FINAL TECHNICAL REPORT / RAPPORT TECHNIQUE FINAL

# TEACHING AND LEARNING WITH TECHNOLOGY IN SUB-SAHARAN AFRICA

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IDRC Grant / Subvention du CRDI: 108356-001-Scaling digital learning in Kenya

# Teaching and Learning with Technology in Sub-Saharan Africa

IDRC Grant no: 108356-001

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## Final Technical Report

December 31, 2020

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# Executive Summary

*Provide an informative summary of the key advances, significant research findings, important outcomes and innovative outputs of the project. The focus should be on project achievements in terms of outputs and outcomes.*


This report presents the summary of results of the *Teaching and Learning with Technology in Sub-Saharan Africa* project completed in Kenya between 2016-2020. The project aimed at achieving significant, scalable, sustainable increases in student learning, enhancements to teaching practices through engagement with a suite of evidence-based educational software tools. These tools, bundled together in the Learning Toolkit Plus (LTK+) include ABRACADABRA (ABRA), interactive multimedia for early literacy, READS, a digital repository of hundreds of free digital books and stories, ELM, interactive multimedia for early numeracy, ePEARL, a multimedia process portfolio, and IS-21, a tool to develop information literacy and inquiry skills.

Within this project we have conducted numerous studies of the impacts of several of the LTK+ tools on student learning and teaching in Kenya. All the studies show positive effects for boys and girls but especially those who were initially struggling. The five ABRA-READS studies revealed important improvement in students' reading skills after learning with the software. Similarly, ELM results showed learning gains for girls and boys with large effects. All studies of literacy and numeracy used international, standardized achievement tests. ePEARL was studied in several secondary schools in Mombasa with positive results including a group of students who won a national science prize and the teacher who won a prestigious international award in educational technology. We have introduced IS-21 in a limited fashion and hope to conduct a pilot study of the tool in the coming years.

In addition to showing significant, substantial gains in student learning, the findings suggest that teaching behaviors were also positively affected. In fact, this project confirmed that with appropriate support, regular teachers are able to integrate software within their regular unscripted lessons in the real-world conditions of Kenyan public primary and secondary schools. The support system was put in place to aid with the classroom implementation of the LTK+ software. It was driven by the local support team and included initial training in LTK+ pedagogies, professional development workshops held systematically over school terms, regular school visits of external LTK+ ambassadors and assistance offered by the school-based ambassadors. Help embedded in the LTK+ tools and complementary teaching materials were also part of the support system. Thus, teachers enjoyed complete autonomy to integrate the tools as they saw fit with the curriculum and syllabus.

Sustainability research was another research component of the project. In 2017-2018 we completed a study that explored factors that increase the likelihood that an evidence-based technology-centered approach to teaching and learning endures and expands. Using the research about scalability and sustainability of educational interventions and value-expectancy-cost theory, we designed a survey and interviewed a range of stakeholders involved in implementation. Exploration of the relationship between expectancy-value-cost beliefs and the specific factors associated with implementation and sustainability yielded a model explaining an important portion of variance in the intent to continue using LTK+ tools with the most contribution from policies, professional development and students.

Along with these research outcomes, this project resulted in the capacity building of Kenyan teachers, head teachers, our local project team and vulnerable groups of the population. Significant pedagogical improvements included teachers' higher levels of comfort and autonomy in using computer technologies, managing the use of technologies with large classes, and implementing a more balanced approach to literacy instruction. The improved capacity of head teachers was reflected in their formal commitment to the project which resulted in the improvement of school facilities, including the provision of technology available for teaching, along with active support of the project activities. The

administrative and research skills of our local coordinators and teacher ambassadors improved significantly as a result of their active engagement in, on the ground coordination, data collection and support of their colleagues. We also highlight the impact of this project on the capacity building of the two vulnerable groups (children and women). LTK+ implementation in the schools ensured that female students were conversant and engaged in use of the software designed to equally advantage both genders. The promotion of gender equity also occurred beyond the classrooms. Throughout this project, women were in leadership positions in our local project teams. It should also be noted that all of the stakeholders that were involved in the project including parents, educational consultants, and policy makers increased their understanding of the importance of using evidence-based and evidence-proven tools and strategies.

A range of outputs have been generated by the project team over the years. These range from traditional scholarly publications, to reports to our partners, to research and professional conferences, to updated releases of the LTK+ tools, to a massive body of support materials for teachers, parents and students. The team communicated the results of the project to broader educational communities by means of LTK+ newsletter, via new coverage as well as via social media platforms. For example, WhatsApp was extensively used to maintain relations with the LTK+ teachers during the COVID-19 lockdown.

Finally, the report outlines a few avenues for future uptake of the LTK+ tools. Over the course of the project, there was a substantial increase in the number of LTK+ users as the numbers reached approximately 10,000 students in 2019. We continued supporting our LTK+ community remotely during the pandemic, and we are optimistic that the teachers and their students will resume using the software after the schools re-open in 2021. We expect there will be continued growth in the number of users in the ensuing years, resulting in further positive impact in the use of this educational innovation to improve the teaching and learning of Kenyan children.

# The Research Problem

*What was the basic rationale of the project and the research problem or problems being addressed? Often, the researchers' understanding of the problems will have evolved since the project was approved. The report should describe this evolution and the reasons behind it. Did the research process lead to a revised view of the research problem?*

*Provide a synthesized reflection on the overall progress of the global project (please include the general objective of the project). Describe the contribution to knowledge that this project represents from a scientific, developmental and/or policy perspective.*

Around the globe, there are nearly 800 million adults who cannot read, write, or count (UNESCO Institute for Statistics, 2014); there are 250 million children who cannot decipher a single sentence, even though many have spent years in school (Bokova, 2014). In the least developed countries one quarter of young men aged 15 to 24 and one third of young women are illiterate (UNICEF, 2012). Countries of sub-Saharan Africa, including 24 countries with 120 million French speakers, represent some of the poorest and least developed areas on Earth. While countries in the Sub-Saharan region of Africa have made significant progress towards achieving universal school enrollment, the quality of schooling stalls leaving millions of students with minimal foundational skills (World Bank, 2018). One reason is that there is little to no special training for lower primary teachers who are expected to teach beginning reading, numeracy, and other essential competencies (Ono & Ferreira, 2010; Akyeampong et al., 2012).

In the face of these difficulties, there is a growing recognition of the need to address the quality of classroom pedagogy in order to improve retention and completion rates, and achieve meaningful learning outcomes. A literature review of pedagogy, curriculum, teaching practices and teacher education in developing countries found an over reliance on basic recall, rote learning, memorization, repetition, and recitation (Westbrook et al., 2013). A major recommendation of the report was that teachers need training to encourage pedagogic practices that are interactive as they are more likely to impact on student learning and hence be effective. Other methods that improve learning in the primary schools of developing countries included educational technology, teacher professional development, and small group learning (McEwan, 2015).

To address the need to act, the Kenyan government has undertaken a massive school reform where the new competency-based curriculum has been introduced. The shift of teaching paradigm towards student-centeredness is at the heart of the curriculum that is designed to foster independent learners capable of succeeding in the 21st century. Further, recognizing the potential of ICT to offer access to quality education, the government has made solid commitments to educational technology by starting the Digital Literacy Programme (DLP, Matiang'i, 2015). The DLP initiative has successfully deployed technology (tablets, content servers and projectors) in Kenyan primary schools.

Given the above, the implementation of the Learning Toolkit Plus (LTK+) would be a solution that ensures that students get exposure and benefit from deep and consequential pedagogical change that this learning software can invoke. The LTK+ is a suite of bilingual (English and French) evidence-based and evidence-proven interactive multimedia tools designed to build essential educational competencies and available to the educational community at no charge. The tools include: an early literacy tool, ABRACADABRA (ABRA); a digital library of books, READS; an emerging numeracy tool, ELM; a multi-level portfolio tool for self-regulation, ePEARL; and a tool for older primary and younger secondary students to learn inquiry skills, IS-21. Each of the tools has three main modules: Students, Teachers and Parents—with the Student or instructional module being the main foci. All tools provide meaningful audio/visual feedback to the students as they complete activities, helping to guide them to the correct answer. Activities are not timed and children always have access to help embedded in LTK+. Student activity in each of the tools may be tracked and organized in the form of teacher assessment reports—accessible via the Teacher modules. The Teacher modules also contain a wide range of online support materials (e.g., lesson plans, teacher guides, instructional videos, classroom resources, and so on). The Parent modules are websites that may be accessed also from outside of the LTK+ and they consist of an array of multi-media of materials that help parents support use of the tools at home. The LTK+ tools are coupled with the system of teacher professional development which consists of three major components. First, the initial training on the software and its pedagogy is conducted. Second, in-school support is provided by an external expert teacher and a school-based ambassador, who was a specially trained school teacher in each school. The support activities include in-school planning meetings with school teachers and class visits. Third, a set of teaching resources is offered to teachers, including among others the materials developed expressly to align the use of the tool with the Kenyan curriculum.

However, even though shown and proven effective, too many educational initiatives in the developing world have had weak results or short-lived ones (USAID, 2012). Among the many reasons for these failures three stand out as especially important: failure to encourage local ownership and customization; failure to create local expertise; and failure to ensure the continuance of the project without external financial and other support.

To address the combination of challenges, the proposed project aimed at achieving significant, scalable, sustainable, and cost-effective increases in student learning, enhancements to teaching practices through engagement with the Learning Toolkit Plus software (LTK+) and wide-scale changes to educational policies concerning educational research in general and educational technology in particular.

Therefore, this project's specific objectives and desired outcomes included:

| Specific Objectives | Desired Outcomes |
|---|---|
| 1. Enhance quality teaching and student learning in Kenyan classrooms through engagement with the Learning Toolkit+ tools, support materials and professional development opportunities. | a. Significant, scalable, sustainable and cost- effective increases in student learning for approximately 4000 students and potentially more.<br>b. Improved teaching practices for approximately 80 teachers in approximately 40 schools and potentially more. |
| 2. Deepen our understanding of the relationship between levels of teacher support, teaching practices, and student learning outcomes. | a. Contribute to existing theory and research about the uses of technology for teaching and learning.<br>b. Improve future LTK+ pedagogical and support materials and implementations by incorporating lessons learned. |
| 3. Promote improved educational technology-related policies and practices. | a. Increase our partner organizations' understanding of teaching and learning with technology.<br>b. Increase our partner organizations' critical understanding of educational research methods and results.<br>c. Build a network of expert practitioners and policy-makers that share the value of evidence- based educational practice. |

The project has made important progress on the way to achieve the proposed objectives and outcomes and to some extent has gone above and beyond. The key achievements include:

1. **Growth**: Since 2016, this project has substantially expanded in size and scope in a variety of ways:

- The number of users grew from 32 teachers and their 2,215 students in year one to include 226 teachers and 9,987 students in 2019. Prior to the schools closing in March 2020 due to pandemics, 174 teachers and 8,402 students were set to embark on the project.
- A greater range of LTK+ tools were used in Kenyan classrooms. With ABRA, READS and ELM remaining the most popular, some classrooms implemented ePEARL and IS-21. The configuration of tools used by a teacher also varied to include ABRA and READS, or ABRA and ELM. ePEARL and IS-21 were brought to secondary students who used the software to complete projects in multiple disciplines such as Physics, Business Studies, Biology, Environmental Studies. ABRA was also piloted with ECE and kindergarten students and used in early secondary classes for remediation.
- The geographic reach of implementation of the tools expanded beyond Mombasa (coastal region). Teacher training and use of the tools expanded to the Kirindon and Matete regions (Trans Mara), and the Trans Nzoia, Laikipia, Meru, and Kwale counties.

2. **Research on Achievement and Instruction:** The research on the LTK+ tools effectiveness we conducted in the sub-sampled classrooms over the years of this project showed significant improvement of student achievement and shifts in teacher practices. These were the studies of ABRA and READS in 2016, 2018, 2019; ELM in 2016 and 2019; and ePEARL in 2018 and 2019.

- **Research on Scaling:** The studies on scalability of the LTK+ tools completed in 2017 and 2018 yielded a combination of factors that were necessary to ensure rigorous and successful use of an educational technology in Kenyan classrooms and also suggested the avenues for bringing the implementation to scale. As well, in **June, 2020** we received approval from the Kenya Institute for Curriculum Development (KICD) to provide access to our tools throughout Kenya. This approval took over two years to achieve.

3. **Teacher Professional Development and Support**: This project resulted in the improvement of TPD strategies, through:
    - Improved the face-to-face, just-in-time support via the use of an in-school support model by instituting school-based ambassadors;
    - The establishment of various LTK+ communities of practitioners, along with the growth in a network of LTK+ teachers. This occurred as a result of regular F2F planning meetings and use a variety of Whats Ap groups. In the latter instance, teachers were seen to regularly post or respond to messages in these groups, shared photos and videos of creative instances of classroom implementation, and helped their peers troubleshoot.
    - An ongoing iterative design and development of relevant multimedia support materials to incorporate explicit links of the LTK+ to the Kenyan curriculum; collect and disseminate model lesson plans; plan assessment strategies, provide tips on how to manage large classrooms and differentiated teaching strategies; and
    - The piloting of a newly designed online course entitled *Teaching Early Literacy with ABRA/READS,* encompassing 10 modules geared to improving early literacy instruction.
4. **Capacity Building in Research and Evidence-based Practice**: The hiring and support of local staff who served as coordinators, ambassadors, school-based ambassadors each of whom developed expertise in the integration of an evidence-based, evidence-proven, technology-based innovation. These individuals further developed their understanding of rigourous research methodologies as they were instrumental is coordinating the data collection efforts on the ground.

5. **Awards**: National and international recognition of LTK+ Coordinators, teachers and students: Dr. **Maina WaGioko** was awarded the 2019 *Aga Khan University Citation on Leadership Recognition* and short-listed for the *Varkey Foundation's 2019 Global Teacher Prize*. Mr. **Dickson Karanja** won the *2020 Bett-MEA, British Educational Training and Technology Middle East and Africa*, award in Innovation in teaching and learning where students in his class used ePEARL to complete a project on Business Studies. Ms **Linah Anyango'**s students used ePEARL to complete a project on bioethanol, the student project won the *2019 National Science Fair award* and they were subsequently selected to represent the country in the ESKOM Fair in South Africa, where they presented their work to Kenyan president Uhuru Kenyatta. This teacher was also short-listed for the Varkey Foundation *2020 Global Teacher Prize.*

# Progress Towards Milestones

*Briefly describe achievement of project milestones (as specified in the Grant Agreement) for the entire reporting period. Have a brief section for each milestone (e.g. Milestone 1.1, 1.2, etc.).*
*Provide evidence that milestones were achieved, and refer to the hard evidence in previous reports and/or attached annexes (as needed). If applicable, explain why any milestones were not achieved.*

## Part 3
## Schedule of Project Milestones

| Milestone | Due Date | Submitted by | Centre Payment Amount |
|---|---|---|---|
| Commencement | Official Commencement Date (see Section 5) | n/a | n/a |
| Initial payment | Upon signature of this Agreement by the Recipient | n/a | 522,500 CAD |
| Copy of Subcontractor country clearance | Upon government approval | Recipient (see Section 6) | n/a |
| First technical progress report, covering the first 12 months of Work.[1] | 13 months after Commencement Date | Recipient [2] | n/a |
| Second technical progress report, covering the 13th to 24th months of Work.[1] | 25 months after Commencement Date | Recipient [2] | n/a |
| Third technical progress report, covering the 25th to 36th months of Work.[1] | 37 months after Commencement Date | Recipient [2] | n/a |
| Final technical report[3] | On or before Work Completion Date (see Section 5) | Recipient [2] | n/a |
| Final financial report covering all funds expended on the Project, in the same form and including the details of the Budget as set forth in Part 4 – see Section A15) | On or no more than 30 days after the Work Completion Date (see Section 5). | Recipient (see Section 2) | n/a |
| Final payment by the Centre, following acceptance of the final technical report (including, among other things, the open access dissemination plan) and satisfactory final financial report. | 30 days after receipt of satisfactory final reports (see Section 5) | | Up to 27,500 CAD[4] |

[1] The technical progress reports must contain sufficient information for Centre staff to determine the progress of the Project as well as its technical success. Guidelines for report preparation are available at the Centre's Web Site (http://www.idrc.ca/admin) or from the Centre's contact (see Section 4.1).

Milestone 1 (Commencement): As identified in the Grant Agreement text, the project started on October 1, 2016. The beginning of the project coincided with the post test data collection for the ABRA study and ELM pilot trial in Mombasa primary schools, Kenya. Both studies started in early January of

2016 and were funded by the Strengthening Education Systems in East Africa project, Aga Khan Foundation. We are reminding the reader that the school year in Kenya runs from January to November.

Milestone 2 (Initial payment): Payment was received.

