WhatsApp Remote Reading Recovery: Using Mobile Technology to Promote Literacy during COVID-19

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Abstract

School closures because of the COVID-19 pandemic affected over a billion young people worldwide and presented a threat to long-term learning, particularly for public school students in low socioeconomic situations. This article offers quasi-experimental evidence on a low-cost strategy for distance learning applied in the Republic of Panama to minimize the negative consequences of the pandemic on public elementary school children's reading levels. We conducted a 12-week intervention that utilized mobile phone technology and dissemination of reading material through WhatsApp, a cross-platform messaging freeware service, to maintain and improve children's reading levels during the pandemic school shutdown. The objective was to determine the feasibility of using WhatsApp as a digital tool to facilitate education and inform evolving practice and policy responses. Results among 292 students between the second and sixth grades indicated overall mean gains of up to 10.3% in the number of words read per minute, with statistically significant improvements overall and higher gains among the second and third grades. In addition, the adoption rate was high, with a reported average of 84% completion of the daily readings. The results of this low-tech intervention have immediate and longer-term implications for using mobile technology as a supplemental or complementary learning tool, especially for developing regions and during school closures or school vacations.

Keywords: EdTech, evaluation research, literacy

The COVID-19 pandemic closed schools and negatively affected learning for 1.6 billion young people, over 90 percent of the worldwide student population, threatening long-term education outcomes for a generation of learners (United Nations, 2020). School closure is associated with widespread learning loss (Andrabi, Daniels & Das, 2020; Angrist et al., 2020; Jaume & Willén, 2019; Slade et al., 2017). Moreover, this interruption at critical schooling stages, such as when children learn to read, can negatively affect outcomes and contribute to higher dropout rates and reduced productivity. Translated into economic terms, the World Bank projects that the educational interruption caused by COVID-19 could represent a global financial cost of up to $10 trillion (Azevedo et al., 2020).

The effects of school closures can be particularly devastating for students from low-socioeconomic situations without access to resources that facilitate learning from home. Many governments and schools around the world have turned toward technology as the most expedient means to providing distance learning, yet those without adequate access to information and communications technology (ICT) are at a distinct disadvantage (Angrist et al., 2020; Azevedo et al., 2020, Save Our Future, 2020). Adequate access is of critical concern in developing regions where much of the population often lacks ICT infrastructure and where COVID-19 has exacerbated existing educational inequalities (Azevedo et al., 2020; Save Our Future, 2020; United Nations, 2020).

COVID-19 has made more visible not only the digital divide within and between countries but also how these technological differences disproportionately impact developing countries and poor communities. Given this scenario, the most effective national responses to the COVID-19 education crisis must include a range of high- and low-tech measures to propel instruction delivery and reach as many families as possible. Successful distance learning strategies rely on multiple delivery approaches and will vary according to the conditions associated with each context (Save Our Future, 2020; Angrist et al., 2020).

This article presents evidence of a low-tech strategy applied in the Republic of Panama designed and implemented to minimize the negative consequences of the pandemic on public primary school children's reading levels. Thus, we examined the results from a 12-week distance learning intervention that utilized mobile phone technology to promote the maintenance and improvement of children's reading levels during the pandemic school shutdown.

Literature Review

Literacy in Panama

Panama's national standardized test, the *Crecer* evaluation, which annually measures learning outcomes in third graders through five performance levels, shows that roughly half of public school third graders test at low or very low literacy levels (MEDUCA, 2018). These data also reveal considerable achievement gaps. Third graders in private schools obtain significantly higher scores than their public counterparts. Similar results in regional UNESCO-led evaluations highlight outcomes below the averages for much of Latin America and the Caribbean (UNESCO, 2016). These pre-pandemic statistics highlight inequities between Panama's public and private school systems and reflect relative underperformance in the public schools. With prolonged absence from school, the risk is that students' attainment levels will further diminish across a range of academic outcomes (Carroll, 2010; Gottfried, 2014).

The combination of pervasive underperformance and school closures because of the pandemic became a concern for elementary school literacy. Moreover, since learning in other subjects at all levels is linked to early reading comprehension, setbacks at this stage will likely affect future learning negatively in multiple ways (Cunningham & Stanovich, 1997; National Institute for Literacy, 2008). Thus, for Panamanian public school students, the COVID-19 crisis threatens an entire cohort's learning possibilities.

