

TECHNICAL REPORT **DRAFT**

April 2022

Title: Impacts of a 2-year education technology program on early primary learning in Malawi amid disruptions due to COVID-19

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Abstract

Malawi's primary education system has been challenged to provide quality learning in the face of expanding enrollment. To address poor learning outcomes, the Ministry of Education piloted use of onebillion's *onecourse* software in about 100 schools. Initial studies of *onecourse* conducted over 8 weeks to 8 months produced significant effect sizes in math and literacy, although absolute gains were modest. To measure longer-term impacts, Imagine conducted a 2-year efficacy randomized controlled trial in two Malawi schools. Despite COVID-related school closures, *onecourse* produced statistically significant impacts in literacy and math. Further, the 13 months of (interrupted) intervention produced larger effect sizes and higher rates of attaining emergent or fluent reading and math benchmarks than the prior 8-month study. Findings suggest that implementing *onecourse* in both Standards 2 and 3 may help Malawi attain its early grade learning goals. Further, results may have implications for periods of disruption due to other causes.

Background

Malawi's primary education system has made progress in increasing access to school over the last decade but is challenged to provide quality learning in the face of expanding enrollment (World Bank 2021). Pupil-Qualified Teacher Ratios exceed 80:1 in Standards 1-3 (Ibid.). By Standard 4, 19 percent of students still score zero on Standard 1 math items and only 22 percent are able to comprehend a short reading passage in the primary language of instruction used in the early grades (Ibid.). Ultimately, only 33% of children complete primary education (National Statistical Office 2021). To address poor learning outcomes, the Ministry of Education piloted use of onebillion's *onecourse* software in about 100 schools and is considering expanding the program nationwide.

Prior Research

Initial randomized controlled trials (RCTs) on *onecourse* in Malawi produced significant effect sizes in math (.63) and literacy (.42) over 8 weeks and 14 weeks, respectively (Pitchford 2015;

Pitchford, Hubber, and Chigeda 2017). A longer 8-month RCT conducted by Imagine produced significant effect sizes of .34 in literacy and .15-.29 in early math skills (Levesque, Bardack, and Chigeda 2020). While these trials produced significant average effects, absolute gains were modest. Only 9% of the literacy treatment group and 19% of the math treatment group attained emergent or fluent status after 8 months. These studies suggest investigating the impact of longer-term implementations of *onecourse*.

Purpose

Imagine launched a 2-year efficacy RCT in October 2019 in two Malawi government primary schools, intending to estimate the learning impacts of using *onecourse* for 16 months. However, due to the COVID-19 pandemic, Malawi schools closed multiple times during the study period (see Table 1 for timeline), resulting in 13 months of interrupted intervention. While COVID-related school closures during the study presented a unique situation, school disruptions are not uncommon in Malawi. In recent years, schooling has been disrupted by political unrest, a cyclone, and floods, and climate-related disruptions are expected to continue (World Bank 2021). Thus, this study presents impacts obtained during extremely difficult circumstances. The findings may be relevant for other periods of interrupted schooling in Malawi and in other countries experiencing similar challenges.

October 2019	March 2020	October 2020	January 2021	April 2021	November 2021
Study launches	Schools close due to COVID-19 pandemic	Schools reopen	Schools close due to a surge in COVID-19 cases and related teacher strike	Schools reopen for the remainder of the school year, which is extended to December 2021	Study concludes (total of 13 months of active intervention)

Research Questions

Primary research questions (with pandemic-related adjustment underlined) include:

1. What are the impacts over standard instruction on literacy and numeracy outcomes of using onebillion’s *onecourse* software in Chichewa (either literacy or math) for 40 minutes per day for 2 interrupted school years (totaling 13 months of intervention)?
2. What impact does attendance in the intervention have on learning outcomes?
3. How far do treatment group children progress toward Malawi government benchmarks for reading and math in the lower primary grades?
4. Do treatment impacts vary by gender?

