A Study of ABRACADABRA Early Literacy Software in Mombasa, Kenya: Phase One Report

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Abstract

Twelve grade two (standard) English teachers and their students from six schools in the Mombasa area participated in Phase 1 of the project. This group was randomly divided in half: six experimental teachers (those using ABRACADABRA early literacy software as part of their English Language instruction in six classes; N= 180) and six control teachers (those not using ABRACADABRA with their students in six classes; N = 174).

In June 2012, after the pre-test student data were collected, a three-day initial training and planning session was held for the experimental teachers on how to use ABRA to teach literacy. Teachers were provided with teaching materials including a tentative ABRA curriculum developed to align with the Kenyan English Language requirements for standard two students.

In total, the ABRACADABRA intervention lasted for 13 weeks. Every week, each experimental group was bussed to the Aga Khan Academy Junior School computer lab, which housed 24 desktop computers with full access to ABRACADABRA. Each lesson lasted only 90 minutes. To increase the exposure time to the technology, some teachers placed students in dyads or triads due to large class sizes. Posttest data were collected at the end of November, 2012.

The Group Reading Assessment and Diagnostic Evaluation, GRADE (Williams, 2001) is a standardized measure designed to assess reading skills and monitor reading progress. The test was administered as a pretest to experimental and control students in May 2012 (form B) and in November 2012 (form A) as a posttest.

There is a relatively strong emphasis in the Kenyan curriculum on vocabulary and word recognition. Consequently, both experimental and control participants gained substantially in this regard. However, the results on other subtests indicate that students in ABRACADABRA classes improved their scores at a significantly higher rate than students in control classes. For example, in passage comprehension and listening comprehension, students in the ABRACADABRA group improved by 13 and 21 percentile points, respectively, over their counterparts in the control group. This is a remarkable improvement given the short duration of the ABRACADABRA intervention.

In addition, the ABRA intervention seems to have had positive effects in several school subject areas. ABRA students outperformed their peers in control classes on the four core, end-of-year subject exams including English, Mathematics, Science and Social Studies. Indeed, this transfer of literacy skills is an important outcome pointing towards the utility of ABRA as a tool that has widespread impact on students' school success.

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Background

"Education is, quite simply, peace-building by another name. It is the most effective form of defence spending there is" (Kofi Annan as cited in UN News Centre, 1999, para. 13).

The introduction presents the need for improving the teaching and learning of literacy in Kenya. It summarizes the nature of, and existing evidence concerning, an educational software tool called "ABRACADABRA" developed for enhancing young children's reading and writing skills.

Need and Potential Impact

According to United Nations Children's Fund (2012), nearly 90 per cent of the world's 127 million illiterate youth live in South Asia (65 million) and sub-Saharan Africa (47 million). In the least developed countries one quarter of young men and one third of young women, aged 15 to 24, are illiterate. In some of these countries, even students attending and completing primary school are unable to read and write basic sentences and are thus unprepared for further education. The gap in lower secondary school completion rates between sub-Saharan Africa and the rest of the world appears to be widening. In fact, sub-Saharan Africa has the worst secondary education indicators of any region. Its level of enrolment of secondary-school-aged children is the lowest, as are its rates of secondary school completion, and it has fewer girls enrolled than boys. Low secondary school enrolment stems in part from low primary school completion. In sub-Saharan Africa, only 47 per cent of 15–19-year-old girls and 52 per cent of 15–19-year-old boys have completed primary school (United Nations Children's Fund, 2012). This is a clear call for attention to the quality of primary schools in sub-Saharan Africa.

Children in Kenya, especially girls, are not achieving educational success to the extent they are capable of (Dubeek, Jukes, & Okello, 2012; Watkins et al., 2010). Only 34% of boys and 27% of girls complete secondary school in Kenya (United Nations Children's Fund, 2012). Literacy, in particular, is linked not only to success at school but also to subsequent employment and economic well-being. Research has established strong links between national economic well-being and adult literacy, with small gains in adult literacy rates being strongly correlated with large gains in national GDP (Murray et al., 2009). International statistics show that Kenyan rates in English literacy, are well below the standards of developed countries in the OECD (Knighton et al., 2010), with males having a higher literacy rate of 64.2%, as compared to 58.9% for females (Kenya Ministry of Planning and National Development, 2007),

In a recent Uwezo survey of literacy rates in Kenya (Mugo, Kaburu, Limboro, & Kimutai, 2012), researchers reached the furthest and most remote villages in all 47 counties in Kenya. They visited 3628 villages, 72,106 households, 3574 schools, and assessed 134,243 children. Their work indicated that nationally, 7 out of 10 children in class 3 are unable to do class 2 work and one out of five children in Class 4 are unable read this simple Class 2 paragraph: "Sara has one brother. His name is Tom. Tom is six years old. He is in class one."

"What Uwezo has found, now in its second year of business, is truly sobering. Large majorities of children lack the competencies they are expected to have developed. Some begin to catch up over time, but still too many children complete primary schooling unable to read and count at the Class 2 level…. In short, Uwezo has demonstrated powerfully that schooling is not

translating into learning. Billions of dollars are wasted each year. An even greater level of aspirations of parents and students are dashed. As nations we are at risk, the very foundation of our democracies, social development and economic progress jeopardized, unable to grow equitably and creatively, unable to compete, unable to imagine and craft better worlds." (Foreword by Rakesh Rajani, 2012).

Low literacy rates in Kenya may be attributable to a number of environmental factors, but also to the lack of teacher awareness of successful literacy instruction approaches (Dubeck, Jukes, & Okello, 2012). According to Bunyi (2006) "the official position as regards teaching-learning methodologies favours learner-centered activity based methodologies. However, a child in primary classes spends most of the time listening to the teachers and/or mindlessly repeating words or sentences after the teacher. Further, literacy development is not given adequate attention in teacher training programmes. For example, there is no special training for lower primary teachers who are expected to teach initial reading. Low morale and lack of commitment have also characterized the teaching profession for a long time. Gender insensitive and child unfriendly school environments are yet other contributory factors. FPE [free primary education] has compounded the quality issues with issues such as very large classes and increased diversity of pupils and over age emerging. The foregoing discussion indicates that large proportions of Kenyan children are not acquiring sustainable literacy levels either because they are not staying in school long enough to do so or because of the poor quality of education" (p. 8).

It is clear that literacy levels of Kenyan students need to be dramatically raised and that the teachers of those students would benefit from enhanced professional development that focuses on evidence-based strategies for literacy instruction. ABRACADABRA is evidence-based and evidence-proven multimedia software designed to meet these dual challenges.

Effective Literacy Instruction

The strongest forms of reading research are those that are both well designed and that have been repeatedly replicated. The National Reading Panel report (NRP, 2000) summarizes the best, consistent evidence on learning to read. In addition, the Panel notes that interventions must be comprehensive or balanced. Truly balanced approaches emphasize reading skills such as: phonemic awareness – ability to hear and manipulate individual sounds in spoken language; phonological awareness – ability to relate specific written letter(s) to specific sound(s) (grapheme–phoneme correspondence); fluency – ability to read text effortlessly and expressively; and comprehension – ability to understand and interpret text; and an emphasis on meta-cognition – ability to reflect and regulate knowledge construction. Dozens of studies worldwide have shown these techniques to be effective in improving literacy when used as part of a classroom approach that also includes the fostering of: on-task activities, student self-regulation, connections across curricular themes, and communications between home and school (Hall & Harding, 2003).

We are in a position now where we know in principle what to do to enhance early literacy. For example, we know that effective preventative reading programmes in the early grades that involve structured phonics, word recognition, and letter–sound knowledge training that are over-learned and repeatedly connected to the end goal of text reading for meaning, are one of several important elements of balanced literacy approaches. The involvement of explicit attention to fluency and to a host of strategies for understanding and evaluating texts is also critical (e.g., Pressley, 1998). We also know that teachers need support and expert professional development to overcome the challenges of teaching struggling readers (Chambers, Abrami, McWhaw, & Therrien, 2001). Finally, we know generally that the effectiveness of classroom

applications of educational software depend on careful attention to instructional design followed by professional development and follow-up support (Abrami et al., 2006; Meyer et al., 2010, Tamim et al., 2011, Gerard, Varma, Corliss & Linn, 2011).

The next question is what prevents progress in literacy at a national and international level? One key problem is the lack of evidence-based practice in classrooms. One issue that prevents more widespread implementation of evidence-based programmes is that such programmes are frequently prohibitively expensive. Allington (2004), for example, argued in an influential paper in *Educational Leadership*, that the costs of current reading programmes in the United States (some $500,000 per typical school) effectively prevents full literacy for all from ever being achieved especially in countries like Kenya where cost issues are serious concerns. By providing ABRA software at no cost, by embedding some professional development and usage tracking within the tool, and by using local expertise for additional training and support, the costs of ABRA dramatically lessen the expense of implementing an evidence-based reading programme in developing countries like Kenya.