Milestone 3 (Subcontractor country clearance): Application to obtain a research permit was submitted on November 30th, 2016 to the National Council for Science and Technology (NACOSTI) of Kenya. The research permit was issued on March 7, 2017 and it did not have a permit number. Ethics clearance for the CSLP Learning Toolkit (#10000298) from Concordia University Human Research Ethics Committee has been active since January 6, 2016.

Milestone 4 (First technical report, covering the first 12 months of work): the 1st interim report was submitted on **October 31, 2017**. The report summarized the results of the 2016 research project that unfolded in the Mombasa primary schools including a) the ABRA quasi-experimental study in standard 3 classes; b) the ELM one-group feasibility study conducted in standard 1 classes and c) the 2017 scalability survey pilot study. The report also describes the progress made by the team in the year 1 correlational (Level 2) and observational (Level 3) research: a) recruitment of schools & training of partners (WV, CEMASTEA, KICD) between Sept.1 – Dec.31, 2016; b) developing research instruments (i.e., sustainability); software implementation between Jan. 1 – March 30, 2017; c) piloting research instruments and developing support materials between May 1 – Aug.31, 2017. In addition, the initial step of the LTK+ project in remote area of Kenya, Kirindon undertaken in partnership with World Vision Canada was reported as was the development of collaboration with CEMASTEA, an agency of the Kenya Ministry of Education, mandated to conduct training in Science, Math and Technology.

Milestone 5 (Second technical report, covering the 13 to 24 months of work): the 2nd interim report was submitted on **November 29, 2018**. The report summarized the findings from the 2017 research conducted in primary schools in Mombasa and Kirindon where students learnt with ABRA and READS and ELM software. The study used a correlational research design without the comparison group and used Kenya exams in terms 1 and 3 to measure learning change over time in English, Mathematics, Social Science and Science. ABRA and ELM trace data were used as a measure of extent of the software use. In addition, the report introduces the change to the support the model (the institute of school-based ambassadors). The report also describes the progress made by the project in 2018 in regard to a) sustainability study and b) experimental study of ABRA and READS.

Milestone 6 (Third technical report, covering the 25 to 36 months of work): the 3rd interim report was submitted on **November 21, 2019**. Faithful to the tradition of interim reports 1 and 2, this report presented the results and discussed the projects that unfolded during the 2018 school year and provided a status report on the 2019 studies. Specifically, it summarized the findings of a) 2018 ABRA-READS two-group pre-post-test study in standard 1 and 2 primary classrooms; b) 2018 study of ePEARL, electronic process portfolio, completed in collaboration with I Choose Life Kenya in secondary public schools in Mombasa; and c) preliminary analysis of the 2018 sustainability interviews. The report also outlined the progress made on the 2019 research including a) the first quasi-experiment of ELM, numeracy software, in Kenya; b) the second phase of ePEARL to further enhance implementation and explore its effects.

Milestone 7 (Final technical report): This report will be submitted by **December 31, 2020**.

Milestone 8 (Final financial report): This report will be sent in **January 2021** as there were some delays with processing expenses due to the pandemic.

Milestone 9 (Final payment by the center following the acceptance of the final technical report and satisfactory final financial report).

## Synthesis of Research Results and Development Outcomes

*The analysis of outcomes should take into account social, gender, and environmental dimensions wherever appropriate and possible. It can be done in two ways, but should be consistent the approach used in your past interim technical reports (confer with the program officer to determine the preferred approach):*
*By each project research objective:*

- *Synthesize the main research results during the project, highlighting the progress made by the project. This should be done by listing each specific objective as it is written in the Grant Agreement, highlighting the progress for each one.*
- *If applicable, include any summarized quantitative analysis to back up the results as an annex to this report*
- *Highlight any unexpected, surprising or interesting innovative results that you can draw out of the research.*
- *Explain how the research results are being used, and what their impact has been on specific communities or populations in the targeted country(ies) at the end of the project.*
- *How were research ethics issues, if any, assessed and managed?*
- *Describe any potential uptake of project results within 3 years of the end of the project*.

The overall goal of the project is to achieve significant, scalable, sustainable and cost-effective increases in student learning and enhancements to teaching practices through engagement with the Learning Toolkit Plus (LTK+). Three specific objectives are as follows:

1. Enhance quality teaching and student learning in Kenyan classrooms through engagement with the Learning Toolkit+ tools, support materials and professional development opportunities;
2. Deepen understanding of the relationship between levels of teacher support, teaching practices, and student learning outcomes, and
3. Promote improved educational technology-related policies and practices in Kenya.

To meet the project objectives, we have conducted a number of field investigations of the impacts of several of the LTK+ tools on student learning and teaching in Kenya. The following is a brief summary of our findings overall and by the LTK+ tool.

It is important to highlight that all LTK+ tools have been in the focus of research for more than a decade with the primary purpose to empirically validate them for their efficacy and effectiveness. One of tools, ABRA, has been researched extensively and internationally whereas other tools tested in North America are at the early phases of study elsewhere in the world, in Kenya, for instance. The Kenyan context, in which the government mandated one digital device per student in elementary grades and initiated competency-based curriculum reform, allowed us to study if the learning needs of Kenyan children can be addressed by introducing the LTK+ software in teaching and learning.

The hallmark of all our research in Kenya is that the LTK+ tools were implemented by the regular teachers within their regular unscripted lessons in the real-world conditions of Kenyan primary and secondary schools where there is a deficit of efficient technology infrastructure, classes are large and the ratio of students per computer is high. In addition to help embedded in the LTK+ tools and complementary teaching materials, a support system was put in place to aid with the classroom implementation of the LTK+ software. Driven by the local support team, the system included initial training in LTK+ pedagogies, professional development workshops held systematically over school terms, regular school visits of external LTK+ ambassadors and assistance offered by the school-based ambassadors. Thus, teachers enjoyed complete autonomy to integrate the tools as they saw fit with the curriculum and syllabus.

### *ABRACADABRA and READS*

From five quasi-experimental studies of ABRA-READS intervention in Kenya, three were completed at the time of this project in 2016, 2018 and 2019. The accounts of the four of them can be found in Abrami et al. (2016), Lysenko et al. (2019) and IDRC 3rd interim report (2019), whereas the results of the fifth can be seen in Appendix A of this report. We synthesized the effects of ABRA-READS across these five studies on student reading-related skills of listening comprehension, vocabulary knowledge and reading comprehension all measured on GRADE standardized test of reading comprehension.

As presented in the table below overall average effect size (statistically adjusted for school effects) based on the 18 comparisons and 2, 626 primary students from grades 1 -3 was +0.43 whereas the highest effect was +0.53 in reading comprehension. The obtained effect sizes suggest that after having been taught with ABRA, an average student scored at the 50th percentile would increase her percentile scores to 67 in overall reading and 70 in reading comprehension.

*Overall Weighted Average Effect Size (Random Effects Model): Adjusted and Unadjusted Data* ***by Outcome Type*** *and Heterogeneity Statistics for Overall Reading Effect Size (Fixed Effect Model, Unadjusted Effects Only)*

| Population Estimates | *k* | *g*+ *(p value) | *SE* | Lower 95th | Upper 95th |
|---|---|---|---|---|---|
| *Listening Comprehension* | | | | | |
| Unadjusted Effects | 6 | 0.469 (0.01) | 0.18 | 0.11 | 0.83 |
| Adjusted Effects | 6 | 0.417(0.000) | 0.12 | 0.17 | 0.66 |
| *Reading Comprehension* | | | | | |
| Unadjusted Effects | 6 | 0.639 (0.000) | 0.18 | 0.28 | 1.00 |
| Adjusted Effects | 6 | 0.527(0.000) | 0.13 | 0.26 | 0.79 |
| *Vocabulary Knowledge* | | | | | |
| Unadjusted Effects | 6 | 0.397 (0.04) | 0.19 | 0.02 | 0.78 |
| Adjusted Effects | 6 | 0.365 (0.01) | 0.14 | 0.10 | 0.63 |
| *Overall READING* | | | | | |
| Unadjusted Effects | 18 | 0.491 (0.000) | 0.10 | 0.30 | 0.69 |
| Adjusted Effects | 18 | 0.427 (0.000) | 0.07 | 0.29 | 0.56 |
| Heterogeneity Analysis $Q_T$ = 288.07 (*df* = 17), *p* = 0.000, $I^2$ = 94.10 | | | | | |

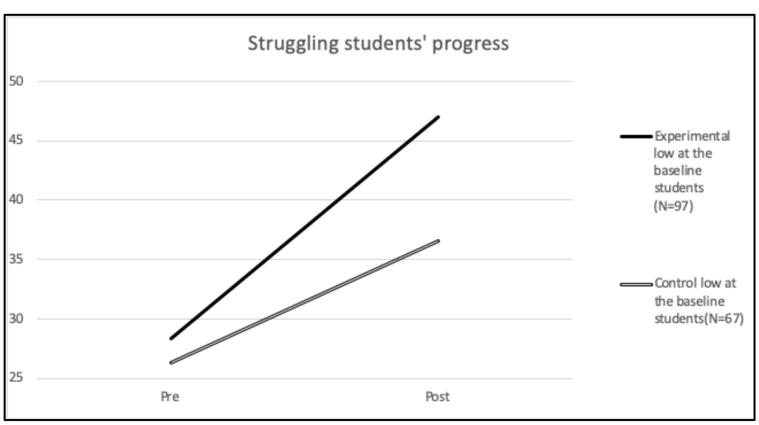
*A d-type (Cohen's d) standardized mean difference effect size (Cohen, 1988) was used as the common metric. To correct for small sample size bias, d was then converted to the unbiased estimate g (Hedges & Olkin, 1985)

The relatively small number of studies/comparisons did not allow us to control statistically for the moderator effects in this summary. However, the primary studies (e.g., Abrami et al., 2016; Lysenko et al., 2019) consistently show that ABRA-READS benefitted both boys and girls about equally and while all

students learned, low-performing students and struggling readers were often able to learn the most while retaining their learning beyond the initial intervention period. In the 2016 study we followed students after one year and found that those who used ABRA and READS maintained an advantage in literacy development. The most recent 2019 investigation of ABRA and READS usage in a remote region, where national examination results are poor, demonstrated that with our software learning gains were dramatic (see Appendix A). The reading improvements also often transferred to other subject areas.
In sum, the impact of the ABRA-READS intervention on students is evident. Such outcomes are especially valuable since it was undertaken by regular teachers within their regular unscripted English lessons in their regular classrooms and computer labs. Even though much of the current scientific evidence on effective instructional uses of computers suggests that the instruction is most successful when taught by researchers or trained professionals (for instance, Okkinga et al., 2018), this study was able to capture the impact of ABRA-READS software use in the real-world conditions of Kenyan primary schools where classes are large, there is a deficit of efficient technology infrastructure, and the ratio of students per computer is high.

### *ELM*

After the promising results of a small-scale feasibility test (IDRC 1$^{st}$ interim report, 2017), in 2019 we conducted a full-fledged validation of ELM software in grade-one elementary classroom in Kenya. In this quasi-experimental study of ELM, 775 students and their 14 teachers from 7 primary public schools in Mombasa participated. The results suggest that after having worked in dyads or triads on ELM activities in the school computer lab during one weekly math lesson for around 14 weeks, young students significantly improved their mathematical abilities in comparison to their peers from the control group. The total effect size was +0.37 on the overall skills measured by a standardized test of mathematics, GMADE. The impact of ELM was especially noticeable on the students' ability to take language and concepts of mathematics and apply appropriate operations and computations to solve word problems. On this set of skills, the magnitude of difference between the experimental and control groups was +0.71 suggesting the percentile gain of 26 points. The overall effects of ELM were evident for both genders. In the context of developing countries, the research suggests that significant gender discrepancies in mathematics emerge by the beginning of grade 2 (e.g., Pitchford, 2018). The implementation of ELM instruction in grade 1 not only prevented the initial difference between boys' and girls' mathematic skills from growing, but indeed reduced it to the negligible level. Another critical finding in this ELM study were the gains of low-ability grade-one students who learned with ELM (see the graph below).



In addition to significant students' improvements, this study also revealed positive shifts in the teachers' perceptions about their practice. The ELM teachers reported having gained more confidence in mathematics and comfort in teaching mathematics with computers. This finding is not surprising since ELM designed as a student-centred software supports classroom teachers in their efforts to guide children to mathematics success through technology integration and, therefore, encourages changes of teaching practices.
A full account of this research, as a manuscript (Lysenko et al., 2020) submitted for a scholarly publication and being under revision, can be seen in Appendix C.

### *ePEARL*

To explore the feasibility of implementing an electronic process portfolio in a Kenyan school context and the impact of the tool on student learning outcomes, we conducted a two-phase pilot study of ePEARL in a few Mombasa secondary classrooms. Over 2018 and 2019, 137 students used the ePEARL digital portfolio in school computer labs to complete a project assignment. This research demonstrated the practicality of implementing the digital process portfolio in the Kenyan context and also captured the impact of the tool on student learning outcomes. The findings consistently show that students who used ePEARL to complete their project work in Biology, Physics, Business Studies or English outperformed their class peers who had hardly used the portfolio for their class assignments or did not use it all on their school exams and their self-reported self-regulation skills. Further, more frequent and comprehensive use of portfolio features translated into higher student achievement in the relevant subject area. On average, one unit increase in using ePEARL improved a student's exam results by +0.39 and +0.30 standard deviations in phases 1 and 2 of the project respectively.
The findings of this study are especially promising because they were obtained in the context of authentic instruction where the implementation of ePEARL was driven and directed by the classroom teachers themselves. Regular classroom teachers were able to use the e-portfolio to support their students' learning in the real-world challenging context of Kenyan secondary school. Despite these challenges, the teachers persevered as they valued the portfolio pedagogy and anticipated it to be successful, as compared to seeing the challenges of implementing ePEARL quite low. At the same time, it also might be that some teachers used the software to give a learner-centered feel to their instruction and thus believed their teaching became more aligned with the current educational trends in Kenya. However, educational change takes time and we realize that even minimal shifts in teaching practice might be indicative of an important step forward on the way to lasting improvement in instructional practice. Since teachers are at the center of any effort to produce positive effects on student learning, further strengthening of the professional development aspect of an intervention is critical so that teachers can fully embrace the pedagogical sophistication offered by the learning technology. We see the support system as the way to continue strengthening contingencies between ePEARL implementation and student learning progress and reducing the perceived disincentives of teaching with technology.
A copy of the journal manuscript detailing the results of the ePEARL feasibility study can be found in Appendix D.

### *LTK+ Scalability and Sustainability*

Over a few years, the LTK+ project evolved from a pilot study in 12 primary classes to spread to more than 500 primary and secondary classrooms in five areas of Kenya. To explore factors that have potential to increase the likelihood that a technology-based approach to teaching and learning (LTK+ software) endures and expands beyond group of participants in Kenya, in 2018 we conducted a scalability study. Based on research about scalability and sustainability of educational interventions and value-expectancy-cost theory, we designed an exploratory "funnel-type" survey. We used it to interview a range of actors involved in the LTK+ implementation. Among the 40 interviewees there were teachers, school administrators, master teachers, coordinators, representatives from partner organizations including chief executive and management officers. To categorize and analyse the narratives, a we used a combination of an a priori and data-driven coding approaches. We organized factors into discrete and finite categories including political factors, economic and technology factors, professional development, software factors, student, school and teacher factors. Then we built a model exploring the relationship between expectancy-value-cost beliefs and the specific factors associated with implementation and sustainability. The structural equation model explained an important portion of variance (39%) in the self-reported intent to stop or continue using the LTK+ with the most contribution from national and local policies, professional development and students. These findings are important in the context where no research-proven principles exist to building sustainable and scalable educational technology-interventions in developing countries.

Appendix F offers a full report of the study results.

***ABRACADABRA in Pre-school***

In 2019 we introduced ABRACADABRA into Early Childhood Education cycle with the purpose to explore the feasibility to the software implementation in pre-primary. For almost a year 16 teachers from 8 ECD centres in Mombasa area taught phonemic awareness and phonics to their 614 students using ABRA alphabetic activities. Overall, the pilot was a success even though issues with technology occurred. The teachers appreciated the features and affordances of the tool that fit the requirements of the ECD curriculum. The interactive nature of the tool, its gaming elements such as mini-games and ABRA characters with personal stories underlying the narrative thread and resonated with preschoolers of both genders increasing their motivation to learning to read.

A detailed account of this experience including teacher testimonials was prepared by the LTK+ training coordinator in Kenya. This can be found in Appendix E.

*Highlights:*

- Our field investigations of the impacts of several of the LTK+ tools on student learning and teaching in Kenya show positive effects for boys and girls but especially those who were initially struggling.
- Regular classroom teachers can achieve these improvements in their regular unscripted lessons in the real-world conditions of Kenyan primary and secondary schools.
- Strengthening professional development will improve implementation and yield stronger effects of the tools.
- More work should be done to seek active support from the local and national educational authorities. Our partners' role is critical.
- Building local LTK+ expertise and ownership is the key of success.

