# ABC, 123: The Impact of a Mobile Phone Literacy Program on Educational Outcomes

**Jenny C. Aker, Christopher Ksoll and Travis J. Lybbert**

## Abstract

We report the results from a randomized evaluation of a mobile phone education program (Project ABC) in Niger, in which adult students learned how to use mobile phones as part of a literacy and numeracy class. Overall, students demonstrated substantial improvements in literacy and numeracy test scores, suggesting that the adult literacy curriculum is effective in increasing learning. Students in ABC (mobile phone literacy) villages showed substantial additional gains in numeracy exam scores, but we cannot rule out that there are no effects on literacy in the full sample. There is evidence of heterogeneity in program effects across regions, suggesting the impact is stronger in a relatively more densely populated region. Furthermore, both literacy and numeracy effects are stronger and statistically significant for younger populations. There is also evidence of persistent impacts: six months after the end of the first year of classes, students in ABC villages retained what they had learned better than the non-ABC students. These effects do not appear to be driven by differences in teacher quality or in teacher and student attendance. These results suggest that simple and relatively cheap information and communication technology can serve as an effective and sustainable learning tool for rural populations.

JEL Codes: D1, I2, O1, O3
Keywords: education; literacy; information technology; program evaluation; Niger

Center for Global Development
www.cgdev.org

Working Paper 223
September 2010

**ABC, 123: The Impact of a Mobile Phone Literacy Program on Educational Outcomes**

Jenny C. Aker
Non-resident Fellow
Center for Global Development

Christopher Ksoll
University of Oxford

Travis J. Lybbert
University of California-Davis

Jenny C. Aker, Department of Economics and The Fletcher School, Tufts University, 160 Packard Avenue, Medford, MA 02155; Jenny.Aker@tufts.edu. Christopher Ksoll, CSAE, Department of Economics, University of Oxford, Manor Road, Oxford OX1 3UQ; christopher.ksoll@economics.ox.ac.uk . Travis J. Lybbert, Department of Agricultural and Resource Economics, University of California-Davis. tlybbert@ucdavis.edu. We thank Catholic Relief Services (CRS) Niger for their cooperation and support in all stages of this project and would especially like to acknowledge the contributions of Ali Abdoulaye, Aichatou Bety, Saley Boukari, Scott Isbrandt, Mahamane Laouali Moussa, Ousseini Sountalma, Lisa Washington-Sow and the entire CRS/Niger staff, who conceived of and implemented this project. Kristy Bohling, Joshua Haynes and Rebecca Schutte provided excellent research assistant. We are grateful for financial support from the Blum Center for Developing Economies (UC-Berkeley), CITRIS, the University of Oxford, the Hitachi Foundation and the Gates Foundation. We would like to thank Maximilian Auffhammer, Michael Clemens, Edward Miguel, Sarah Baird and participants at seminars at the Centre for the Study of African Economies (CSAE) at the University of Oxford, the University of Gottingen, and the German Economic Association's Sixth Annual Research Committee on Development Economics Conference for their helpful comments and suggestions. All errors are our own.

CGD is grateful for contributions from the William and Flora Hewlett Foundation and the Australian Agency for International Development in support of this work.

Jenny C. Aker, Christopher KSoll, and Travis J. Lybbert. 2010 "ABC, 123: The Impact of a Mobile Phone Literacy Program on Educational Outcomes." CGD Working Paper 223. Washington, D.C.: Center for Global Development. http://www.cgdev.org/content/publications/detail/1424423

**Center for Global Development**
**1800 Massachusetts Ave., NW**
**Washington, DC 20036**

202.416.4000
(f) 202.416.4050

**www.cgdev.org**

## 1. Introduction

Few topics in the economics have received as much attention as the social and private returns to human capital investments (e.g., Acemoglu, 1996, Becker, 1962, Galor and Moav, 2004, Schultz, 1961). Decades of econometric wrangling with measurement error and endogeneity bias have produced compelling evidence that education that effectively builds cognitive skills can improve productivity, earnings, health outcomes, and social networks (Akerlof and Kranton, 2002, Case, 2006, Hanushek, 1995, Hanushek and Woessmann, 2008, Krueger and Lindahl, 2001). Moreover, human capital investments have been found to improve an individual's ability to "deal with disequilibria" (Schultz, 1975) by refining one's ability to acquire and process information and to discover and benefit from new technologies (e.g., Foster and Rosenzweig, 1996).

Despite the importance of education in the development process, educational achievements remain remarkably low in some of the world's poorest countries. Approximately 18 percent of adults worldwide were unable to read and write in 2005 (UNESCO 2008).[1] Such figures have long spurred major educational investments in supply-side interventions (school infrastructure and inputs) as well as demand-side interventions (conditional cash transfers, school feeding and scholarships). While school-aged children are the common focus of these investments, governments in developing countries have also invested in adult literacy programs with the hopes of reaping more immediate private and social returns (Blunch and Pörtner 2009).[2] Nevertheless, the literature has generally been skeptical of large-scale adult literacy programs, which tend to be characterized by low enrollment, high dropout rates, and a rapid loss of acquired skills (Ortega and Rodriguez 2008, Romain and Armstrong 1987, Abadzi 1993, (Oxenham, et al., 2002).[3] These disappointing gains may be partly due to the relevancy of basic literacy for development, as well as the lack of

[1]Literacy is defined as the skills of: 1) "recording information of some kind in some code understood by the person making the record and possibly by other persons in some more or less permanent form; and (2) decoding the information so recorded." Similarly, numeracy is defined as "the skill of using and recording numbers and numerical operations for a variety of purposes" (Oxenham, et al., 2002). The data in the UNESCO report uses data from "around" 2000, which could be as early as 1995 and as recent as 2005 for particular countries.

[2] Blunch and Pörtner (2009) provide an overview of the literature on adult literacy programs in both developed and developing countries, including Ghana.

[3]Abadzi (2003) notes that during the 1970s, literacy programs surveyed had success rates of 12.5 percent, though in the 1980s these rose to a median of about 60 percent of adults acquiring basic literacy skills.

opportunities to practice literacy and numeracy skills, especially in an individual's local language. Mobile phones provide a unique opportunity to address these constraints to literacy adoption.

Partly due to their rapid spread throughout the developing world, mobile phones have drawn substantial attention for their potential impacts on economic development (Bhavnani, et al., 2008, Castells and et al., 2007, Corbett, 2008, Donner, 2008, Aker and Mbiti 2010). One of the demonstrated channels through which mobile phones improve the welfare of the poor is improved market efficiency and spatial integration (Aker 2010, Jensen, 2007, Jensen forthcoming, Labonne and Chase, 2009). While information technologies could have an indirect effect on education via improved earnings (Jensen 2007), mobile phones may have an even more direct effect on education. The comparatively cheaper pricing scheme of Short Message Service (SMS) as compared with voice in many developing countries provides a powerful financial incentive to use SMS, thereby allowing adults to practice their reading and writing skills in local languages (Figure 1).[4] The original motivation for this project was based precisely on this incentive: the large cost difference between SMS and voice services encouraged some previously illiterate grain traders to teach themselves how to read and write simple SMS.

We estimate the impact of a mobile phone-based literacy and numeracy program for adult women and men in Niger (Project *Alphabétisation de Base par Cellulaire,* or ABC), which uses simple mobile phones as an educational tool.[5] Mobile phone coverage and adoption have spread throughout Niger since 2001; over 40 percent of the population has access to mobile phone coverage (GSMA data for 2009) and mobile phone subscribers represent 10 percent of the population (Wireless Intelligence data for 2009).[6] Niger is a compelling setting for testing the potential literacy and numeracy impacts of these growing mobile phone networks as Niger's education indicators are among the worst in the world: over 71.3 percent of the population over 15 was classified as illiterate in 2007 (INS and Macro International, 2007).

This paper reports the results of a randomized evaluation of a mobile phone-based literacy and numeracy program (Project ABC), developed and implemented by Catholic Relief Services

[4] (Kim, et al., 2010)) find evidence that SMS and voice are (weak) substitutes.
[5]We distinguish between simple mobile phones – those which primarily have voice and SMS capability – from smart or multimedia phones, which often have some type of internet or video capability. An example of a mobile phone program that relies on smart phones is the MILLEE program, which developed software and games for school-aged children in India (Kam et al. 2009).
[6] For data on mobile phone coverage and adoption, we use data from the GSM Association (herein GSMA), an association that represents the interests of the worldwide mobile communications industry, and Wireless Intelligence.

(CRS).[7] The project was conducted in two regions of Niger, each with separate randomizations into treatment and control groups. Program villages were randomly selected from among a group of 105 eligible villages, allowing differences in educational outcomes between the program and comparison villages to be attributed to the mobile phone-based literacy curriculum. While some studies exist on the impact of adult literacy programs on both educational and economic outcomes (Blunch and Pörtner, 2009, Carron, 1990, Ortega and Rodríguez, 2008), many studies often suffer from serious methodological problems, such as small sample sizes, failure to account for selection bias, participant attrition and self-reported literacy scores. By contrast, the randomized nature of the intervention allows us to assess the causal relationship between the mobile phone curriculum and educational outcomes.