ABRACADABRA

Figure 1. ABRACADABRA Characters

ABRA is evidence-based educational software, available to educators without charge. It provides a web-based environment of engaging interactive multimedia for learning, accompanied by a wide range of support material. The content of ABRA learning activities is derived directly from systematic reviews of evidence about what works in reading and spelling (National Reading Panel (NRP), 2000). Moreover, the embedded activities provide guidance for teachers in support of their transition from purely drill and recitation methods of teaching (Arnold & Bartlett, 2010) towards an approach that focuses on student comprehension of written and oral English. ABRA's division into essential skills for reading proficiency (most of which have various levels of difficulty allowing for differentiated instruction) ensures that teachers provide students with all the building blocks necessary for success. There is also a plethora of print-based materials and a large collection of 15 additional student-generated stories, helping to ensure usability and student engagement across a range of contexts and with a diverse collection of learners.

In its current iteration, ABRA consists of a: 1) Student Module (32 alphabetic, fluency, comprehension and writing instructional activities, many at different levels of difficulty and complexity; 17 stories of various genres linked to the activities; and 15 stories written by students; 2) Teacher Module (professional development material such as explanations, lesson plans, embedded video teaching vignettes, and printable resource materials, as well an assessment reporting feature (where teachers can review student and class performance on instructional activities for any period of time; 3) Parent Module (for access to multimedia resources and tips on how to support the use of ABRA in the home); and 4) a Communication Module or wiki (to encourage teachers and other professionals to share information about learning to read and ways to promote student literacy)

Figure 2. Alphabetics, Fluency, Comprehension and Writing Activities in ABRA

Finally, we placed ABRA in the Learning ToolKit that also includes an electronic portfolio, ePEARL. ePEARL is a multimedia container that supports literacy development by encouraging students' self-regulation processes including goal-setting, monitoring of and reflecting on their performance. Given the natural fit between process portfolios and literacy (Abrami, Venkatesh, Meyer & Wade, in press), we strengthened the link between ABRA and ePEARL.

Figure 3. The ABRA Chooser. Users select an activity along with the linked story

Balanced literacy - Early on in the conceptualization of ABRA, we decided that the pedagogical underpinnings of the software would replicate those contained in programs of Balanced Literacy. Defined as the "radical middle" by Jeanne Chall (1967; 1983) and described by Marilyn Jager Adams (1990), our software would emphasize a harmonious balance between code-emphasis and a literature-rich context. This would allow children to explore their interests by applying a large repertoire of strategies that can be readily accessed when meaning breaks down (Pressley, 2002). This balanced literacy approach also means that instructional activities are designed within the context of story texts and vice versa (see Figure 3).

Available without charge - We also decided from the outset that our software would be adaptive to learners with special needs, promote learning among otherwise struggling and at-risk students, and be widely available at the lowest cost -- especially given the financial situation in many urban and rural schools where literacy rates are poorest. We coined the slogan: "we do not profit from children, but children profit from us," to underscore the notion that the success of our software, first and foremost, is tied to learning outcomes.

To date, all CSLP educational software is available without charge. Face-to-face training for research sites is available without charge and other training is provided on a cost recovery basis. This not-for-profit and philanthropic philosophy is markedly different from commercial software and is one of our greatest commitments, as well as one of our greatest challenges.

Flexible and modular design - From the early days of imagining our tools, the CSLP decided it would design the software content in the form of reusable learning objects. This would enable teachers all over the world, to access a rich pedagogical resource and re-use the instructional components, based on their teaching styles and the needs of their students. This early design philosophy of modularity and reusability, was eventually abandoned in favor of a single, underlying database. However, the legacy of modularity and reusability allowed us to take advantage of technology to design a tool that is not linear in use and not prescriptive of a single approach or method of teaching students to read. The toolkit metaphor aptly describes the notion that our software was intended to be a collection of resources that the teacher could use when, how, and with whom s/he saw fit.

In addition, we consider that to have an impact on the literacy problem, our tools must be easy to use and fit the realities of classrooms. We did not design the LTK to run only on the latest computers or where every schoolchild has unlimited access to technology. Instead, the LTK and its tools are designed for 'the state of the practice, not the state of the art'.

Embedded professional development and support - All CSLP educational software includes embedded just-in-time multimedia for professional development and virtual tutorials to help teachers and students start using the tools appropriately and immediately. This embedded support helps ensure the tools and their underlying curricular and pedagogical principles and features are used properly. Embedded teacher support also helps reduce the cost of in-service follow-up.

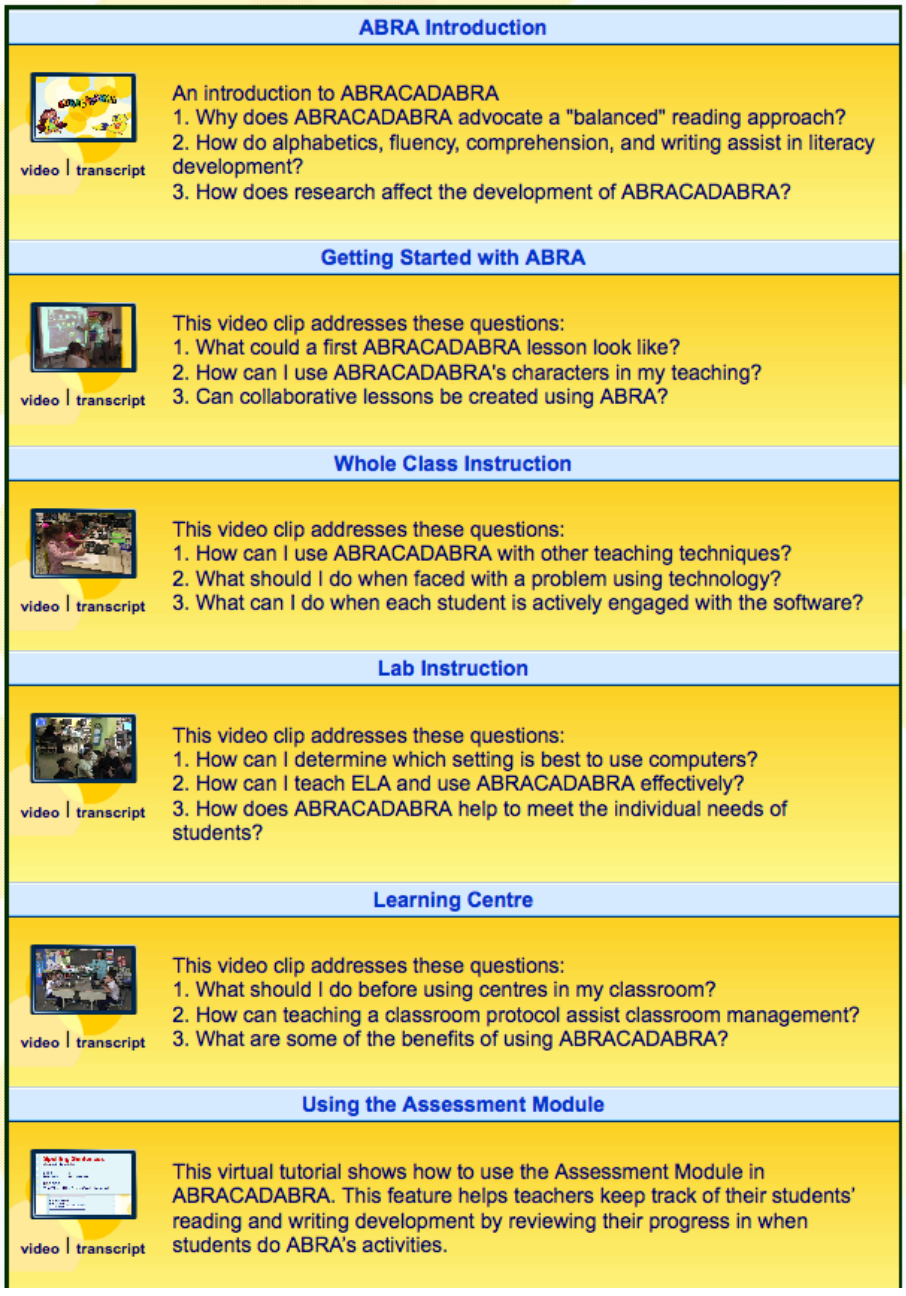


Figure 4. Embedded multimedia support for teachers

Based on evidence - Early on in the development of every tool, we conduct a lengthy needs-analysis where experts in the educational community are surveyed, research is reviewed, and finally, initial design decisions are made. As a research centre, the commitment of the CSLP to evidence-based practice is strong and we used the best evidence to design each version of

our software. We also believe in the importance of partnerships to ensure knowledge mobilization for scalability and sustainability—by applying a combination of scholarly expertise and practical wisdom. Finally, we committed ourselves to evidence-proven practice, ensuring that our software does produce the intended impacts on teaching and learning. Several of these studies are summarized in the section below.