*Impact*

Over the year of the project, we continued working on the <u>capacity building of the key actors</u> involved in the LTK+ implementation. Although we are aware that we have a way to go to achieve the desired outcomes, we can report on some progress we have done. To begin with, this project has positively influenced the pedagogical capacity of the teachers. This impact is reflected in the teachers' improved levels of comfort and autonomy in (1) using computer technologies, (2) managing the use of technologies with large classes, and (3) implementing a more balanced approach in teaching where sub-skills are now being addressed. The project also stirred teachers' enthusiasm and engagement in using evidence-based tools such as the LTK+ and in participating in project-related activities--important prerequisites for changing teaching practice. To this end, the support system we put into place is instrumental, although it evolved significantly. This includes initial interactive training and systematic classroom support provided by the School-based ambassadors in the form of meetings with teachers and regular classroom visits. The local support system extended beyond the ambassadors to also include support from Head Teachers and Boards of Management as they too made formal commitments to the project.

The project is contributing to reinforce the capacity of schools participating in the project. Indeed, as part of their formal commitment to the project, schools improved their facilities and augmented the technology available for teaching. This includes among other the setting up of school computer labs, installation of the LTK+, the provision of ongoing maintenance of the LTK+ tools. Participation in this project increased the school administrations' awareness about other contributions expected for the success of the project, such as creating schedules to maximize students' access to school labs and liberating teachers' time to attend training and weekly planning meetings. Indeed, these expectations have contributed to the establishment of school ownership over the project, critical to ensure its sustainability.

The impact of the project continues to influence the capacity-building of the local project team as the administrative and research skills of the local project team have improved significantly. They work towards strengthening relations with schools, seeking school administrative support for the project, scheduling the events according to the project time-line, and coordinating activities of multiple actors. The research skills of the local project team and ambassadors is the area where the effects are the most obvious. They include raising awareness about rigourous research methodology and its use to inform practice; developing skills in data collection for summative (pretest and posttest) and formative (classroom observations) purposes; administering instruments (consent forms and measures); preparing materials for scanning; and scanning and scoring the forms. The support skills of the local team have grown to include pedagogical support to classroom implementation as well as technical support.

Finally, the ongoing impact of the project on the capacity building of the two vulnerable groups (children and women) should be highlighted. After using the LTK + tools, students significantly have gained in their literacy and numeracy skills. Even small gains in these essential skills are known to be linked not only to academic success, but also to increases in employment opportunities and the economic well-being of both the individual and their nation. LTK+ implementation in the schools has also ensured that female students are conversant and engaged in use of the software designed to equally advantage both genders. For this purpose, additional classroom resources were developed to help provide teachers with cooperative learning strategies, including the use of role assignment and turn taking within group work. As noted earlier, the results show that girls and boys benefited equally from classroom instruction in which LTK+ tools were integrated. The promotion of gender equity also occurred beyond the classrooms. Throughout this project, women were in leadership positions in our local project teams. For example, some project coordinators and all of the ambassadors are women.

In addition to the above-mentioned positive impacts, it should also be noted that all of the stakeholders that were part of our project (teachers, school administrators, parents, educational consultants, and policy makers) have increased their understanding of the importance of using evidence-based and evidence-proven tools and strategies.

*Future uptake*

As we noted earlier, over the years of this project the number of the LTK+ users in Kenya has grown significantly. From 32 teachers and their 2,215 students in 2016 we counted 226 teachers and 9,987 students in 2019 as project participants. The research results that we communicate to our partners and local educational authorities and coupled with the "LTK+ works" vows coming from teachers who experienced the tools first-hand accounts for this expansion. Although the pandemic shelved our 2020 research plans (e.g., a quasi-experiment of ABRA in pre-school), we continue working with the LTK+ teacher community on WhatsApp groups. In this community we examine the lessons learnt from the past implementation, discuss teacher professional needs, brainstorm back-to-school ideas and share materials. We are enthusiastic of supporting our LTK+ teachers when schools re-open in 2021 and are ready to work with them to address the challenges of the post-pandemic school context.

### *Online Teacher Professional Development: Emerging Project*

Over the past two years, the Concordia LTK+ team has been designing a series of web-based modules entitled *Teaching Early Literacy with the Learning Toolkit+* (see https://literacy.concordia.ca/tpd/) structured around evidence-based literacy instruction, in an effort to tackle the need for global teacher professional development. The development of this course was timely given the school closures in March, 2020. After our Mombasa LTK+ team designed and conducted an online survey of LTK+ teacher support needs in April, the LTK + team, including researchers Wood and Gottardo from Wilfrid Laurier University, started to plan for the piloting of a new course.

Throughout May and June an LMS environment hosted by WLU, was designed to support a 10-week fully online course centred around these literacy modules. In July, over 80 LTK+ teachers signed up to participate in the course. After one month, it became clear that participation in the weekly lessons was variable, hence the enrolment was weeded down to active students only and this resulted in 15 students completing the course. We learned that a major impediment to participation was the cost of data bundles. This is not surprising given the financial constraints that many Kenya families are experiencing given the pandemic.

However, of the fifteen teacher students who did complete the course, feedback on their experience and learning of literacy instruction was extremely positive. Many of these teachers spoke at the online graduation ceremony and some suggested the Kenya Teacher Services Commission must approve this course (https://www.dropbox.com/s/dgusx9rarbzwe0l/Celebration_Zoom%20Recording_20201217.mp4?dl=0)

The extensive data collected during this pilot project is currently being analyzed. However, the team has learned a lot in terms of how best to conduct a fully online course and support teachers as it unfolds. This experience will be invaluable as we continue our efforts to scale up use of the LTK+ tools in Kenya and beyond. Future plans will involve a comparison of different models of TPD, including F2F, blended and online. It should also be noted that this pilot project precipitated a rapid review of evidence of online TPD conducted by the CSLP's systematic review team.

# Methodology

*Describe and discuss the research methods and analytical techniques used and any problems that arose. Research instruments such as questionnaires, interview guides, and any other documentation judged useful to understanding the project should also be included. Indicate and explain any changes in orientation that may have occurred since the project was designed. Indicate any particular learning about merits of different methods for addressing the project's research problem and generating desired outputs and outcomes.*

In this project we followed the research design outlined in the original proposal where we intended to explore:

- The relationships between the provision of the three varying degrees of training and support (from the greatest external cost and involvement (level 1) to the lowest external cost and involvement (level 3), with technology serving as a constant on teaching and learning outcomes; and
- The aspects of sustainability of LTK+ implementation in the context of Kenya schools.

We studied sustainability and scale up of LTK+ use across the three levels of training and support. In 2017, year one of the project, we reviewed the relevant research literature and designed a short funnel type semi-open-ended interview to explore factors that have potential to increase the likelihood that a technology-based approach to teaching and learning (LTK+ software) endures and expands beyond the group of initial participants. We used the results of the pilot interview reported in the IDRC 1st interim report to inform the refinement of the interview protocol that used for data collection in year 2, fall of 2018 (the IDRC 3rd interim report). Representatively sampled participants of all groups of actors such as teachers, school principals, ambassadors, partners involved in the implementation were targeted by the interview. This representative sampling insured a widely diverse range of participants providing an array of perspectives and experiences. Yet, because of the contextual reasons we were not able to interview ministry representatives.

During years two and three of the project (2018-2019), we worked in active partnership with the Aga Khan Academies and World Vision Kenya to conduct research on the impacts of specific LTK+ tools on teaching and student outcomes.  These included studies of ABRACADBRA and READS in Mombasa (2018) and Kirindon (2019) in primary classrooms and pre-primary (2019) as well as ELM (2019) and ePEARL (2018 and 2019). *Interest in the LTK+ tools expressed by I Choose Life Kenya (ICL) allowed us to bring ABRA and READS to remote areas of Kenya (Laikipia and Meru counties) although the schools were not involved in research data collection. The support to implementation was provided by the ICL staff (comparable to Level 3). The studies of ABRA and ELM relied on the quasi-experimental research design (i.e., nonequivalent pretest- posttest control group design) and included experimental and control classes matched on income levels. In addition, we statistically controlled for initial in-equivalence of students across experimental and control groups. In the experimental condition, in addition to the specific LTK+ tools two levels of pedagogical support were provided to the participants by the local team. Maximum support (level 1) was provided to schools in Mombasa and medium level of support (level 2) was provided to schools in Kirindon. When interested, the control participants received training following the conclusion of the year’s data collection. In addition to classroom data collection, we collected LTK Ambassador school visit reports, LTK coordinator reports, partner reports to keep record of barriers and facilitators to implementation fidelity as ways to understand scalability and sustainability issues when support varies.

Over three years (2017-2019) in level 2, we conducted correlational research (e.g., no control group of non-users) on the impacts of the LTK+ tools. This correlational research explored the impacts and reactions to the LTK+ with moderate levels of pedagogical support provided directly, albeit infrequently, by trained staff from the partner organizations with the limited involvement from local LTK+ team. For instance, one such project unfolded in a couple of remote schools in Kirindon region in 2017 and 2018 where ongoing support was undertaken by the WV Kirindon ADC staff (IDRC 2nd interim report). 2018-2019 ePEARL project supported by the ICL staff in a few secondary schools in Mombasa is another example of level 2 support (IDRC 3rd interim and final reports).

Simultaneously with correlational research, over the years of 2017-2019, we planned to conduct observational research focussing on the minimal level of support (level 3). Working in partnership with Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) we intended to conduct qualitative and observational research on whether and how their trainers were able to provide training and support to potential adopters in countries outside of Kenya in sub-Saharan Africa. Unfortunately, this research component has not been completed.

All data collection was completed using the instruments listed in the original proposal; all of them were refined for the purposes of the project. Copies of the refined CSLP-owned instruments used for this project (e.g., teacher, classroom, ambassador) have been posted in Appendix F and organized by the study:

- ABRA-READS: *Literacy Instruction Questionnaire; Literacy Instruction Observation form; ABRA activities Checklist; READS Checklist*.
- ELM: *Mathematics Teacher Pre-survey; Mathematics Teacher Post-survey; Mathematic Instruction Observation form; ELM activities Checklist*.
- ePEARL: *Student Learning Strategies Questionnaire; Teacher Implementation Survey; ePEARL Assessment Rubric*.
- Scaling: *Sustainability Survey*.
- Learning Toolkit+ trace data (a sample of the ABRA trace data report

# Project Outputs

*Making reference to the open access dissemination plan, what were the main outputs of the project? Identify any outputs that were planned, but which have yet to materialize. Specify when these outputs will be completed, including plans for any future publications. Specify how you have met the requirements of IDRC's Open Access Policy. If appropriate, highlight any unique or innovative outputs. If appropriate, explain why outputs were not completed or were of poor quality.*

The project outputs are many and diverse. They include:

- Updated releases of the LTK+, a collection of evidence-based digital tools for learning and teaching available without charge;
- Professional development materials, including teaching aids, multimedia materials such as training videos, online teacher professional development modules, and a revised version of the online textbook (Learning Toolkit Teacher's Guide Kenya Edition) embedded in the software and also available online without charge;
- Yearly LTK+ newsletter (4 of them were released);
- Updated research instruments such as interview protocols, questionnaires, observation forms
- LTK+ professional development workshops and presentations where hundreds of teachers and school administrators were made aware of and/or using LTK+ tools with thousands of students;
- Research reports and scholarly publications also available through open-access outlets such as Concordia's open access repository, Spectrum; see http://spectrum.library.concordia.ca/
- Presentations at the national and international conferences;
- News coverage that LTK+ project obtained in the news; and

- The cumulative list of the project outputs that we generated between October 1, 2016 and June 31, 2020 follows.

**LTK+ Websites**

https://www.concordia.ca/research/learning-performance/tools/learning-toolkit.html.

Global access to ABRA and READS: https://literacy.concordia.ca/en/index.html

***LTK+ teacher and parent resources***

ABRA parent resources are here: https://literacy.concordia.ca/resources/abra/parent/en/.

ABRA  print and video teaching resources are here:
https://literacy.concordia.ca/resources/abra/teacher/en/.
https://literacy.concordia.ca/reads/index.html#en/.

READS resources are here: https://literacy.concordia.ca/reads/index.html#en/.

Online TPD modules for ABRA and READS are here: https://literacy.concordia.ca/tpd/.

ELM resources and a video are here: https://www.concordia.ca/research/learning-performance/tools/learning-toolkit/elm.html/.

ePEARL resources and videos are here: https://www.concordia.ca/research/learning-performance/tools/learning-toolkit/epearl.html/.

IS-21 resources and a video are here: https://www.concordia.ca/research/learning-performance/tools/learning-toolkit/is-21.html/.

Access to the Kenyan teacher's guide is here:
https://literacy.concordia.ca/resources/common/assets/pdf/LTK-TG-Kenya-E3-20190114.pdf

***LTK+ Newsletter***

The 2020 edition of the LTK+ newsletter is here:
https://www.concordia.ca/content/dam/artsci/research/cslp/docs/tools-software/learning-toolkit/LTKNewsletterSpring2020.pdf/.

The 2019 edition is here: https://www.concordia.ca/content/dam/artsci/research/cslp/docs/tools-software/learning-toolkit/LTKNewsletter_Spring2019.pdf/.

The 2018 edition is here: http://www.concordia.ca/content/dam/artsci/research/cslp/docs/tools-software/learning-toolkit/LTKNewsletter_Spring2018.pdf/.

The 2017 edition is here: https://www.concordia.ca/content/dam/artsci/research/cslp/docs/tools-software/learning-toolkit/LTKNewsletter_Spring2017.pdf/.

***LTK+  research instruments*** including interview protocols and questionnaires are at:
https://www.concordia.ca/research/learning-performance/knowledge-transfer/instruments.html/

## In the News

Wade. A. (2020, Aug.). *Partnership for wider uptake. Part one: CSLP use of ASb on READS and Partnership for wider uptake* and *Part Two: CSLP use of ASb on READS: ABRA @ Home* https://www.africanstorybook.org/ under **Use.**

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## Promotional Videos/Media Events

IDRC. (2020). *Improving Literacy and Numeracy in Kenyan Schools* (series of 5 videos). https://www.youtube.com/watch?v=aw1naf_A1kk&list=PLhhb-JA5bQ7PRiBMksRv3Lk2X2-yBhenC

French translations: https://www.youtube.com/watch?v=eIFWHaERN5c&list=PLhhb-JA5bQ7NWYh0JSQisa7g2Q7t3y-0O

## Professional Development Workshops and Presentations

Abrami, P.C. & Wade, A. (2019, Oct. 4). *Developing fundamental skills using the Learning Toolkit.* Presentation at the SSHRC Partnership meeting, Aga Khan Foundation East Africa, Nairobi, Kenya.

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Wade, A., Abrami, P.C. & WaGioko, M. (2019, May 19). *Using ePEARL to develop self regulated learning skills*. Presentation to the Kenya Girl Guides Association. Nairobi, Kenya.

Wade, A. & Kiforo, E. (2019, Jan.), *Using IS-21 to develop information literacy skills.* Presentation to the Middle School faculty, Aga Khan Academy, Mombasa, Kenya.

Wade, A. & Kiforo, E. (2018, Sept. 26 and 27), *Using IS-21 to develop information literacy skills.* Presentation to the school librarians, Aga Khan Academy, Mombasa, Kenya.

Wade, A., Abrami, P.C. & WaGioko, M. (2019, May 19). *Using ePEARL to develop self regulated learning skills*. Presentation to the Kenya Girl Guides Association. Nairobi, Kenya.

Wade, A. & Kiforo, E. (2019, Jan.), *Using IS-21 to develop information literacy skills.* Presentation to the Middle School faculty, Aga Khan Academy, Mombasa, Kenya.

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## Journal Manuscripts

Abrami, P. C., Lysenko, L., & Borokhovski, E. (2020). The effects of ABRACADABRA on reading outcomes: An updated meta-analysis and landscape review of applied field research. *Journal of Computer-Assisted Learning. 36, 260-279.* https://doi.org/10.1111/jcal.12417

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**[CJLT / RCAT] Submission Acknowledgement**

CM CJLT Managing Editors <cjlt@ualberta.ca> — Sunday, July 12, 2020 at 4:47 PM
To: Larysa Lysenko

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Larysa Lysenko:

Thank you for submitting the manuscript, "The Sustainability and Scalability of Digital Tools for Learning: The Learning Toolkit Plus in Kenya" to Canadian Journal of Learning and Technology / La revue canadienne de l'apprentissage et de la technologie. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://www.cjlt.ca/index.php/cjlt/authorDashboard/submission/27961
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CJLT Managing Editors

Lysenko, L., Wade, A., Abrami, P.C., Iminza, R. & Kiforo, E. (2020). *Self-regulated learning in Kenyan classrooms: A test of a process e-portfolio*. [Under review]. *International Journal of Educational Technology.*

**From:** "Edmund Forest, PhD" <educationaltechnologynet@gmail.com>
**Date:** Sunday, September 27, 2020 at 5:51 PM
**To:** "LARYSA.LYSENKO CONCORDIA.CA" <larysa.lysenko@concordia.ca>
**Subject:** [IJET] Submission Acknowledgement

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## Reports

Lysenko, L., Abrami, P.C., Wade, A., Kiforo, E., & Iminza, R. (2020, April). *The effects of ELM software on the learning mathematics in Kenyan elementary: A brief report on the 2019 study* (Brief Report). Montreal, QC: CSLP.