After one year of the program, and using half of our sample, we find evidence for positive impacts of mobile phone-assisted learning on educational outcomes. The ABC program increased adults' math test scores by .32 points during the first year. Math test score gains in the somewhat more densely populated region of Dosso were larger, but we cannot reject the hypothesis that there was no program effect in the Zinder region. Moreover, younger students (those between 18 and 45 years of age) gained the most. We posit that these effects might be due to the relevance of SMS for younger participants, as well as their greater ease of acquiring new skills via information technology.

These gains depreciated somewhat after the end of the first year of classes, although they remained significant for the targeted classes: Eight months after the end of classes, adult students in the ABC program scored higher on math tests than those in non-ABC villages, suggesting that test score improvements reflect real learning. Students were not aware that there would be a second test six months after the end of the program, and so these tests capture persistent active knowledge.

The remainder of the paper is organized as follows. In the next section, we situate our analysis relative to other work on literacy and technology. Section 3 provides the background on the setting of the research, as well the randomized intervention. Section 4 describes some key features of the data. Section 5 outlines our estimation strategy. Section 6 contains the preliminary results and discussion. In Section 7, we provide a simple cost-effectiveness analysis of the ABC program. We

[7] More recently, mobile phone-based adult literacy programs have emerged in Pakistan (UNICEF) and Senegal (the Jokko Initiative, implemented by Tostan and UNICEF).

conclude by summarizing our results and offering a discussion of the relevance of these findings for policymakers and mobile service providers.

## 2. Information Technology and Education

Simple mobile phones can serve as an educational tool by allowing adults to practice their reading, writing and math skills via communications with family, friends and commercial contacts.[8] While such communication can occur by voice, SMS is substantially cheaper than voice in many developing countries, particularly in sub-Saharan Africa (Figure 1). Relatively cheaper SMS in such countries may have important unintended benefits among illiterate populations by providing a powerful financial incentive to learn to read and write text messages.[9] Moreover, the benefits associated with learning to use SMS may include gains in both literacy and numeracy: while both share cognitive roots in symbolic representation (Bialystok, 1992), the symbolic links between the two are particularly explicit in the case of SMS.

This paper speaks to the large literature on the education production functions and the debate on the value of educational inputs (Hanushek, 1995, Kremer, 2003, Kremer, et al., 2009). More specifically, we show that skill acquisition can be facilitated and strengthened through modern information technology (Linden, et al., 2003). We explore three potential channels through which SMS-based training might produce functional literacy gains. First, when used effectively, technology can directly improve teaching efficacy. In this sense, mobile phones might provide a pedagogical platform for teaching literacy, and this analysis contributes to the broader discussion of educational inputs.

Second, technology and skills are often complementary. Thus, having access to mobile phones can increase the private returns to literacy by making it possible to communicate easily via (relatively cheap) SMS. Since the degree of complementarity between literacy and technology is heterogeneous, the value of SMS communication will differ based on individuals' endowments. We would expect greater learning benefits among subpopulations for whom the complementarities are stronger, such as those who are engaged in entrepreneurial activities and relatively younger

[8] In this paper, we distinguish between simple mobile phones – those which primarily have voice and SMS capability – from smart or multimedia phones, which often have some type of internet or video capability. An example of a mobile phone education program that relies heavily on smart phones is the MILLEE program in India (Kam, et al., 2009).

[9] Kim et al. (2010) find evidence that SMS and voice are (weak) substitutes.

populations. This paper is therefore also related to the literature on heterogeneous returns to skills and on endogenous skill acquisition. Whereas a simple correlation between owning a mobile phone and being literate cannot tell us whether the availability of mobile phones encourages people to learn to read and write or whether more literate people choose to buy mobile phones, the randomized design of Project ABC allows us to test the causal relationship between mobile phones and literacy.

Third, in the presence of communication technologies, complementarities exist not just between technology and the skills of an individual but also *between* individuals. Mobile phones may produce and sustain literacy gains via the potent network externalities that are inherent in information and communication technologies generally, and in mobile phones with SMS capabilities in particular. The value of SMS to a mobile phone owner (or one who has access to a mobile phone) is an increasing function of the number of people in her social or economic network who also have access to a mobile phone, and in particular, SMS. The profitability of SMS-based services, such as mobile phone money transfer systems, can similarly increase as the network of SMS users growers. These network effects can increase the returns to functional literacy and thereby magnify the incentive to obtain and retain these skills. While we cannot directly test for these effects, the relatively stronger results in the more densely populated region are consistent with this hypothesis.

Finally, this paper relates to the literature on skills depreciation (most of which is centered around skills lost during unemployment), suggesting that technology might mitigate skills depreciation. Unused labor market or education skills are lost more easily when they cannot be used on a regular basis (De Grip and Van Loo, 2002)). Nevertheless, mobile phones, computers and other devices can encourage students to continue to learn outside of the classroom, as well as after the end of schooling. While this paper focuses on impacts eight months after the end of classes, our findings suggest that information technology can help sustain impacts after the end of the program (Linden et al 2003, Banerjee et al 2007).

## 3. Project ABC

### 3.1 Project Description and Timeline

Project ABC was implemented by Catholic Relief Services (CRS) in two rural regions of Niger, Dosso and Zinder. CRS is an international non-governmental organization (NGO) with a presence

in over 80 countries, and has been operating in Niger since the 1990s. Niger is one of the poorest countries in the world, and the lowest-ranked country on the UN's Human Development Index (HDI). The country's education indicators are particularly striking: over 71.3 percent of the population over 15 was classified as illiterate in 2007 (INS and Macro International, 2007). The problem of illiteracy is even more pronounced in our study regions: Close to 90 percent of adults in the regions are illiterate, and male and female literacy rates are estimated to be 15 and 7.5 percent, respectively. Dosso is primarily populated by the Zarma and Hausa ethnic groups, with income-generating activities focused on agricultural production and small ruminants. Zinder is primarily populated by the Hausa and Kanuri ethnic group, with agro-pastoral traditions. The main focus of CRS' program in Niger is agriculture, water and sanitation, emergency response and education, including adult literacy. In partnership with CRS, the authors developed a curriculum to incorporate a mobile phone module into the adult literacy and numeracy curriculum in CRS' program villages.

There were 140 CRS intervention villages across the two regions, 105 of which were eligible for our study.[10] The randomization first stratified villages by region, and then by administrative divisions within each region. Randomization into program and comparison groups was then carried out within each stratum using a computer random number generator. Approximately half of the villages (59) were selected to participate in the first year of classes in 2009, and half of these were selected to participate in the ABC program (28 villages). The same approach was followed for the 2010 villages. In line with the initial stratification, we often present tests for equality of means and the results separately by region.

Starting in February 2009, CRS implemented an adult literacy program in 59 villages across the two regions, with two classes per village, separated by gender. A total of fifty slots (25 males and 25 females) were available for the literacy classes within each village. Eligible applicants for the literacy classes had to be members of existing or newly formed producers' associations and unable to read or write in any language. While the number of eligible applicants varied according to village size, on average, eligible applicants represented more than 60 percent of the adult population. Approximately 10 percent of the fifty slots were reserved for members of the village development

[10] A number of CRS' intervention villages were not included in the randomized evaluation, for two reasons: First, at CRS' request, we excluded villages where there existed already existed an ongoing adult literacy program administered by a different NGO or organization. We also excluded villages in which there was no mobile phone coverage at the time of the village selection in December 2008 (though these villages did receive the literacy program). .

committee (VDC) with whom CRS works. The remainder were randomly chosen among the eligible participants in a public lottery.

The adult literacy intervention implemented by CRS covers 8 months of literacy and numeracy instruction over a two-year period. Courses start in February of each year and continue until June, with a eight-month break between June and January due to the agricultural planting and harvesting season. Thus, classes that started in February 2009 finished in June 2010. All classes focus on basic literacy and numeracy in the local language of the village (either Zarma or Hausa) during the first year and functional literacy topics (agro-enterprise and health) during the second year.[11] Participants in ABC villages followed the same literacy and numeracy training as those in traditional literacy villages, but with two modifications: 1) participants were trained in how to use a simple mobile phone, including turning on and charging the phone, learning how to recognize numbers and letters on the mobile phone handset, sending and receiving calls and writing and reading SMS; and 2) the project provided mobile phones to groups of literacy participants (one mobile phone per group of five people) at wholesale prices.[12] The mobile phone module began three months after the literacy courses started, and neither students, teachers nor project staff were informed which villages were selected for the ABC project until two weeks prior to the start of mobile phone activities.[13]

An important characteristic of Project ABC is the potential ease for scale-up. Because the mobile phone literacy module relied upon simple mobile phones, as opposed to smart phones, and was based upon achieving basic skills on these phones (calling, writing and receiving SMS), the ABC program adds relatively low costs to the normal adult literacy program.

[11] In comparison with other countries in West Africa, the number of indigenous languages in Niger is fairly limited, with less than 10 local languages (as compared to over 60 in Ghana and 100 in Nigeria). The primary languages spoken in Niger are Hausa, Zarma, Fulani, Kanuri and French. The primary local languages spoken in the Dosso and Zinder regions of Niger are Hausa, Zarma and Kanuri.

[12] Although the provision of subsidized mobile phones to groups of five could potentially have a wealth effect, as the phones did not belong to one specific household, we would expect an impact upon group dynamics.

[13] In 2009, students in ABC villages had less than 6 weeks of practice using mobile phones. Mobile phones were therefore introduced at the same time in the 2010 villages. Students in ABC villages did not have any extra class time. Literacy courses are held for five days per week for three hours per day. One day per week is often allocated to revision of previous material.