The foundation of the Student Module is illustrated in the ABRA research matrix (see Figure 5) as described in Abrami, Savage, Wade, Hipps & Lopez, 2008. The basis of the matrix is the National Reading Panel's (2000) meta-analysis. This analysis examined over 100,000 research studies conducted over 35 years and used the best evidence to summarize the findings and make recommendations regarding the skills necessary to become competent readers. The skill areas are those that beginning readers need to develop, grouped in four major skill categories--Alphabetics, Fluency, Comprehension, and Writing—and associated sub-skills.

With our commitment to include the tenets of a Balanced Literacy philosophy, we created a link between stories and activities. The ABRA Research Matrix demonstrates the link between text from the stories and the activities. It also shows the scope of each activity, defining the various levels and specific content related to each level.

For instance, the Word–Level Sound Discrimination skill is practiced through the activity called Word Counting. This activity has two levels of difficulty, which differ from each other by the number of words the user has to count in a sentence. This activity is linked to multiple stories because the content (words from the stories) is used in the activity. Ultimately, the activities and stories are connected by shared content providing users with contextualized learning experiences.

The approach of constructing and applying evidence matrices are carefully designed for all 17 stories in ABRA and for all text-, word- and fluency- level activities.

Skill Area	**COMPREHENSION**							
Skill	Prediction	Comprehension Monitoring	Sequencing	Summarizing	Vocabulary	Vocabulary (ESL)	Story Response	Story Elements
Story Titles								
Folk and Fairy Tales								
Little Red Hen	x	x	x	x	x	x	x	x
Dove and the Ant	x	x	x	x	x	x	x	
Three Billy Goats Gruff	x	x	x	x	x	x	x	x
Henny Penny	x		x	x	x	x	x	x
Frogs and the Well	x	x	x	x	x	x	x	x
Poetry								
I Can Move Like A...					x	x		
When I Open My Eyes					x	x	x	
Darryl! Don't Dawdle		x			x	x	x	x
Feelings					x	x	x	
Fiction								
Waterfall	x		x	x	x	x	x	x
Non-Fiction								
How a Bean Sprouts		x	x		x	x		

Figure 5. Sample from the ABRACADABRA Research Matrix for Comprehension

Supporting Research

Numerous studies have already shown that high quality ABRA interventions promote significant and meaningful gains in students' alphabetic, fluency, comprehension and writing skills (e.g., Abrami et al., 2010). There are more than a dozen studies exploring the impacts of ABRA on various facets of children's reading skills. Two of these studies are longitudinal, randomized

controlled field trials, one conducted across Canada (Savage et al., 2012) and the second conducted in remote and rural areas of the Northern Territory of Australia (Wolgemuth et al., 2011). As one can see from Table 1, the positive effects of ABRA hold for all types of reading skills and measures, even under stringent conditions of experimentation compared to other forms of reading instruction. Furthermore, the effects of ABRA are not trivial in size; ABRA produces noticeable gains in learning compared to traditional means of reading instruction. A complete list of ABRA research papers and publications may be found on the CSLP website along with an introductory video and access to the interactive, multimedia instructional materials. See http://doe.concordia.ca/cslp/.

Table 1

Research on ABRACADABRA: Evidence of Impacts

Reading Skill	**k (# of comparisons)**	**Average Effect Size**	**Percentile Advantage**
Alphabetics	21	+0.396	15.39
Fluency	19	+0.187	7.42
Comprehension	11	+0.340	13.31
Overall	51	+0.306	12.02

The use of ABRA to overcome some of the above-mentioned challenges in Kenya has previously been tested in another developing educational context. In 2009, ABRA was used in several Australian Northern Territory primary schools where the literacy outcomes of indigenous and non-indigenous students were evaluated (Wolgemuth et al. 2011). Student and teacher absenteeism and a shortage of teachers with the appropriate qualifications, skills and experience describe the conditions of the schools in the Northern Territory of Australia. The use of ABRA proved highly beneficial as results revealed both indigenous and non-indigenous students who received ABRA instruction had significantly higher reading scores than their control group peers, with a large effect size for this difference (eta squared= 0.14).

The use of ABRA in Kenya and other developing countries fits well with many of the recommendations from the Brookings Institute (Perlman Robinson, 2011), including “the need to build foundational skills in literacy and numeracy in the lower primary grades” (p.23) and the need to “prioritize literacy and numeracy in the lower primary grades”(p. 24). This is to be achieved through teacher professional development, increased time spent on reading, more appropriate reading material, and the creation of a culture of reading (including at home).

There is also much optimism regarding the potential of eLearning in Africa given recent improvements in the infrastructure (i.e. shared resource computing models, mobile phones and tablets, access to broadband connectivity etc.) (Isaacs & Hollow, 2012), although Hennessy & Onguko (2009) found there was a significant need for research on how to effectively integrate technologies in their review of the use of ICT in East African schools. This project is timely given the broad aim of the initiative is to positively influence the current discourse on teaching and learning within the Kenyan context. Our efforts also align with the Kenyan Government

Vision 2030 (www.vision2030.go.ke/) and the Ministry of Education's expressed interests and directives in both improving literacy and in increasing technology use in schools.

The Kenya Institute of Education has advocated technology integration through the development of portable digital content (www.kie.ac.ke*)* For example, the Ministry's ICT initiative targets mainstreaming of information technology in 20,000 public primary schools, 6,000 public secondary schools, 22 PTTCs, 2 diploma colleges and 10 model e-learning centres for Adult and Continuing Education. Furthermore, we will ensure that this project targets teachers' ICT skills as per UNESCO-IICBA's (2012).

Our summary of systematic reviews of the uses of technology for learning (Tamim et al, 2011) found that teachers play an even greater role in students' technology-enhanced learning than the nature of the technology intervention itself. The effectiveness of the technology intervention depends on the teacher's goals, pedagogy, and content knowledge. Even in developed countries, few pre-service programmes prepare teachers to use technology-enhanced materials to enhance inquiry learning. As a result in-service professional development programmes are the most common approach to introducing teachers to the goals and designs of technology interventions and to cultivating teachers' pedagogical content knowledge in this new domain (Mishra & Koehler, 2006). In a recent review of technology integration and in-service support, Gerard, Varma, Corliss & Linn (2011) found that professional development programmes that engaged teachers in a comprehensive, constructivist-oriented learning process and that were sustained beyond one year were the most effective.

Project Objectives

The larger aim of the proposed initiative is to positively influence the current discourse on teaching and learning within the Kenyan context. Our efforts align with the Kenyan Ministry of Education's expressed interests and directives to both improve literacy and to increase technology use in schools. The specific purpose of the current study is to explore the feasibility and effectiveness of using ABRA, early literacy software and print-based materials, with emerging readers and their teachers in Mombasa, Kenya.

From an examination of the Kenyan curriculum and discussions with the AKA staff and Mombasa school teachers, we learned that there was a heavy emphasis in grade two on vocabulary including word meaning and reading. Therefore, we did not expect that the ABRA group would outperform the control group on these facets of reading. We did, however, expect enhanced performance of the ABRA students compared to control students on other essential reading skills.

In this project we attempted to answer the following questions:

- What is the effect of ABRA on students' reading skills?
- Does ABRA produce positive effects on boys' reading skills? Girls' reading skills?
- Does ABRA produce positive effects on students of low reading ability?
- Does the use of ABRA help change the pedagogical approach to teaching literacy?
- Does the effect of ABRA transfer to other school subjects?

Methodology

Research Design

A pre-test/post-test control group design with delayed treatment to the control participants was used in this study. Six pairs of volunteer teachers, with their classes matched on pre-test scores and other characteristics as closely as possible, were randomly assigned to either experimental or control conditions. Experimental teachers gave the ABRA intervention first while the control teachers used traditional methods of instruction. Control teachers and their students then used the software following post-testing.

Sample

Twelve grade two (standard) English teachers and their students (N=429) from six schools in the Mombasa area participated in phase 1 of the project. This group was randomly divided into two: six experimental teachers (those using ABRA as part of their English Language instruction in six classes comprising a total of 212 students) and six control teachers (those not using ABRA with their 217 students in six classes). From the total sample of 429 second-graders, 71 students did not write at least one of the tests for a variety of reasons. Specifically, 13 students were transferred to different classes during the year, 10 students were new to their classes and 47 did not attend lessons on the day of testing. Additionally, 4 students enrolled in the control classes (2 students from school 3 and 2 students from school 5) but mistakenly registered in the ABRA database as users, were also removed on the premise that their exposure to ABRA would have affected their post-test scores. These reductions resulted in usable data for 354 students (N_c= 174 and N_e= 180).