Lysenko, L., Abrami, P., Wade, A., Del Col, N., Wachinga, A., Kedoki, J., WaGioko, M., Kiforo, E., Iminza, R. (2020, February). *2019 Kirindon Literacy study: Using ABRACADABRA and READS.* Brief report prepared for World Vision Canada and World Vision Kenya. Montreal, QC: CSLP

Abrami, P. C., Wade, A., Marsh, J., WaGioko, M., Lysenko, L., Wachinga, A., Del Col, N. & Head, J. (2019, November). Teaching and learning with technology in Sub-Saharan Africa. (IDRC, Interim Report 3). Montreal, QC: CSLP.

Lysenko, L., Wade, A., Abrami P.C., Venkatesh, V., WaGioko, M., Kiforo, E. & Gatende, A. (2019, July). *Self-Regulated learning and ePEARL: A brief report on the 2018 feasibility study*. Prepared for I Choose Life Kenya. Montreal, QC: CSLP

Abrami, P. C., Wade, A., Marsh, J., WaGioko, M., Lysenko, L., Wachinga, A., Del Col, N. & Warwick, E. (2018, November). Teaching and learning with technology in Sub-Saharan Africa. (IDRC, Interim Report 2). Montreal, QC: CSLP.

Abrami, P. C., Wade, A., Marsh, J., WaGioko, M., Lysenko, L., Wachinga, A., Del Col, N. & Warwick, E. (2017, October). Teaching and learning with technology in Sub-Saharan Africa. (IDRC, Interim Report 1). Montreal, QC: CSLP.

Abrami, P. C., Marsh, J., Lysenko, L., Maina, W., & Wade, A. (2017, November). *Improving literacy and numeracy in Kenyan schools.* (SESEA, Strengthening Education Systems in East Africa, Final Report). Montreal, QC: CSLP

### Conference Presentations

Abrami, P.C. (2019, October). Using evidence to improve the teaching and learning of essential educational competencies with technology. Keynote speech at the Ideas and Actions for Educational Excellence International Conference, Suiyuan Campus of Nanjing Normal University, Nanjing, China.

Abrami, P.C. (Chair) (2019, May 18). The Learning Toolkit Plus in Kenya Symposium. Canadian Association for African Studies (Montreal, Qc).

Gottardo, A., Eileen Wood, E., Phillip Abrami, P.C., Wade, A., WaGioko, M., Iminza, R., Kiforo, E. (2019, May 18). Collaborating to develop optimal training for educators using software as an instructional tool: The Kenyan context. Paper presented at the Canadian Association for African Studies (Montreal, Qc).

Lysenko, L., Wade, A., Abrami,P.C., (2019, May 18). Teaching with LTK+. Preliminary lessons about sustainability and scale up in Kenya schools. Paper presented at the Canadian Association for African Studies (Montreal, Qc).

Lysenko, L., Wade, A., & Abrami, P.C. (2020, June). Scaling up educational technology in Kenyan elementary schools. Paper accepted for presentation at the 48th Annual Conference of the Canadian Society for Studies in Education, Symposium-panel: Using Technology for Learning: Generalizable Lessons Learned, Western University, Ontario, Canada. Conference cancelled due to COVID-19

Lysenko, L., WaGioko, M., Venkatesh, V. , Kiforo, E., & Gatende, A. (2019, May 18). *Self-Regulated Learning and ePEARL: 2018 pilot study.* Paper presented at the Canadian Association for African Studies (Montreal, Qc).

Xin, G., Cheung, A., Mak, B., Abrami, P.C., & Wade, A. (2019, May 18). Activity theory as a framework for understanding teachers' perceptions of the use of ABRACADABRA (ABRA) at primary schools in Kenya. Paper presented at the Canadian Association for African Studies (Montreal, Qc).

WaGioko, M. (2019, Oct. 22). Keynote address at the first international conference on open distance and eLearning (University of Nairobi, Nairobi, Kenya)

### Instruments

READS checklist (2018, Jan.)
Literacy Instruction Questionnaire, adapted (2018, Jan.)
LTK Sustainability Interview Protocol, V. 1.3 (2018, Aug.)
Chapleau, N. et Santos E. (2019). Un outil d'évaluation de la lecture et de l'écriture pour les élèves entrant dans l'écrit en Afrique francophone. Document inédit. Université du Québec à Montréal.
Mathematics Teacher Pretest survey (2019, Jan.)
READS checklist (2019, Jan.)
ePEARL Implementation Form (2019, April)
LTK+ Ambassador Report template (2019, April)
Mathematics Teacher Post-test survey (2019, Sept.)
ABRACDABRA Activity Checklist (2020, Jan.)

ELM Activity checklist (2020, Jan.)
READS checklist (2020, Jan.)
ABRA Observation Form [dynamic form] (2020, March)
ABRA @ Home Teacher Observation Form (2020, March)
Mathematics Instruction Observation Form [dynamic form] (2020, March)
Mathematics Teacher Pretest survey. Version 1.2 (2020, Aug.)
Mathematics Teacher Post-test survey. Version 1.2 (2020, Aug.)
Train the Trainer Module: Expectancy-Value Survey (2020, Aug.)
ABRA Activity checklist [dynamic form] (2020, Sept.)
ELM Activity checklist [dynamic form] (2020, Sept.)
READS checklist [dynamic form] (2020, Sept.)

## Problems and Challenges

*Have there been any problems or challenges faced by the project? These could include delays, problems amongst stakeholders, with research activities etc. Highlight any risks that might have emerged in the project, and innovative ways you have found to deal with these risks. Reflect on possible problems and challenges related to ethics.*

Throughout this grant, our team faced various challenges many of which we were able to address by ensuring our plans were flexible and adaptable to the changing landscape. In addition, ***development of local expertise*** has been the key factor that helped address the majority of these challenges. Specifically, this pertained to building the capacity of the local LTK+ project team to coordinate and guide the day-to-day activities of our project. This and other aspects related to the capacity building of project participants have been addressed earlier in the **Impact section** of this report.

These challenges mainly related to research, technology and software implementation. The following is an overview of these challenges and the actions that were taken.

***Research-related challenges as they impact the reliability and conclusive power of a study:***

- Systematic collection of student data:
    - Participation of a third party in test administration helped us avoid situations when homeroom teachers might prime their students or bias the results. School-based ambassadors were assigned to administer student tests in schools in which they didn't teach;
    - Given a variety of exams used in the Kenyan primary education and related to this phenomenon, some idiosyncrasies, we collected student data with standardized measures of reading and mathematics. To provide locally relevant information, these data were then correlated with the exam scores;
    - Student absenteeism during testing might be linked to lower student achievement, thus imposing additional biases on the findings. We made efforts to have students not attending the lesson when the test/exam was administered be tested within the following two weeks. We ensured data collection from the students of all abilities.
- Systematic collection of data on classroom instruction:
    - To ensure classroom observations were completed on a regular basis (in both the experimental and control classes), the schedule was compiled for the LTK+ Ambassadors

to follow first. Later, one designated person was hired to complete classroom observations according to the pre-set schedule.
    - The observers were carefully trained on the observation forms.
    - Classroom teachers were trained on using weekly checklists.

***Technology-related challenges*** may disrupt instruction, reduce its efficacy, and potentially demotivate or frustrate teachers.

- Turning a desk-top computer into a server that was able to host the LTK+ software helped more schools participate in the project given many schools were unable to connect to the LTK+ hosted in a remote location.
- Through a partnership with a non-profit social enterprise, Camara, the majority of the participating schools had reconditioned desktop computers that formed the school lab. However, breakdown of some computers and peripheral devices, and hanging servers and network problems plagued some of the lessons. These issues were minimized by engaging the Camara technicians to conduct regular technology maintenance at a reasonable cost to the schools.
- Teachers were trained on the basic trouble shooting and lab maintenance skills such as dusting the devices, fixing loose wire connections, rebooting the network, and ensuring safety in the computer laboratory or with devices.
- Power failures caused by the unpaid electricity bills were addressed by asking headteachers to make a formal budgetary commitment to paying hydro bills.
- Teachers were instructed on offline literacy instructions strategies, in the event there were potential unavoidable power failures during an LTK+ lesson.
- Technology issues can also impact the trace data collection activities. Specifically, issues with a server clock due to a low battery made it impossible to retrieve the relevant data on the use of the LTK+ tools recorded by the software. Thus, when the LTK+ was installed on locked Raspberry Pi computers, it made it impossible to retrieve the recorded trace data.

***Implementation-related challenges*** primarily associated with technology issues as summarized above. However, contextual influences also impacted the project. The project unfolded when a number of national initiatives were unfolding, such as TUSOME, PRIEDE, and the Digital Literacy Program.

- We made a concerted effort to link our tools with the evolving curriculum. A range of alignment documents and lesson plans showing how ABRA-READS and ELM software complemented these mandatory programs was prepared and distributed so that the teachers were able to see the fit with the LTK+ tools.
- LTK+ training was structured in a way to build and consolidate the skills teachers needed to successfully achieve the national curricular goals through the integration of the LTK+ tools. This was easy to accomplish given the LTK+ tools were designed for use in a competency-based, student-centered curriculum.

***Other Challenges***

Some challenges remained beyond our control. Two national events in 2018 unfolded--a presidential election and the introduction of primary school reform, a competency-based curriculum, throughout Kenya. These imposed delays on the start of ABRA-READS intervention and on its implementation. In addition, tribal tensions in the Kirindon community also had some indirect effects on the classroom implementation.

In August 2019 we applied to IDRC for an extension to Nov. 30, 2020 and supplementary funds as the government representative for the Eastern Trans-Mara region was so impressed with the project in the seven schools equipped with technology by World Vision that he has requested, with enthusiastic school support, that we expand the program to other schools in the region equipped with technology under Kenya's Digital Literacy Program. With these funds we were able to conduct some initial training at the end of 2019, with a full implementation throughout the school year in 2020. Our focus was to be on the development of literacy skills using the ABRA/READS software in Grades 1-3 and extended READS use for upper elementary grades, creating a school culture of reading. Where needed, remedial use of ABRA/READS will be undertaken with older non-readers. While IDRC agreed to this request and teachers were trained in 2019, given the school closures in March, this project never fully got off the ground.

Certainly, the impact of the 2020 pandemic had the most significant impact on the last year of the project as we had to shelf our planned above-mentioned extension project and two research projects (e.g. 2020 ELM quasi-experiment and 2020 quasi-experiment of ABRA in pre-school). However, the LTK+ team switched their focus to piloting the online teacher professional development course with these teachers (and others) which proved to be an informative and useful stepping stone for the recently received KIX grant.

## Overall Assessment and Recommendations

*This section is not about research recommendations, **but administrative recommendations** for IDRC. What would you do differently as a result of this experience, and what general and useful lessons can be derived for improving future projects? What recommendations would you make to IDRC with respect to the administration of the project, related to the scope, duration, or budget? Candid observations about the overall experience with the project are encouraged. However, any sensitive or confidential information should be addressed through a direct exchange with the program officer, and documented and filed separately.*

Over the course of this grant we worked actively with the IDRC program and finance officers, who responded to our queries in a timely and productive fashion. They were exceptionally helpful and flexible, such that administering this grant was a very positive experience for the project team. For example, various finance officers worked with our grants officer to help in the preparation of financial reports. In some cases, this even resulted with them preparing a template for us to use. Our program officer was also exceptionally supportive and adaptable. For example, he helped advocate for the extension of the project and offered encouraging and insightful suggestions throughout.

In Dec. 2019, we learned that our application to the *Knowledge and Innovation Exchange* program was one of 12 out of 200 applications to be successful. We believe that if it were not for this IDRC grant, we would not have been a contender in this competition.

# Appendices

## Appendix A.

# 2019 Kirindon Literacy study: Using ABRACADABRA and READS

For the past four years, World Vision (WV) Canada and Kenya, the Centre for the Study of Learning and Performance (CSLP), and the Aga Khan Academies (AKA) have collaborated on a literacy and numeracy project in a remote region in the Trans Mara, Kirindon. WV typically establishes Area Development Projects in vulnerable regions where their educational and health services are most needed. The objective of this collaborative project was to improve the teaching and learning within this county. According to the Narok county director, Steve Gachie (2020) in Kirindon an average student from grades 1 to 3 scores **400 out of 800** on a combination of the end-of-the-year exams. Thus, in order to improve early primary students' achievement, three tools within the Learning Toolkit software—ABRACADABRA (ABRA), READS and ELM have been used throughout Early Childhood, and grade 1, 2, 3 classes in seven primary schools. In 2019, one class was pulled to participate in a small-scale study looking specifically at the effectiveness of using and ABRA and READS on the development of literacy skills. The following report summarizes this study.

### Research Design

A pre-test/post-test control group design was used in this study. One pair of teachers, with their classes matched on pre-test scores and other characteristics as closely as possible, were part of experimental or control conditions. To optimize the ABRA-READS implementation, the experimental teacher was supported extensively by her colleague with extended experience of using the software in her instruction. While the ABRA-READS intervention unfolded in the experimental class, the control teacher used traditional method of reading instruction.

### Sample

**Two grade-one English** teachers and their students from **two World Vision schools** in **Kirindon** participated in this study. This comprised of **one experimental** teacher who used ABRA-READS as part of her English Language instruction with her **40 students** and **one control** teacher and her **40 students** who did not use the tools. From the total sample of 80 first-graders, 2 control students did not write the post-test therefore leaving the **data of 78 students for analyses** ($N_c$= 40 and $N_e$= 38).

### The ABRA-READS Intervention

The intervention started in **term 2 in April of 2019** after the pre-test student data were collected. The experimental teacher attended an initial training workshop and the follow-up support sessions held for teachers on how to use ABRA and READS to teach literacy. She was provided with teaching materials including an ABRA curriculum developed expressly to align the use of the tool with the Kenyan English Language requirements for grade-one 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 the teacher's discretion. Multimedia scaffolding and support for teachers and students embedded in ABRA were also available. As mentioned earlier, a **seasoned ABRA/READS teacher** from the same school **supported the use of both tools** in the experimental class.

In total, the ABRA **intervention lasted for about 20 weeks** during the second and third terms. Weekly **one 45-minute-long ABRA and READS lesson** was conducted in the experimental class. Classmate laptops were used for the instruction. Since the student-laptop ratio was 2 to 1, to increase the exposure time to the tools, teachers placed **students in dyads** where students took turns to interact with the computer. About two weeks of the intervention were spent at the outset familiarizing students with computer learning environments in general and ABRA-READS navigation in particular.

## Instruments

### *Student Achievement Measures*

The ***Group Reading Assessment and Diagnostic Evaluation, GRADE*** (Williams, 2001) was used for the purposes of this study. 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** subtests each measure slightly different **vocabulary related skills**. Word Reading 28 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.

**Sentence Comprehension** and **Passage Comprehension** subtests each measure **reading comprehension skills**. Each of the 19 Sentence Comprehension items is 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 28 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 the skills of vocabulary, grammar and inference.

Consistently with previous studies of ABRA/READS in Kenya, we used **GRADE Level 2** to measure the development of reading skills as it allows for testing a broad group of elementary students (from grade 1 to grade 3). The **test was administered** to the experimental and control students in **March 2019** (form A) to collect baseline data and in **September 2019** (form B) to assess end-of-year reading achievement. It is important to note that at the pre-test three of the five GRADE subtests were administered to grade-one students in both conditions. These were Listening Comprehension, and Vocabulary subtests including Word Reading and Word Reading. At the post-test, students completed all five GRADE subtests.

### *Teacher 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 three sections to explore: 1) approaches to reading and comprehension instruction; 2) use of technology; and 3) student-teacher interaction. Based on the findings of the *National Reading Panel* (NRP report, 2000), the 23 items **inquire about the activities students engage in to develop their reading and comprehension skills including phonemic awareness, phonics, oral reading fluency, vocabulary, comprehension and writing**. To capture the possible changes in the literacy instruction, the teachers were asked to complete the questionnaire at the pre- and post-test. However, the post-test questionnaires were made available for the analysis.

## Analyses

Before the main analyses, standard procedures were used to verify, clean the data and test them for normality. No anomalies were discovered. **Composite scores** were created when possible. These were: **Vocabulary** (Word Reading + Word Meaning); **Reading Comprehension** (Sentence comprehension + Passage Comprehension) and **Total GRADE** (Vocabulary + Reading Comprehension + Listening Comprehension). It is important to note that the Total GRADE composite we aggregated in this study differed from the GRADE Total Test score that did not include Listening Comprehension since it measures comprehension without printed cues.