# 4. Data

## 4.1 Household Survey and Test Score Data

In this section we provide information about the datasets used in this paper and compare characteristics of program (ABC) and comparison (non-ABC) villages. We do not yet examine the implications of sample attrition across program and comparison villages, although differential attrition between treatment and control villages does not appear to have been a major problem.[14]

A baseline survey of test scores was conducted prior to the start of literacy classes in February 2009. Literacy and numeracy tests were administered to all fifty class participants in each village, providing a baseline sample of 4,750 students for the 2009 and 2010 cohorts. Due to the phase-in of the program, approximately half of this sample participated in the 2009 cohort of classes. We conducted follow-up literacy tests with the 2009 cohort immediately after the course in June 2009 and again in January 2010, prior to the start of the second year of courses) (Figure 2).[15] Prior to the June 2009 tests, participants in ABC villages had the opportunity to work with mobile phones for less than two months. Any literacy or numeracy gains based on such limited exposure to mobile phones would provide compelling evidence of potential mobile phone effects. The comparison of the June 2009 and January 2010 test results enables us to detect the persistence of any initial gains and further gains due to continued mobile phone use.

The literacy and numeracy tests were developed in collaboration with the Ministry of Non-Formal Education and were identical in structure and difficulty for all survey rounds and between the two regions. For writing, each student was asked to participate in a dictation exercise, and the Ministry of Non-Formal Education staff then assigned scores into six categories, from Level 0 ("beginner") to Level 6. Level 0 corresponds to being "completely illiterate" (not being able to write down any letters of the alphabet correctly), whereas Level 1 implies a minimum level of literacy,

[14] Attrition in literacy classes typically occurs within the first month of the course. As mobile phone activities did not begin until two months after the start of the course, and project staff, literacy teachers and students were not informed of the ABC program or their treatment status in advance, the decision to drop out of the literacy course could not have been based upon the ABC program. Similarly, once a student misses several weeks' of classes, the literacy teacher will typically not allow him or her to continue, as they have fallen behind in the curriculum.

[15] At the onset of the program, the original intention was to collect literacy data from the 2009 and 2010 cohorts during each phase of data collection. Conducting literacy tests in June 2009 with the 2010 cohort proved to be unfeasible, and so data from the 2010 cohort (in which no program was implemented) is not available for this round of data collection.

meaning that the student can correct write letters of the local language alphabet. Level 6 implies that the student can correctly write two complete sentences with more complex word patterns. The levels are similar for the numeracy test, ranging from a low of Level 0 (complete "innumeracy"), Level 1 (simple number recognition) until a maximum of Level 6 (math word problems involving addition, subtraction, multiplication and division). The literacy and numeracy tests are provided in Figure 3. Test scores are our primary data for analyzing the impacts of mobile based literacy and numeracy classes on educational outcomes.

In addition to the literacy data, 11 students per village were randomly sampled from among all literacy students to participate in a household survey, with a balance between men and women. A total of 1,038 individuals were surveyed across 100 villages. The baseline survey covered information on household demographics, assets, production and sales activities, access to price information, migration and mobile phone ownership and usage. Average household size was 8.2, half of whom were children under 15. Among adult survey respondents, only 4 percent have ever attended primary school, with approximately 20 percent ever having attended a Koranic school. Children's educational achievements were similarly low: only 60 percent of children aged 7-15 have ever attended primary school (Table 1).

## 4.2 Pre-Program Characteristics of ABC and Non-ABC Literacy Centers

We utilize the 2009 household baseline survey data to compare socio-demographic characteristics of ABC and non-ABC students. Table 1 provides this comparison and suggests that the randomization was largely successful in creating groups comparable along observable dimensions. Controlling for stratified sampling, we find no significant differences in the age of respondents, their occupation, household size, assets owned (including mobile phone ownership) or whether the individual used a mobile phone prior to the program across ABC and non-ABC villages in the Dosso region (Table 1, Panel A). Household characteristics are also broadly similar across program and comparison villages in the Zinder sample (Table 1, Panel B). The one exception is the percentage of children under the age of 15 having ever attended primary school in the Dosso region; a higher percentage of children in non-ABC villages attended primary school, and this difference is statistically significant at the 5 percent level. To the extent that this is indicative of adults' attitudes towards education, and hence their performance in literacy classes, this could potentially bias our results. Nevertheless, as this

percentage is higher in the comparison households, we would expect that this would put a downward bias on our literacy results.

Baseline test score distributions provide further evidence on the comparability of the program and comparison groups (Table 2). We cannot reject the equality of means for pre-program writing and math test scores in both regions. Literacy and numeracy scores for both program and comparison villages were close to zero, suggesting that the project successfully selected participants who were illiterate prior to the start of the program.

## 5. Empirical Strategy and Results

We focus on reduced form estimates of the impact of mobile phones on both literacy and numeracy test scores. To better understand possible mechanisms underlying test score impacts, we also estimate program impacts on several channels, including measures of teacher quality and student effort. The main estimation equation is:

$$(1) \qquad test_{icvt} = \alpha + \beta_1 ABC_v + \beta_2 year_t + \beta_3 ABC_v * year_t + X'_{iv}\gamma + \mu_{cv} + \varepsilon_{iv,t}$$

$test_{icvt}$ is the literacy or numeracy test score attained by student $i$ in class $c$ in village $v$ in the year of the literacy class (i.e., 2009 for cohort 1 villages, the current sample).[16] $ABC_v$ is the program village indicator, $year_t$ is the time period (January 2009, June 2009 or January 2010) and $ABC*year$ is the interaction between the two. The coefficient $\beta_3$ captures the average program impact on the population targeted for program incentives. $X'_{iv}$ is a vector of student-level baseline covariates, such as sex, ethnicity and age. The error term consists of $\mu_{cv}$, a common class-level error component perhaps capturing common local or teacher characteristics, and $\varepsilon_{ivt}$, which captures unobserved student ability or idiosyncratic shocks. We cluster the error term at the class level and include region- and randomization-level fixed effects in the regressions pooling Dosso and Zinder.[17] While estimating the average program impact is important, so too is appreciating the heterogeneity of this

[16] It is common practice in many education studies to normalize test scores (Glewwe, et al., 2004, Kremer, et al., 2009), as often test instruments are not comparable across rounds. Our test spans the range from illiterate/innumerate to being able to write sentences and solve mathematical problems, and the same test structure is used during each round. Therefore the normalized test score is not appropriate for our program.

[17] Since the level of randomization was the subregional administrative unit, we account for this by including fixed effects which we call "randomization fixed effects."

impact across participants. To understand more precisely which participants benefit most from the program, we test for heterogeneous impacts by including indicator variables for gender and age.

## 5.1 Average Test Score Impacts in the Short-Term

Our sample includes all students who were in the program and comparison villages in 2009, and who had test scores in January and June 2009. Figure 4 summarizes the key results of this paper. The graph shows the difference in mean literacy (Panel A) and numeracy (Panel B) test scores prior to the program, immediately after the program and eight months after the end of the first year classes. In general, adult literacy and numeracy classes are associated with a positive and strongly statistically significant increase in participants' math and literacy scores immediately after the program. Literacy and math scores are higher in ABC villages immediately after the program, with a relatively stronger impact on math scores as compared with writing. Both groups experience a strong depreciation in literacy and numeracy skills during the eight months when classes are not held, but ABC math scores are still higher in ABC villages. This suggests that the ABC program could not only improve skills acquisition in the short-term, but also mitigate skills depreciation after the end of the program.

Table 3 shows the simple difference-in-differences (DD) estimates for the pooled sample without region-level or gender fixed effects. Overall, the literacy program strongly improved literacy in both the ABC (Panel A, Column 1) and non-ABC group (Panel A, Column 2) after 4.5 months of courses, and 1.5 months of mobile phone treatment. The literacy program was successful in teaching basic writing skills, as most students moved from a "beginner" level (i.e., not being able to recognize and write letters) to an average score of 2.05 and 1.78 in ABC and non-ABC villages, respectively. This suggests that participants in ABC villages could correctly write letters, syllables and two-syllable words, whereas those in non-ABC villages could only write letters and syllables. Although literacy test scores were 0.28 points higher in ABC villages, this effect is not statistically significant at conventional levels.

Table 3 (Panel B) shows similar evidence for the participants' numeracy skills. Overall math test scores increased considerably, reaching 2.46 and 2.17 in ABC and non-ABC villages, respectively. More concretely, students were able to transition from an inability to recognize any

numbers to successfully completing simple addition and subtraction problems. Math scores were 0.30 points higher in ABC villages, and the effect is statistically significant at the 10 percent level. This means that 1 of 4 students were able to attain a higher level of numeracy due to mobile phones. The results for both sets of results are robust to the inclusion of pre-program literacy and numeracy test scores.

Table 4 disaggregates these DD results by region. Consistent with the previous results, we do not find significant differences in literacy test scores across program and comparison villages in either Dosso or Zinder. These results do not change after controlling for randomization fixed effects (Column 2), village-level fixed effects (Column 3) or gender (Column 4). Yet the results are quite different for math scores: participation in the ABC program leads to a 0.50-point higher math score in the Dosso region, and this difference is statistically significant at the 5 percent level (Column 1). These results are robust to the inclusion of randomization and village-level controls, as well as gender. Nevertheless, we do not find a statistically significant difference in math scores between ABC and non-ABC villages in Zinder.

