and pupils;
b) Weak school level supervisory and management structures.
c) Insufficient school inspection and/or low quality of the inspection service,
d) Lack of accommodation for teachers, particularly in hard-to-reach areas;
e) Non-functional SMCs and low level of community interest/involvement in school activities;
f) Inadequate availability of teaching/learning materials in schools;
g) Large class sizes in lower grades (P1-3) often due to enrolment of underage and overage children and high repetition rates, and poor deployment practices in schools that favour the upper years over to the lower ones
h) Difficulties in deployment of teachers in disadvantaged areas;
i) Lack of midday meals for pupils;
j) Misuse of grants.

2.1 Literacy rates

The UNHS defines Literacy as the ability to read with understanding and write a meaningful sentence in any language. The 2012/13 Uganda National Household Survey showed an overall literacy rate of 71 percent among persons aged 10 years and above. Findings reveal that men are more literate than their female counterparts with literacy rates of 77 and 65 percent respectively. A trend analysis indicates a slight increase in the literacy rate over the years for persons 10 years and above from 69 percent in 2005/06 to 71 percent in 2012/13. In rural Uganda, literacy rates remain steady at 66 percent from 2003 through 2103 (Uganda Bureau of Statistics, 2014).

4. Review of Related Literature

4.1 The role of Reading While Listening (RWL) evidence from prior studies

Audiobooks provide an excellent bridge between decoding and comprehension for struggling readers. Children who are reluctant to read or who have particularly low rates of fluency benefit from hearing a text read aloud while following along in a print version. When they are able to hear the words and phrases, these children pick up on the speed and prosody (intonation) appropriate to the reading task and are able to accurately identify more words. The audiobook serves as a positive fluency model for the reader (K12 Reader). Blum et al., (1995) conducted a comparative study between students who participated in home-based repeated reading of books with those home reading while listening (RWL) to audiotaped books to see if RWL has any significant benefit. The study ran for a period of 19 weeks on five international children who had very limited linguistic knowledge. The study showed that compared to those students who did home-based repeated reading, those who participated in reading while listening to audiotaped books substantially benefited and exhibited a greater level of fluency. Chang (2013) also showed improved listening fluency among students who read while listening to audiobooks.

Similarly, Brown et al., (2008) compared learning vocabulary among Japanese students exposed into three reading modes: reading only (RO), reading while listening (RWL), and listening only (LO). They found that students learned most words and understood the story better in the RWL mode, followed by reading only and then LO. Similar findings were also reported and found that listening while reading the same text facilitated and helped improve reading fluency for third-grade students (Rasinski, 2013).

In addition, Shany and Biemiller (1995) found that listening while reading significantly improved the

reading comprehension and fluency of at-risk third and fourth graders, as compared to a control group. Additionally, they found that ‘‘listening while reading resulted in twice the amount of reading as the other [experimental] method [of teacher assisted reading] and led to higher scores on listening comprehension measures’’ (Shany and Biemiller, 1995, p. 382)

Research suggests fluency and comprehension are two distinct processes (Woodall, 2010). A large body of research have shown that students' ability to fluently, automatically decode text is linked to higher levels of text comprehension (Wren, 2006). And students who develop good decoding skills at a young age are typically better at comprehending text in subsequent grades (Juel, 1994). Arguably, for most struggling readers, lack of fluency limits reading comprehension.

When word identification becomes sufficiently fluent and automatic, the child does not have to concentrate on the basic identification of words and can concentrate fully on the meaning of the text (Wren, 2006). Research to support the students listening to books at their instructional level, as we are trying to prove, that the audiobooks are a tool (like a teacher) to help increase fluency.

Vygotsky’s concept of the zone of proximal development offers a different explanation for the effects of simultaneous reading and listening observed in this study (Woodall, 2010). From this sociocultural perspective, the audio recording of the text may have acted like a more experienced or knowledgeable assistant, helping the reader decode to achieve a higher level of reading fluency than he or she would otherwise be capable of doing independently. A sociocultural perspective does not require rejecting either the dual route theory or amalgamation theory (Ehri, 1992). According to this perspective, all higher level thinking, which would include reading, begins on the social or intermental plane and moves to the intramental plane via the intervention of a more experienced ‘‘teacher’’ or collaborator. The audio recording, even though it is a mechanical device, may have fulfilled this social role. Here, too, the Simultaneous Listening and Reading in ESL 197 assisted gains in reading fluency are presumed to facilitate reading comprehension.