COVID-19 and Education: Worldwide and in Panama

The coronavirus pandemic disrupted education systems in almost every country, forcing most schools to close for extended periods and jeopardizing education outcomes for over a billion learners of all ages and over 100 million students in Latin America and the Caribbean alone (UNESCO, 2020). This situation has intensified the global education crisis, pushing an already precarious situation to the brink of catastrophe. Even before COVID-19, international organizations had documented the extent of global educational inequities and how disproportionate opportunities for quality learning keep large blocks of young people from reaching their potential and participating productively in the global economy (Education Commission, 2016; Psacharopoulos & Patrinos, 2018; Save Our Future, 2020; UNESCO, 2016). For example, half of the children in low- and middle-income countries are not learning to read correctly by age 10 (Save Our Future, 2020). Furthermore, less than 25 percent of children in low-income countries and only 50 percent in lower and middle-income countries complete secondary education (Education Commission, 2016). Nearly 90 percent of the world's school-aged children live in low- and middle-income countries; thus, this inequity lays the foundation for a skills gap that will negatively affect economic growth and have far-reaching social repercussions (Education Commission, 2016).

The COVID-19 crisis worsened these pre-existing disparities. The learning losses may extend beyond this generation, reversing decades of educational progress. The UN estimates that nearly 24 million additional children and youth may drop out or be unable to access school because of the pandemic's economic impact alone (United Nations, 2020).

The Republic of Panama, a small country in Central America with a population of approximately four million, has just over 400,000 registered primary school students, 87% in its public system (INEC, 2017). The pandemic forced a strict national quarantine and school closure beginning in March 2020. The Panamanian school year runs from March to December, which resulted in most students attending school in 2020 for only a few days when the new school year began before the COVID-19 shutdown.

The government announced an official return to class starting July 20, 2020, but all activity shifted to distance learning, which continued through 2021. Panamanian schools encountered numerous obstacles in their struggle to return to classroom learning and led global lists of nations with the most consecutive days out of school (De Hoyos & Saavedra, 2021; Svenson, 2021). Before the outbreak of COVID-19, Panama did not have broad-based remote learning platforms or academic content prepared for home delivery via the Internet, TV, or radio. Since the second half of 2020, Panama's Ministry of Education, or MEDUCA for its acronym in Spanish, implemented radio, TV, and internet-based programming, as well as conducted numerous training to bring its teachers up to date with educational technology (EdTech) (MEDUCA, 2020).

Nevertheless, the fact that many public system students and teachers in Panama (and the rest of Latin America) did not have adequate access to or experience with using advanced ICT (Saez, 2020) complicated distance learning. Additionally, many families had little access to supplemental learning materials or programs in their homes, compounding pandemic education difficulties. Given the circumstances of prolonged school absence and limited learning opportunities, these students risk considerable academic setbacks (MEDUCA, 2020), especially regarding reading skills, as these skills form the base for subsequent learning (Cunningham & Stanovich, 1997; National Institute for Literacy, 2008).

Distance Education, Technology, and Equity Implications

Digital technology offers many possibilities for education (Yang, Kuo, Ji, & McTigue, 2018), and Panama's MEDUCA worked to build more technology-assisted learning into its system because of the pandemic (MEDUCA, 2020). However, a family's ability to utilize this depends on its access to connectivity. Many do not have access to a fixed Internet connection, computer, or even electricity. Only an estimated 40% of public-school students have access to the Internet at home, and less than 30% have a computer (INEC, 2017).

Although Internet access is limited in many parts of the country, mobile connections are more extensive. 100% of Panamanians report cellular phone ownership (indicating that some have more than one), and 62% report some Internet use (Kemp, 2020). This coverage varies considerably by region; the indigenous territories and other areas far removed from urban centers are among the most disadvantaged concerning cellular accessibility (De Leon, 2020; INEC, 2017). Nevertheless, most Panamanian families in the public school system have at least one mobile phone and some type of access to the Internet, even if it is intermittent.