For the GRADE achievement measures, first analyses of variance (ANOVA) on pre-test scores was used to test for the baseline differences between the experimental and control groups. Second, we used the analysis of covariance (ANCOVA) to compare the average change rates of the two groups after statistically adjusting for the possible pre-test differences between them as measured by the GRADE pre-test composites. Since Reading Comprehension composite scores were only available at the posttest, we used the GRADE pre-test Vocabulary Composite to adjust the initial difference between the groups. In addition to all the statistical analyses of significance, standardized effect sizes are reported. We also report each group's descriptive statistics including mean scores and standard deviations.

## Results

### *Student Achievement: Overall GRADE Results*

In order to answer the question if using ABRA and READS impacted students' reading skills as measured by GRADE, we first compared the test scores of the control and experimental students at the baseline, before the ABRA/READS intervention. At the pretest, the experimental and control groups did not differ significantly on the three GRADE basic scales as well as the two composite scores of Vocabulary and Total GRADE**.** Specifically, the coefficients were: $F(1, 76) = 1.10$, $p = 0.30$ (Listening Comprehension); $F(1, 76) = 0.12$, $p = 0.73$ (Word Reading); $F(1, 76) = 1.46$, $p = 0.23$ (Word Meaning); $F(1, 76) = 1.09$, $p = 0.23$ (Vocabulary composite) and $F(1, 76) = 1.68$, $p = 0.20$ (Total GRADE composite as a combination of Listening Comprehension and Vocabulary scores). Overall, these results suggest that **the experimental and control students were mostly equivalent in literacy skills at the outset of the ABRA/READS**

**intervention**. A summary of the descriptive statistics and ANCOVA results by group on the GRADE subscales and composites at pre- and post-test are reported in Table 1.

The results show reading gains from pre-to post-test for the students in both experimental and control classes. At the same time, the **effects consistently favour the students who used ABRA and READS**. The analyses found that after exposure to the ABRA and READS instruction, the students improved their scores at a higher rate than their peers from the control class. Specifically, **the ABRA/READS students showed significantly larger improvements in Vocabulary** ($F(1, 75) = 16.71$, $p = 0.000$), **Reading** Comprehension ($F(1, 75) = 5.42$, $p = 0.02$) and **Total GRADE** ($F(1, 75) = 13.18$, $p = 0.000$). The progress of the experimental students in Listening Comprehension was noticeable albeit non-significant what would be expected considering quite low statistical power due to the modest sample size in this study.

Consistent with the above results are the **effect sizes** as expressed by partial eta-square ANCOVA coefficients (variance explained by group membership). They **vary from small (0.02 for Listening Comprehension) to medium (0.07 for Reading Comprehension) and large (0.18 and 0.15 for Vocabulary and Total GRADE respectively).**

Table 1
*GRADE means (adjusted means in parentheses), standard deviations, and group difference ANCOVA coefficients*

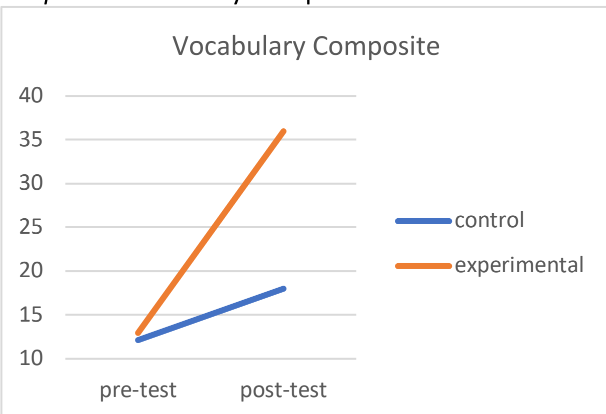
| GRADE scales | ABRA-READS students (N= 38) | | Control students (N=40) | | Difference between the groups (F value and significance) |
|---|---|---|---|---|---|
| | Post | Pre | Post | Pre | |
| Word Reading (WR) | 14.16 | 6.23 | 10.55 | 6.05 | |
| *Standard Deviation* | *6.13* | *2.42* | *4.89* | *2.36* | |
| Word Meaning (WM) | 22.00 | 6.68 | 7.45 | 6.08 | |
| *Standard Deviation* | *2.34* | *2.60* | *2.97* | *1.80* | |
| Vocabulary Composite (WR+WM) | 35.97(35.78) | 12.92 | 18.00(18.41) | 12.13 | 16.71*** |
| *Standard Deviation* | *7.29* | *3.53* | *7.24* | *3.19* | |
| Sentence Comprehension (SC) | 7.00 | | 2.55 | | |
| *Standard Deviation* | *2.46* | | *1.72* | | |
| Passage Comprehension (PC) | 6.39 | | 0.00 | | |
| *Standard Deviation* | *2.66* | | *0.00* | | |
| Reading Comprehension Composite (SC+PC) | 13.39(13.23) | | 2.55(2.81) | | 5.42*[1] |
| *Standard Deviation* | *3.62* | | *1.72* | | |
| Listening Comprehension (LC) | 7.21(7.17) | 4.00 | 4.18(4.13) | 3.65 | 1.21 |
| *Standard Deviation* | *1.44* | *1.45* | *1.74* | *1.49* | |
| Total GRADE (VC+RCC+LC) | 56.58(56.19) | 16.92 | 24.72(25.09) | 15.77 | 13.18*** |
| *Standard Deviation* | *10.04* | *3.87* | *7.71* | *3.93* | |

* p< .05, *** p<.000

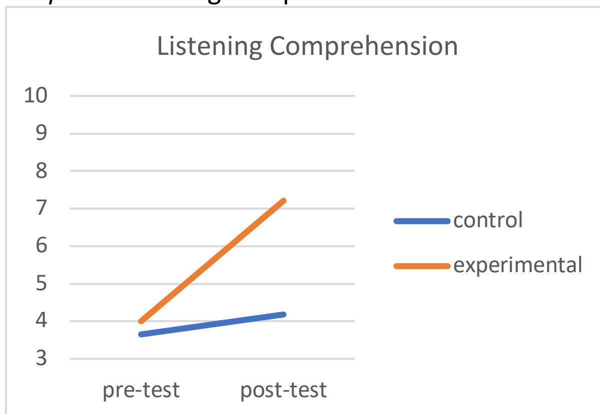
[1] pre-test GRADE Vocabulary composite was used for adjustment

The graphs below visually represent the change in mean scores in the experimental and control groups for the GRADE subtests where pre- and posttest scores were available. These are **Vocabulary Composite** (graph 1), **Listening Comprehension** (graph 2) and **Total GRADE composite** (graph 3). As illustrated by the graphical representation of results, **the experimental students' gains were important**.

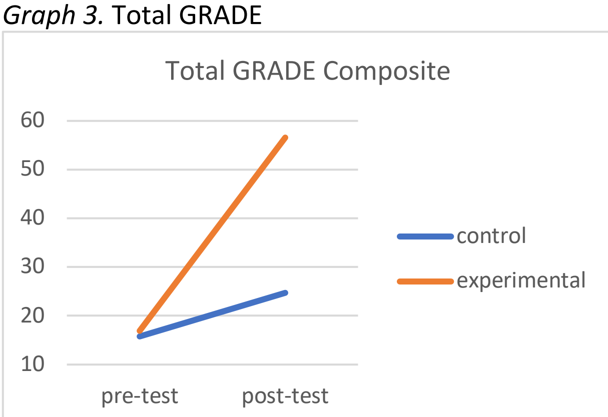
*Graph 1.* Vocabulary Composite




*Graph 2*. Listening Comprehension




*Graph 3.* Total GRADE




It is important to note, that at the posttest an average student from the ABRA/READS class was able to complete correctly 36 out of 55 Vocabulary items, 13 out of 47 Reading Comprehension items and 7 out of 17 items on Listening Comprehension. We compiled **Table 2** to summarize **the percentage of experimental and control students at and above the GRADE test norms** (grade 1, end of the academic year), according to which 50% of grade-one students should achieve the threshold of: 31 on Vocabulary Composite; 14 on Reading Comprehension Composite; and 13 on Listening Comprehension. The table suggests that **after being exposed to ABRA and READS reading instruction, an average grade-one student from Kirindon might perform similarly to an average first-grader from the US on a standardized measure of vocabulary and reading comprehension skills**. On the contrary, progress in listening comprehension is not large enough.

Table 2
*Percentage of students reading at and above the GRADE average*

| | Vocabulary Composite (31 and more) | Reading Comprehension Composite (14 and more) | Listening Comprehension (13 and more) |
|---|---|---|---|
| ABRA-READS group | 74% | 53% | 0% |
| Control group | 1% | 0% | 0% |

### Teacher Self-reports

The experimental and control teachers and the expert teacher completed the ***Literacy instruction Questionnaire*** at the posttest and the summary of their self-reports follows.

As it would be expected, such literacy components as alphabetics, fluency, vocabulary and comprehension have been addressed more frequently in the experimental instruction where students interacted with ABRA-READS software designed to develop this range of literacy skills.

For instance, the control teacher (5 years of teaching experience) reported having taught phonics and phonemic awareness occasionally (4-6 times per term) whereas the teachers in the experimental group (10 and 12 years of teaching experience) addressed these two key literacy areas twice as often.

Reading aloud was the only technique that the control teacher used to develop reading fluency whereas the students in the experimental condition were also exposed to guided and repeated reading activities as well as reading in pairs and groups.

With the exception of question answering, reading comprehension activities were not used in the control classroom. On the contrary, in the experimental class, students were involved in asking questions, predicting, monitoring comprehension, summarizing and sequencing.

In addition to spelling activities used in both conditions, experimental instruction also offered guided writing, filling worksheets and editing. Commenting on their student achievement by the end of grade one, the control teacher noted that her students “can blend 3 letter words”; experimental students were reported to be able to decode 4- and 5-letter words and “to convey the message by use of pictures”.

*GRADE implementation*

*ABRA Implementation*

The teacher with extended experience of using the ABRA-READS software, who extensively supported the experimental teacher, summarizes the 2019 grade-one students' learning outcomes as follows:

> *"Literacy and numeracy skills has been achieved so far as learners are able to read and decode given words. What is so interesting is that the software makes these learners so active and reason faster. Manipulation skills in this grade is so much developed perhaps because the learners began using the software from ECDE. It really amazes me how they mastered the sounds, that they could blend three to four letter sound so fast, and within a short time! The software is child friendly that make learning so interesting. Being the fourth group to use the software since 2016, and the first class to use the toolkit right from ECDE (PP2), I [Naomi] am very proud to attest the fact that the class is far much ahead as compared to every first classes. The Learning Toolkit really enhances the very early literacy and numeracy skills! Early use of the software, yields big payoff!"*

## Conclusions and Recommendations

When used with grade-one students from Kirindon schools, **ABRA and READS resulted in positive effects on the students' reading skills, mostly benefiting their vocabulary knowledge and reading comprehension skills**. **Such significant improvements in these reading skills allowed these students to perform on par with, or better than, their average grade-one peers from North America.**

Integrating ABRA-READS in classroom instruction and, therefore, spending more time on phonics and phonemic awareness, as well as bringing more diversity to fluency and comprehension activities in teaching grade-one students may account for the important shifts in the reading competencies of the experimental group. For example, the expert teacher who supported this class describes the achievement of her own grade-four class who have been using the software since 2016:

> "*A continued use of LTK has really enhanced acquisition of literacy. This has been depicted by grade 4 students from KIMINTET PRIMARY SCHOOL, who have been interacting with the software since 2016. Then they were in grade 1 luckily enough LTK landed just right on their heads and on time! The class has shown a clear indication of the toolkit enhancing literacy and numeracy skills. It is a different class altogether as far as academic performance is concern in the entire school. I [Naomi] being their class teacher since then, I was like seeing a mountain in front as they were joining grade 4 early this year. Amazingly, they did well in their first exams for English despite the fact that they were introduced to choices of ABCD for the first time. Actually, these boys and girls are really doing well in comprehension part of these papers. The two passages contained in an English paper is their favorite and they sweep all the answers here. I have been analyzing this from term 1 and mark you, for this term (term 3) was an exemplary one! Almost the whole class of 42 students got the comprehension questions right. This great performance in English has led to great performance in other subjects as well. So there has been a shift in literacy!"*

Future focus of implementation may be placed on the development of listening comprehension skills with grade-one students**.** This need arises from the fact that in rural areas such as Kirindon the use of the English language outside school might be less than in the urban areas such as Mombasa. For instance, Marten in Brown, Asher and Simpson (2006) state that population of rural areas in Kenya tend to speak their native languages rather than the official languages of English and Kiswahili. In this context, English language teaching becomes more of a second language instruction, whereas the development of listening comprehension requires special effort. This is because acquiring listening comprehension in a second language is a different cognitive process than the acquisition of listening skills in one's mother tongue (Churchland, 1999).

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Appendix B.

# Emergent Literacy in Mathematics (ELM): Learning mathematics with interactive technology in Kenya grade-one classes

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## Abstract

While countries in Sub-Saharan Africa have made significant progress towards achieving universal school enrollment, millions of students lack basic numeracy skills. This paper reports the results of a study that aimed at using the Emerging Literacy in Mathematics (ELM) software to teach mathematics in early primary grades in Kenya. Designed as a pretest-post-test non-equivalent group research, the study unfolded in 14 grade-one classes from 7 primary public schools. After having learned with ELM for about two terms, the experimental students (N=283) considerably outperformed their peers (N=171) exposed to traditional instruction with the effect sizes of +0.37 on the overall skills measured by a standardized test of mathematics. The impact of ELM's activities was the greatest on students' ability to take language and concepts of mathematics and apply appropriate operations and computation to solve word problems. On this set of skills, the magnitude of difference between the experimental and control groups was +0.71. This study also revealed positive shifts in the teachers' perceptions about their practice. The ELM teachers reported having gained more confidence in mathematics and comfort in teaching mathematics with computers.

Keywords: interactive mathematic software, primary mathematics instruction, student mathematics achievement, Sub-Saharan Africa, Kenya

## Introduction

Together with literacy, Science, Technology, Engineering and Mathematics (STEM) education has been recognized for the critical role it plays in driving countries' economic growth. National

Research Council (2009) noted STEM education as a stable source of employment brought about by innovations and, therefore, the primary builder of the future economy. Further, research suggests that mathematics attainment may have an important impact on individual income potential both in economically advantaged (Crawford & Cribb, 2013; Hanushek et al., 2015) and disadvantaged contexts (Dickerson et al., 2015). At the same time, while countries in the Global South have made significant progress towards achieving universal school enrollment, millions of students lack basic numeracy skills (World Bank, 2018). For instance, the Uweso assessment 2016) reports that in Sub-Saharan Africa, by the end of primary school less than one third of students can solve a simple two-digit subtraction problem and only one in five students have second-grade mathematics skills. Multiple challenges hinder quality mathematics education in the region including large classes, insufficient resources and lack of qualified mathematics teachers to name a few (Tickly et al., 2018). With computer technology becoming cheaper and increasingly wide-spread, education policy-makers and practitioners, view it as a means to help address the issue; hence a growing number of government-supported initiatives such as Digischool in Kenya, UConnect and INetwork in Uganda, SchoolNet in South Africa to name a few. Moreover, research has confirmed the potential of digital technology to enhance both teaching and learning by increasing students' foundational skills (Cheung & Slavin, 2013) and scaffolding teachers' instructional practices (Angeli & Valanides, 2009). In the contexts where the demand for quality resources is high, the possible benefits of technology use become particularly relevant. This paper reports the results of a study in Kenya where research-based multimedia software is being used to equip primary teachers with effective instructional strategies to improve their students' learning of mathematics.

## Study Background

### *Early mathematics instruction*

Over a few decades, the teaching of foundational mathematics skills has been studied substantially. The findings of this research largely reflected in instructional goals and principles suggest that effective teaching develops young students' conceptual understanding of numbers and quantities, connects this understanding to computational methods and strategies, and instils procedural fluency and mastery in their application to solve mathematical problems (e.g., NCTM, 2014; NRC, 2001). On her way to proficiency, the student gains conceptual understanding, computational procedures are remembered better and are used more flexibly to solve new problems. As a procedure becomes more automatic, the student is enabled to think about other aspects of a problem and to tackle new kinds of problems, which leads to new understanding (Fuson, Kalchman, & Bransford, 2005). Therefore, gaining mastery and fluency of multiple aspects within the number concept enables the student to proceed from concrete to abstract, reaching the ability to carry out mental computation (Baroody, 2006). This requires the development of number sense that includes to students' understanding of numbers and their magnitude, relationships between numbers and working with patterns (e.g., Clements & Sarama, 2009). In its turn, learning the numbers requires that students have solid command of concepts and procedures such as place value and operations with single-digit whole numbers. Being the basis of all numerical procedures, operations with single-digit whole number should be made automatic (e.g., Griffin, 2005, Baroody & Purpura, 2017).