According to the National Reading Panel Report, in order to develop reading fluency, it is more beneficial to have children read with guidance than to read silently without feedback (www.nationalreadingpanel.org). In addition, the panel concluded that “deliberate development of reading fluency” should be part of a well designed classroom instructional model.

The International Multisensory Structured Language Education Council, a consortium that accredits training programs for teachers, supports the following principle of instruction: teaching actively involves listening, speaking, reading and writing in order to enhance learning and memory; often visual, auditory, tactile and kinesthetic senses are engaged simultaneously to reinforce associations (Geisert, 1990).

4.2 Fluency: Theory

The processes that underlie reading and writing acquisition are: phonological (awareness of sound structure in words), orthographic (visual memory for sequence of letters in a word) and fluency (speed). Fluency is the ability to read a text at an automatic level with proper expression following appropriate punctuation. It is "the ability to read text rapidly, smoothly, effortlessly and automatically with little attention to the mechanics of reading such as decoding," (Meyer, 1999). It encompasses three components: accuracy, speed, and fluidity (Jong, 2011). It is measured in words correct per minute (WCPM). Although the terms automaticity and fluency often are used interchangeably, they are not the same thing. Automaticity is the fast, effortless word recognition that comes with a great deal of reading practice. In the early stages of learning to read, readers may be accurate but slow and inefficient at recognizing words. Continued reading practice helps word recognition become more automatic, rapid, and effortless. Automaticity refers only to accurate, speedy word recognition, not to reading with expression. Therefore, automaticity (or automatic word recognition) is necessary, but not sufficient for fluency.

Fluency is important because it provides a bridge between word recognition and comprehension. When fluent readers read silently, they recognize words automatically. They group words quickly to help them gain meaning from what they read. Fluent readers sound effortless and are able to read with expression. Their reading sounds natural, as if they are speaking. Readers who have not yet developed fluency read slowly, word by word and do not have the ability to use punctuation as a guide.

Fluent readers do not have to concentrate on the actual decoding (word attack) of the words, so they can focus their attention strictly on the meaning of the text. They are able to synthesize information and make connections among the ideas in the text and their background knowledge. In other words, fluent readers recognize words and comprehend at the same time. Less fluent readers, however, must focus their attention on sounding out the words, leaving them little attention for understanding the meaning of text (www.readingrockets.org).

It is important to point out here that while reading fluency is an essential element in language acquisition through the promotion of comprehension, it received little attention in past research (Chang, 2011).

4.3 Importance of sight words: Dolch Sight Words

A strong foundation in basic sight words is one of the primary components of fluency. Because fluency depends on a reader's ability to quickly and accurately decode words, sight word instruction has a significant and beneficial effect on this aspect of reading. Sight words make up between 50 and 70% of all words in children's literature (http://www.k12reader.com). When a young reader is able to efficiently move through this percentage of the words on a page, their fluency and comprehension rates increase. Therefore sight word instruction is essential to improving a reader's fluency.

Dolch created specific lists of sight words for students to learn at each grade level. They provide a sequence for helping children acquire the words that they will encounter most frequently in their reading. Students should master all of the words on the grade level list before the end of a school year, and then move on to the next list. Similarly, if a child does not commit all of the words on a list to memory by the end of the recommended school year, adults working with the child should continue to help him or her learn all sight words on the previous year's list before moving on to the next grade level's list.

Kindergarten - Grade 1:

The heaviest emphasis on mastering sight words should come in the primary grades. Because a few words are used so often in English language texts, providing children with access to them gives them tremendous advantages as developing readers. Sight word mastery is one of the keys to fluent reading. Young children already have these high frequency words in their verbal vocabularies. Teaching them to read the words simply requires connecting each sight word in the child's memory to the written version of the word.

Dolch's pre-primer list of 40 words is recommended for students in grades K and 1. This list includes the most frequently occurring words in children's books. A, and, for, in, is, it, said, the and to are the building blocks of this list. After learning the pre-primer list, children should be taught the primer list. This list consists of 52 words and includes at, be, but, came, did, do, he, into, no, on, saw, she, was, with and yes. Dolch recommended that children learn all of the words on the pre-primer list by the end of Grade 1.