The short-term impact of the ABC program on math scores is aligned with the methodology of the mobile phone module. The ABC curriculum in the 2009 villages was only introduced six weeks prior to the end of classes, meaning that participants were unable to fully complete the mobile phone curriculum. For this reason, teachers in most ABC villages were able to cover a limited number of topics in the mobile phone curriculum, namely, turning on and off the mobile phone, learning how to recognize numbers on the keypad and making and receiving phone calls. Few villages were able to reach the level of identifying the letters on the mobile phone, and even fewer were able to teach the SMS component of the program. Second, writing SMS via mobile phones is based on numeric representation of letters. While symbolic representation undergirds the development of both literacy and numeracy (Bialystok, 1992), these cognitive linkages are more explicit in the case of SMS.

### 5.2. Heterogeneous Program Effects

The short-term effects of the ABC program suggest that mobile phones are more useful for math skills in one of the two regions. Similar to the education and labor economics literature, we investigate heterogeneous effects along two other characteristics: the participants age and gender,

which might reflect different incentives to learn as well as different selection processes. Table 5 presents these results by gender for the entire sample and by region. Controlling for a time trend, randomization and village-level fixed effects, the results are consistent with the average effect of the program: the ABC program does not have a statistically significant short-term effect on literacy scores in the overall sample nor in Zinder. Nevertheless, the program has a positive impact on literacy scores for women in the Dosso region (Column 4), although we cannot reject the hypothesis that there is not a statistically significant difference between men and women. For numeracy, the ABC program has a positive and statistically significant impact on women's math scores in the overall sample (Column 2) and in the Dosso region (Column 4), although a Chow test only allows us to reject the hypothesis that there is not a statistically significant difference between men and women for the overall sample.

Table 6 disentangles the same effects by age. Most empirical specifications of the education production function impose a quadratic age relationship based upon the assumption that educational achievement increases with age but at a decreasing marginal rate. The average age of literacy participants is 36 years, ranging from 13 to 70 years. While there is not a statistically significant difference in the ages of participants across program and comparison villages, literacy participants are relatively younger in Zinder as compared to Dosso. Overall, the results in Table 6 suggest that the ABC program is relatively more useful for younger participants (where we set the cutoff point at 45 years of age). Using the entire sample (Columns 1 and 2, Panel A) and the Dosso (Columns 3 and 4, Panel A), younger participants have higher literacy scores, but there is only a statistically significant difference between the two samples in the Dosso region. In terms of numeracy, ABC increases math scores for younger populations overall (Columns 1 and 2, Panel B), but we cannot reject the hypothesis that the two samples are not statistically significant in the Dosso region. While the ABC program has a positive impact on literacy and numeracy for younger populations in the Zinder region, the results are not statistically significant at conventional levels. The relatively larger impacts of the ABC program on literacy and numeracy among the younger populations of Dosso might be due to several factors: younger populations are able to benefit from access to SMS, as their social networks are more apt to use SMS, and the greater ease with acquiring new skills in education and information technology.

### 5.3. Persistent Program Effects

One of the key assumptions of the ABC program is that information technology can not only reinforce skills acquisition in the short-term, but also mitigate skills depreciation when students are no longer in classes. Consequently, Table 7 contains longer run effects for both regions, using literacy data from January 2010 (eight months' after the end of the first cycle of classes, about 12 months after the beginning of classes and prior to the second year). The tests conducted during this period were unannounced, so neither students nor teachers were able to prepare for the tests in advance. For this reason, the sample size is considerably smaller than the June 2009 sample; the number of adult participants who took the test was 4,697, slightly more than 80 percent of the participants who started in 2009. If the people who took the test in January 2010 were the best-performing participants, then this could overestimate our results. If, however, those who were absent were the worst-performing students, then the results in Table 7 would underestimate our results.

As a majority of those absent in January 2010 were seasonal migrants – namely, younger populations who showed stronger test scores gains in Table 6 – we posit that the results in Table 7 serve as a lower bound on the long-term effect. To econometrically deal with the attrition problem, we use the inverse Mills' ratio.[18] Table 7 shows the results of the regression in equation (1) using the long-term data and a Heckman two-stage selection procedure to account for possible selection bias. The results of the first stage are in the appendix Table A1.[19] In the entire sample, the point estimates of the effect on literacy (Panel A) are positive but not statistically significant at conventional levels. However, the effect of ABC on math scores is .11 and statistically significant at the 10 percent level. We also find a strong heterogeneous effect by region: math scores in ABC villages are 0.21 points higher than non-ABC villages eight months after the end of classes and the effect is statistically significant at the 5 percent level. This suggests that the impact on numeracy skills is persistent, and that the mobile phone-based curriculum could mitigate skills depreciation after the end of classes.

[18] An alternative to the Mills' ratio is bounding the treatment effect (Lee 2005), whereby upper and lower bounds are created by dropping the best-performing and the worst-performing students who were not absent in January 2010. The untrimmed average treatment effect (ATE) is then compared with the trimmed ATEs. We will use this approach as a robustness check in future work.
[19] In the first stage we regress a student's presence at the January 2010 literacy tests on a variety of determinants to calculate the inverse Mills' ratio. In the second stage, we include the inverse Mills' ratio as an additional regressor in the OLS regression.

# 6. Alternative Explanations and Mechanisms

There are a variety of mechanisms through which the ABC program could affect learning in the short- and long-term. First, the presence of a mobile phone curriculum – including the additional two-day training that teachers received – could potentially lead to increased teacher participation and motivation, thereby improving the effectiveness of the overall literacy curriculum. Second, the presence of mobile phones can increase students' motivation and incentives to learn, reflected by increased class participation and attendance. And finally, the mobile phone can be used as a tool for learning outside of the classroom – both during the course and after the end of courses --- thereby serving as a dynamic learning incentive. We will first address a potential alternative explanation to our results before investigating the extent to which extent these particular channels contributed to the overall increases in numeracy skills..

### 6.1. Alternative Explanations

One principal concern with respect to the previous results is a difference in teacher quality. If the Ministry of Non-Formal Education or CRS chose better-quality teachers for ABC villages, or better-quality teacher self-selected into those villages, then any differences that we observe in test scores between villages might be due to observable differences in teachers' quality, rather than the presence of the ABC program. While this concern is highly unlikely due to the randomized nature of the intervention – and the fact that the villages were only informed of the program immediately before the introduction of the ABC module -- we test for differences in teacher quality across program and comparison villages. Table 8 shows the difference of means of teachers' education levels, age and gender. There is not a statistically significant difference in observable teacher characteristics in the overall sample nor by region.

### 6.2. Potential Mechanisms

It is plausible that the presence of mobile phones or a new curriculum could have increased teacher motivation and effort within or outside of the classroom, thereby improving students' performance on test scores. While we are unable to directly observe teacher effort, we are able to provide an observable proxy of effort. As CRS and the Ministry of Non-Formal Education provided norms for the number of classes during teach month, the actual number of classes taught was at the

discretion of each teacher. Therefore, while imperfect, we use the number of classes taught as a proxy for teacher effort. In 2009, teachers taught an average of 22 classes per month (Table 8), and there was not a statistically significant difference in the number of classes taught between program and comparison villages. This provides evidence that teachers in ABC classes were not teaching more classes and hence improving test scores.

The presence of the ABC program could also encourage greater student attendance and participation during classes. While we cannot observe in-class student performance, using daily attendance data, we do not find a statistically significant difference in student attendance between ABC and non-ABC villages.[20] The average attendance rate in 2009 was 73 percent, but there is not a statistically significant difference between ABC and non-ABC villages (Table 8). Student attendance is somewhat higher in ABC villages in Zinder, but the difference remains statistically insignificant.

Overall, these results – combined with the persistent effects of the ABC program on numeracy scores after the end of classes – suggest that the primary mechanism through which ABC affects learning outcomes is the opportunity to practice the newly acquired skills outside of the classroom.

## 7. Cost Effectiveness Analysis

A natural question related to the use of a new approach or technology is whether the expected benefits coincide with the additional costs. Annual government expenditure on education in Niger is one of the lowest in the world; approximately 3 percent of the annual budget is spent on education (World Bank 2004). Thus, investing in mobile phone technology to improve adult literacy outcomes is one of many potential education interventions competing for scarce public resources. In this section, we explore the question as to whether a mobile-phone based adult literacy program should be a public policy priority for the poorest countries using a simple comparison of the benefits and costs of the ABC program.

While a cost-benefit analysis of the ABC program would require estimates of the social and private returns to adult literacy (Kremer et al 2009), we conduct a cost-effectiveness analysis, thereby

[20] The high rate of student attendance in ABC and non-ABC villages is unsurprising, as students were provided with a monthly food ration based upon their monthly attendance record. Therefore, conditional on receiving food aid, there was not a statistically significant difference in student attendance between ABC and non-ABC villages.

focusing only on the costs of the ABC program as compared to its educational impacts.[21] Evans and Ghosh (2008) assess the cost-effectiveness of different education interventions in developing countries using three outcomes (enrolment, attendance and test scores). They find that adult literacy programs are cost-effective in terms of increasing enrolment, but did not measure the impacts of such programs on academic performance. We therefore follow the approach outlined in Ortega and Rodriguez (2008) and define "benefits" as the number of students who attained a certain level of literacy or numeracy on the test (in this case, Level 1).[22] We then compare ABC and non-ABC centers to isolate the additional costs and benefits associated with introducing mobile phones into adult literacy training, implicitly netting out broader livelihood gains from increased literacy.