In early 2020, there were 2.4 million social media users in Panama, an increase of 9.0% over 2019 (Kemp, 2020). Most Panamanian social media users also have access to WhatsApp, a free instant message application that operates across multiple platforms to transfer text and multimedia material (Dichter y Neira, 2015). The accessibility of this ubiquitous, potentially inexpensive, user-friendly platform has made WhatsApp a convenient for learning and messaging. Research is beginning to signal its success as an educational tool.

An exploratory qualitative study conducted in Israel with high school teachers found WhatsApp class groups helpful in communicating with students, creating a sense of belonging, promoting dialogue, and using and sharing a learning platform (Bouhnik & Deshen, 2014). It is helpful for studies to explore student perceptions regarding the use of WhatsApp, as successful adoption for educational interventions would depend mainly on students' willingness to use and enjoyment of using such a platform. In India, a controlled trial used WhatsApp to improve children's English reading and comprehension skills in grades 4 through 7 across 50 rural government schools in the Bundi district (Voluntary Services Overseas (VSO)/Pratham Foundation, 2015). Pratham Foundation's (2015) study serves as a precursor to show that WhatsApp works as a learning tool for small children. Also in India, a comparative study showed that fourth-semester medical school students who studied pathology via WhatsApp, as opposed to didactic lectures, achieved higher average scores on post-test assessments (Gon & Rawekar, 2017).

During the COVID-19 pandemic, WhatsApp demonstrated potential as a supplementary instructional vehicle for students at all levels. In addition, it garnered the interest of educators

in developing countries because it offers a relatively low-tech, low-cost means for delivering digital learning to a large portion of the school-age population.

WhatsApp as an Educational Tool

Research documents the positive effects of reading interventions over vacation periods when children, especially low-income students, are out of school for consecutive months with few opportunities to reinforce reading skills (Allington et al., 2010; Beach et al., 2018). In addition, research has also shown how mobile technology is a feasible alternative for delivering reading material to children, particularly those living in rural areas or lacking educational and technological resources (Sung et al., 2015; Kim, Miranda, & Olaciregui, 2008). Combining these two proven concepts to promote continued reading among primary school students during out-of-school periods through widely available mobile technology became a significant challenge during COVID-19. This challenge prompted the design of mobile literacy programming utilizing cell phones and the WhatsApp messaging platform to address the reading dilemma during the pandemic school closure.

WhatsApp is a familiar vehicle used by most households and Panamanian teachers to communicate with parents. A routine learning opportunity occurred within an already known and comfortable digital system by adding a reading delivery element to this communication. This ease-of-use aspect would increase the likelihood of adoption and application of the learning opportunity as it did not require learners or facilitators to confront the navigation of complexities associated with new platforms or applications (Plutino, Borthwick, & Corradini 2019). This study sought to determine the feasibility of using WhatsApp as a digital tool to facilitate education through an educational intervention of daily delivery of readings by WhatsApp to students in elementary school. The goal was for students to maintain (or expand) their reading skills during school closure.

Using input from other programs that demonstrated positive results (Bouhnik & Deshen, 2014; Gon & Rawekar, 2017; Voluntary Services Overseas (VSO)/Pratham Foundation, 2015), this intervention targeted elementary school students in the public system (grades 2-6) who were able to read and had access, through their families, to a mobile phone and a WhatsApp account. The hypothesis was that by establishing a daily reading habit, these students could sustain (or possibly expand) existing abilities and avoid reading setbacks due to prolonged classroom absence. The project delivered grade-appropriate digital stories through parent-teacher WhatsApp groups to 292 students to stimulate daily reading during the COVID-19 quarantine. Intervention pre- and post-tests measured students' reading levels and evaluated rate, fluency, and comprehension. These tests were also conducted remotely via WhatsApp.

The main research question guiding the study was: can WhatsApp be utilized effectively as an EdTech tool to maintain or increase reading levels in elementary school children? The specific questions were:

1. Did a reading intervention through WhatsApp significantly improve words read per minute (WRPM)?
2. Did a reading intervention through WhatsApp lead to a more substantial improvement in lower elementary grades (2-3) than in students in higher elementary grades (4-6)?
3. Were levels of take-up achieved through a reading intervention delivered through WhatsApp?