Grades 2-3:

In grades 2 and 3, parents and teachers should continue to reinforce and teach any sight words from earlier lists that their children have not already acquired while at the same time moving on to Dolch's second and third grade lists. The words placed on these two lists are not seen as often in children's texts as those on the previous lists, but are still essential to reading grade level literature. Dolch's second grade list contains more complex words such as always, before, which, would and your. The third grade list features many high frequency words that cannot be easily decoded by the reader and therefore must be memorized. This list includes about, clean, laugh, myself and together. Since Dolch created (http://www.k12reader.com/).

Given the importance of sight words and their impact on reading fluency, we created sentences comprised of only the sight words in a given list. For example, list one has a complete set of sentences comprised only of words found on list one. List two has a set of sentences comprised of only sight words found in list one and two and so on.

5. Research Question

The present study explores the development of primary students' reading fluency through Reading While Listening (RWL) to audiobooks. The main research question asked is: To what extent do the reading fluency scores differ between the groups who participate in Reading While Listening (RWL) to audiobooks program and control groups after the program?

6. Methods

6.1 Description of the study area, school setting, and participants

The experiment was conducted in Nabagoya Village at Hadassah Primary school in rural Mbale, Uganda where communities have little exposure to technology. It is an Abayudaya school for Jewish, Christian and Muslim children founded in 2001. The classrooms are set up by grade level, but comprised of multi age students. Students come from many neighboring villages up to 20 km away.The school has limited resources and limited exposure to scholastic material including pencils.

Participants: The students' ages were between 8 and 12 years old and all were enrolled in a grade 3 level classroom. The forty-six-person class was divided into two groups: the treatment group (those using our reading application) and the control group (students who read the same books in class using the same font for the same amount of time without the use of simultaneously listening to the text) using random assignment.

6.2 Materials

Electronics for recording: We supplemented the existing computer lab with ten tablets and twenty five pairs of headphones. In addition, we provided stopwatches to both groups to ensure that students read for precisely 10 minutes per day.

Literature for recordings:
High School students from three schools in Vancouver recorded 60 children's audiobooks. Each book is between five and ten minutes in length for the average reader. These recordings became the audio recordings that were paired with the attached PDF's to enable students in our study to read and listen simultaneously.

Teaching Material:
In order to test the students, laminated reading passages were used to test initial and final WCPM. This process also involved training the volunteers and the school teachers to ensure consistent pre and post test WCPM. Volunteers and teachers were trained and practiced on each other.

The control group was given text in two formats: reading passages and sight word lists and sentences. The classroom was given a binder containing the sixty stories as well as one duo tang per student to review sight words. These materials were distributed at the beginning of the lesson and removed from the classroom immediately following the lesson.

6.3 Experimental Design and Outcome Variable
We employed a before-after with control group experimental design in order to evaluate the effectiveness of our reading program. This design randomly divided the class/students into two groups: one group that was exposed to our our reading program (treatment group) and another group (control group) that will not be introduced to the reading application, but will use text alone. The assignment was done randomly to give each and every student under study equal chance to be included in the study which reduced the bias. However both groups still received the same in class instruction and continued to read in class for the required amount of time (10 minutes). At the end of the 30 day trial, both groups were tested to see how their WCPM has changed and/or progressed. A pretest measurement of our outcome variable (WCPM) will be made in both treatment and control groups. After the reading program is implemented and after the 30 day period, posttest measurements were taken of the outcome variables (WCPM) in both groups. The groups were equivalent and hence as comparable as possible. This design can be shown as follows:

Experimental (treatment) group (R) *O1 X O2*
Control group (R) *O3 O4*

$$E = (O2 - O1) - (O4 - O3)$$

Pretest measurements of the dependent variables are taken at the same time from both groups in the beginning (O1 and O3). The R indicates that we randomly divided our class into two groups: experimental group and control group. X symbol shows that only in the experimental of classes were the reading program implemented. And posttest measurements of the outcome variables are taken at the same time in both groups of classes as indicated by O2 and O4. The difference between the treatment (experimental) group and the control group, (O2 - O1) - (O4 - O3), results in a measure of E, the treatment or experimental effect.