Figure 5 shows the cost per student attaining Level 1 proficiency during the first year of the program for ABC and non-ABC villages. The program cost is US$21.50 per student in non-ABC villages and US$28 in ABC villages. Thus, for an additional US$6.50 per student, 4 percent more students were able to reach Level 1. This suggests that the ABC program is approximately 10-15 percent more expensive per percent of students who attain a satisfactory level than the traditional literacy program. Since we do not include any other benefits the students might reap due through access to mobile phones (including access to price information), nor the longer-term benefits, we think this is quite a low additional cost.

# 8. Conclusion

Adult literacy and numeracy programs are an important part of the educational system in many countries, though their successes have been mixed, partly due to the relevance of literacy and the dearth of easily accessible materials in local languages. We present evidence that mobile phones can be used as cost-effective teaching tool, resulting in higher math scores for students. We also find quantitatively stronger results in one region, particularly for women and for younger students. The effects on math appear to persist even 8 months after the end of classes. As being able to read and write SMS presumes that students have a higher level of knowledge, we posit that literacy impacts could occur during the second year of literacy courses.

[21] For a concise discussion of the difference between cost-benefit and cost-effectiveness analysis, see the J-PAL Cost Effectiveness Methodology (March 2010).

[22] In our context, a "Level 1" is defined as passing the literacy and numeracy exam, as it coincides with simple letter and number recognition.

Overall, these results suggest that simple information technology could be a simple and low-cost way to promote adult's educational outcomes in developing countries in the short- and long-term. First, the rapid expansion of mobile phone coverage and adoption in sub-Saharan Africa suggests that a broad spectrum of populations (urban and rural, rich and poor, men and women) are already using this technology for social and commercial reasons. Second, the relatively cheaper cost of SMS as compared to voice in some countries provides a financial incentive to use SMS, thereby increasing the demand for literacy skills. Third, even without SMS skills, using mobile phones for voice calls appears to lead to modest improvements in numeracy. These results could potentially be sustained without the need for costly village-level libraries or local language newspapers. And finally, the use of simple mobile phones as the basis for Project ABC suggest that this curriculum could be easily scaled up by governments and NGOs, potentially in collaboration with the private sector.

## REFERENCES


Acemoglu, D. 1996. "A Microfoundation for Social Increasing Returns in Human Capital Accumulation." *The Quarterly Journal of Economics* 111(3):779-804.

Aker, Jenny C. 2010. "Information from Markets near and Far: Mobile Phones and Agricultural Markets in Niger." *American Economic Journal: Applied Economics*. 2(July 2010): 46-59.

Aker, Jenny C. and Isaac Mbiti. Summer 2010. "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives*. 24(3): 207-232.

Akerlof, G., and R. Kranton. 2002. "Identity and Schooling: Some Lessons for the Economics of Education." *Journal of Economic Literature* 40(4):1167-1201.

Banerjee, Abhijit, Shawn Cole, Esther Duflo and Leigh Linden. August 2007. "Remedying Education: Evidence from Two Randomized Experiments in India," *Quarterly Journal of Economics*, 122(3):1235-1264.

Bandiera, O., and I. Rasul. 2006. "Social Networks and Technology Adoption in Northern Mozambique*." *The Economic Journal* 116(514):869-902.

Becker, G. 1962. "Investment in Human Capital: A Theoretical Analysis." *The Journal of Political Economy* 70(S5).

Bhavnani, A., R. Chiu, S. Janakiram, P. Silarszky, and D. Bhatia. 2008. "The Role of Mobile Phones in Sustainable Rural Poverty Reduction." *Retrieved November* 22:2008.

Carron, J. 1990. "The Functioning and Effects of the Kenyan Literacy Program." *African Studies Review*. 33:3 *97-120*

Bialystok, E. 1992. "Symbolic Representation of Letters and Numbers." *Cognitive Development* 7(3):301-316.

Case, A. (2006) The Primacy of Education, ed. A.V. Banerjee, R. Benabou, and D. Mookherjee. Oxford ; New York, Oxford University Press.

Castells, M., and et al. 2007. *Mobile Communication and Society: A Global Perspective*: Mit Press.

Corbett, S. 2008. "Can the Cellphone Help End Global Poverty." *The New York Times* 13.

De Grip, A., and J. Van Loo (2002) The Economics of Skills Obsolescence: A Review, ed. J. Van Loo, and K. Mayhew, vol. 21, pp. 1-25.

Donner, J. 2008. "Research Approaches to Mobile Use in the Developing World: A Review of the Literature." *The Information Society* 24(3):140-159.

Evans, D., and A. Ghosh. 2008. "Prioritizing Educational Investments in Children in the Developing World." *RAND Labor and Population Working Paper* WR 587.

Foster, A., and M. Rosenzweig. 1996. "Technical Change and Human-Capital Returns and Investments: Evidence from the Green Revolution." *The American Economic Review* 86(4):931-953.

Galor, O., and O. Moav. 2004. "From Physical to Human Capital Accumulation: Inequality and the Process of Development." *Review of Economic Studies*:1001-1026.

Glewwe, P., M. Kremer, S. Moulin, and E. Zitzewitz. 2004. "Retrospective Vs. Prospective Analyses of School Inputs: The Case of Flip Charts in Kenya." *Journal of Development Economics* 74(1):251-268.

Hanushek, E. 1995. "Interpreting Recent Research on Schooling in Developing Countries." *The World Bank Research Observer* 10(2):227.

Hanushek, E., and L. Woessmann. 2008. "The Role of Cognitive Skills in Economic Development." *Journal of Economic Literature* 46(3):607-668.

INS, and Macro International. 2007. *Enquête Démographique Et De Santé Et À Indicateurs Multiples Du Niger 2006*. Calverton, Maryland, USA: Institut National de la Statistique (INS), Macro International.

Jensen, R. 2007. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector*." *The Quarterly Journal of Economics* 122(3):879-924.

Jensen, R. Forthcoming. "Information, Efficiency and Welfare in Agricultural Markets." *Agricultural Economics.*

Kam, M., A. Kumar, S. Jain, A. Mathur, and J. Canny. 2009 "Improving Literacy in Rural India: Cellphone Games in an after-School Program." Doha, Qatar, pp. 17-19.

Kim, Y., R. Telang, W. Vogt, and R. Krishnan. 2010. "An Empirical Analysis of Mobile Voice Service and Sms: A Structural Model." *Management Science* 56(2):234-252.

Abdul Latif Jameel Poverty Action Lab (J-PAL). March 30, 2010. *J-PAL Cost Effectiveness Methodology.* Cambridge, MA: MIT J-PAL.

Kremer, M. 2003. "Randomized Evaluations of Educational Programs in Developing Countries: Some Lessons." *American Economic Review* 93(2):102-106.

Kremer, M., E. Miguel, and R. Thornton. 2009. "Incentives to Learn." *The Review of Economics and Statistics* 91(3):437-456.

Krueger, A., and M. Lindahl. 2001. "Education for Growth: Why and for Whom?" *Journal of Economic Literature* 39(4):1101-1136.

Labonne, J., and R. Chase. 2009. "The Power of Information: The Impact of Mobile Phones on Farmers' Welfare in the Philippines." *Policy Research Working Paper Series.*

Lee, D. S. 2005. "Training, Wages, and Sample Selection: Estimating Sharp Bounds on Treatment Effects. *NBER Working Paper #11721.* Cambridge, MA: National Bureau of Economic Research.

Linden, L., A. Banerjee, and E. Duflo. 2003. "Computer-Assisted Learning: Evidence from a Randomized Experiment." *Poverty Action Lab Paper* 5.

Ortega, D., and F. Rodríguez. 2008. "Freed from Illiteracy? A Closer Look at Venezuela's Mision Robinson Literacy Campaign." *Economic Development and Cultural Change* 57:1-30.

Oxenham, J., A. Diallo, A. Katahoire, A. Petkova-Mwangi, and O. Sall. 2002. *Skills and Literacy Training for Better Livelihoods: A Review of Approaches and Experiences*. Washington D.C.: World Bank.