Method

Design

The study was quasi-experimental, with a single sample of participants who received the WhatsApp Remote Reading Recovery intervention, evaluated through a pre-test before the intervention began, a post-test one at week seven, and a post-test two at week 12. During the first seven weeks of the intervention, which took place between May and June of 2020, the public school system was not offering courses in any format, meaning most students in the country were not receiving formal educational instruction. During weeks 8 to 12 of the intervention, the public school system started offering online courses. The study measures were speed, through the count of words read per minute (WRPM). Another measure for this study was the level of adoption, or take-up, self-reported by parents to teachers to confirm that the child had completed the daily reading. Teachers used spreadsheets (manual or digital) to keep track of adoption levels.

Teachers were responsible for sending out the PDF files via WhatsApp with the daily readings to the parent or caretaker of each student participating in the project. Furthermore, teachers collected data by recording WhatsApp video calls and using pre-existing benchmark readings with word count rubrics to measure WRPM. Once the data were collected, tabulated, cleaned, and checked, researchers conducted the statistical analyses.

Ethics

This study was reviewed and approved by the Ethics Committee at Quality Leadership University. In addition, all participants' guardians provided digital written informed consent through WhatsApp.

Participants

Study participants were elementary school students in the public school system from second to sixth grade. Teachers contacted the students' parents via WhatsApp, invited them and their children to participate in the study, and obtained parental consent.

The sample of 292 (grades 2-6) was composed of 47% male (n=138) and 53% female students (n=154). Distribution among the grades and geographic regions studied is depicted in tables 1 and 2, respectively. The distribution of participants by educational region shows that most participants were within the metropolitan area of Panama (Panama Center, West, North, and San Miguelito) and accounted for 76% of study participants. Despite recruitment efforts, teachers and students from indigenous communities did not participate in the intervention. Nine out of sixteen educational regions in Panama participated in this study.

Table 1
Distribution of Participants by Grade

Grade	%	n
Second	30	88
Third	13	37
Fourth	22	63
Fifth	19	56
Sixth	16	48

Table 2
Distribution of Participants by Educational Region

Region	%	n
Bocas del Toro	1.5	4
Chiriqui	2	5
Cocle	12	35
Colon	1.5	4
Panama Center	22	64
Panama Norte	6	18
Panama West	27	79
San Miguelito	21	61
Veraguas	7	21

Procedure

In April 2020, Panama's Centro de Investigación Educativa (Center for Education Research, CIEDU), ProEd Foundation, and Quality Leadership University (QLU) came together to design and implement the WhatsApp Remote Reading Recovery project. MEDUCA and a corps of 60 volunteer public school teachers supported this initiative, maintaining contact with students and their families throughout the onset of the pandemic and the closure of schools. The project was also the focus of an official MEDUCA COVID-19 teacher-training program. The teacher training, project fieldwork, and evaluation research were implemented from April to August 2020 to produce results to inform MEDUCA decision-making related to supplemental digital literacy support and contingency planning for potential future education disruptions.

The first phase of this project involved recruiting, training, and coaching MEDUCA primary school teachers to implement the intervention. Teachers had the opportunity to take a certificate course in action research within MEDUCA's teacher training program, which included an applied component that required teachers to be field implementers of the project. The teacher-training portion lasted approximately 80 hours, including synchronous instruction, discussions, small group coaching, and follow-up sessions. As an incentive to follow through with the requirements of this project, teachers received a certificate of participation and points toward the Panamanian point-based promotion system for public school teachers. Teachers participated from regions around the country in the teacher development program and used WhatsApp to send their students daily readings over 12 weeks for a total of 60 readings.

Teachers committed to sending each student one reading per weekday during the intervention. Teacher training included courses on literacy assessment, daily reading distribution and pre/post-test materials, WhatsApp broadcast group setup, communications design for parents, and data registration. All volunteer teachers also participated in monthly workshops and weekly coaching sessions to maintain implementation fidelity. Teachers monitored daily take-up of the intervention by logging delivery, receipt, and completion of the readings. Researchers used these data to measure take-up levels of the readings as a percentage of the total content delivered throughout the intervention. Teachers also video-recorded students' pre- and post-test words read per minute through WhatsApp. Six researchers coached the teachers and took notes during each follow-up session to provide qualitative data to complement the analysis. The discussion of results contains observations that occurred during these sessions.