Outcome Variable
In assessing the efficacy of our reading program, we used Words Correct Per Minute (WCPM). WCPM has been shown, in both theoretical and empirical research, to serve as an accurate and powerful indicator of overall reading competence, especially in its strong correlation with fluency (Hasbrouk and Tindal, 2006). As such, we decided that this would be our variable of interest to determine the impact behind adopting our reading program. This outcome variable is used by educators to understand how a student has progressed in terms of reading fluency.

6.4 Procedure
Step 1 - Test all students using Florida's Assessments for Instruction in Reading; Ongoing progress Monitoring Oral Reading Fluency (OPM) levelled reading passages. The fluency passages were selected based on ease of language within many cultures. The vocabulary appears to require little to no prior knowledge of concepts: puppies, beaches whereas in other assessments the vocabulary discusses firefighters, citizenship and holidays such as Valentine's day that are culture specific. We are testing to determine the students instructional levels. Instructional level is characterized as being challenging but manageable for the reader in that they are able to read with 90 per cent accuracy. We are targeting instructional levels as opposed to frustration level (less than 90% accuracy) and independent levels (95% accuracy and higher) in order to determine if reading and listening simultaneously improves fluency and acts as an instructional tool.

Step 2 - Using the OPM levelled passages, all of the students were assessed for fluency at their instructional reading level. We chose a grade 1 passage because the average WCPM range was between 25 and 50 WCPM using a random sample which coincides with Hasbrouck and Tindal's fluency assessment chart (see Appendix 1). They were timed reading for 3 consecutive minutes with a WCPM count tracked at the end of each minute. The aggregate of the words per minute between minute 1, 2 and 3 were averaged providing a more accurate assessment of words read per minute to account for fluctuations seen from the beginning to the end of a

passage when fatigue and working memory overload occur.

Step 3 - The students were divided randomly into 2 groups each receiving the same direct instruction from the classroom teacher(s). One group was exposed to our reading program: listen and read simultaneously to one audiobook (passage) each school day as well as exposure to the Dolch Sight Word lists. The students read for ten minutes per day. Once they completed their book, they used the remaining time to study their sight words and sentences.

When dividing the grade three class into two groups we followed a random assignment procedure. This helped us to remain as objective and impartial as possible. Moreover, it was imperative that neither group felt that their 'treatment' was less effective than their counterparts. It is known that human motivation plays a profound role in determining the outcome and will skew results if not accounted for (Chan et al., 1997). This means that students who feel they ought to perform better due to whatever placebo, will in fact outperform their peers. The inverse of this relationship also holds true. Students who feel that they have been given the short end of the stick, (in this case using traditional reading educational materials rather than SiMBi) will perform increasingly poorly compared to their peers. This would greatly skew our results and was taken into consideration from experimental design to implementation. The books they read will be at their instructional level (grade two level). The group not participating in the audio program had a silent reading period to ensure both groups were exposed to the same amount of print each day.

Step 4 - At the end of 30 days, all of the students (both groups) reading fluency was tested by the teachers at Hadassah Primary School. They used the same assessment passage as the baseline data assessment. We believe enough time will have passed that using the same reading passage will not impact the results and we would have the opportunity to look for patterns (if any exist) between the two tests. The students' fluency was again tested for 3 consecutive minutes taking the average WCPM for the 3 minutes.

6.5 Development of baseline data

The first phase of this program was to develop baseline data. For this process, three classes were tested to find a classroom reading at a grade 2 reading level. We selected a grade 2 reading level because the greatest fluency gains are typically observed at this stage of reading acquisition as these students have mastered the basic code and are strengthening fluency at that stage (Hasbrouk and Tindal, 2006). Through this test, students were asked to read a passage at their instructional level. Word counts were recorded at the end of minutes 1, 2 and 3. Students read for a minimum of 3 minutes because minute 1 often has the highest WCPM, then as they become more overloaded, the number of WCPM drops significantly from minute 1 to minute 2. For some students, the difference is 20 WPM different. We then average of the 3 minutes to get an accurate WCPM count. Our educators monitored this process to ensure reliability.