Figure 4. ABRA Facilitators

Intervention

In the spring of 2012 after the pre-test student data were collected, a three-day initial training workshop and several planning sessions were held for the experimental teachers on how to use ABRA to teach literacy. Teachers were provided with teaching materials including an ABRA curriculum developed expressly to align the use of the tool with the Kenyan English Language requirements for standard 2 students. The materials also included lesson plans, classroom activities, and job aids for teachers. The use of these materials was suggested rather than

prescribed and their use was left at each teacher's discretion. Multimedia scaffolding and support for teachers and students embedded in ABRA were also available. On a weekly basis, the CSLP project coordinator conducted telephone conferences both to support teachers and to provide them with a forum to discuss teaching issues using ABRA. Additionally, AKA staff provided help to the teachers by supporting the teachers during the lab sessions and by providing feedback on teachers ABRA lessons.

In total the ABRA intervention lasted for 13 weeks from spring to fall during the second term. Every week, each experimental class was bussed to the AKA Junior School computer lab, which housed 21 desktop computers with full access to ABRA. The lesson for each class lasted up to two hours per week. To increase the exposure time to the technology, teachers placed students in dyads or triads due to the large class sizes. About two weeks of the 13-week intervention were spent at the outset familiarizing students with computer learning environments in general and ABRA navigation in particular. Lab time was also occasionally lost due to late arrivals and the occasional technological glitches and there was a one-month delay mid-project due to a teacher strike.

Figure 5. Class visits to the computer lab at the Aga Khan Academy

Instruments

Student Achievement Measures

The Group Reading Assessment and Diagnostic Evaluation, GRADE (Williams, 2001) was used for the purposes of phase 1. GRADE is a standardized measure designed to assess reading skills and to monitor reading progress. It contains five core subtests of Word Reading, Word Meaning, Sentence Comprehension, Passage Comprehension and Listening Comprehension. Word Reading and Word Meaning are the two subtests each measuring slightly different vocabulary related skills. Twenty Word Reading items measure a student's ability to both decode regularly spelled words (e.g. excitement) and recognize sight words (e.g. their). The teacher reads a target word, and then reads a sentence that contains this word and then repeats the word. The student picks the target word from a list of four or five choices. Word Meaning subtest includes 27 items measuring both word decoding or sight-reading and understanding of early-reading vocabulary. Teachers neither read any of the words nor identify pictures. Students are to read a word and to make one choice among the four picture distractors to match the word. There are two reading comprehension subtests, Sentence Comprehension and Passage Comprehension. Each of the 19 Sentence Comprehension items

includes a sentence with a missing word. Students are to select one correct word among four single-word choices. This subtest identifies if the student can comprehend the sentence as a whole thought by using contextual cues, knowledge of grammar and vocabulary. Passage Comprehension subtest measures reading comprehension skills with a variety of multiple-choice questions (e.g. questioning, clarifying, summarizing and predicting) about each of the 24 passages of different types (e.g. poem, fiction, science) on different topics and of different lengths (short, medium and long). Seventeen Listening Comprehension items measure linguistic comprehension without printed cues. Students are to listen and understand orally presented text and choose one of the four pictures that best corresponds to what is read to them. The item types focus on Vocabulary, Grammar and Inference. We used GRADE Level 1 to measure the development of reading skills as it allows for testing a broad group of elementary students (from kindergarten to grade 2). The test was administered to students in May 2012 (form B) to collect baseline data and in November 2012 (form A) to assess end-of-year reading achievement gains.

Finally, experimental and control teachers also provided us with end-of-year examination results for students in English, in other subject matters taught in English, including Social Studies, Mathematics, and Science, and in Kiswahili.

Teacher and Classroom Measures

The *Literacy Instruction Questionnaire* (LIQ; Abrami et al., 2011) was used to collect information about the English Language instruction. This is a CSLP-developed instrument that elicits teacher reports on aspects of the instructional methods they used in their classroom over the past semester. Specifically, the questionnaire includes two sections to explore: 1) approaches to reading and comprehension instruction; and 2) use of technology. Twenty six items investigate the activities students engage in to develop their reading and comprehension skills including phonemic awareness, phonics, oral reading fluency, vocabulary, comprehension and writing (NRP report, 2000). To capture the possible changes in the literacy instruction, the twelve teachers were asked to complete the questionnaire at the pre- and post-test, in May and November 2012 respectively.

Figure 6. Using ABRA in the classroom

An ABRA classroom observation form (Centre for the Study of Learning and Performance, 2012) was used to collect additional data about the details of classroom instruction. The form is a CSLP-developed instrument and includes four sections. The first section pertains to general classroom environment (including physical context and environment, classroom management, quality of teaching and learning and effects of technology). The second section focuses on English language activities such as word-level and text-level writing and extension activities and elicits specific information about the type of activity (e.g. segmenting, vocabulary development), time spent on each activity, and technology used as part of activity instruction. A separate section on classroom management draws attention to details of collaborative work such as types of collaboration, types of activities and time spent, and teachers' facilitation and instruction. Each item on the form is followed by a space where observers can leave their

comments with regard to what they observed. Finally, the form includes a five-point scale to evaluate the overall classroom instruction. Each point on the scale is assigned a label containing a number of statements providing a description of a probable classroom situation. For instance point three is "Most students are attending to the given task. There is minimal or no off-task behavior. The teacher is able to guide students through activities effectively."

Lesson plans, involving the integration of ABRA into language instruction, were requested from experimental teachers in order to cross-validate the trace data collected by the software as students used ABRA. The format of lesson plans was left to the teachers' discretion. Although thirteen lesson plans were expected from each teacher, the number of submissions varied from 1 to 11.

Videotaping of English language instruction was conducted during the 13-week long intervention in order to capture teachers' pedagogical techniques and students' learning experiences in both the ABRA and control groups. To ensure quality and usability of video materials, the video team was provided with the Videotaping User's Guide (Lysenko & Pillay, 2012). The length of each video clip was set to five minutes. Teachers' instruction around ABRA or ABRA-related activities as well as students' interaction with the ABRA tool was focused on in the experimental ABRA classes.

Teacher final interviews were conducted shortly after the end of the intervention. The objective of holding these interviews was to learn about teachers': attitudes towards the use of the technology when teaching generally, and in the use of ABRA specifically; the factors that facilitated or impeded the use of ABRA; the extent to which the professional development material supported the use of ABRA; and the teachers' beliefs about effective pedagogy in the teaching of literacy. Some questions were drawn from the LIQ to determine the consistency of teacher replies.

Analyses

Before the main analyses, standard procedures were used to clean the data. At this stage, we detected systematic anomalies in the pre-test scores in one of the six experimental classrooms. In order to keep this school as part of the analysis, its pre-test data on all five GRADE subtests were imputed. In other words, the invalid data were replaced with plausible data (estimates) generated through a regression model.

For all GRADE achievement measures, analyses of variance (ANOVA) on simple difference scores (post-test minus pre-test) was used. Although the difference score has often been maligned as an unreliable index of change, recent work (Zimmerman & Williams, 1998; Thomas & Zumbo, 2012) demonstrates a flaw in this perspective and suggests that the resulting non-use of difference score analysis is unwarranted.

In order to explore additional aspects of GRADE score changes between the groups, two additional analyses were run. The first one examined the changes in GRADE scores separately for boys and girls. The sample included 141 boys and 213 girls. The second analysis assessed if the GRADE change scores varied with student pretest reading scores. For this analysis, students' pre-test scores were divided into three equal-size groups. GRADE gain scores of low and high pre-test readers were then compared across ABRA and control groups.

Analysis of covariance was used to examine the differences between the groups on the end-of-term exam results in the following core subjects of the Kenyan curriculum: English, Math, Science and Social Studies. To do so, we compared scores between control and ABRA groups after statistically adjusting for pre-test differences as measured by the GRADE pre-test.

In addition to all the statistical analyses of significance, standardized effect sizes (i.e., Cohen's d) were calculated to estimate the magnitude of differences between ABRA and the control groups.

Results

Student Achievement

Overall GRADE Results

To answer the question if ABRA produced results on students' reading skills as measured by GRADE, we compared the test scores of control and ABRA students collected before and after the 13 weeks of ABRA intervention. At the pretest, the experimental and control group did not differ significantly on the five GRADE basic scales except in word reading where students' scores in the experimental group were significantly higher ($t(1, 353) = 3.82$, $p < 0.00$). Overall, these results lend credibility to the notion that the experimental and control students were mostly equivalent in literacy skills at the outset of the ABRA intervention.