The second phase of this project involved taking the data from the video recordings of all students' pre- and post-test readings and quantifying it to assess WRPM. We stored all video data in a cloud drive. Five additional teachers who had received previous literacy training through the ProEd Foundation but did not take part directly in the first phase of the project implementation received training as evaluators to process the data recorded.

Data Analysis Techniques

We used Statistical Package for the Social Sciences (SPSS) to analyze the data. An inspection of boxplots revealed five outliers in the data; however, outliers were kept as part of the sample. Words read per minute for each time point was normally distributed, as assessed by the Shapiro-Wilks test ($p>0.05$). Mauchly's test of sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(2)=0.898$, $p=0.638$. We conducted a one-way repeated measures analysis of variance (ANOVA) to determine whether there were statistically significant differences in WPRM throughout the 12-week reading intervention. Afterward, we conducted a Bonferroni post hoc test to determine whether there were statistically significant differences in WRPM between the different time points.

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Results

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This section presents the results of the implemented intervention designed and implemented, which aimed to minimize the pandemic's negative consequences on public primary school children's reading levels.

Overall, with the five grades combined, the results indicated a statistically significant gain in WRPM over time $F(2,582)=52.16$, $p<0.001$, partial $\eta^2=0.15$, with WRPM increasing from week 0 (M=81.51, SD=1.84) to week 7 (M=95.18, SD=1.91), and then slightly decreasing in week 12 (M=89.89, SD=1.88). The mean WRPM was 81.5, with a reported increase at the end of the 12 weeks to 89.9, representing a 10.3% increase. However, the mean WRPM at week 7 was 95.2, representing a 16.8% increase at the midpoint of the intervention. Post-hoc tests revealed a statistically significant increase in WRPM from week 0 to week 7 (*M*=13.67 WRPM, 95% CI [10.34, 17.0], $p<0.0005$), and from week 0 to week 12 (*M*=8.38 WRPM, 95% CI [5.21, 11.55], $p<0.0005$), despite a statistically significant decrease in WRPM that occurred from week 7 to week 12 (*M*=-5.29 WRPM, 95% CI [-2.03, -8.54], $p<0.0005$). The intervention elicited significant gains, including an effect size of partial $\eta^2=0.15$, which indicated a large effect according to SPSS rules of thumb (SPSS, 2022).

The lower elementary grade group comprised 125 second and third-grade participants. Upon a closer look at this group, WPRM was statistically significantly different at the different time points during the intervention for the lower elementary grade group, $F(1.864, 231.084)=75.099$, $p<0.001$, partial $\eta^2=0.377$. The effect size for the lower elementary group is larger than that for the overall group. In addition, post hoc tests revealed a statistically significant increase in WRPM from week 0 to week 7 (*M*=20.944 WRPM, 95% CI [16.218, 25.670], $p<0.001$), and from week 0 to week 12 (*M*=15.496 WRPM, 95% CI [11.089, 19.903], $p<0.001$), despite a statistically significant decrease in WRPM that occurred from week 7 to week 12 (*M*=-5.448 WRPM, 95% CI [-9.163, -1.733], $p=0.002$). This group started with significant gains, which decreased in the second half of the intervention, but resulted in a significant general increase.

The upper elementary grade group was comprised of 167 fourth, fifth, and sixth-grade participants. For this group, WPRM was statistically significantly different at the different time points during the intervention for the upper elementary grade group, $F(1.915, 317.870)=9.727$, $p<0.001$, partial $\eta^2=0.055$. Post-hoc tests revealed a statistically significant increase in WRPM from week 0 to week 7 (*M*=8.222 WRPM, 95% CI [3.825, 12.618], $p<0.001$), an increase that was not statistically significant from week 0 to week 12 (*M*=3.054 WRPM, 95% CI [-1.179, 7.286], $p=0.246$), and a statistically significant decrease in WRPM that occurred from week 7 to week 12 (*M*=-5.168 WRPM, 95% CI [-10.175, -1.179], $p=0.041$). This means that this group started with significant gains, which decreased in the second half of the intervention, and resulted in a general increase that was not significant. However, SPSS rules of thumb indicate that a partial eta squared of .055 is equivalent to a small to medium effect (SPSS, 2022).