In addition, we tried to capture individual student information (age, grade, gender, etc.) and many other potential variables that can impact WCPM such as the amount of reading that a student currently does (how frequently they read, the last book they read, favorite book, etc), motivational characteristics, and other interesting variables (including some socioeconomic variables, walking distance, daily nutrition-breakfast etc.) through a structured pre test questionnaire. Research has shown that socioeconomic factors have been shown to be substantially related to reading achievement (Chan, 1997).

6.6 Methods of Data Analysis

The three most frequently used statistical methods by researchers to test whether there is statistically significant difference between treatment and control groups in the amount of change in the outcome variable of interest from pretest to posttest are: a t-test on the difference scores, analysis of covariance (ANCOVA), and residual change score analysis (Jennings & Cribbie, 2016).

1. *t-test on the difference scores*: compares the amount of change in the outcome variable from pretest to posttest across groups. The model takes the difference between the pretest and posttest scores and regresses this difference on the grouping variable. This approach tests the null hypothesis of no difference across groups in the amount of raw change from pretest to posttest.
2. *Analysis of Covariance (ANCOVA)*: this approach combines ANOVA and regression methods and treats the pre-test value as a covariate that can be a source of variation that may influence post-test scores, and accordingly the post-test score is regressed on both the pre-test score and the grouping variable (Kisbu-Sakarya et al., 2013). This approach tests the null hypothesis of no difference between the control and treatment post-test scores, conditional on the pre-test scores.
3. *Residual Change Score Analysis*: first it estimates the predicted post-test scores by regressing the post-test scores on the pretest scores, ignoring group assignment. Then residual change is calculated by subtracting the predicted post-test scores from the observed posttest scores, which is then regressed on the grouping variable. This approach tests the null hypothesis of no difference between the control group and treatment group post-test scores, conditional on the pretest scores where the conditioning occurs in the absence of group membership.

Previous studies show that in case of experiments where randomization to groups is performed, the ANCOVA has slightly greater statistical power than the difference score (Jennings & Cribbie, 2016: pp 209). However, (Kisbu-Sakarya et al., 2013), argue that the residual change score method is comparable to the ANCOVA and both approaches have greater statistical power than the difference score. Therefore, in the present study we employ the ANCOVA method. The dependent variable is the post-test scores and the independent variables are grouping variable (treatment/control) and the covariate is the pre-test scores. The post-test score is regressed on the pre-test score and the grouping variable as the pre-test value (serving as a control for initial ability levels) is considered as a covariate potentially exerting influence on post-test scores (Kisbu-Sakarya et al., 2013). By so doing the ANCOVA procedure adjusts the pre-test scores thereby enhancing the power of determining the presence/absence of the effect of the treatment (Jennings & Cribbie, 2016). Following Jennings & Cribbie (2016) we can express the ANCOVA model as:

$posti = \beta 0 + \beta 1\ groupi + \beta 2prei + \varepsilon i$, or

$posti\text{-}prei = \beta 0 + \beta 1 groupi + (\beta 2\text{-}1)prei + \varepsilon i$ in difference score form.

The null hypothesis to be tested using this procedure is: No difference between the control and treatment post-test scores of WCPM, conditional on the pre-test scores

Before running ANCOVA, we conduct some tests to see if the necessary assumptions hold (such as a test of the homogeneity of regression) so that the use of ANCOVA is justified for the data.

7. Preliminary Results

7.1 Descriptive results

The study was conducted at Hadassah Primary School in grade three students who are reading at grade 2 fluency level. The age of students ranges from 6 to 13 with mean age of 9.6 years. Of the total students under study, 26.1% are boys and the 73.9% are girls. For 55.3% of the students English the main language at home followed by Luganda (21.3%). But 63% of the students read English books at home every day. Other languages spoken included Mayris, Lungi, Bagiso, Ganda, Echar, and Liguse.

Concerning means of travel to school, 68.8 % of the students walk to school whereas 14.6% use bus as a major means of transportation to school each day. To understand their breakfast eating habits, we asked students " How many times per week do you have breakfast before starting school?". The results indicate that 84.8% eat breakfast before starting school every day and the most frequently cited type of breakfast food is porridge (39.5%) followed by bread and tea (23.3%) and rice (11.6%).