A summary of the ANOVA results of the difference scores on all the subscales of GRADE test are reported in Table 2. The results vary somewhat, mainly showing effects favoring the ABRA students.

Table 2

GRADE means, standard deviations, change scores (full sample)

GRADE scales	ABRA means (N= 180)			Control means (N=174)			Difference in gains between ABRA and control groups	F value and significance	Effect size (Cohen's d)
	Post	Pre	Change	Post	Pre	Change			
Word Reading (WR)	18.89	17.53	1.36	17.99	16.27	1.72	-0.36	1.03	-0.13
Standard Deviation	*2.08*	*3.18*	*3.12*	*3.18*	*4.08*	*3.45*			
Word Meaning (WM)	24.32	23.60	0.72	23.74	23.29	0.44	0.28	0.35	0.07
Standard Deviation	*3.46*	*5.21*	*4.82*	*4.00*	*4.62*	*3.99*			
Vocabulary Composite (WR+WM)	43.21	41.13	2.08	41.72	39.56	2.16	-0.08	0.14	-0.01
Standard Deviation	*4.91*	*6.81*	*6.19*	*6.41*	*8.02*	*5.85*			
Sentence comprehension (SC)	12.63	12.17	0.46	11.94	12.17	-0.25	0.71	2.59	0.15
Standard Deviation	*4.48*	*4.31*	*4.07*	*4.79*	*4.67*	*4.22*			
Passage comprehension (PC)	12.24	10.11	2.13	11.21	10.77	0.43	1.70	12.26***	0.32
Standard Deviation	*4.92*	*3.97*	*4.42*	*5.51*	*4.43*	*4.71*			
Reading Comprehension Composite (SC+PC)	24.87	22.28	2.59	23.13	22.95	0.18	2.41	10.35***	0.26

Standard Deviation	*8.73*	*7.21*	*6.96*	*9.52*	*8.14*	*7.16*			
Total (VC+RC)	68.08	63.41	4.67	64.87	62.51	2.36	2.31	4.81*	0.17
Standard Deviation	*12.42*	*12.17*	*10.00*	*14.53*	*14.87*	*9.90*			
Listening	13.63	11.84	1.79	12.76	12.61	0.15	1.64	29.04***	0.54
Standard Deviation	*2.66*	*3.43*	*2.67*	*3.35*	*3.56*	*3.03*			

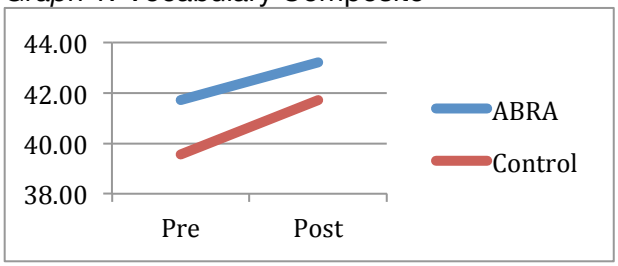
*** p< 0.00, **p<0.01, * p< 0.05

As expected, the analyses did not find statistically significant difference in change scores between the groups on vocabulary-related subscales including word reading and word meaning (student capacity to decode, recognize sight words and to understand their meaning) as well as on sentence comprehension (that provide contextual clues to derive the meaning of the unknown words). As is illustrated in the graphical results **both the ABRA and control students gained equally and significantly over the term.** Given the emphasis placed on vocabulary in the classes of both groups, this is not an altogether surprising result.

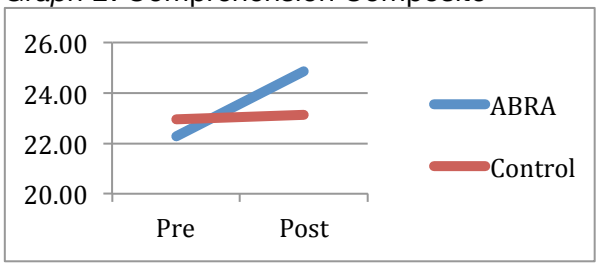
On the other hand, the results indicate that on comprehension-related scores, **students in ABRA classes improved their scores at a significantly higher rate than students in control classes.** Specifically, they showed significantly larger improvements compared to their control counterparts in passage comprehension ($F(1, 353) = 12.26$, $p < 0.00$) and listening comprehension assignments ($F(1, 353) = 29.04$, $p < 0.00$). The effect sizes for all subscales range between small (< 0.30) and medium (0.30 – 0.50). On the basic scores of passage comprehension (d= 0.32) and listening (d=0.54), an average student in the ABRA group improved by 13 and 21 percentile points respectively over his/her counterpart in the control group.

The graphs below visually represent the difference in means change scores between the two groups on the three main aspects of the GRADE test including vocabulary composite (graph 1), reading comprehension composite (graph 2), the total score (graph 3) and listening comprehension (graph 4).

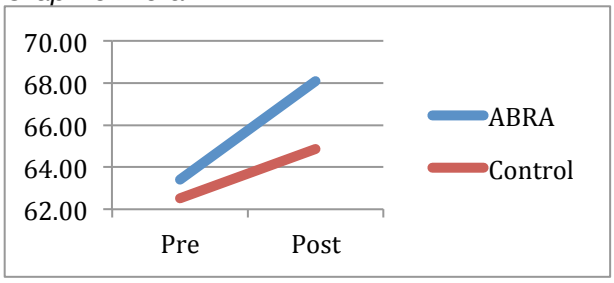
Graph 1. Vocabulary Composite



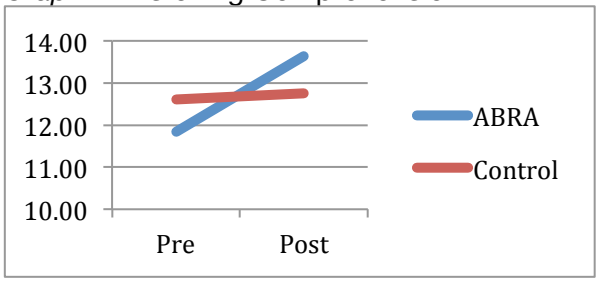
Graph 2. Comprehension Composite



Graph 3. Total



Graph. 4 Listening Comprehension



We compiled table 3 to determine how comparable student post-test reading scores in the Kenyan experimental and control groups are to the GRADE norms for US grade 1 students. Table 3 summarizes the percentage of Kenyan students at the US average for grade 2. According to the GRADE norms (level 1 for students in grade 1, form A, end of the academic year), 50% of students should achieve the threshold of:

- 43 on Vocabulary Composite
- 26 on Comprehension Composite
- 67 on Total Test
- 16 on Listening

Table 3

Percentage of students reading at and above the GRADE average (US sample, grade 1)

	Vocabulary Composite 43 and more	Comprehension Composite 26 and more	Total Test 67 and more	Listening 16 and more
ABRA group	73.3%	51.6%	60%	28.9%
Control group	69.5%	42%	55.2%	23.5%

The table shows that the percentage of students in the six schools reading at or above average is comparable to the GRADE norms for the US grade one students on major sub-tests except listening comprehension. As expected, the percentage of students performing at or above average in the ABRA group is consistently higher than students in the control group. However, there remains room for improving the number of students to meet the norms set for grade two students.

Gender Differences

In addition to the main analysis, we examined if ABRA effects differed for boys and girls. Table 4 consolidates the results of the analyses of the GRADE gain score differences for boys in ABRA and control classes. The data show that boys in the ABRA group demonstrate higher gains than boys in the control group on all subtests except word reading. Moreover differences between them is statistically significant for comprehension-related scores of sentence ($F(1, 140)= 4.78$, $p < 0.05$) and passage comprehension ($F(1, 140)= 19.99$, $p < 0.00$), total test ($F(1, 140)= 6.78$, $p < 0.01$)and listening comprehension ($F(1, 140)= 9.34$, $p < 0.00$).

Table 4

Reading gains for boys in ABRA and control classes

GRADE scales	**ABRA boys (N=73)**	**Control boys (N=68)**	**Mean difference**	**F value and significance**
Word Reading (WR)	1.67	2.10	-0.43	0.62
Standard Deviation	*3.26*	*3.18*		
Word Meaning (WM)	0.75	0.13	0.62	0.57
Standard Deviation	*4.98*	*4.72*		
Vocabulary Composite (WR+WM)	2.42	2.23	0.19	0.03
Standard Deviation	*6.46*	*6.38*		
Sentence comprehension (SC)	0.60	-0.63	1.23	4.78*
Standard Deviation	*3.54*	*3.13*		

Passage comprehension (PC)	2.53	-0.38	2.91	17.99***
Standard Deviation	*4.23*	*3.90*		
Reading Comprehension Composite (SC+PC)	3.13	-1.06	4.19	17.40***
Standard Deviation	*6.75*	*4.98*		
Total (VC+RC)	5.56	1.22	4.34	6.78**
Standard Deviation	*10.44*	*9.26*		
Listening	1.55	0.04	1.51	9.34***
Standard Deviation	*2.83*	*3.01*		

*** p< 0.00, **p<0.01, * p< 0.05

As table 5 demonstrates, the comparison of girls' gains scores in the ABRA and control groups reveals higher gains for girls in ABRA classes on all basic tests except word reading. However, this difference was significant for the test of listening comprehension ($F(1, 212)= 20.06$, $p < 0.00$) and non-significant for the other four.