Setting

We purposively selected two government primary schools for the study to represent urban and peri-urban (more rural) environments and to meet sample size requirements. The schools were located in the Lilongwe district in the central region of Malawi, which contains the capital city. Conditions in the two communities and schools are challenging. Families in both communities are very low income and face food insecurity and other poverty-related challenges. Neither school has electricity. Most children walk to school; road conditions are particularly bad leading to the peri-urban school and can be impassable at times during the rainy season. Class sizes at both schools are very large (up to 100 children) and absenteeism is a persistent problem.

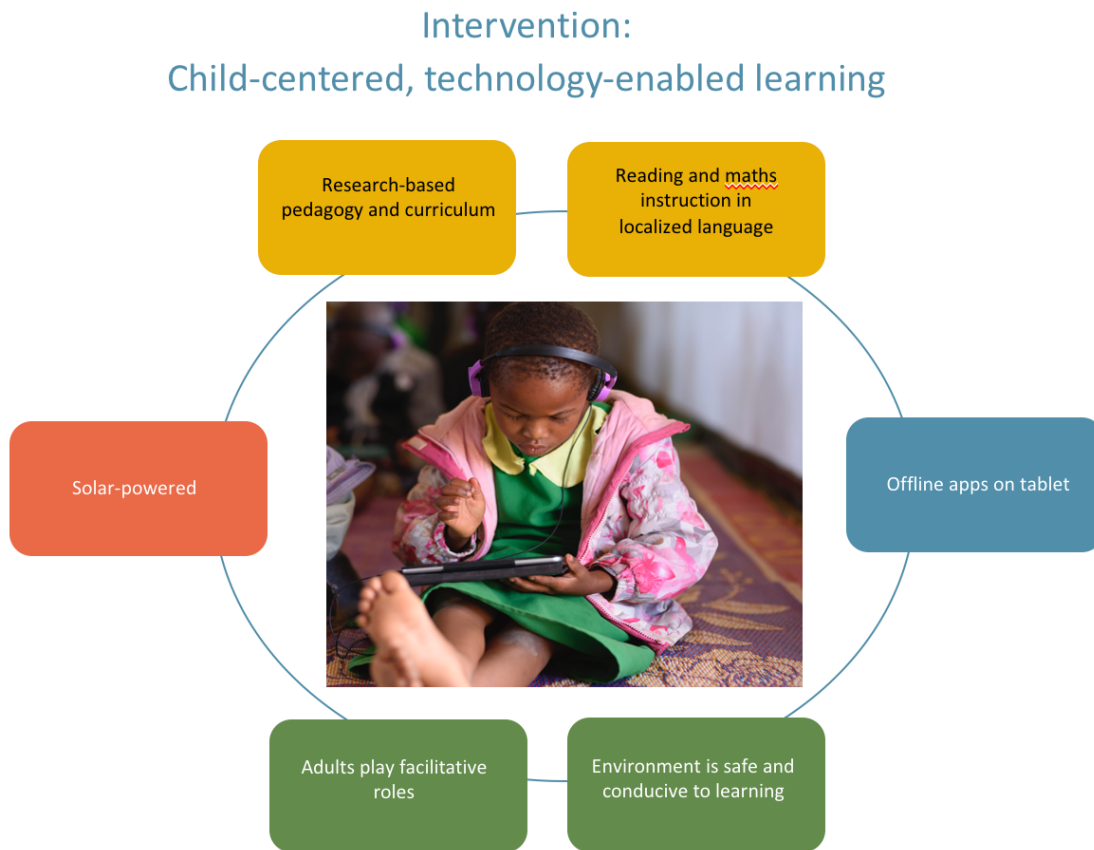
Program and Sample

The program using *onecourse* is called “Unlocking Talent through Technology” (Unlocking Talent) and represents a collaboration among the Malawi Ministry of Education, onebillion, and Voluntary Service Overseas. Unlocking Talent typically focuses on Standard 2 children. Ultimately, 578 Standard 2 learners across the two selected schools were enrolled in the study. The final study sample represented primarily first-time Standard 2 learners of normative age who did not have a severe disability preventing use of the tablets. Table 2 describes the sample demographics and eligibility criteria.