Since children's acquisition of new mathematical ideas depends on their prior knowledge (e.g., Anthony & Walshaw, 2007), effective instruction also frequently assesses what students understand and are able to do mathematically, and then responds to individual student's strengths and weaknesses. By adjusting to students' different levels of understanding, differentiated instruction enables students to proceed at their own level of understanding (NTCM, 2014). In this regard, no one practice can dominate across all settings and learners, and therefore a "balanced approach" to teaching mathematics can be beneficial. Clements et al. (2017) argue for balanced instruction based on learning trajectories that can provide guidance for engaging and developmentally appropriate mathematical experiences that have been demonstrated to help all children learn to high standards. For instance, such balance allows low-achieving students to learn from explicit and direct instruction, while more advanced students enjoy tasks offering them opportunities to learn at their own pace (Fuson et al., 2015). To reinforce the student-centred aspect of the balanced mathematics instruction computer technologies have shown useful (e.g., Li & Ma, 2010; Deunk et al., 2018).

***Mathematics instruction in developing countries***

Much of what is known about effective mathematics instruction has come out of high-income countries that is not always fully applicable to less affluent developing countries. The latter contexts, however, generated some evidence. For instance, Sitabkhan and Platas (2018) completed a narrative review of instructional strategies in early-grade mathematic interventions studied by 24 randomised control trials and quasi-experiments of math instruction with 11 studies from Sub-Saharan countries. They report the use of manipulatives and developmental progressions as the most prevalent evidence-based practices employed in the interventions. Conversely, the use of strategies targeting higher order skills such as encouraging children to explain and justify their thinking and making explicit connections between formal and informal language were not seen in the reviewed studies. The authors ponder that since the implementation of these strategies requires significant changes in teacher behaviours and attitudes, the studies opted for excluding them from the design of interventions. The research literature points to one possible reason – little or no special training for lower primary teachers who are expected to teach beginning reading, numeracy, and other essential competencies (e.g., Akyeampong et al., 2012). In this regard, there is an urgent need to prioritize teachers' capacity for progress in mathematics attainment as expressed in a World Bank commissioned report on mathematics education in Sub-Saharan Africa (Bethall, 2016). Bold et al. (2017) identified important gaps in teacher content knowledge and pedagogical skills. For instance, only 15% can solve a more advanced math word problem, 55% can formulate questions to check understanding; 30% can assess their student's abilities and learning progression whereas 17% are able to apply the full set of general pedagogical skills—structuring, planning, asking questions and giving feedback—in their lessons for the benefit of their students' learning. Teachers' limited proficiency in English may be an additional inhibitor as teachers themselves struggle with subject-specific topics when engaging in formal classroom talk (Kembo-Sure & Ogechi, 2016; McCoy, 2017).

To raise the quality of teaching, the longer-run system-wide actions including improvements to teacher training programs (e.g. Barasa, 2020) could be complemented with short-term solutions. For instance, prescriptive instruction is one such fast-track way to improve low-performing systems where teachers over-rely on basic recall, and rote-learning in their instruction (e.g., De Clercq, 2014; Shalem et al, 2018). Although scripted lessons can guide teachers to correct pacing, sequencing, coverage of the official curriculum and syllabus (e.g., Piper et al., 2016; Fleish et al., 2016), they do not work to improve instruction catering to higher-order learning where teachers struggle the most (e.g., Bold et al., 2017). Questioning the prescriptive approach, Fullan (2016) argues that it is not through imitation but through innovative adaptation that teachers learn about complex solutions that would influence their practice and drive "deep change work". Computer-assisted teaching and learning has been noted for its potential to bolster students' access to quality education in low-teacher-capacity settings (Bethall, 2016).

***Computer-assisted mathematics instruction in developing world contexts***

Considerable improvements in connectivity and accessibility of technology account for the increasing enthusiasm that less affluent nations have in using educational ICTs. Moreover, the implementation of computer-based pedagogic initiatives in developing countries, has generated the important body of systematic evidence that indicate positive effects of educational technology on learning. McEwan (2015) in his meta-analysis of primary school interventions, found that computer-assisted instruction was associated with the highest impact on learning outcomes (+0.15). Conn (2017) reports the effect size of +0.43 that computer-assisted learning programs adapted to the student's learning level may have when compared to traditional instruction. Evans and Popova's (2016) analysis of six systematic reviews of educational interventions in developing countries, concluded that despite the important variations in the reported findings, the reviews tend to agree that computer-assisted instruction can be highly effective.

Although few individual studies tested the impact of computer-based mathematics interventions in low income countries, their findings suggest positive effects of computer instruction on learning mathematics in primary schools (e.g., Pitchford, 2015), and for students with special needs (Kiboss, 2012). Interactivity (Pitchford et al., 2019) and self-paced learning Banerjee et al., 2007) were the design features with most benefit to students. In view of research sparseness, calls are made for more studies to evaluate the interventions and technologies to improve mathematics instructional practices and learning outcomes (e.g., Bolton, 2019; Bethall, 2016).

*The current study* targeted teacher implementation of ELM, mathematics interactive software, in grade-one classrooms in Kenya schools. The research that unfolded was influenced by primary school reform including the introduction of a competency-based curriculum with an almost simultaneous roll-out of the TUSOME and PRIEDE national programs. The government also made a massive commitment to the provision of educational technology by implementing the Digital Literacy Programme (DLP, aka Digischool). They successfully deployed technology (tablets, content servers and projectors) in primary classrooms across the nation.

For this context, we developed a multi-component ELM intervention model, brought it into the authentic context of schools, and examined its impact with regard to classroom instruction and student mathematics skills. Specifically, we examined two sets of questions:

- Is ELM a usable and effective tool for math instruction in the Kenyan context? How does the software and associated professional development and support impact Kenyan students with respect to the learning of essential mathematics competencies? Do these effects vary across student characteristics such as gender and baseline achievement?
- What are the impacts of the software and associated professional development and support on Kenyan teachers' mathematics instructional practices and professional skills? How do teachers adapt and adjust their implementation of the software?

**Method**

***Research design***

This study was designed as a non-equivalent pretest-post-test control group design where teachers and their students were part of either experimental or control conditions. While the ELM intervention unfolded in the experimental classes, the control classes were exposed to their usual method of mathematics instruction. Student and teacher data were collected twice; first in January, at the beginning of school year, before the ELM implementation started in the experimental classes and, then, in late September, at the conclusion of the intervention.

***Study sample***

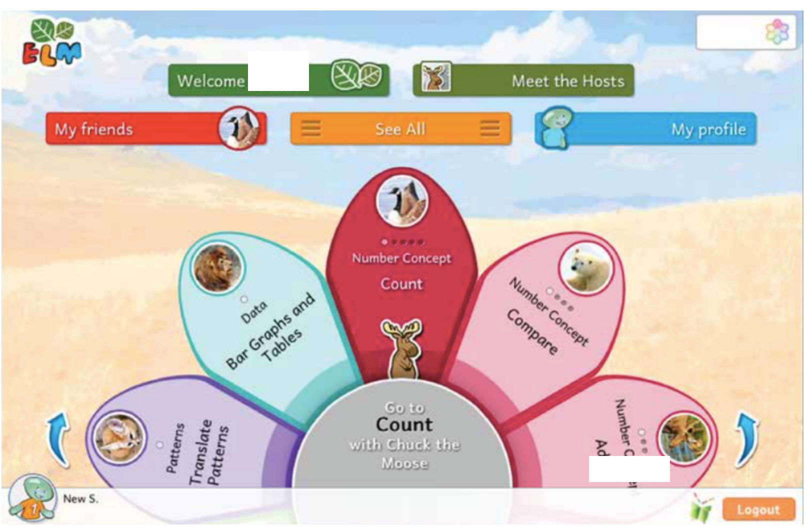
Seven public schools with comparable socio-economic characteristics from Mombasa area were recruited by the local project coordinator to be part of the project either as experimental or control schools. The total sample of 14 grade-one teachers and their 613 students included nine experimental teachers who used ELM as part of their mathematics instruction with their 358 students and five control teachers and their 255 students who did not use ELM. The number of students in participating classes varied from 28 to 61 students with the average class size of 41 students in experimental and 50 students in control classes. The gender split in both conditions was about equal with ~ 56% of boys and ~44% of girls. Because some students missed either pretest or post-test due to illness or changing school, the data for 454 cases ($N_{exp}$ =283; $N_{control}$=171) were analysed.

Teachers in both conditions ($N_{exp}$=9; $N_{control}$=5;) were comparable in regard to mathematics training and experience. Besides one control teacher with a high school education, all control and experimental teachers received some certification either from university or teacher training colleges. Only one teacher was able to name a math-related course she took when in university. On average, the teachers taught between three to 34 years with an average of 21 years of experience.

ELM Program

Emerging Literacy in Mathematics (ELM) software

Offered within the Learning Toolkit (LTK+) suite of evidence-based software, ELM is a collection of engaging game-like activities designed to promote the development of young children's foundational skills in mathematics as described by the NCTM (2009) among others (see http://www.concordia.ca/research/learning-performance/tools/learning-toolkit/elm.html) Figure 1



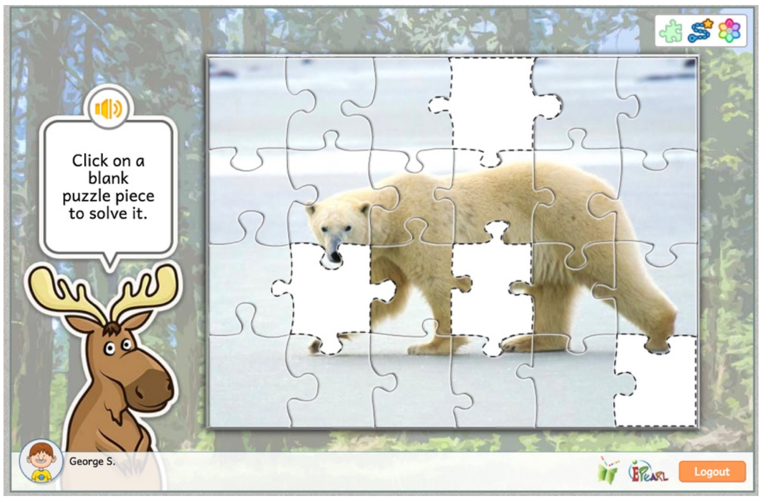

The software design is based on the current evidence showing promising links between mathematic instruction and computer technologies (e.g., Li & Ma, 2010). Multimedia designed principles (e.g., Mayer, 2008) also informed the design of the software helping reduce cognitive load, engage learners, reduce anxiety, and scaffold the understanding of mathematical concepts.

The ELM content is organized into Themes, overarching branches of mathematics, which are further divided into Ideas (mathematical concepts). Figures 1 and 2 illustrate the content structure of ELM.

Figure 2

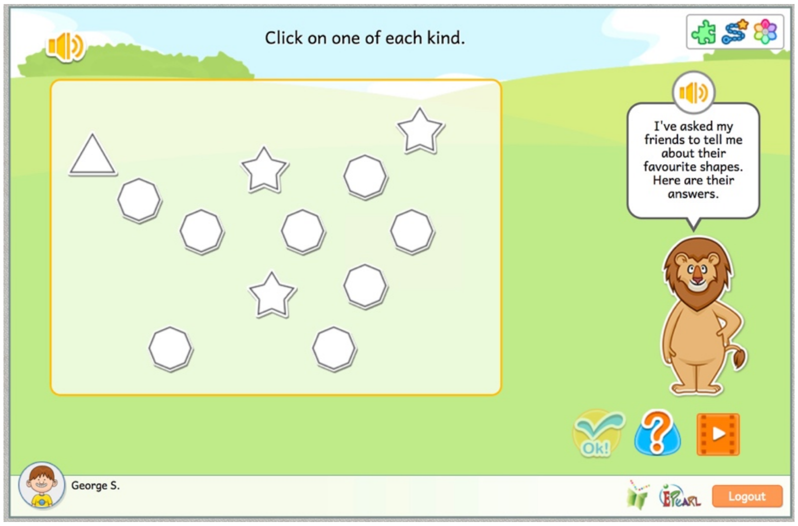

In order to build children's understanding of a concept, each Idea then follows a certain number of carefully sequenced activities moving from concrete to more abstract, from images and physical actions to mental images and symbolic representations. For example, initially a student is asked to count by performing the equivalent of touching the image of each object, then by generating a mark corresponding to each object being counted, and finally by counting in their head and reporting that count using number symbols. Each activity is presented as a jigsaw puzzle (Figure 3) having a number of missing puzzle pieces, where each piece represents a set within the activity. The activity is completed once the student gains all the missing puzzle pieces. Through 38 ELM activities, children gain skills and confidence in: Number Concept (Count, Compare, Add, Subtract, Decompose, Place Value); Geometry (Identify shapes); Patterns (Translate patterns); Data (Bar graphs and tables); and Number Line: (Number as displacement).

Figure 3




ELM provides meaningful audio and visual feedback to the students as they complete activities at their own pace, helping to guide them to the correct answer. To encourage student autonomy, ELM offers a system of embedded support. Demos were created for each activity and are presented to correspond with each phase to avoid overwhelming students. All activities have a 'help' button to provide built-in just-in-time support (Figure 4). This help generally consists of a brief audio instruction followed by visual cues, and is context-sensitive, dependent on the phase of the activity the student is progressing through.

Figure 4




The teacher interface in the software offers a collection of multimedia resources specifically intended to help teachers use ELM (see https://literacy.concordia.ca/resources/elm/teacher/en/) These resources include information on each activity within the tool, detailed lesson plans for each activity, with learning objectives, an extension activity and a reflection exercise, video demos, and recommended external resources such as online math games. The ELM report allows teachers to obtain an overview of the progress of their class, as well as the progress of individual students. For example, it provides information about how many puzzle pieces each student has completed, whether the student eventually completed a particular activity, or if the student had trouble at some point in the activity. Further, ELM allows teachers to differentiate instruction. They can create a plan for a single student or groups of students and adjust the number of repetitions required in any given activity, or assign an additional 're-do' for any activity. If a student has been assigned a specific plan, the ELM report reflects the settings of that plan and the students' progress through it.

As part of the design and development cycle, the ELM software passed through initial validation in Canadian grade-one elementary classrooms. Designed as a non-equivalent control group the pilot study with 450 students, the test demonstrated ELM impacts on students' learning outcomes. After having learned with ELM for about one term, the experimental students considerably outperformed their peers exposed to traditional instruction with the effect sizes of +0.22 (Lysenko et al., 2016) on the overall skills respectively measured by the standardized tests of mathematics (CAT-4, 2008). In addition, the effects of ELM were observable on a set of affective outcomes. Students in classes where ELM was part of mathematics instruction reported more enjoyment from learning math and less anxiety and boredom than their peers in the control group.

ELM intervention

ELM integration in mathematics instruction was in the heart of ELM intervention. The implementation took from 10 to 14 weeks between January and September of 2019 where the tool was expected to be used at least for 60 minutes per week but was often less. The teachers used the school computer lab for the ELM instruction. The devices were desktop computers or government-provided DLP tablets or some combination of both. In the context of big classes, students had to work in pairs or small groups.

To ensure adequate integration of the ELM software into classroom instruction, professional development on ELM was a key component of the intervention. All experimental teachers were trained on the ELM software and its pedagogy at a full day training workshop. Three half-day out-of-school follow-up sessions took place once per term to continue training teachers on how to use ELM for mathematics instruction. In-school support to experimental teachers was provided by an external expert teacher (Ambassador) and a school-based ambassador (SBA), who was a specially trained school teacher in each experimental school. The SBA facilitated in-school planning meetings with her school teachers, helped scheduling access to the computer lab and assisted teachers during the ELM lessons. Since technical issues were frequent, the planning meetings also focussed on using some ELM print-based extension activities. To complement the efforts of SBAs, each Ambassador rendered between three to five visits to the assigned classrooms. These visits were held on the days of the in-school planning sessions. The topics were of general (LTK+ suite-related) and more targeted (ELM-related), and included establishing the ELM school timetable, registering students in the LTK+ database, linking ELM to the curriculum, learning how to differentiate within ELM etc. The Ambassadors also used such visits to observe classes and also assist teachers during the lesson if needed. Both the Ambassadors and SBAs benefited from the support system as they met regularly for planning and reflection.

A set of ELM teaching materials was offered to teachers. This included an ELM curriculum developed expressly to align the use of the tool with the Kenyan grade-one Mathematics requirements. The ELM supplementary pedagogical materials also included lesson plans, classroom activities, and job aids for teachers. These materials were suggested rather than prescribed and their use was left at the teachers' discretion.