We also tried to assess the intrinsic and extrinsic reading motivators of students by asking several questions using the pre-test questionnaire. The results show that 82.6% of students state that they like English and 76% state the reason for reading English is because they like stories. However, only 38.3% report that reading English is fun. While 44.7% considered it as boring.

With regard to extrinsic motivation factors, majority of the students point out that they read English because their parents find it important that they read a lot (78.8%), because their parents want them to do so and to make their parents proud (65.2%). On the other hand, 55.6% read English because they have to read for school, 78.3% read English because they think that it is important in life to be a good reader and some 44.4% indicate they read English because they want to learn a lot through reading English.

Furthermore, to determine if there is any difference in terms of their pre-existing level of reading fluency and gender of the student, whether the language at home is English, whether English book is read at home, and whether the student consider English is fun, we conducted independent samples t-test. The result of the analysis (see Appendix 2) show in all the cases there is no statistically meaningful difference between those variables and pre-existing reading fluency level measured by WCPM.

7.2 Empirical results

Before running ANCOVA, we have to check out a couple of assumptions to make sure that the covariate meets the requirements. The first assumption is that pre-test cannot be statistically significantly different across the levels of the independent variable. In other words, there cannot be a difference between treatment and control on the pretest score. To test this, we run an ANOVA with group as independent variable and the pre-test score as dependent variable. The result of this analysis demonstrate no difference between the two groups in terms of pretest scores (as shown in Table 1).

Table 1: Pre-test score between Treatment and Control Groups

Tests of Between-Subjects Effects Dependent Variable: WCPM in pretest					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	118.837[a]	1	118.837	.249	.621w
Intercept	50813.059	1	50813.059	106.501	.000
group	118.837	1	118.837	**.249**	**.621**
Error	16221.913	34	477.115		
Total	69933.000	36			
Corrected Total	16340.750	35			
a. R Squared = .007 (Adjusted R Squared = -.022)					

7.3 ANCOVA results

The descriptive statistics for the experimental outcomes can be found in Table 2. The results show a greater average increase in the word count per minute in the treatment group (from 40.8 to 43.32 words per minute) compared to the control group (from 35.27 to 36.80 words per minute), although the improvement seems fairly modest and the study had a reduced sample size compared to the original experimental design.

Table 2: Descriptive Statistics on Word Count between Treatment and Control Groups

Descriptive	Treatment Group		Control Group	
Statistics	*Pre WCPM*	*Post WCPM*	*Pre WCPM*	*Post WCPM*
Mean	40.80	43.32	35.27	36.80
Standard Error	4.12	4.13	4.45	4.48
Median	37.67	37.67	30.17	31.00
Standard Deviation	19.76	19.78	19.91	20.05
Kurtosis	-0.43	-0.63	-0.56	-0.63
Skewness	0.67	0.64	0.89	0.88
Range	67.33	65.17	61.67	59.50
Minimum	13.67	16.33	14.33	16
Maximum	81	81.5	76	75.5
Count	23	23	20	20

As previously stated, the ANCOVA model can be represented as:

$post_i = \beta_0 + \beta_1\ group_i + \beta_2 pre_i + \varepsilon_i$, or whereby the dependent variable ("post") is the post-test scores and the independent variable "group" is the dummy variable (treatment/control) and the covariate "pre" is the pre-test scores. Using robust standard errors (as initial models suffered from heteroskedastic errors), the ANCOVA model is estimated as follows:

Post-WCPM = 1.566 + 0.994 group + 0.999 pre-WCPM
(.536) (.59) (.016)
n = 43, R^2 = 0.991

Interpreting the "group" coefficient we can say that the post-WCPM scores are approximately 1 word per minute higher on average in the treatment group compared to the control group. The control and pre-WCPM are highly significant (p-values less than 0.001) and the group coefficient is only significant at the 10% level. Due to failing misspecification tests (RESET), alternative transformations were considered in this study. It was found that a log-log model specification created a model with homoscedastic errors with no signs of misspecification.

The log-log model generated is:

Log(Post-WCPM) = 0.264 + 0.032 group + 0.939 Log(pre-WCPM)
(.044) (.016) (.013)
n = 43, R^2 = 0.99

Interpreting the "group" coefficient in the log-log model (taking its exponent) we can say that the post-

WCPM scores are 3.2% higher in the treatment group compared to the control group and the treatment effect "group" is significant at the 5.1% level of significance. The control and pre-WCPM variables are again highly significant (p-values less than 0.001).