	Urban school	Peri-urban school	Total
Total (n)	299	279	578
%	100%	100%	100%
Gender			
Female (n)	162	153	315
%	54%	55%	55%
Male (n)	137	126	263
%	46%	45%	45%
Age category			
Older (8-10) (n)	136	123	259
%	45%	44%	45%
Younger (6-7) (n)	163	156	319
%	55%	56%	55%
The children above met the following eligibility criteria at baseline:			
1. Were confirmed to be enrolled in Standard 2.			
2. Were 6-10 years old.			
3. Had not previously used the tablet program (some repeaters used the program the previous year).			
4. Did not have a serious disability that would prevent use of the tablets (e.g., vision impairment).			

Intervention

The study tested the efficacy of an updated version of *onecourse* in the Chichewa language, containing additional content compared with software versions used in earlier studies. The *onecourse* curriculum followed accepted literacy and numeracy pedagogy and was loosely aligned to the Malawi national education standards. Children progressed through the tablet curriculum at their own pace.



The intervention provided supplemental learning in either reading or math. Treatment groups stepped out of different classes on different days of the week to use the reading or math software for 40 minutes per day in a dedicated learning center. The control group students continued with standard instruction only. The learning centers accommodated 60 learners at a time. Each center contained two cabinets of 30 iPads each, one designated for literacy and the other for math. One solar cell per cabinet was installed on the roofs of the learning centers. The solar cells charged a battery in each cabinet that in turn charged the iPads. The learning center was dedicated to the

intervention and both the cabinets and center were locked when the learning center was not in session.

VSO staff offered a technical training to all teachers in both schools. The schools determined which teachers would supervise the learning center sessions. The schools also designated a learning center coordinator and established a supervision schedule, where teachers took turns supervising the tablet sessions. No new teachers were hired to implement the program.

Research Design

The efficacy RCT used a non-clustered, blocked individual random assignment design. Because the two schools were purposively and not randomly selected, the resulting impact estimates represent average effects for the two study schools and do not generalize to all primary schools in Malawi. All Standard 2 children at the two schools were assessed at baseline prior to randomization. Independently within each school, children were randomly assigned to two treatment groups (literacy and math) and one control group within four gender (male and female) and age category (6-7 years and 8-10 years) strata. After randomization, we confirmed that standardized mean differences on key pre-treatment variables (gender, age category, baseline achievement) satisfied baseline equivalence standards (with or without statistical adjustment), ranging from 0.00 to 0.06 standard deviations in absolute value.

Data Sources and Key Measures

Primary outcomes for the study were based on the Malawi adaptations of the Early Grade Reading Assessment (EGRA) and Early Grade Mathematics Assessment (EGMA) in the Chichewa language: (1) average EGRA percent correct (for literacy intervention) and (2) average EGMA percent correct (for math intervention). Because the two outcome measures represent independent domains (literacy and math), it was not necessary to adjust the statistical significance of the treatment effects for multiple treatment-control comparisons. The same forms of the test were used at baseline (October 2019) and endline (November 2021). EGRA and EGMA were developed to fill a gap in international assessment of foundational and emerging literacy and numeracy skills and have become the early grade assessment standard in developing countries and development organizations (RTI International 2014 and 2015).

We used tablet usage data in our analysis of the impact of attending the intervention on learning outcomes. The *oncourse* software collected data on the tablet usage of each child in the treatment groups and transmitted these data to the software developer, who generated weekly reports for the research team. We used data on children's log-ins to the learning software to calculate daily attendance and corroborated these data with hand-written attendance registers and with additional activity data from the tablets.