Another measure tabulated for this study was the rate of adoption, or take-up, where we used available data from a sample of 187 students in second and fourth grade and found that, on average, students completed 84% of the daily readings or an average of 51 of a total of 60 readings. This means that most students regularly completed the daily readings and assigned tasks.

Inter-Rater Agreement

We ran inter-rater agreement tests to ensure evaluative uniformity and assessment fidelity for a randomly selected sample portion. Inter-rater agreement is a critical – and often overlooked – component affecting assessment fidelity; thus, incorporating high inter-rater agreement within the research design is vital for ensuring data integrity (Reed, Cummings, Schaper &

Biancarosa, 2014). Therefore, we implemented the following process to determine the degree of inter-rater agreement:

1. Groups of students were assigned to the five evaluators. Each video was evaluated by one of the evaluators, and a group of students was randomly selected to be assessed by a second evaluator to obtain the degree of inter-rater agreement. The second randomized evaluation was conducted for 74 of the 292 students, or approximately 25% of the sample.
2. Each evaluator calculated the total WPRM for the pre-test, post-test one, and post-test two.
3. The results of the records chosen for inter-rater agreement were added to a separate table. Each teacher's record was placed side by side, with an additional column marked "difference" to measure the difference noted in the result by evaluator.
4. Differences greater than three words per minute were considered "not in agreement" and marked in red.
5. Only the WRPM within the three-word difference was considered for the calculation of inter-rater agreement.

We obtained an overall inter-rater agreement of 82% in WRPM. Typically, inter-rater agreement of 80% and above is in the acceptable range (McHugh, 2012).

Discussion

The initial aim of this project was to stem reading loss, which seemed inevitable for many students given the prolonged classroom absences caused by the COVID-19 pandemic, particularly for those in the early stages of solidifying their reading skills. However, the gains we observed with processing the data far surpassed this aim and provided positive empirical data in support of the EdTech potential for mobile literacy interventions, especially in developing regions. The results also contained more nuanced implications for specific grade levels.

Figure 1 presents a visual depiction of mean WRPM over time for lower elementary and upper elementary groups. The figure also demonstrates how the lower elementary group had a steeper increase between week 0 and week 7, compared to the upper elementary group, making up for the slight decline that both groups experienced from week 7 to week 12, allowing for the overall increase from week 0 to week 12 to be significant. Possible explanations for this backslide in the final weeks of the project leading up to post-test 2 include the following:

a. The "reopening" of classes in July 2020 via distance education channeled student attention toward multiple subjects.
b. The use of slightly higher-level readings for post-test 2.
c. Pandemic-related stress and fatigue in connection with the reopening of classes in July 2020, a situation for which no one was adequately prepared and which caused additional stress for teachers, parents, and students.
d. The 12-week length of the intervention, with daily readings Monday through Friday, entailed a total of 60 readings, which may have been excessive for some students.