***Instruments***

*Student achievement measures*

Students' skills in mathematics were assessed using *Group Mathematics Assessment and Diagnostic Evaluation*, GMADE (Williams, 2004), a standardized achievement measure. GMADE level 1 was chosen to measure the change in the students' mathematic skills. This level covers the age band from 6 to 11 years old by offering items at a wide range of difficulty that allows reliable measurement of low-, average- and high-performing students. Parallel forms (A or B) were used alternatively to collect pre- and post-data. Each form contained eighty multiple choice items pertaining to the content-driven categories such as algebra, comparison, geometry, measurement, money, numeration, quantity, sequence, statistics and time.

The *Concepts and Communication* subtest of GMADE addresses the language, vocabulary and representations of mathematics and contain symbols, words and phrases that fit the content-driven categories (except algebra and statistics). The *Operations and Computation* subtest evaluates the ability to use basic operations of addition and subtraction in both vertical and horizontal forms with a variety of mathematical representations. The *Process and Applications* subtest measures the students' ability to take language and concepts of mathematics and apply the appropriate operation(s) and computation to solve a word problem that fits the content-driven categories (except comparison). The majority are one-step or single-operation problems, whereas one is a multiple-step problem.

*Instruction and teacher measures*

The *Mathematics Teacher pre- and post-surveys* were used to collect information from control and experimental teachers (https://www.concordia.ca/research/learning-performance/knowledge-transfer/instruments.html). Although obtaining teacher demographic information was the main focus of the pre- survey, it also elicited teacher reports on the content they taught in grade 1, accessibility and use of technology, as well as the comfort and confidence they had in teaching early math and using computers. The post-survey collected teacher self-reports about the instructional methods they relied also including use of ELM.

*ELM Trace Data* generated by the software provided an estimation of time that a student spent in each ELM activity. The accuracy of these data is dependent upon multiple factors including electricity blackouts, students logging in and out correctly, and students working in pairs or small groups. This statistic was aggregated to reflect time spent on counting, comparing, adding, subtracting, decomposing, place value etc.

Additional information about the ELM implementation was available from the end of term reports from the SBAs and Ambassadors. The numeric data collected at this stage of the project were included into the datafiles and used to inform the final analyses.

**Analyses**

All student and teacher data were entered into SPSS 26 for Mac OS X and verified for accuracy. After merging student pre and post-test data, the datafile contained 613 cases. The students who missed either time of testing were excluded from the analyses, the data of 454 students ($N_{experimental} = 283$; $N_{control} = 171$) were analyzed. The data did not deviate from normality; the indices of skewness and kurtosis ranged from -2.5 to 2.8. The composite scores were calculated as a simple sum of the raw scores along the three GMADE sub-scales of Concepts and Communication, Operations and Computation, Processes and Applications, and GMADE Total score. The initial difference between the groups had been detected on the GMADE pretest ($F(1, 453) = 3.85$, $p < .05$), thus the repeated measures analysis of variance (RM MANOVA) was used to analyze the GMADE composite scores. The basic one-way model included testing time (pretest-post-test) as the within-subject variable and treatment (ELM -- no-ELM) as a between subject factor. Supplementary analyses were run to explore if ELM effects a) vary as a factor of student gender and b) are detectable for struggling learners.

At the pretest the complete set of data were collected from 14 teachers. Matching teachers' pre- and post-tests, yielded data for 8 experimental and 2 control teachers. Paired sample t-test was run to examine the change in experimental teacher self-reports overtime. For both student and teacher data, we report the descriptive statistics by group including mean scores and standard deviations as well as standardized effect sizes (i.e., Cohen’s d). Being an index of magnitude of difference between groups, these were calculated as the mean difference between the two groups’ pre-post change score divided by the pooled standard deviation.

**Results**

The following section presents the results that we obtained after analyzing the student and teacher data.

***Student results***

As summarized in Table 1, student achievement data on each of the GMADE subtests suggest that students in both groups improved over time with important benefits to the ELM students. To explore whether the ELM students' mean change in mathematics skills from pre- to post-test on the GMADE differed from those of their peers from control classes, the one-way repeated measures analysis was run with testing time as the within-subject variable, and treatment as a between-subject factor. The RM MANOVA Pillai's trace criterion indicates statistically significant difference between experimental and control students' change scores on a combined set of mathematic measures overtime; Pillai's trace criterion is $F(3, 450) = 14.72$, $p < .000$ with partial eta squared of 0.08 confirming the difference. The univariate tests reveal the significant effects of ELM on the experimental students' mathematic skills measured on the GMADE subtests of Concepts and Communication ($F(1, 452) = 5.95$, $p=0.02$; partial $\eta^2 = 0.01$) and Process and Applications ($F(1, 452) = 42.76$, $p= .000$, partial $\eta^2 = 0.085$) as well as the GMADE Total test ($F(1, 452) = 18.40$, $p=.000$; partial $\eta^2 = 0.038$).

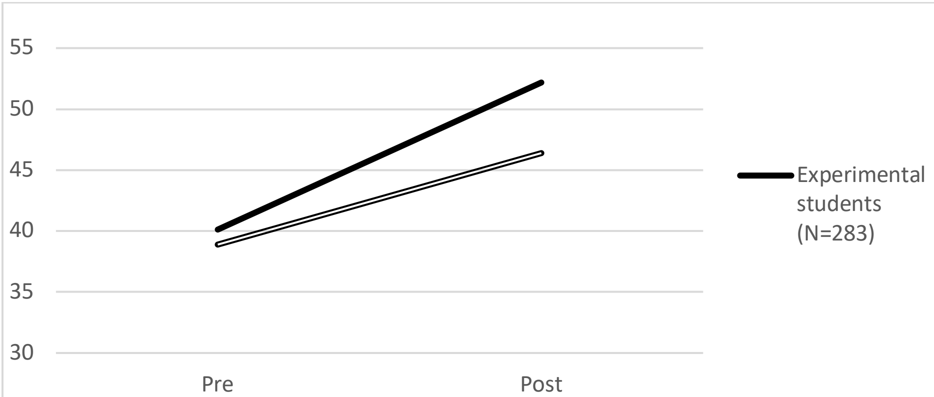
Table 1. Student mathematic achievement: Group means and standard deviations, gains and standardized effect sizes

| | Concepts and Communication (max 28) | | Operations and Computation (max 24) | | Processes and Application (max 28) | | Total Test (max 80) | |
|---|---|---|---|---|---|---|---|---|
| | Post | Pre | Post | Pre | Post | Pre | Post | Pre |
| Experimental group | 19.90 | 16.63 | 16.83 | 12.92 | 15.45 | 10.57 | 52.18 | 40.12 |
| (N=283) | *4.02* | *3.74* | *5.37* | *5.68* | *3.73* | *4.735* | *10.81* | *11.02* |
| Change scores | 3.27 | | 3.91 | | 4.88 | | 12.06 | |
| Control group (N=179) | 18.44 | 16.22 | 15.15 | 11.65 | 12.8 | 11.02 | 46.39 | 38.89 |
| | *5.13* | *5.65* | *6.77* | *5.87* | *4.47* | *3.39* | *14.19* | *12.63* |
| Change scores | 2.22 | | 3.50 | | 1.78 | | 7.50 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Effect size (Cohen's d)* | *0.23* | | *0.07* | | *0.77* | | *0.37* | |
| Male experimental | 20.05 | 16.67 | 16.65 | 13.43 | 15.64 | 10.37 | 52.34 | 40.47 |
| students (N=150) | *4.09* | *3.68* | *5.17* | *5.64* | *3.63* | *4.59* | *10.74* | *10.93* |
| Change scores | 3.38 | | 3.22 | | 5.27 | | 11.87 | |
| Male control students | 18.01 | 15.59 | 13.95 | 11.21 | 11.82 | 10.89 | 43.78 | 37.69 |
| (N=98) | *5.32* | *5.49* | *6.68* | *5.38* | *4.54* | *3.38* | *14.37* | *12.26* |
| Change scores | 2.42 | | 2.74 | | .93 | | 6.09 | |
| *Effect size (Cohen's d)* | *0.21* | | *0.08* | | *1.08* | | *0.47* | |
| Female experimental | 19.74 | 16.58 | 17.02 | 12.35 | 15.23 | 10.8 | 51.99 | 39.72 |
| students (N=133) | *3.94* | *3.82* | *5.59* | *5.69* | *3.84* | *4.9* | *10.92* | *11.15* |
| Change scores | 3.16 | | 4.67 | | 4.43 | | 12.27 | |
| Female control | 18.96 | 16.98 | 16.59 | 12.19 | 13.99 | 11.17 | 49.54 | 40.33 |
| students (N=81) | *4.87* | *5.79* | *6.63* | *6.40* | *4.1* | *3.42* | *13.38* | *12.99* |
| Change scores | 1.98 | | 4.40 | | 2.82 | | 9.21 | |
| *Effect size (Cohen's d)* | *0.27* | | *0.04* | | *0.41* | | *0.26* | |
| Experimental low | 18.64 | 13.69 | 13.78 | 7.54 | 14.55 | 7.14 | 46.97 | 28.37 |
| performers (N=97) | *3.93* | *3.02* | *5.36* | *2.99* | *4.20* | *2.87* | *11.16* | *4.28* |
| Change scores | 4.95 | | 6.24 | | 7.41 | | 18.6 | |
| Control low | 15.57 | 11.72 | 10.58 | 6.48 | 10.39 | 8.09 | 36.54 | 26.28 |
| performers (N=67) | *4.92* | *3.24* | *5.60* | *2.91* | *3.42* | *2.57* | *11.05* | *4.91* |
| Change scores | 3.85 | | 4.1 | | 2.30 | | 10.26 | |
| *Effect size (Cohen's d)* | *0.25* | | *0.39* | | *1.31* | | *0.75* | |

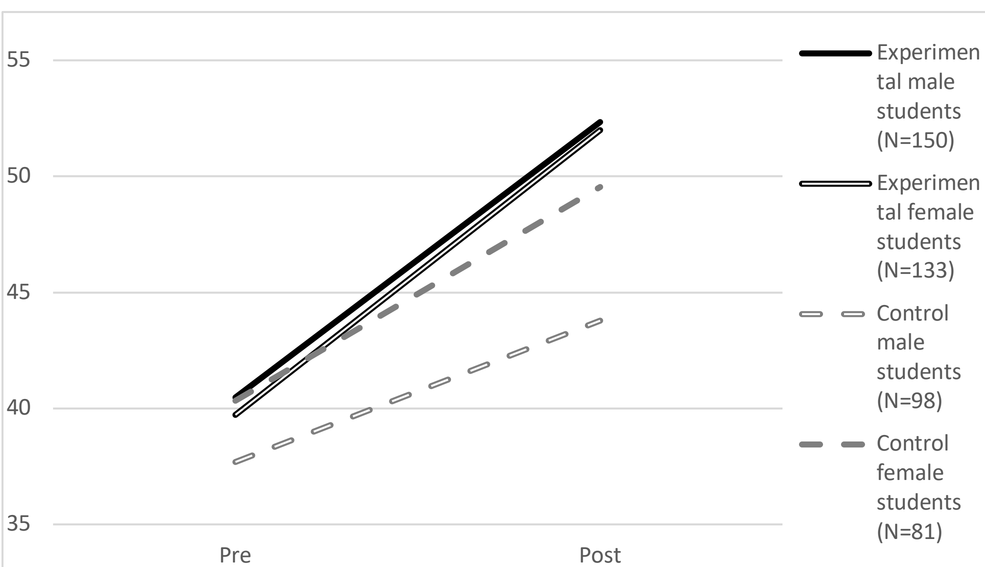
On the scale of Operations and Computation the groups did not differ significantly ($F (1, 452) = .52$, $p= 0.47$, partial $\eta^2 =0.00$). Figure 5 illustrates the change of the GMADE Total score for the students from both groups. These results are also echoed by the positive standardized effect sizes (Cohen's d) suggesting the most important effects of ELM on the students' ability to solve mathematical problems. On this set of skills, the experimental students outperformed their control peers by .77 standard deviation.

Figure 5



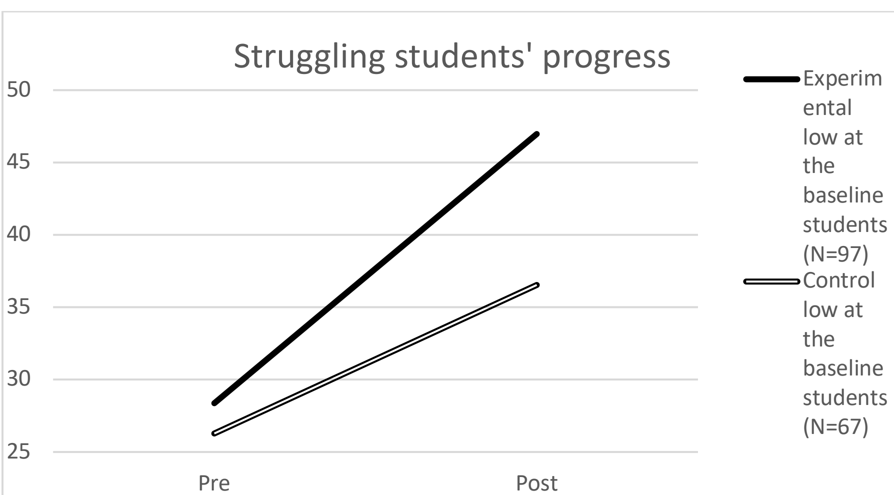

When included to the repeated measures model as another between-subject factor, in addition to the treatment effect, the student gender factored into the difference between experimental and control students' mathematics skills from pre to post-test, F (3, 448) = 3.25, p = .002; partial $\eta^2$ =0.02. The univariate results suggest that on each of the four GMADE scales the experimental students of both genders gained more than their control peers with the statistically significant difference on the scale of Process and Applications (F (1, 450) = 8.37, p= .004, partial $\eta^2$ =0.02). The variation of gain scores between boys and girls from experimental and control groups on the GMADE total test is reflected in Figure 6. The ELM instruction minimized the difference between students of both genders. Not only the control students' gains were significantly smaller than those of the experimental students of both genders, the initial gap between the control male and female students became increasingly larger at the conclusion of the study.

Figure 6



Finally, we explored if the ELM effects may vary as a function of student pretest mathematic ability differences. We performed a repeated measures analysis to compare pre-post change in GMADE scores of the students of low mathematic ability (scored below 34 points at the pre-test) from experimental (N = 97) and control (N = 67) groups – about 30% of students from both groups. The results reveal statistically significant differences between low performing students from experimental and control groups on the set of mathematic measures – $F(3, 160) = 17.34$, $p = .000$, partial $\eta^2=0.25$. Univariate tests indicated differences between the groups on all GMADE subtests that were statistically significant for the subtests of Operations and Computation ($F(1, 162) = 4.68$, $p = .03$; partial $\eta^2 =0.03$), Process and Applications ($F(1, 162) = 52.17$, $p = .000$; partial $\eta^2 =0.24$) and GMADE Total test ($F(1, 162) = 24.61$, $p = .000$; partial $\eta^2 =0.13$). Figure 7 illustrates the improvements of low math performing students in the experimental and control groups. As a result of ELM instruction, the low math ability students made an important progress to catch up with an average math student from the experimental group. The overtime improvements of the control students were less important and the gap separating the low-level math ability students from both conditions grew significantly larger at the post-test. It is important to note that it is for the sub-sample of low-achieving math students, that the ELM effects were consistently the largest on all GMADE measures of mathematic skills. It was on the Process and Applications and Total scales that the low-level math skills experimental students outperformed their control peers by 1.31 and 0.75 of standard deviations.

Figure 7



In summary, all the analyses yielded consistently positive effects of ELM on the four mathematic outcomes where all grade-one students who learned with ELM for over two terms benefited from the software. The effects were important for the students of both genders and particularly significant for those struggling in mathematics. We observed the largest effects on the student's ability of solving word problems in algebra, geometry, measurement, money, numeration, quantity, sequence, statistics and time measured on the GMADE Process and Applications subscale.

***Teachers and ELM instruction***

The data from teacher surveys, observations of mathematics classrooms and checklists of ELM activities, although incomplete, allowed us to outline the context in which the ELM and regular grade-one mathematics instruction unfolded.

The summary of *teacher self-reports* is presented below. A combination of computer technology was available for teaching in each participating school. The school computer lab was supplemented with a set of government-provided (DLP) computer tablets. Since a quarter of the experimental teachers reported their classes having no access to technology, scheduling and coordinating access to computer devices was critical at the onset of the study. Around 70% percent of teachers described these devices as reliable. With the average ratio of 2.5 students per computer, about 35% of teachers stated that there were enough of them for the entire class. Availability of electricity was reported as an issue by 17% of experimental teachers. At the pretest teacher self-reports revealed that the experimental teachers felt more comfortable in their abilities to teach with computers (M=3.45; SD=1.44) than their control colleagues (M=2.88; SD=.99). Meanwhile, the control teachers expressed more confidence in teaching early mathematics (M= 3.6; SD=.55) than the experimental teachers (M= 2.8; SD=1.6). In regard to the mathematics content the teachers taught to grade-one students, teachers' responses were split (Table 2). Teachers unanimously reported counting as the concept they taught and decomposing as the concept they did not teach in grade one. The majority of teachers in both conditions reported teaching comparing, subtracting and adding whereas the self-reports of teaching the concepts of place value, geometry and patterns varied.