Table 5

Reading gains for girls in ABRA and control classes

GRADE scales	ABRA girls (N=107)	Control Girls (N=106)	Mean difference	F value and significance
Word Reading (WR)	1.15	1.47	-0.32	0.49
Standard Deviation	*3.03*	*3.58*		
Word Meaning (WM)	0.69	0.64	0.05	0.01
Standard Deviation	*4.74*	*3.45*		
Vocabulary Composite (WR+WM)	1.85	2.11	-0.26	0.11
Standard Deviation	*6.02*	*5.50*		
Sentence comprehension (SC)	0.36	-0.00	0.36	0.34
Standard Deviation	*4.40*	*4.79*		
Passage comprehension (PC)	1.85	0.95	0.9	1.86
Standard Deviation	*4.53*	*5.11*		
Reading Comprehension Composite (SC+PC)	2.22	0.97	1.25	1.42
Standard Deviation	*7.11*	*8.18*		
Total (VC+RC)	4.07	3.08	0.99	0.52
Standard Deviation	*9.69*	*10.26*		
Listening	1.95	0.21	1.74	20.06***
Standard Deviation	*2.55*	*3.06*		

*** p< 0.00, **p<0.01, * p< 0.05

Differences in Reading Levels

As the next step we examined whether student reading level at the pre-test was related to ABRA reading gains in other words if ABRA had positive effects on students with low reading ability. Table 6 indicates that low readers' gains using ABRA were slightly higher and occasionally significant than high readers' gains on all GRADE subtests except Passage

Comprehension. By improving low readers gains, ABRA was able to diminish the difference between high and low readers.

Table 6

Reading gains for low and high readers at the pre-test in ABRA and control classes

GRADE scales	ABRA mean gains (N= 118)			Control mean gains (N=119)			Difference in gains between low and high readers in ABRA and control groups	F value and significance
	Low (N=58)	High (N=61)	Difference	Low (N=57)	High (N=61)	Difference		
Word Reading (WR)	3.22	0.28	2.94	3.64	0.26	3.38	-0.44	0.26
Standard Deviation	*3.99*	*2.31*		*3.87*	*2.75*			
Word Meaning (WM)	3.34	- 0.65	3.99	2.15	-1.08	3.23	0.76	0.38
Standard Deviation	*7.01*	*2.38*		*4.72*	*3.69*			
Vocabulary Composite (WR+WM)	6.57	-0.36	6.93	5.80	-0.82	6.62	0.31	0.04
Standard Deviation	*7.95*	*3.80*		*6.94*	*4.40*			
Sentence comprehension (SC)	0.52	-0.48	1	0.59	-1.09	1.68	-0.68	0.48
Standard Deviation	*4.30*	*3.51*		*3.90*	*3.38*			
Passage comprehension (PC)	1.57	1.65	-0.08	-0.11	0.14	-0.25	0.17	0.03
Standard Deviation	*4.95*	*3.97*		*3.69*	*4.75*			
Reading Comprehension Composite (SC+PC)	2.10	1.17	0.93	0.52	-0.94	1.46	-0.53	0.10
Standard Deviation	*7.95*	*5.98*		*5.96*	*6.37*			
Total (VC+RC)	8.67	0.80	7.87	6.39	-1.76	8.15	-0.28	0.01
Standard Deviation	*12.29*	*7.57*		*9.81*	*9.39*			
Listening	2.09	1.55	0.54	0.12	0.09	0.03	0.51	0.43
Standard Deviation	*3.46*	*1.84*		*3.68*	*2.49*			

*** p< 0.00, **p<0.01, * p< 0.05

Exam Results

To examine if ABRA effects are associated with students' learning in the core curriculum subjects, we used the results of end-of-term exams provided to us by Kenya teachers. Because exam results from one of the control classes had not been furnished, this class and their matching ABRA class were dropped from the analyses (N=43). We compared the scores in English, Math, Science and Social Studies of control and ABRA students collected at the end of term three (November, 2012) after statistically adjusting these scores using the GRADE pre-test score as the covariate. The first analysis was performed for English exam scores. The second analysis was run for Math, Science and Social Studies in their totality.

The test for the effect of ABRA on English exam scores showed the difference between the groups was statistically significant ($F(1, 336) = 11.45$, $p < 0.001$). The multivariate test for the

main effect of ABRA on the three exams of Math, Science and Social Studies after having accounted for differences in pre-test GRADE scores was also significant (Pillai's trace = 0.070), F (3,334)=8.13, p< 0.001.

The descriptive statistics summarized in Table 7 show that students in ABRA group performed higher than control students on each of the four core exams. Although the magnitude of difference between the two groups was fairly modest across the exams, it is in English where an average ABRA student was able to improve by 11 percentile points as compared to her peer in the control group.

Table 7

Core exams results for ABRA and control classes (means/adjusted mean, standard deviations/standard error, and effect size)

Core subject exams	ABRA Means[1] (N= 168)	Control Means[1] (N=173)	Effect Size[2]
English	80.32 (80.39)	76.73 (76.65)	0.29
Standard Deviation/Error	*16.37 (0.99)*	*20.71 (0.98)*	
Mathematics	68.10(68.15)	65.82 (65.74)	0.15
Standard Deviation/Error	*19.57 (1.29)*	*21.16 (1.27)*	
Science	77.68 (77.74)	74.71 (74.65)	0.17
Standard Deviation/Error	*19.09 (1.37)*	*21.74 (1.35)*	
Social Studies	72.91 (72.99)	71.06 (71.01)	0.10
Standard Deviation/Error	*22.67 (1.52)*	*22.12 (1.49)*	

*** p< 0.00, **p<0.01, * p< 0.05

[1] Adjusted means for post-test scores and standard error calculated in the model appear in parentheses. GRADE pre-test covariate scores model were evaluated at 64.32.

[2] Adjusted means and standard errors were used to calculate Cohen's d

ABRA Implementation

In order to answer the question if ABRA helped change teaching styles, this section presents a combination of instruction-related data collected by means of lesson plans, classroom observations, videotapes and final interviews.

Lesson Plans

All of the 24 hand-written lesson plans received were transcribed and put into a standard template. The majority of lesson plans were submitted in the fall of 2012, between weeks 7 and 13 of the ABRA intervention. The lesson plans showed that teachers attempted to integrate activities targeting different literacy components including phonemic awareness, phonics, fluency, and comprehension. At the same time, these components were allotted different weights. For instance, activities built around text reading such as tracking were most frequently included in teacher lesson plans. These activities were followed in frequency of use by alphabetics and writing-related activities including spelling words and sentences. Among activities targeting comprehension teachers preferred vocabulary work. ABRA extension activities planned by teachers pertained to vocabulary development such as reporting new

words learned in ABRA activities and using these words in writing sentences; writing sentences from stories; and finishing sentence starters. One teacher planned an ABRA story retelling activity; another one planned on using ePEARL's (electronic portfolio) recording feature to record her students' reading ABRA texts and writing their accounts of these texts in ePEARL's creation section.

Observations

Teachers were observed twice from late October to early November. The observation reports suggest that teachers, in addition to reading ABRA stories, used ABRA activities targeting alphabetics (same words, basic decoding, rhyming), vocabulary and comprehension. It is important to note that only one ABRA activity was ever the focus of the lesson and uniformly for all the students in that class. In large classes students were put to work in dyads and triads. Some student modeling to peers was reported by observers. It was also observed that boys' engagement with the tool was high. A few observations showed that students needed more guidance to complete an activity, and that students in one of the classes lacked syntactic background knowledge to successfully complete an activity.

Videotaped Instruction

Each ABRA class was filmed up to four times whereas only two videos of two control classes were completed. The bulk of filming was done at the beginning of the intervention but a few videos were taken towards the end. The videos reveal that ABRA teachers and students grew increasingly comfortable with technology and with the software. Students became at ease modeling ABRA behaviours to their classmates. Teachers developed autonomy teaching with ABRA and supporting their students. The teachers' capacity to use the tool to teach the English curriculum also improved: they were able to integrate ABRA in order to pursue the literacy objectives they had set. One of the teachers even experimented with the features of ePEARL, the tool she was barely acquainted with, in order to provide additional learning opportunities to her students.