Figure 1

Mean Words Read per Minute over Time for Lower Elementary and Upper Elementary Groups
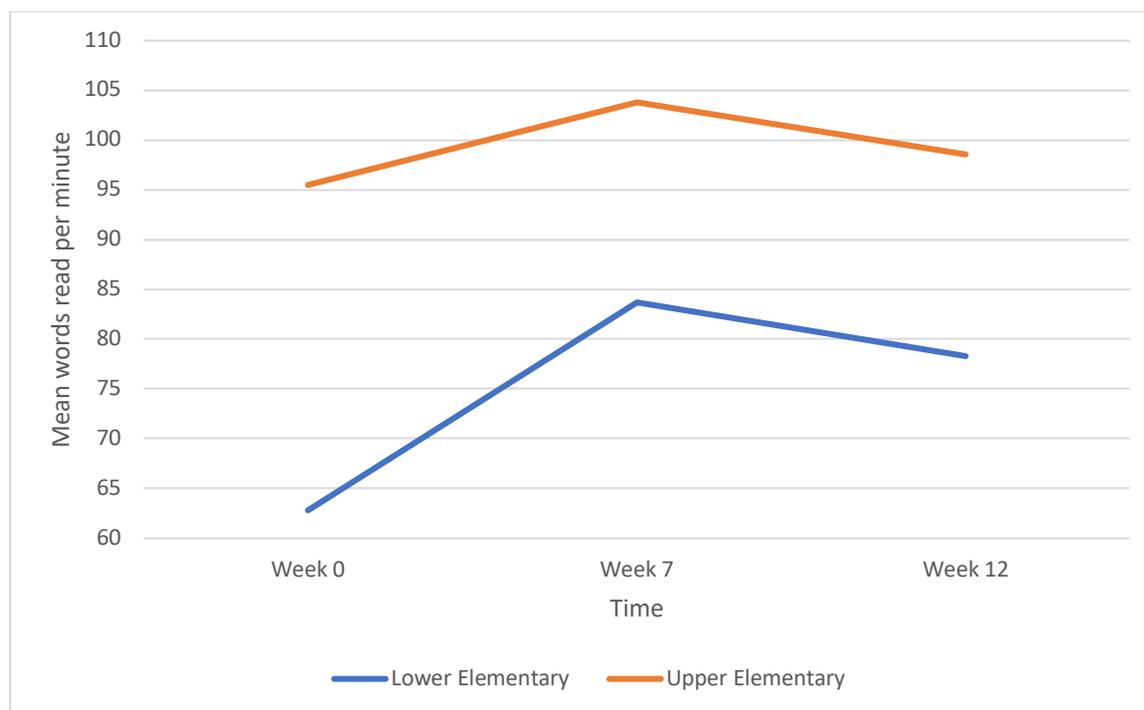
Results suggested that the gains associated with the mobile reading intervention significantly impacted the younger students in early primary. It is also important to note that the intervention effect was much higher for the lower elementary grade group (partial η^2=0.377) than for the upper elementary grade group (partial η^2=0.055). This is consistent with other studies that have noted how gains in basic skills acquisition are likely to happen more quickly in lower grades (LoGerfo, Nichols & Reardon, 2006).

These findings are especially noteworthy given the recently released NWEA data on the effects of COVID-19 on students in the early elementary years (Kuhfeld & Lewis, 2022). This NWEA research shows how first- and second-grade student achievement at the end of 2021–22 was lower compared to pre-pandemic reading trends by 6 to 7 percentile points and how this learning loss was greater than that of students in grades 3-5. The study also demonstrates how high school students were disproportionately impacted, with reading losses often double those of their counterparts in low-poverty schools. Suppose mobile literacy interventions such as WhatsApp Remote Reading Recovery can be quickly implemented in times of crisis and school closure. In that case, it may be possible to reduce early-grade reading losses, even in typically marginalized areas, which continue to impact achievement beyond the crisis period.

Likewise, the relatively high percentage of take-up – an average of 84% completion of the daily readings – coupled with the high retention rates noted for teachers and families throughout the 12-week project bodes well for this intervention's future applicability. This measure is crucial to international organizations interested in the gains obtained through reading interventions and the probability that participants will follow through with the

intervention to determine the feasibility for broader application in the future (McKenzie, 2011; 2019).

Relative to previous research conducted with the utilization of WhatsApp in a learning context (Bouhnik & Deshen, 2014; VSO/Pratham Foundation, 2015) and given the take-up statistics achieved in this study, this research reinforces the value of the WhatsApp platform as a viable vehicle for content delivery due to teachers,' families' and students' familiarity with and willingness to adopt WhatsApp for educational purposes beyond simple messaging. Additionally, this research builds on prior evidence for WhatsApp's utility in promoting language and literacy outcomes (VSO/Pratham Foundation, 2015). Finally, it echoes the conclusions of other pandemic studies that present positive results with WhatsApp use for advancing literacy in developing country primary school scenarios (Chai & Bin Rasi, 2021; UNGEI, 2022).