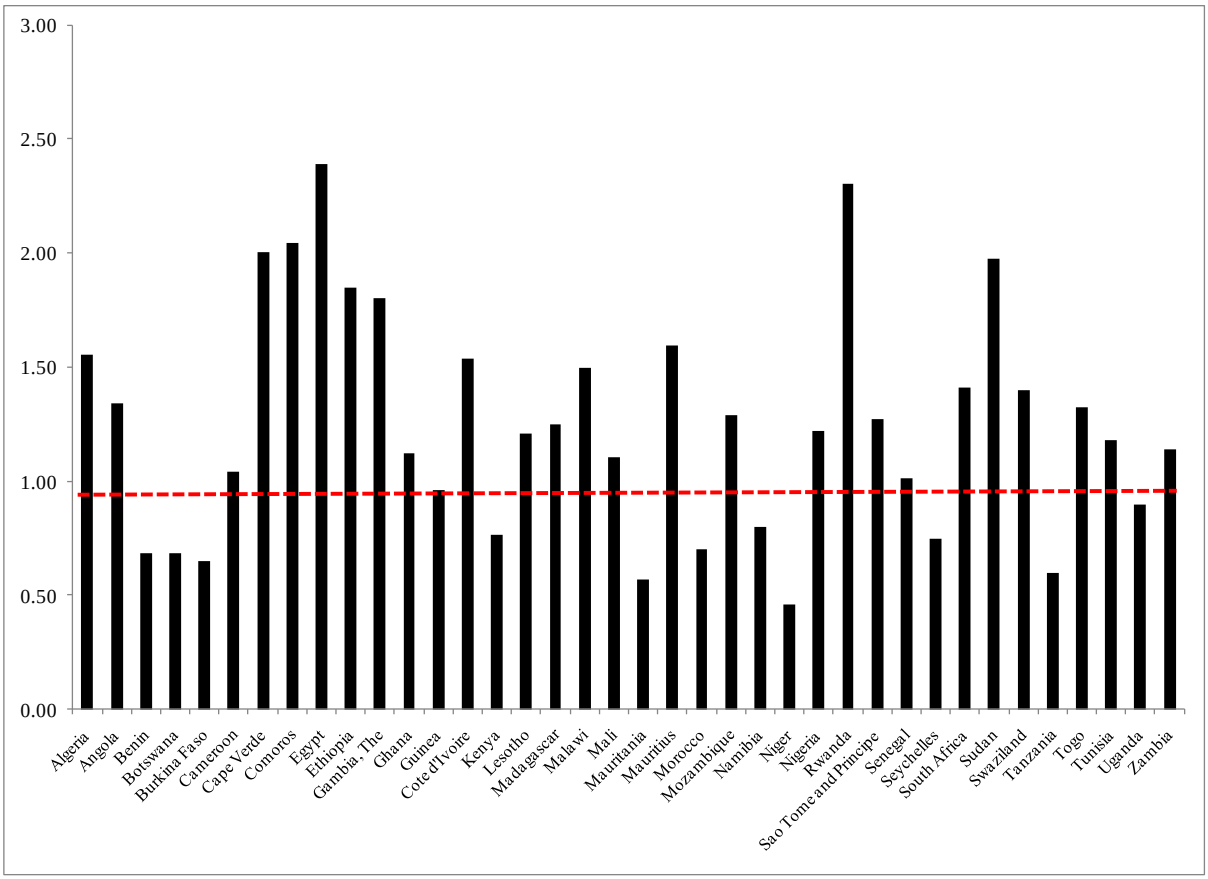
Schultz, T. 1961. "Investment in Human Capital." *The American Economic Review* 51(1):1-17.

---. 1975. "The Value of the Ability to Deal with Disequilibria." *Journal of Economic Literature* 13(3):827-846.

UNESCO. 2008. *International Literacy Statistics: A Review of Concepts, Methodology and Current Data.* Montreal: UNESCO Institute for Statistics.

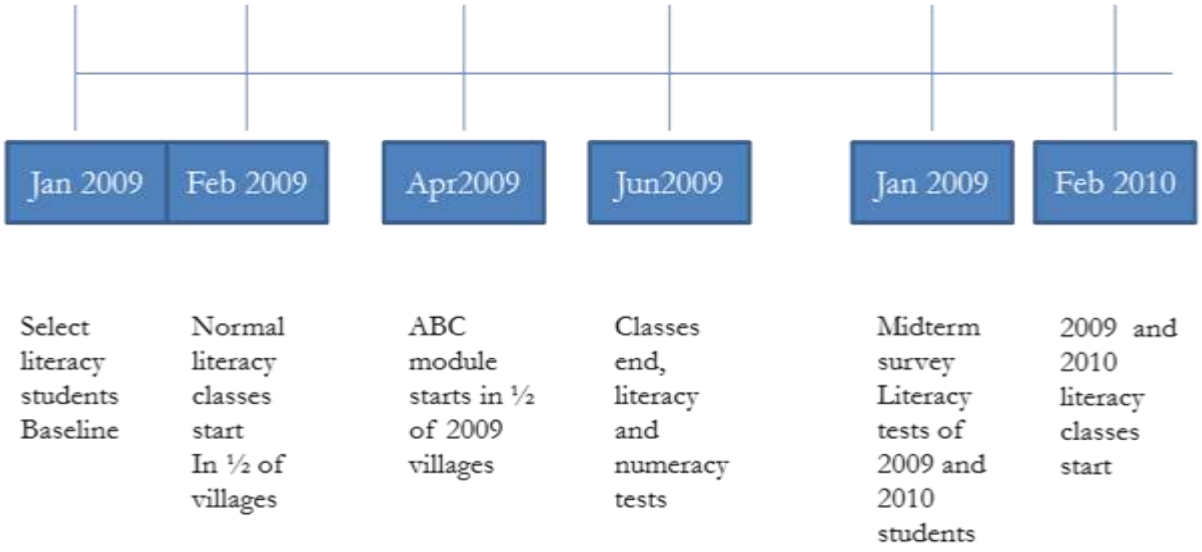
World Bank. 2004. "La dynamique des scolarisations au Niger – Evaluation pour un développement durable." *Human Development Working Document Series*, no. 40. World Bank: Washington, DC.

**Figure 1. Ratio of Prices for One SMS to a Three-Minute Voice Call, by Country (2008)**




Notes: The mean SMS/voice price ratio for all countries in the sample is 1.25 and .70 for Niger. Authors' calculations based upon data from the International Telecommunications Unit (ITU), 2008.

**Figure 2. Calendar of Data Collection and Project Activities**



## Figure 3. Literacy and Numeracy Tests

**PROJET ABC**
**Evaluation Initiale Fiche**

**Lissahi**

Matsayi na 1: 7, 6, 8, 9, 2, 4, 3, 5, 0, 1

Matsayi na 2:

| 6 | 8 | 7 | 9 |
|---|---|---|---|
| +3 | -5 | +2 | - 4 |

Matsayi na 3:

| 16 | 14 | 17 | 19 |
|---|---|---|---|
| +12 | -13 | + 11 | - 17 |

Matsayi na 5:

| 45 | 84 | 22 | 94 \| 6 |
|---|---|---|---|
| + 25 | - 36 | x 5 | |

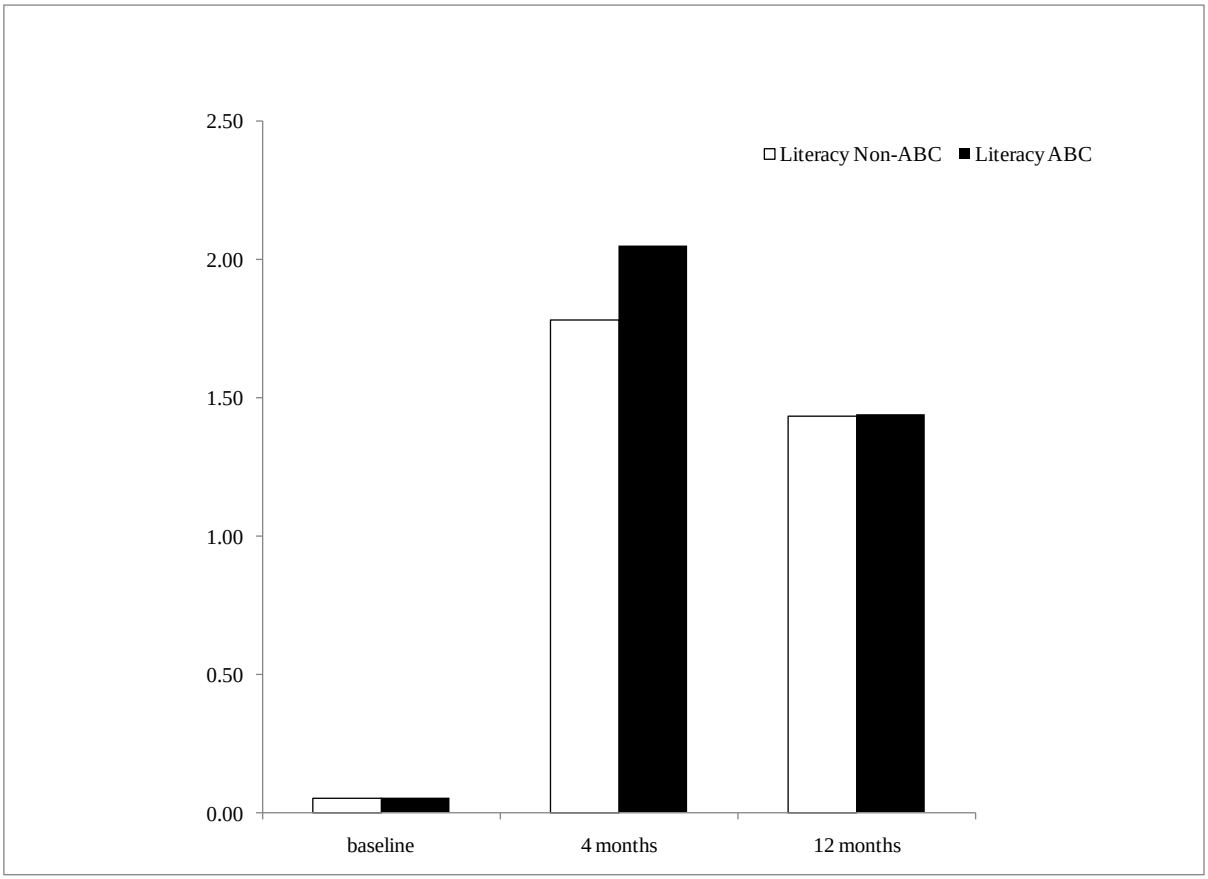
Matsayi na 5: Zaynabu ta sayi kashi 3 na tumati. A cikin kowane kashi akwai dan tumati 4. Dan tumati nawa ta samu a jimilce ?