The videos also show that within and beyond ABRA, language instruction was mostly teacher-centered. Whole class, uniform activities were given priority even though in ABRA classes the tool allowed for the differentiation of instruction to accommodate readers of different levels and ability. Teacher talking time took from 60% to 70% of class time. Preference was given to choir work whereas students' individual responses were elicited less frequently. When responses were elicited, one-word responses were encouraged instead of complete sentences. Repetition after the teacher was a frequent technique. In order to support comprehension development, teachers preferred asking general questions; for instance, "What did you read about yesterday?" or "What was the story about?" Special questions, focusing on the story elements, allowing students to reconstruct the story in detail, and using new vocabulary, were seldom asked.

Teacher Self-reports (LIQ)

Pre- and post-data provided by eleven teachers (6 ABRA and 4 controls) were available for analysis. Two control teachers did not complete one of the 2 questionnaires. This small sample size meant very low power for significance testing. Twenty-six items of the Literacy Instruction Questionnaire were combined into four composite scores reflecting the four major literacy-related components including alphabetics (n=5), fluency (n=5), comprehension (n=11) and writing (n=5).

As shown in Table 8, the literacy instruction practices of experimental and control teachers were similar at the baseline. On average, they reported that they taught major components of literacy occasionally and did not use technology as part of their classroom practice. At the post-test, ABRA teachers reported nonsignificantly higher frequencies of teaching fluency, comprehension, and significantly higher frequencies of teaching writing and using computers for instruction.

Table 8

LIQ means, standard deviations, change scores

Literacy instruction	ABRA teachers (N= 6)			Control teachers (N=4)			Difference between change scores of control and experimental teachers	t value and significance
	Post	Pre	Change	Post	Pre	Change		
Alphabetics	2.43	1.86	0.57	2.36	1.96	0.40	0.17	0.31
Standard Deviation	*0.68*	*1.15*	*0.75*	*0.61*	*1.12*	*0.73*		
Fluency	3.20	2.86	0.34	2.70	2.45	0.25	0.09	0.12
Standard Deviation	*0.42*	*0.63*	*0.88*	*1.11*	*0.66*	*1.41*		
Comprehension	2.90	2.42	0.48	2.29	2.06	0.22	0.26	0.70
Standard Deviation	*0.54*	*0.56*	*0.65*	*0.61*	*0.98*	*0.50*		
Writing	3.03	2.00	1.03	1.95	2.10	-0.15	1.18	2.48*
Standard Deviation	*0.75*	*0.89*	*0.91*	*1.11*	*1.01*	*0.59*		
Technology use	2.66	0.17	2.49	0.50	0.00	0.50	2.00	2.39*
Standard Deviation	*1.75*	*0.41*	*1.64*	*1.00*	*0.00*	*1.00*		

*** p< 0.00, **p<0.01, * p< 0.05

Teacher Final Interviews

Interviews were conducted for 30-60 minutes with all six experimental ABRA teachers. See Table 9 for quotes excerpted from the interviews. The following were especially salient in the interviews:

Successes

- Although there were varying degrees of ICT literacy held by the teachers prior to beginning this project--with novice through to advanced users--all teachers stated their experience using ABRA impacted positively on their comfort level using the technology. Furthermore, all teachers expressed enthusiasm when asked if they would feel comfortable continuing to use the technology in their classroom during Phase 2.
- All teachers exhibited a positive shift in their attitudes towards using computers to teach literacy, as they saw a marked improvement in student achievement, especially

with the slow leaners, increases in student motivation and engagement, and greater facility with classroom management.

- All teachers expressed a positive shift in their own teaching of English Language Arts due to a greater awareness of the need to instruct on the four different components of merging literacy (Alphabetics, Fluency, Comprehension, and Writing).
- The majority of teachers used a dedicated iBook in their classroom for remediation, and as a complement to the lab sessions. For the most part, low ability students would use the computer prior to school, during breaks, or after school.
- The extent to which the print-based ABRA material was used in the classroom varied with the majority of the teachers using the worksheets to complement written work.
- All the teachers used the Teacher module, accessible from the dedicated iBook, when preparing lesson plans. Support materials such as the Teacher Guide were used moderately.

Table 9

Excerpts from teacher interviews

"Next year my teaching will change. I used to look at non-readers negatively and felt I was wasting my time…. But now I realize that every student is reachable, you just need the right tools."
"ABRA added value to my teaching, especially when we were doing vocabulary as I introduced new words with the help of the characters, whereas in the curriculum there is nothing of interest to the children to help them remember… it is just wording. The pupils (especially the remedials) remembered the characters and made the linkages."
"I would give them a book in the classroom to read and they couldn't read, but in ABRA they could read and spell. Surprisingly they could read –it was amazing!"
"[At the end of the year] marks in English were high and also in other subject areas. Eighty percent and over in English. Other teachers were surprised because everyone could read and write in my class."
"Before teaching [my English lesson] I would sit down and review an activity. ABRA is a very good program. I learned a lot about teaching literacy. …. I can comfortably stand and teach reading skills now."
"I had about five non-readers. By the end [of the 13 weeks], they could read 3-letter words and write sentences. Without ABRA they may have been reading 2 to 3 words. Now if you talk about ABRA they get very excited and they remember the activities."
"This ABRA program has been a big help to some of my students. In fact, all of them."
"One parent couldn't believe that a child could read a word on their own without the teacher first reading it. "How did you know who to read that word?", they asked. [The reply was] I went to ABRA which taught us how to break down words."
"The parents were so excited, they wanted to come to the lab. The students would speak about ABRA at home."

"The students would shout out when they received the rewards in the Decoding activity."
"My students would say, "We used ABRA we have to do well."… One student said, "I will study so much I will go to ABRACADABRA University."

Areas for Improvement

- The single greatest challenge using ABRA in the lab related to technical issues, such as lack of availability of headphones or non-functioning computers.
- Other challenges expressed by the teachers related to the need for further support in the lab, and more time assigned to using ABRA.
- Some teachers were unable to accurately describe the four main categories of literacy instruction.

Discussion

The objective of the project aligns with the Kenyan Ministry of Education's Vision 2030 expressed interests and directives in both improving literacy and in increasing technology use in schools. In order to verify the feasibility and effectiveness of using ABRA in different teaching contexts within Mombasa, Kenya, a rigorous, small-scale study was conducted as a proof-of-concept precursor to a large scale, multi-year project. This section includes a set of inferences drawn from the student and teacher data. It also attempts to identify gaps and formulate recommendations for future phases of the project.

The reading achievement data show that after thirteen weeks of ABRA exposure, students in the six experimental classes improved significantly more than students in the six control classes. Significantly greater gains were achieved in comprehension-related skills, including reading and listening comprehension. In addition, both groups gained in vocabulary-related skills such as decoding and sight-reading. The results also indicate that the recorded increases in all skills by the ABRA classes helped to move them towards the norms for grade-one North-American students.

Both experimental and control students gained equally on the vocabulary subtests of the GRADE. An explanation we favour relates to the emphasis in the Kenyan curriculum on this aspect of reading. However, the failure of the ABRA students not to outperform the control students may indicate that the experimental teachers spent less time on certain alphabetic activities in ABRA. Otherwise, it may be that introducing ABRA earlier than the second term of Grade Two may be justified.

The reading achievement results also show that it was the boys who benefited most from ABRA exposure. Although research in early literacy development reports that girls outperform boys (for instance, Soderman et al, 1999), the computer technology aspect in ABRA intervention might have yielded the gains favouring boys in the ABRA group. According to research evidence, male students feel more competent and confident with computer tasks, and they also gain more from computer-based instruction than female students.

The data indicate that it was the low-reading students, those in the greatest need of reading instruction, who enjoyed the greatest gains as they moved through the thirteen weeks of

instruction with the ABRA software. In fact, as a result of exposure to ABRA the gap between the high and low performers in ABRA classes diminished contrary to the well-known "Matthew effect" where the differences between high-ability and low-ability students increase when they progress through the formal system of education.

Interestingly, the ABRA intervention seems to have had positive effects in several subject areas. Specifically, analyses based on the curricular end-of-the-year examinations demonstrate that ABRA students outperformed their peers in control classes on the four core subjects including English, Mathematics, Science and Social Studies. Indeed, this transfer of literacy skills is an important outcome pointing towards the utility of ABRA as a tool that has widespread impact on students' school success.