A final form of analysis is to carry out a t test to determine if this there is a significant difference in the mean improvement between the treatment and control groups. In other words,

Our t test (t statistic = 1.66) provides sufficient evidence at the 5% level of significance to reject the null hypothesis and conclude that the mean improvement in word count in the treatment group is greater than the mean improvement in the control group.

8. Limitations

There are several limitations to this study. We broadly classified them into statistical, cultural, technological and locational limitations and we briefly discuss them below.

Statistical

The first one is the sample size and its composition. As a pilot study, this experiment focused on one rural village in Uganda and one classroom in the school limiting our sample size to forty six students. We could not enlist a second classroom on board the program because logistically getting a computer person to the school to help us was difficult enough for one classroom. We did not have the physical presence to include a second classroom in the study; it would have required us to be there for the implementation of the entire program. In addition, during our testing period, the school tuition was due and the students who were unable to pay their tuition were "chased away" as the headmaster told us, meaning they were sent home. There is a the need for larger study with larger sample size with diverse student population.

Cultural

At the school in Uganda, they spoke a form of English that was a second language to many of the students. It was difficult to communicate with the students as they did not always understand what we were trying to explain to them particularly with the reading questionnaire. They struggled with the language and meaning of the passages we selected. The passage was called "A Trip To The Farm" and the majority of the students did not read the word "farm" and didn't know what the word meant. When asked for their "last names", they did not know how to respond until we changed the wording to "second name." Additionally, the reading questionnaire focused on motivation as a predictor for reading success as well as time spent reading at home, we feel there should have been questions about light, power and access to books at home as that could play as much of a role if not more than motivation.

Technological

The students had limited exposure to computers and in addition to needing to learn how to use the reading application, had to be shown how to use the computer. There are limitations with the wifi which we resolved while we were implementing the program. We used some language in the app that the students did not understand such as "previous" page and "next" page.

9. Conclusion

This study was conducted as a preliminary investigation into the potential benefits associated with a new reading application software called SiMBi that facilitates Reading While Listening (RWL) that may potentially improve reading fluency and comprehension. A randomized control experiment was conducted on forty six students enrolled in grade 3 at Hadassa Primary School in rural Mbale, Uganda. The preliminary results of this study demonstrate that the RWL app is a promising tool to potentially improve both reading comprehension and fluency of the English language. Despite various limitations (that have been broadly defined in this paper as statistical, cultural, technological and locational limitations), our study shows a significant word count per minute improvement in the treatment group compared to the controlled group over a 30 day period of regular use. Future work will focus on applying a similar study in a larger scale (devoid of similar limitations) to further investigate the true effects of this innovative reading application. Our research team are conducting two additional studies to further understand the efficacy of SiMBi. The first study is set in Putti Village outside of Mbale, Uganda and includes a statistically significant sample size of 150 students who have been given access to the SiMBi application through the implementation of a SiMBi classroom which provides the students with constant access to an offline version of the app. Our research team is also focusing on two studies within the North American context. The first is a continuation of the abovementioned study that aims to replicate the results with students in HIC's with greater exposure to technology. The second is to further understand SiMBi's impact in improving student motivation to read through both qualitative and quantitative analysis.

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Appendices

Appendix 1:

Hasbrouck & Tindal Oral Reading Fluency Data

This table shows the oral reading fluency rates of students in grades 1 through 8, based on an extensive study conducted by Jan Hasbrouck and Gerald Tindal. The results of their study are published in a technical report entitled, "Oral Reading Fluency: 90 Years of Measurement," which is available on these websites:

- **ERIC website:** eric.ed.gov/?id=ED531458
- **BRT website:** www.brtprojects.org/publications/technical-reports

This table can help you assess the oral reading fluency of your students relative to their peers. Students scoring 10 or more words below the 50th percentile using the average score of two unpracticed readings from grade-level materials need a fluency-building program. Teachers can also use the table to set long-term fluency goals for struggling readers.