Follow-up sessions with teachers provided insights which we highlight below:

a. Familiarity with the user-friendly WhatsApp platform appeared helpful for maintaining participation throughout the intervention for teachers, parents, and students.
b. Many teachers who had access to a computer in their homes used the WhatsApp desktop version and reported ease of navigation.
c. The utilization of high-quality international-standard digital materials was essential to the project. It helped children view reading as a diversion instead of a homework assignment and propelled participant take-up.
d. The literature recommends that establishing a daily reading habit is instrumental to achieving more significant literacy gains throughout the intervention (Cullinan, 2000).
e. The WhatsApp-aided literacy promotion methods used in this project relied upon a triangulation of teacher-family-student relationships conducive to supporting literacy gains.
f. The flexibility of the WhatsApp platform facilitates its utilization in combination with other distance learning strategies, including radio, television, and internet instruction delivery.
g. One of the biggest obstacles to project implementation was the cost of data plans. For example, though WhatsApp is a cost-free application, its usage requires access to a cellular signal and a data plan. Telecommunications companies united to reduce data costs during the pandemic (Mi Diario, 2020). Still, implementation was reportedly uneven and inconsistent, often leaving poorer families without resources to invest in continued data access, especially in cases of suspended employment. Moreover, homes in remote areas (particularly the indigenous territories) often do not have immediate or constant access to cellular signals.

Implications

A survey conducted by UNICEF Panama in June 2021 showed that almost 70% of low-income household children participating in distance education during the COVID-19 pandemic were doing so via mobile phone, and most on a device they shared with other family members. The survey also noted that online learning is not accessible in most indigenous and many rural communities in Panama due to a lack of signal (UNICEF, 2021). These figures reiterate the importance of the work presented in this article. Mobile learning is possible for most Panamanian schoolchildren – if they have the connectivity. The same is

true for students in almost every country throughout the world. Thus, mobile education has been a topic of increasing discussion, even pre-pandemic, mainly because of its potential for developing regions (West & Chew, 2014).

This project emphasized how the realization of mobile technology's potential for education gain is intrinsically tied to three critical issues. The first is *connectivity*, which depends directly on access to a signal, the Internet, and a mobile electronic device. To mitigate these obstacles and move toward more and better signal coverage as well as an increase in the number of mobile devices available per family, most countries and school districts will likely need to pursue effective public-private partnerships with signal providers, mobile device manufacturers, and other key actors. The second critical issue affecting the implementation of mobile tech education programming is *capacity*. Teachers, students, and often students' families must be familiar with and comfortable using mobile devices and the corresponding software and platforms involved. This usually requires some capacity development activity (training, coaching, mentoring, or a combination of these) to enhance all participants' knowledge and skill sets, without which meaningful commitment over the long term is difficult to achieve. The third critical issue for implementation is quality course *content*, regarding both didactic materials and pedagogy. Instruction based on exciting and engaging materials and teaching methods has a much better chance of delivering real learning opportunities. These elements – connectivity, capacity, and content – individually and in combination, can make or break a given mobile EdTech intervention.

Since mobile technology offers the most ubiquitous modality available worldwide for propelling remote learning, its potential for leveling the educational playing field is enormous. Future directions should seek to enable and encourage possibilities to explore this realm in literacy and other academic areas. Advancing mobile learning to the point that it begins to level the educational playing field, nationally and internationally, will require enormous effort and dedication of resources from multiple sources.

Conclusion

We hope this study will inform the school system, government, private sector, and general public in Panama regarding the potential for and obstacles to propelling literacy gains through low-tech, low-cost distance learning options that utilize mobile technology. This knowledge is helpful for and applicable to crises such as COVID-19, but it also has implications for situations beyond the current pandemic. For example, school closures occur during annual school holidays, other public health crises, and natural disasters or weather-related shocks, among other disturbances. At such times, instructional methods to substitute in-person instructional delivery are needed. Mobile learning is a valuable tool, and the procedures detailed in this project are easily adaptable across various circumstances. In addition, they may add value as complements for supplemental coursework design when schools are open during the regular academic year.

The results also signal promise for digitally supported distance education tools that can be used in less technologically connected communities. This type of instruction offers multiple benefits. For example, it educates students on a given topic (literacy, in the case of this project); it trains teachers and students to utilize familiar digital devices and platforms for innovative educational purposes; it makes it possible for less technologically connected schools and households to tap into some of the more sophisticated digital learning content currently being developed throughout the world.

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