*[Note à l'enquêteur : Pour le niveau 6, il faut que l'apprenant lise et traite l'énoncé sans aide].*

Matsayi na 6: Ali ya aiko ma matanshi 3 zannuwa 13. Zane nawa kowace za ta samu ? Zane nawa za ya yi saura ?

**Figure 4: Year 1 (2009) Test Score Impacts of ABC and non-ABC Literacy Centers for Cohort 1**

**Panel A: Literacy Test Scores**



**Panel B: Numeracy Test Scores**

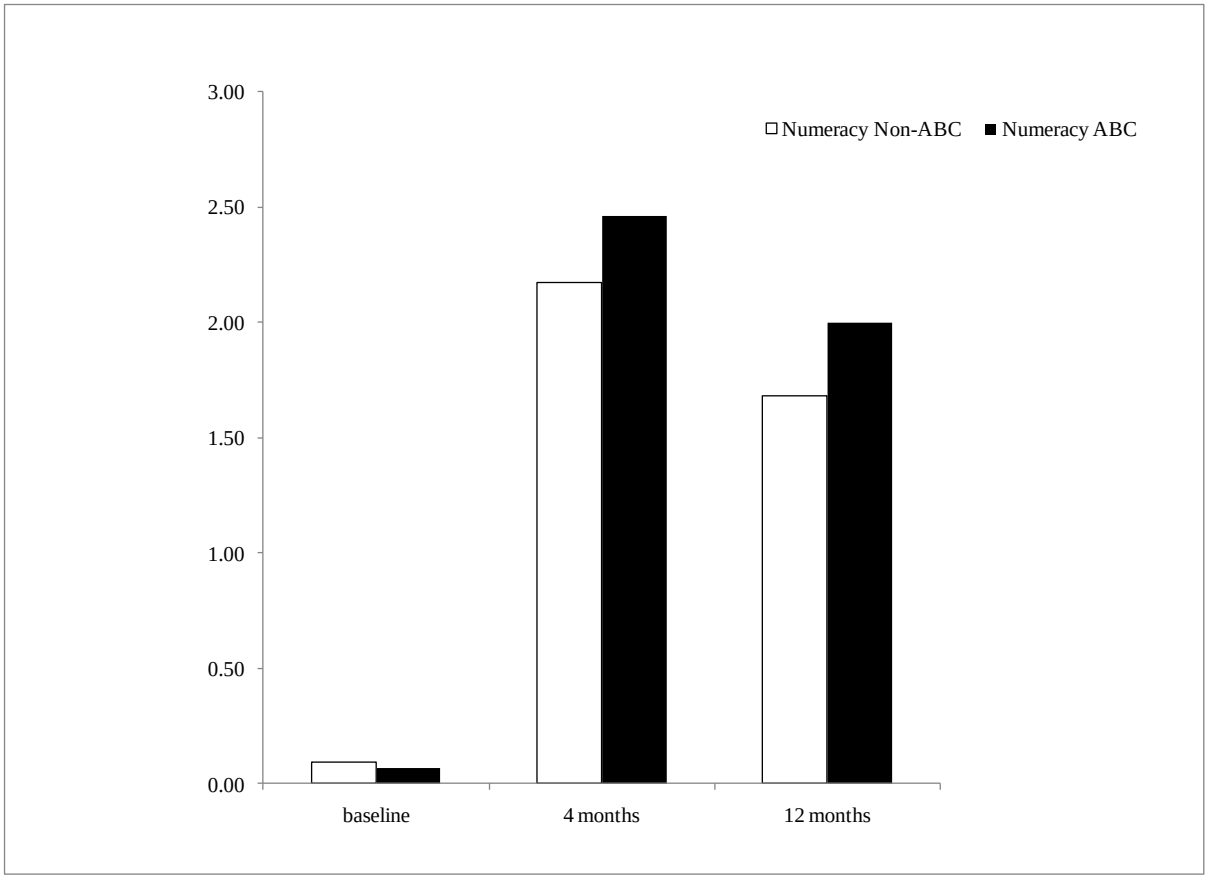


**Figure 5 Cost per student attaining Level 1 in the first year of participation in the program**

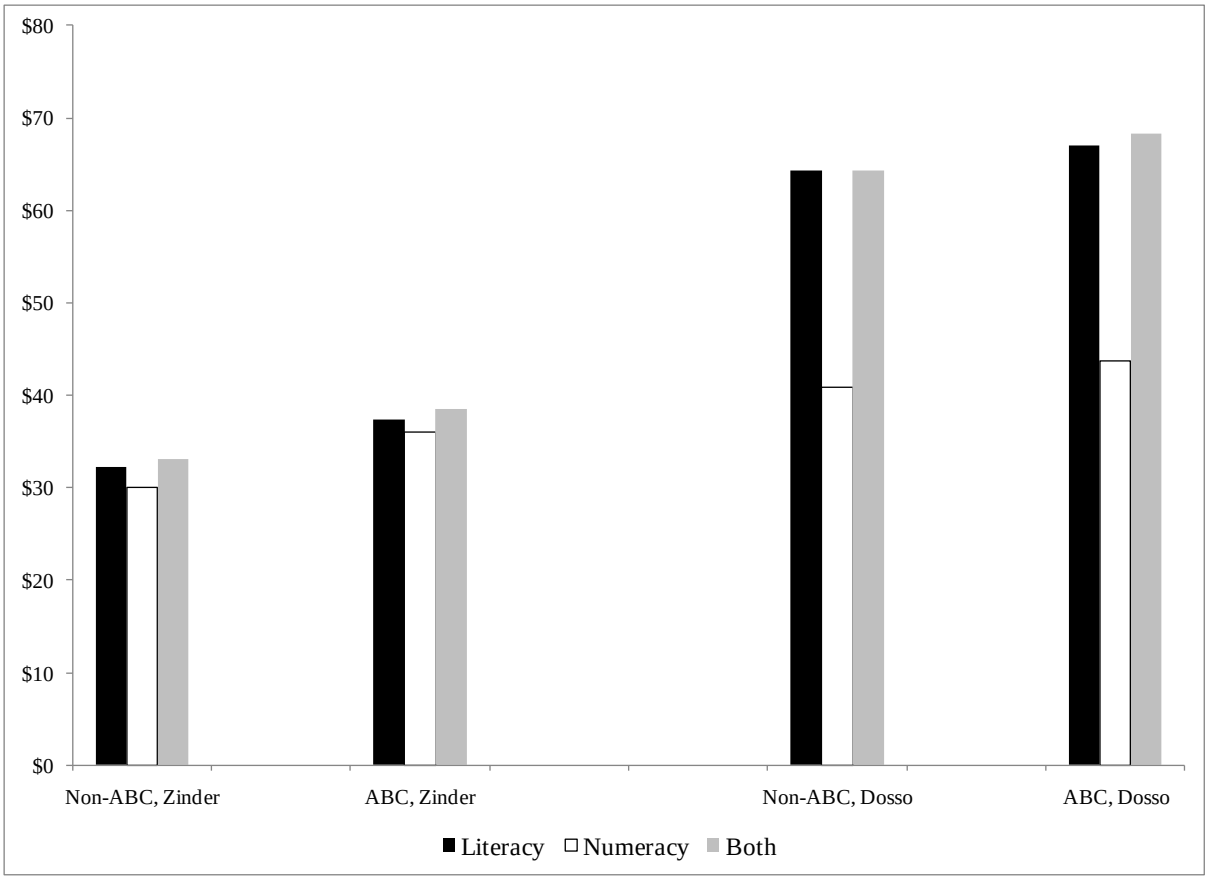


**Table 1: Baseline Household Descriptive Statistics (by Treatment Status)**

| | ABC | Non-ABC | Difference | |
|---|---|---|---|---|
| **Panel A: Dosso** | | | | |
| Age | 41.13 | 41.84 | -0.71 | |
| Head of Household | 0.49 | 0.54 | -0.05 | |
| Farming is respondent's main occupation | 0.78 | 0.75 | 0.03 | |
| Household chores are respondent's main occupation | 0.21 | 0.23 | -0.01 | |
| Number of household members | 8.92 | 9.17 | -0.25 | |
| Percentage of Children <15 with at least some primary education | 0.60 | 0.71 | -0.12 | ** |
| Number of assets owned | 9.67 | 10.07 | -0.39 | |
| Number of houses owned | 3.03 | 3.36 | -0.33 | |
| Respondent has used mobile phone since harvest | 0.63 | 0.65 | -0.01 | |
| Access to a market in the village | 0.32 | 0.23 | 0.09 | |
| **Panel B: Zinder** | | | | |
| Age | 34.18 | 34.53 | -0.35 | |
| Head of Household | 0.50 | 0.47 | 0.03 | |
| Farming is respondent's main occupation | 0.85 | 0.83 | 0.02 | |
| Household chores are respondent's main occupation | 0.14 | 0.15 | -0.01 | |
| Number of household members | 7.23 | 7.68 | -0.45 | |
| Percentage of Children <15 with at least some primary education | 0.54 | 0.55 | -0.02 | |
| Number of assets owned | 8.40 | 9.24 | -0.84 | |
| Number of houses owned | 2.92 | 3.10 | -0.19 | |
| Respondent has used mobile phone since harvest | 0.44 | 0.50 | -0.05 | |
| Access to a market in the village | 0.22 | 0.40 | -0.18 | |