For more information:

- **Essential Components of Reading:** readnaturally.com/components
- **Correlation Between Oral Reading Fluency and Overall Reading Achievement:** readnaturally.com/correlation
- **Read Naturally Tools for Assessing Fluency:** readnaturally.com/assessment-tools
- **Read Naturally Intervention Programs That Develop Fluency:** readnaturally.com/fluency-interventions

Grade	Percentile	Fall WCPM*	Winter WCPM*	Spring WCPM*	Avg. Weekly Improvement**
1	90		81	111	1.9
	75		47	82	2.2
	50		23	53	1.9
	25		12	28	1.0
	10		6	15	0.6
2	90	106	125	142	1.1
	75	79	100	117	1.2
	50	51	72	89	1.2
	25	25	42	61	1.1
	10	11	18	31	0.6
3	90	128	146	162	1.1
	75	99	120	137	1.2
	50	71	92	107	1.1
	25	44	62	78	1.1
	10	21	36	48	0.8
4	90	145	166	180	1.1
	75	119	139	152	1.0
	50	94	112	123	0.9
	25	68	87	98	0.9
	10	45	61	72	0.8
5	90	166	182	194	0.9
	75	139	156	168	0.9
	50	110	127	139	0.9
	25	85	99	109	0.8
	10	61	74	83	0.7
6	90	177	195	204	0.8
	75	153	167	177	0.8
	50	127	140	150	0.7
	25	98	111	122	0.8
	10	68	82	93	0.8
7	90	180	192	202	0.7
	75	156	165	177	0.7
	50	128	136	150	0.7
	25	102	109	123	0.7
	10	79	88	98	0.6
8	90	185	199	199	0.4
	75	161	173	177	0.5
	50	133	146	151	0.6
	25	106	115	124	0.6
	10	77	84	97	0.6

*WCPM = Words Correct Per Minute

www.readnaturally.com

**Average words per week growth

Appendix 2: T-test results

T-test

Group Statistics

EnglishAtHome		N	Mean	Std. Deviation	Std. Error Mean
WCPM n pretest	no	15	38.0667	20.04447	5.17546
	yes	20	39.6000	23.54481	5.26478

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-ailed)	Mean Difference	Std. Error Difference	Lower	Upper
VCPM in pretest	Equal variances assumed	.879	.355	-.203	33	.840	-1.53333	7.55800	-16.91019	13.84352
	Equal variances not assumed			-.208	32.401	.837	-1.53333	7.38263	-16.56397	13.49731

T-test

Group Statistics

EnglishFreq		N	Mean	Std. Deviation	Std. Error Mean
VCPM in pretest	otherwise	13	39.6154	23.14641	6.41966
	Always	21	38.5714	22.09202	4.82087

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-ailed)	Mean Difference	Std. Error Difference	Lower	Upper
VCPM in pretest	Equal variances assumed	.326	.572	.132	32	.896	1.04396	7.93797	-15.12516	17.21307
	Equal variances not assumed			.130	24.648	.898	1.04396	8.02825	-15.50254	17.59045

T-test

Group Statistics

EnglishFun		N	Mean	Std. Deviation	Std. Error Mean
VCPM in pretest	no	4	39.7500	21.40677	10.70339
	yes	31	38.4839	22.32916	4.01044

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
VCPM in pretest	Equal variances assumed	.109	.743	.107	33	.915	1.26613	11.81932	-22.78046	25.31271
	Equal variances not assumed			.111	3.894	.917	1.26613	11.43005	-30.81306	33.34532

T-test

Group Statistics

EnglishBoring		N	Mean	Std. Deviation	Std. Error Mean
VCPM in pretest	no	9	45.5556	22.28290	7.42763
	yes	26	36.2308	21.71139	4.25795

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
WCPM in pretest	Equal variances assumed	.183	.671	1.103	33	.278	9.32479	8.45091	-7.86873	26.51830
	Equal variances not assumed			1.089	13.650	.295	9.32479	8.56154	-9.08213	27.73170

T-test

Group Statistics

Gender of the student		N	Mean	Std. Deviation	Std. Error Mean
WCPM in pretest	Male	8	33.5000	13.86671	4.90262
	Female	26	40.1538	23.81544	4.67059

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
WCPM in pretest	Equal variances assumed	5.824	.022	-.747	32	.460	-6.65385	8.90541	-24.79358	11.48588
	Equal variances not assumed			-.983	20.698	.337	-6.65385	6.77127	-20.74799	7.44030