Analytic Methods

We conducted the study in two main parts: (1) analysis of the impact of the intervention on learning outcomes for the overall sample and (2) exploratory analysis of whether treatment effects varied by gender. We produced two sets of impact estimates: Intent-to-Treat (ITT) estimates representing the impact of being assigned to the intervention, relative to being assigned to the control group; and Treatment-on-the-Treated (TOT) estimates representing the impact of attending the intervention at least 50% of the days the learning center was open, relative to attending the intervention fewer or no days. Attending at least 50% of the offered days was considered minimum compliance with the treatment.

For both impact analyses, we followed standard practice for estimating impacts from a non-clustered, blocked individual random assignment design evaluation. Because we purposively selected the two schools in the study, and randomly assigned learners independently within each school, the schools represented independent samples. We conducted the impact analysis as a multi-site randomized trial, averaging separately derived site-level impacts and assuming fixed site effects. To produce the average treatment effect for each outcome measure, we estimated the treatment impact and associated effect size separately for the two schools and then averaged the estimates. We calculated standard errors for the averages by pooling the site-level standard errors.

To obtain more precise school-level impact estimates, we adjusted for baseline student characteristics in an ordinary least squares regression model that used the gain score for each outcome measure as the continuous dependent variable. We use gain scores instead of endline outcomes as the dependent variables to avoid attenuation bias due to measurement error in the baseline measures. In the regression model we included fixed effects for the gender-age category strata as well as baseline covariates for gender, age category (6-7 years vs. 8-10 years), the relevant outcome measure, and the opposite-subject outcome measure. We did not make adjustments for data nonresponse, which was very low. For each site-level impact estimate, we computed the associated effect size, which reflected the magnitude of the impact relative to the variation in the outcome measure in the sample (the treatment and control groups combined). Site-level effect sizes were calculated using Cohen's d .

To estimate site-level ITT impacts, we used a regression model that compared the mean gains of the relevant treatment group (literacy or numeracy) to those of the control group on the outcome measures, allowing the impact estimates to vary for each site. The basic form of the ordinary least squares model was:

$$(1) y_{isj} = \alpha_j + \beta X_{isj} + \delta_j T_{isj} + \lambda_s + \varepsilon_{isj}$$

where

y_{isj} was the simple gain score (endline score minus baseline score) on the outcome of interest for student i in strata s in site j ,

α_j was a site-specific intercept,

X_{isj} was a vector of baseline characteristics of student i in strata s in site j ; the control variables included

gender (male vs. female)

age category (6–7 years vs. 8–10 years)

baseline score on the relevant outcome measure

baseline score on the opposite-subject outcome measure

T_{isj} was a binary variable for treatment status, indicating whether student i in strata s was assigned to the relevant treatment (literacy or numeracy) in site j ,

represented fixed effects for the gender-age category strata,

ε_{isj} was a random error term that reflects the influence of unobserved factors on the outcome,

β was a vector of parameters to be estimated for the control variables, and

δ_j was the estimated coefficient on treatment status in site j and represented the impact of participating in the treatment at site j .

For each site-level impact estimate (δ_j), we also computed the associated effect size, which reflected the magnitude of the impact relative to the variation in the outcome measure in the sample (the treatment and control groups combined). Site-level effect sizes were calculated using Cohen's d . To produce the overall average treatment effect (δ) for each outcome measure, we averaged the site-level estimate for the treatment impact (δ_j) and the associated effect size produced by the regression in (1) above. We calculated standard errors for these averages by pooling the site-level standard errors.

For the TOT analysis, we used treatment status as the “instrumental variable” to predict attendance, and then used predicted attendance (met threshold, did not meet threshold) as the treatment indicator.