The data from the teacher self-reports provide some detail about the literacy instruction that occurred in the experimental and control classes. ABRA teachers' responses to the survey and interview questions reveal some positive shifts in their literacy instruction. Specifically, throughout the two semesters, they allotted more time to teaching all the literacy components and their comfort level with teaching with computers significantly improved. Experimental and control teachers differed in their self-reports of literacy instruction showing that the ABRA teachers integrated activities targeting their students' alphabetic skills, fluency, comprehension, and writing more frequently than their control counterparts. Statistically significant differences were indicated between the groups with respect to teachers' declared use of writing activities and computers.

The observational data and lesson plans showed that during the thirteen-week intervention, teachers developed a certain capacity in the integration of the ABRA software throughout the class 2 English Language curriculum. While there was a shift towards serving in new roles as facilitators of their students' learning, the period of time was rather short for them to turn away completely from a teacher-directed method of literacy instruction.

ABRA was designed to support all learners but especially to scaffold students who are struggling to read. Both teacher testimonials and the results for several students who had poor pretest performance but improved dramatically on the posttest and on end-of-year examinations, suggest that the greatest gains from ABRA were among Kenyan students who are the weakest. Further research on a larger sample of teachers and students will help validate this tentative conclusion.

In Phase 2 of this project, experimental teachers will be provided with up to three laptop computers to use in their classrooms of up to 66 students each. They will not be traveling to the Academy weekly with their students but, now trained and experienced in using ABRA, will do so under more realistic and challenging conditions. We are collecting additional data on teachers' experiences and student learning in Phase 2.

Methodological considerations

The following ***recommendations*** should be considered to improve the methodological quality of the next phase of the project:

1. Additional effort should be made to improve pre- and post-test completion rates by students and teachers to avoid missing data. Students not attending the lesson when the test is administered should be tested within the following two weeks.

2. To obtain the most accurate results, the procedures of test administration as outlined in the Administration Manual should be followed.
3. A systematic approach to collecting evidence about classroom literacy instruction is essential:
    a. Classroom observations and videos should be taken both in ABRA and control classes on a regular basis;
    b. To learn more about the use of the ABRA extension activities, observations in ABRA classes should also be taken outside the computer lab classes;
    c. Appropriate tools such as observation forms developed for the project should be used carefully by observers;
    d. Teachers should submit their ABRA lesson plans weekly;
4. In order to increase the quality of student data, the research team should further explore the existing group reading instruments for their adequacy (cultural appropriateness and sensitivity) to Kenyan English Language learning context.

Substantive considerations

The following ***recommendations*** about teaching reading with ABRA may help improve implementation in the future phases of the project:

1. In alignment with the findings of previous ABRA studies and existing evidence about effective reading instruction (NRP report, 2000; Hattie, 2009; Slavin, Lake, Davis & Madden, 2009) it is important to promote the **systematic** (regular) and **balanced** use of the instructional strategies embedded into ABRA, which are geared to developing the five key components of literacy:
    - **phonemic awareness** and **phonics** instruction implies teaching beginning readers the alphabetic code and how to use this knowledge to read words (e.g. phoneme isolation, identification, blending, segmentation etc);
    - **fluency** instruction via repeated reading instruction including orally re-reading a short and meaningful passage until a satisfactory level of fluency is reached (e.g. repeated reading, radio reading, paired reading, guided oral reading);
    - **vocabulary** instruction consisted of teaching word meanings (e.g. semantic mapping, contextual analysis, deriving word meanings, mnemonics techniques, pre-instruction vocabulary words);
    - **comprehension** instruction implies teaching students to use comprehension strategies (e.g. asking questions, comprehension monitoring) and to identify and use text's organizational structure (e.g. story mapping, summarizing)
2. A good balance between these five literacy components in daily instruction is contingent on teachers' awareness about their students' learning needs. In the context of this project, insufficient additional growth in students' capacity to decode and read sight words may suggest that teachers need to give more weight to activities targeting phonemic awareness and phonics skills. ABRA's 18 alphabetics activities possess a full capacity to develop such phonics and phonemic awareness skills.
3. Considering a multilingual context where English is not the dominant language (Bunyi, 2005), there is a need to build oral English proficiency for students who are below a threshold of linguistic competence in English (August & Shanahan, 2006). The evidence consolidated in the report suggests that for the instructional strategies targeting English

literacy development including decoding and comprehension to be successful, they should be combined with the concerted and parallel efforts to help students who have low requisite language proficiency to comprehend the text, such as develop oral vocabulary knowledge and listening comprehension.

4. Hattie's (2009) synthesis of 50 meta-analyses based on 2,000 primary studies of literacy instruction emphasizes the importance and value of active teaching. This means that the instruction should be planned, deliberate, explicit and differentiated. In an integrative review of primary evidence on teaching reading in Kenyan primary school, Comeyras and Inyega (2008) argue about the importance of making a child the focus of reading education requiring the "move away from rote learning and teacher-centered procedures toward activity and child-centered procedures" (p.276) In the context of this project, instructional use of ABRA should be a priority where students' needs are considered in the choice of activity with respect to its level, time of exposure and the mode of interaction between students.
5. Reports generated by the ABRA Assessment Module can serve the purpose of informing the effective design of instruction with ABRA, which addresses students' learning needs. These assessment reports provide statistics about class and individual student performance in every ABRA activity with regards to the time spent on it and the number and nature of errors made. This data should be used to inform teachers' instructional decisions in order to find the effective balance in literacy components and make ABRA part of active teaching.
6. To enable teachers to more effectively construct their instruction with ABRA, teachers should be further supported in:
    a. using the computer technology;
    b. integrating the literacy components that ABRA activities address into classroom teaching during non-computer-based activities;
    c. developing students' oral language proficiency as a foundation for successful literacy;
    d. applying instructional strategies systematically and with maximum fidelity;
    e. using data generated by the ABRA Assessment Module to inform teachers' instructional practice in order to accommodate learners of different levels and abilities.
7. A closer alignment is possible between ABRA and the Kenyan curriculum and the Kenyan context by developing stories that relate more closely to Kenyan life, culture and history. These stories can stand alone but ideally should be linked to the instructional activities in ABRA. Adding Kenyan stories to ABRA's Canadian and Australian stories would further move ABRA in the direction of providing a global education to children from all corners of the world.
8. While the CSLP initiated the training, the core of the training and the follow-up support was completed by local experts in teacher professional development. In addition, the teachers who volunteered for this project displayed a high level of interest, enthusiasm, and commitment. To use the ABRA tool well requires both teaching skills that can be acquired through targeted professional development and support, and the will both to integrate technology under challenging conditions and to actively pursue excellence. As this project expands, it is essential that these ingredients become part of every implementation. To ensure this, every teacher should be made aware of the commitment required for training, follow-up, and implementation.

Conclusion

With about two dozens hours of targeted exposure to ABRA in dyads and triads and some amount of additional in-class activity, we were able to substantially enhance the reading performance of Kenyan youngsters on an internationally recognized, and well-validated literacy measure. At the same time, we facilitated what appear to be changes in teaching practices about effective reading instruction and demonstrated that youngsters in large classes can be taught using technology integrated into the curriculum, promoting the development of an essential educational competency.

In February 2013 at the end of Phase 1, a celebratory reception was held with the research teachers, facilitators, head teachers, project coordinators, team members from the CSLP and the Academies Unit, senior administrators from the Aga Khan Academy, a couple of parents, and one student. It began with a singing of the national anthem, a prayer, and speeches from the senior team members, followed with a presentation by Anthony Gioko (a local Coordinator) that provided an overview of the Phase 1 project, along with a video of various classes in the AKAM lab - great moments showing the students' engagement. Next the audience heard from two teachers, two principals and two parents, all of whom spoke about their experiences with ABRA. The incredible appreciation that was expressed by these individuals is difficult to capture in words. One principal spoke at length about the effect it had on the students in her school --the excitement of the bus rolling up each week, the substantial increase of the marks in the ABRA class, the frequent requests from other teachers in her school to be able to use ABRA etc. The teachers spoke of how they are now better literacy teachers, how motivated their students are and how much better they are doing academically in all subject areas. ABRA has helped them do meaningful and significant work--it is a blessing, they said, and they thank the CSLP daily for bringing it to them. A parent spoke of how she was losing her son after the departure of his father, that he was demotivated, sad, and falling behind academically. He then learned how to read with ABRA and is now correcting her English and teaching her--he is engaged in class and now completes his homework quickly and correctly. A second parent spoke about her son, a non-reader, who is now second in his class and a completely different person—he has a love of reading and is motivated to learn. The testimonials were genuine, heart felt and emotional.

How does one sit through testimonials like this and not feel moved? These individuals were so appreciative and thankful that ABRA had been brought to them. Although they gave abundant whole hearted thanks that they were given ABRA, they pleaded that it go beyond their schools and be used to develop the literacy skills of all Kenyan children.

We are eager to continue.

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