Notes: Table displays summary statistics for treatment (Column 1) and control group (Column 2). Column 3 reports the difference. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Summary statistics are for respondents with non-missing information

**Table 2: Baseline Literacy Test Outcomes (by Treatment Status)**

| | ABC | Non-ABC | Diff(s.e) |
|---|---|---|---|
| **Panel A: Dosso** | | | |
| Baseline literacy test scores | 0.06 | 0.05 | .02(.03) |
| Baseline math test scores | 0.09 | 0.11 | -.02(.04) |
| **Panel B: Zinder** | | | |
| Baseline literacy test scores | 0.04 | 0.06 | -.01(.02) |
| Baseline math test scores | 0.04 | 0.07 | -.02(.02) |

Notes: Table displays summary statistics for ABC (Column 1) and non-ABC (Column 2). Column 3 reports the difference. Standard errors in parenthesis, adjusted for stratified sampling. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Summary statistics are for respondents with non-missing information

**Table 3: Effects of Mobile Phone Literacy Program: DD Results**

**Panel A: Literacy**

| | | (1) ABC | (2) Non-ABC | (3) ABC-Control |
|---|---|---|---|---|
| 1 | 4-month results | 2.05 | 1.78 | 0.28<br>(0.20) |
| 2 | Baseline | 0.05 | 0.05 | 0.00<br>(0.02) |
| 3 | 4-month results - baseline | 2.00<br>(0.14)*** | 1.73<br>(0.15)*** | 0.27<br>(0.20) |

**Table 3: Effects of Cell Phone Literacy Program: DD Results**

**Panel B: Numeracy**

| | | (1) ABC | (2) Non-ABC | (3) ABC-Control |
|---|---|---|---|---|
| 1 | 4-month results | 2.46 | 2.17 | 0.30<br>(0.18)* |
| 2 | Baseline | 0.07 | 0.09 | -0.02<br>(0.02) |
| 3 | 4-month results - baseline | 2.39<br>(0.13)*** | 2.07<br>(0.12)*** | 0.32<br>(0.18)* |

*Notes:* ABC villages are the villages in which traditional literacy training was complemented by cell phone based literacy training. 4-month results are the results after 4 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class

**Table 4: Program Effects by Region**

| **Panel A: Effects on Literacy** | Dosso | | | | Zinder | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| ABC*4-months | 0.273 | 0.269 | 0.260 | 0.245 | 0.293 | 0.297 | 0.277 | 0.271 |
| | (0.216) | (0.214) | (0.216) | (0.216) | (0.285) | (0.286) | (0.287) | (0.286) |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Randomization fixed effects | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Village fixed effects | No | No | Yes | Yes | No | No | Yes | Yes |
| Gender | No | No | No | Yes | No | No | No | Yes |
| N | 2,966 | 2,966 | 2,966 | 2,966 | 2,421 | 2,421 | 2,421 | 2,421 |
| R-squared | 0.276 | 0.299 | 0.326 | 0.356 | 0.479 | 0.499 | 0.535 | 0.543 |
| **Panel B: Effects on Numeracy** | Dosso | | | | Zinder | | | |
| | (1) | (2) | (3) | (4) | (1) | (2) | (3) | (4) |
| ABC*4-months | 0.507** | 0.483** | 0.480** | 0.470** | 0.112 | 0.119 | 0.105 | 0.102 |
| | (0.209) | (0.208) | (0.209) | (0.211) | (0.286) | (0.288) | (0.290) | (0.289) |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Randomization fixed effects | No | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Village fixed effects | No | No | Yes | Yes | No | No | Yes | Yes |
| Gender | No | No | No | Yes | No | No | No | Yes |
| N | 2,977 | 2,977 | 2,977 | 2,977 | 2,424 | 2,424 | 2,424 | 2,424 |
| R-squared | 0.537 | 0.556 | 0.584 | 0.601 | 0.519 | 0.538 | 0.584 | 0.585 |

.

*Notes:* ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 4-month results are the results after 4 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

**Table 5: Program Effects by Gender**

| **Panel A: Effects on Literacy** | Whole Sample | | Dosso | | Zinder | |
|---|---|---|---|---|---|---|
| | Men | Women | Men | Women | Men | Women |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ABC*4 months | 0.104 | 0.393 | -0.003 | 0.442* | 0.258 | 0.318 |
| | (0.253) | (0.269) | (0.276) | (0.248) | (0.372) | (0.397) |
| N | 2,646 | 2,741 | 1,441 | 1,525 | 1,205 | 1,216 |
| R-squared | 0.442 | 0.312 | 0.377 | 0.217 | 0.517 | 0.454 |
| **Panel B: Effects on Numeracy** | (1) | (2) | (3) | (4) | (5) | (6) |
| ABC*4 months | 0.165 | 0.440* | 0.402 | 0.553* | -0.095 | 0.311 |
| | (0.242) | (0.244) | (0.244) | (0.304) | (0.422) | (0.388) |
| N | 2,654 | 2,747 | 1,448 | 1,529 | 1,206 | 1,218 |
| R-squared | 0.560 | 0.508 | 0.599 | 0.506 | 0.524 | 0.520 |

*Notes:* ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 4-month results are the results after 4 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

**Table 6: Program Effects by Age**

| **Panel A: Effects on Literacy** | Whole Sample | | Dosso | | Zinder | |
|---|---|---|---|---|---|---|
| | Younger than 45 | Older than 45 | Younger than 45 | Older than 45 | Younger than 45 | Older than 45 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ABC*4 months | 0.374* | 0.258 | 0.609** | 0.065 | 0.322 | 0.238 |
| | (0.217) | (0.217) | (0.285) | (0.259) | (0.319) | (0.351) |
| N | 2,752 | 2,649 | 1,155 | 1,811 | 1,592 | 829 |
| R-squared | 0.520 | 0.533 | 0.286 | 0.279 | 0.471 | 0.498 |
| **Panel B: Effects on Numeracy** | (1) | (2) | (3) | (4) | (5) | (6) |
| ABC*4 months | 0.506** | 0.025 | 0.531** | 0.504* | 0.271 | -0.157 |
| | (0.241) | (0.233) | (0.242) | (0.262) | (0.328) | (0.307) |
| N | 2,747 | 2,640 | 1,158 | 1,819 | 1,594 | 830 |
| R-squared | 0.390 | 0.347 | 0.570 | 0.519 | 0.493 | 0.574 |

*Notes:* ABC villages are the villages in which traditional literacy training was complemented by mobile-phone based literacy training. 4-month results are the results after 4 months of training. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

**Table 7: Persistent Effects of ABC on Literacy and Numeracy**

| **Panel A: Effects on Literacy** | Whole Sample (1) | Dosso (2) | Zinder (3) |
|---|---|---|---|
| ABC village * 11 months | 0.028 | 0.077 | 0.025 |
| | (0.09) | (0.128) | (0.125) |
| N | 4485 | 2355 | 2129 |
| R-squared | 0.3214 | .2732 | .3690 |
| **Panel B: Effects on Numeracy** | Whole Sample (1) | Dosso (2) | Zinder (3) |
| ABC village * 11 months | .11* | .215** | 0.014 |
| | (0.065) | (.080) | (.104) |
| N | 4697 | 2568 | 2129 |
| R-squared | 0.5459 | .5982 | .5213 |

*Notes:* ABC villages are the villages in which traditional literacy training was complemented by cell phone based literacy training. 11-month results are results 11 months after the beginning of classes and 7 months after the end of the first year of classes. OLS regressions that control for ABC village, time, region (except columns (4) and (5)) , sex (except columns (2) and (3)), and columns (1) and (6) also for sex*region. Panel A: contains results for literacy. Panel B: contains results for numeracy. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively. Robust standard errors clustered at the class.

**Table 8: Teacher and Student Characteristics and Attendance**

| | ABC | Non-ABC | Diff(s.e) |
|---|---|---|---|
| **Teacher Characteristics** | | | |
| Level of Education | 8.90 | 8.30 | .604(.403) |
| Age | 32.14 | 32.64 | -.495(1.75) |
| Sex (1=Woman, 0=Men) | .25 | .32 | .065(.089) |
| **Teacher Attendance (Number of Classes Taught)** | | | |
| Overall | 56.74 | 57.13 | -.388(3.36) |
| Doutchi | 58.66 | 59.95 | -1.29(4.01) |
| Zinder | 54.11 | 53.49 | .621(5.65) |
| **Student Attendance Rate** | | | |
| Overall | 0.739 | 0.727 | .012( .034) |
| Doutchi | .705 | .743 | -.038(.041) |
| Zinder | .786 | .704 | .082(.056) |

Notes: Table displays summary statistics for ABC (Column 1) and non-ABC (Column 2). Column 3 reports the difference. Standard errors in parenthesis. ***, **, * denote statistically significance at 1, 5, 10 percent, respectively.