Findings

At endline, 25 months after baseline, 462 out of 578 children persisted in the study. Overall attrition was 20%: 18% for each treatment group and 24% for the control group. Standardized mean differences met group design standards for baseline equivalence of the final analytic sample (with or without statistical adjustment), ranging from 0.01 to 0.08 standard deviations in absolute value, supporting the causal validity of our impact findings.

Treatment groups attained a 64% average attendance rate in the intervention and accumulated an average of 90 hours of time on task. While these participation levels were lower than anticipated, due to COVID-related disruptions (we had targeted 70% attendance and 120 hours of time on task), the resulting impacts were strong. Table 3 summarizes the impacts.

Table 3. Impact results for the literacy and math tablet interventions of the 2-year (13-month) Malawi study during COVID		
Subject and measure	ITT	TOT
Literacy		
1 Effect size for overall literacy	0.37*	0.47*
2 Rate of advancing treatment students to the next stage on reading continuum compared with control	1.5x	—
3 Percentage of treatment group who attained emergent or fluent reader status at the end of study**	29%	33%
4 Exploratory subgroup analysis****	—	—
a Effect size for girls in overall literacy	0.41	—
b Effect size for boys in overall literacy	0.32	—
Mathematics		
5 Effect size for overall math	.54*	.65*
6 Rate of advancing treatment students to the next stage on math continuum compared with control	1.4x	—
7 Percentage of treatment group who attained emergent or fluent mathematics status at the end of the study***	72%	75%
8 Exploratory subgroup analysis****	—	—
a Effect size for girls in overall math	0.70	—
b Effect size for boys in overall math	0.33	—
*Indicates a statistically significant result at the $p < 0.05$ level.		
**Based on Malawi government benchmarks for early grade reading (determined by the oral reading fluency subtest of EGRA).		
***Based on Malawi government benchmarks for early grade mathematics (determined by the pattern completion subtest of EGMA).		
****Differences in effect sizes for boys and girls were not statistically significant.		
NOTES:		
ITT = Intent to Treat, comparing the full treatment group with the control group.		
TOT = Treatment on the Treated, comparing children who attended the treatment at least 50% of the time with those who attended less or who were in the control group. Attending at least 50% of the offered days was considered minimum treatment compliance. About 77% of the literacy treatment group and 83% of the math treatment group attended at least 50% of the time.		

Key findings related to our primary research questions include

1. The intervention produced statistically significant impacts in both literacy and math: ITT effect sizes were 0.37* and 0.54**, respectively;
2. Attending at least 50% of the days that the tablet program was offered was associated with even greater impacts: TOT effect sizes were 0.47** and 0.65*** for literacy and math, respectively;
3. Based on Malawi government benchmarks for the early grades, 50% more of the literacy treatment group than the control group and 40% more of the math treatment group than the control group advanced in reading and math: at the end of the study, 29% of the literacy treatment group had attained emergent or fluent reader status and 72% of the math treatment group had attained emergent or fluent math; and
4. Exploratory analysis of the differences in literacy and math effect sizes for girls and boys found the differences were not statistically significant, indicating that both groups benefited similarly from the intervention.

Conclusion

Despite COVID-related school closures during the study, and lower than anticipated time on task, *onecourse* produced statistically significant impacts in both literacy and math. Further, the 13 months of (interrupted) intervention produced larger effect sizes and higher rates of attaining emergent or fluent reading and math benchmarks than the prior 8-month study. Findings suggest that implementing *onecourse* in both Standards 2 and 3 may help Malawi attain its goals for early grade literacy and math. Further, these impacts were obtained despite COVID-related disruptions, which may have implications for periods of disruption due to other causes. Nevertheless, pandemic conditions were unique and results for the purposively selected schools do not generalize to all primary schools in Malawi. However, positive results from all four RCTs conducted on *onecourse* in Malawi to date offer a strong basis for considering program expansion. If undertaken, we recommend a staged approach that evaluates effectiveness at larger scale and further investigates 2-year program impacts under less unusual circumstances.

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