Table 2. Teacher self-reports: Teaching grade-one mathematic concepts

| Grade-one math concepts | Experimental teachers(N=9) | Control teachers(N=5) |
|---|---|---|
| Counting | 100% | 100% |
| Comparing | 72.7% | 62.5% |
| Subtracting | 72.7% | 75% |
| Adding | 72.7% | 87.5% |
| Place value | 63.6% | 37.5% |
| Geometry | 45.5% | 75% |
| Patterns | 45.5% | 62.5% |
| Decomposing | 0% | 0% |

Table 3 summarizes overtime change statistics for the 8 experimental teachers. From pre- to post-test, there were shifts in teaching mathematic concepts. With the exception of counting and decomposing that the respondents either taught or did not teach consistently, teaching all other concepts were reported more frequently. There were noticeable improvements in teachers' perceptions of their own confidence in mathematics as well as comfort in teaching mathematics with computers. For instance, their level grew from "somewhat unconfident" to "confident" in math confidence and from "neutral" to "very comfortable" in ability to use computers for instruction.

Table 3. ELM teachers' self-reports: pretest and post-test statistics including means, standard deviations and paired difference

| | Post-test | Pretest | Paired t-test, significance |
|---|---|---|---|
| *Concepts and operations taught:* | | | |
| Counting | 1.00 (.00) | 1.00 (.00) | .00 |
| Comparing | .88 (.35) | .75 (.46) | .55 |
| Subtracting | 1.00 (.00) | .75 (.46) | 1.53 |
| Adding | 1.00 (.00) | .75 (.46) | 1.53 |

| | | | |
|---|---|---|---|
| Place value | 1.00 (.00) | .63 (.52) | 2.05 |
| Geometry | 1.00 (.00) | .63 (.52) | 2.05 |
| Patterns | 1.00 (.00) | .63 (.52) | 2.05 |
| Decomposing | .00 (.00) | .00 (.00) | .00 |
| *Confidence in early mathematics* | 4.38(.74) | 2.5 (1.60) | 3.07** |
| *Comfort to teach with computers* | 4.25(.46) | 3.25(1.67) | 1.60 |

** p< .00

At the conclusion of the study, experimental teacher reported some details about their experiences of teaching mathematics with ELM. Over the weeks of implementation, teachers became more comfortable in teaching mathematics with ELM (M=3.75; SD=.71). They used the ELM activities to teach a range of mathematical concepts including subtraction (100%) and addition (100%). ELM counting and comparing was used by 62.5% and 50% of teachers respectively whereas 37.5% reported having taught place value, geometry, patterns and number displacement with ELM. ELM bar graphs activities were used by 12.5% of teachers. All eight teachers reported having received in-school support on how to integrate ELM in mathematics instruction and their satisfaction with it (M=4.13; SD=.64).

**Discussion**

This study demonstrates the impact of the ELM computer software on the educational achievement of Kenyan grade-one students. The results complement and extend prior research on ELM (Abrami et al., 2017; Lysenko et al., 2016). Establishing foundational skills in mathematics gives students a headstart on the development of essential numeracy skills useful in STEM subjects in school, after graduation, and later in life. The improved young students' mathematical abilities, as the main outcome include both basic and more complex skills such as understanding mathematic language and solving problems. In addition to putting higher levels of cognitive demands, solving word brings variation to students' practice in basic mathematical operations and prepares students to use mathematical skills in everyday situations outside of the classroom. This improvement in problem solving skills is particularly important in the light of the Kenya results on a mathematic survey conducted by People's Action for Learning (PAL Network, 2020) in 13 low- and middle-income countries. The report suggests that only 29.3% of students in grades 2 and 3 from rural Kenya were able to successfully complete the word problem two-digit subtraction task.

The overall effects of ELM were evident for both genders. In the context of developing countries, the research suggests that significant gender discrepancies in mathematics achievement emerge by the beginning of grade 2 (e.g., Pitchford, 2018). The implementation of ELM instruction in grade 1 not only prevented the initial difference between boys' and girls' mathematic skills from growing, but indeed reduced it to the negligible level. Conversely, the gender discrepancy in the control group became significantly larger. This comes as no surprise since by design, ELM offers mathematic content and activities that equally advantage students of both genders. The training and support materials offered to the teachers suggested ways to enhance gender equality in their instruction.

The gains of low-ability grade-one students who learned with ELM is another critical finding. A key objective of any early intervention is to improve the skills of the students who are in greatest need of instruction. Thus, by diminishing the gap between achieving and struggling students, this result implies that exposing grade-one students to ELM may reverse the "Matthew's effect" (Stanovich, 2009), the phenomenon describing how the gap between high- and low-ability students increases as they progress through the years of schooling. Such important improvement in mathematics ability is promising in the context of evidence suggesting that in developing countries it might be the students with stronger skills who gain more from using technology than their peers with weaker baseline skills (e.g., Kim et al., 2016).

The success of ELM can be explained, in part, by what is known about designing instructional multimedia (Mayer, 2008) and by the research summaries and recommendation of the NCTM (2009, 2014) and others (e.g., Cheung & Slavin, 2013; Hardman, 2019) The application of these principles to the ELM design resulted in a reduction of extraneous elements in the software, by keeping the design simple, supporting working memory with learner-paced segments, and using both verbal and visual modes of representation. Moreover, ELM scaffolds the development of skills and sub-skills identified by the research on emerging mathematical proficiency. Further, the use of interactive multimedia in the tool illustrates key mathematical concepts in an engaging and readily understandable fashion for young learners and because students manipulate the software, it ensures a high degree of learner interactivity, rather than passivity, often associated with teacher-centred frontal instruction. Also, the levelled and progressive difficulty of the ELM tasks ensures that students advance through what the research evidence concludes are key mathematical concepts, at a pace appropriate for their prior achievement and understanding. Such features of the ELM software make it an important learning supplement in the context of the national DLP initiative where the curriculum-linked digital content is mainly a static duplication of textbook materials (Gaible et al., 2018).

ELM is not designed to be a substitute for classroom instruction, but instead is meant to support the efforts of classroom teachers when properly integrated into the mathematics curriculum and classroom routines. To this end, the ELM intervention benefited from ongoing professional development as teachers experienced the rewards and challenges of using ELM. The model of in-school continuous professional development is one of the keys to successful implementation, where ELM is an essential part of instruction affecting teacher comfort and student achievement. In short, ELM is not designed as a stand-alone application to replace teachers, but to support them in guiding children to mathematics success through technology integration. It has been widely noted that elementary school teachers often suffer from both a lack of understanding of mathematical concepts and a certain anxiety about teaching mathematics which can be transmitted to students, who may experience their own low mathematical self-concept (e.g., Kaskens et al., 2020). ELM provides the type of scaffolding that teachers need to insure not only that they cover mathematics curriculum but deliver the concepts to students correctly and confidently. Indeed, this intervention involved regular classroom teachers who acted within their regular mathematics classrooms. The ELM teachers had complete autonomy in making decisions about when and how the tool fit the curriculum and syllabus as well as how to integrate ELM into their mathematics instruction.

This study demonstrates that the ELM interactive software impacts positively student learning of key mathematical skills in a developing world context. All students learned whether they were boys or girls, or whether their prior mathematics achievement was low. Classroom integration of ELM, coupled with ongoing professional development and support, suggested important shifts in teaching behavior. Future research of ELM needs to explore the impact of the software on a larger sample of teacher and student participants where data collection is less compromised by attrition. It may also take more government and school administrative effort to improve access to working technology. After all, a longstanding change cannot be maintained through teacher commitment alone; hence, the importance assigned to systematic support including educational policies, school environments, and widespread professional development. At the same time, the instructional design of ELM may need refinement to increase the flexibility with which both teachers and students use the software; for instance, making it easier to navigate activities and addressing difficulty levels. As we work from a research project to wide-scale implementation we hope that this encouraging experimental evidence gets translated to a greater number of schools, teachers, and students. For teachers, this may mean working at both the pre-service and in-service levels and using interactive multimedia to support professional development at a distance that is scalable and cost efficient.

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**Declaration of Interest**

We have no known conflict of interest to disclose.

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Appendix C.

# Self-Regulated Learning in Kenyan Classrooms: A Test of a Process ePortfolio[1]

Lysenko, L., Wade, A., Abrami, P.C., Iminza, R., & Kiforo, E.

## Abstract

This study explores the feasibility of implementing an electronic process portfolio (ePEARL) in a Kenyan school context and the impact of the tool on student learning outcomes. Four teachers and their students from two public secondary schools in Mombasa, Kenya participated in this research. The analyses of data of 137 students showed benefits for those who used ePEARL to complete their class assignments. Their exam scores and self-regulation skills significantly improved over time when compared to their peers who hardly used the tool. More frequent and comprehensive use of the ePEARL features translated into higher exam results. Summaries of students' ePEARL work have been included to illustrate the use of electronic portfolios.

Keywords: electronic portfolios; self-regulated learning; secondary education; Sub-Saharan Africa; Kenya; technology uses for education

## Introduction to the Problem

Recent international reports on the performance of secondary school students in Western, industrialized countries (e.g., OECD, 2016) have found that a significant number of students in every surveyed country lacked fundamental literacy, numeracy, and scientific reasoning skills. Findings from these reports imply that students may lack the sophisticated strategies for learning how to learn, strategies which may be increasingly important to succeed in the knowledge age. In addition to having substantial personal consequences, such gaps in essential competencies and skills also come at important costs both for society and the economy (Conference Board of Canada, 2016). Meanwhile, contemporary trends in education research indicate that when students become more active and engaged participants in their learning, thereby enhancing the extent to which learning is personalized, it is then that meaningful improvements in educational success will occur (e.g., Abrami et al., 2013).

Countries of the developing world also increasingly express the need for their educational systems to enhance the capacity to develop active, autonomous individuals capable of advancing their national economies in the 21st century. For example, the Kenyan Ministry of Education's Vision 2030 introduced a student-centered, competency-based curriculum designed to foster "independent, confident, co-operative, and inspired learners" (KICD, 2017). Despite the growing interest, locally-designed pedagogical interventions targeting the development of such self-directed individuals are sparse (Stephen et al., 2018). To bridge this gap, we designed an intervention based on the Zimmerman's model of self-regulation (2000) using a digital portfolio tool (e.g., Meyer et al., 2010) that had been adapted to fit the landscape of Kenyan school reform

[1] This study was funded by the Canadian Social Sciences and Humanities Research Council

and implemented it in Kenyan secondary classrooms. A brief summary of the research foundations to this study follows.

### *Self-regulated Learning*

Defined as "self-generated thoughts, feelings and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman 2000, p.14), self-regulated learning (SRL) addresses both meta-cognitive and motivational aspects of learning that unfold through the cyclical phases of forethought, performance, and self-reflection. In the three phases, students activate and sustain cognitions, behaviours, and affects that systematically orient them toward the attainment of learning goals (Zimmerman & Schunk, 2011). In the forethought phase, goal setting and strategic planning is affected by learners' self-motivation beliefs in the form of self-efficacy, outcome expectations, intrinsic interest or value, and goal orientation. In the performance phase, learners participate in the processes of self-instruction, attention focusing, self-recording and self-experimentation and use task strategies, to yield vital information about how well they are progressing towards a goal. Finally, at the self-reflection phase, the processes of self-judgment and self-reaction are triggered as learners evaluate themselves relative to others, attribute their successes and failures, experience self-satisfaction, and activate adaptive-defensive responses to the achieved outcome. Constant monitoring and subsequent correction of one's own performance based on feedback about recent efforts enable the cyclical nature of the self-regulation process. It is important to note, that recently individual cognitive-constructive models of self-regulation have been extended (Hadwin et al., 2018) to include social forms of regulation such as co-regulation and shared regulation to reflect interactive learning contexts from which shared knowledge construction and collaboration emerge.

Existing empirical evidence suggests that self-regulation skills provide the foundation for lifelong learning critical to drive the development of the contemporary knowledge society (e.g., Sloep et al., 2011). In this regard, benefits that self-regulation brings to students' achievement, motivation to learn, and development of learning strategies, clearly argue in favour of designing self-regulation instruction. In two related meta-analyses, Dignath and Buettner (2008) and Dignath et al., (2008) found important effects of self-regulation on academic performance, learning strategies used, and the motivation of primary- and secondary-school students. The average effect size of SRL instructional programs on achievement outcomes was + 0.61 for primary schools and + 0.51 for secondary schools. For cognitive and meta-cognitive strategy use, the average effect size for primary students was + 0.72 and + 0.88 for secondary students. For motivation outcomes, the average effect size for primary schools was + 0.75 and + 0.17 for secondary schools. Both in primary and secondary instruction, the highest effect sizes were for mathematics. The greater effects were achieved when the instruction was delivered by researchers rather than regular classroom teachers.

### *SRL and Digital Portfolio*

Grown from within the constructivist paradigm, the use of a portfolio is a meaningful way to document one's learning path and progress (e.g., Jonassen, 1991). Abrami and Barrett (2005) distinguished between process, showcase and assessment portfolios. All three types can be used to display selected work, enable learners to develop their metacognitive skills, reflect on how they meet the assessment criteria and edit their work based on the feedback. Yet, only the process portfolio offers embedded structures and strategies to support learning. As such, it is a personal learning management tool meant to encourage and support individual growth and improvement and to yield a purposeful collection of work in one or more discipline areas that demonstrates a learner's efforts, progress and achievement (Barrett, 2007).

With the increasing accessibility of computer technologies, digital or e-portfolios added value to their traditional paper-based counterparts by keeping traces of learning, connecting ideas, relating information and feeding reflection processes, among other things. The evolution of web technologies was especially beneficial for the process portfolio. Primarily, the remote access of an e-portfolio encourages anytime and anywhere learning. Furthermore, a process e-portfolio engages a learner in knowledge construction by scaffolding processes of self-regulation including goal-setting, self-monitoring, and reflection, the key skills to drive lifelong learning. Finally, an e-portfolio enables input from peers and more knowledgeable others and aggregates these inputs into overviews of personal growth.

Although digital portfolios as knowledge tools have been used in instruction for over two decades, the evidence of their impact on the development of skills of self-regulated learning and student achievement remains quite sparse. For instance, a systematic review of e-portfolio interventions included only 17 experimental studies (Becker et al., 2016). Fourteen came from the context of tertiary education, whereas one and another two were completed in the secondary and primary education respectively. Relying on vote-counting, the review found positive effects of using process-oriented e-portfolios on students' self-regulation skills. In their review of 26 studies of e-portfolio interventions, Blaustein and Lou (2014) report important effects of e-portfolio on students' writing skills. According to Becker et al (2016) digital portfolios are most effective, when their use becomes part the instructional routine, when students are trained and offered scaffolds in the use of the portfolio, and, finally, when the portfolio software is designed to explicitly support major self-regulation facets.

### *Kenyan Context*

Authorities of some developing nations express concerns over the capacity of their educational systems to promote quality learning. This phenomenon also known as the learning crisis, reflects the situation when important investments in extending access to education do not fully translate to the development of functional skills and knowledge needed for the workforce to advance developing national economies (Global Monitoring Report, 2016). To address the challenge of realizing education's promise to the nation (Republic of Kenya, 2013) initially expressed in Kenya Vision 2030 and the Constitution of Kenya, the Kenyan Ministry of Education has undertaken a massive reform of curriculum starting at the primary school level. The new competency-based curriculum aims at developing citizens capable of succeeding in the 21st century in line with the global move towards education that encourages human capital development. The shift of teaching paradigm towards student-centeredness is at the heart of the curriculum that is designed to foster "independent, confident, co-operative, and inspired learners" (KICD, 2017). Competencies and skills cut across the disciplines and enable students to be self-reliant, creative and innovative. The curriculum also targets the development of *lifelong skills of learning to learn* that will allow youth to work independently in order to satisfy their learning needs and upgrade their skills; in other words, to empower youth on their path to success. Recognizing that ICT offers potentially significant gains for educating future workforce (e.g., digital skills), the government has made solid commitments to educational technology by starting the Digital Literacy Programme (DLP). The DLP initiative has successfully deployed technology (tablets, content servers and projectors) in Kenyan primary schools. Yet, the use of technology requires more than distributing computers to students. Teachers and students should have the skills to adequately use new curriculum-linked content so that technology helps realize the intended shifts in teaching and learning. Although the population of secondary students has not yet been targeted by this new curriculum, it will be soon and, therefore, there is a growing need for effective instructional programs to develop self-directed Kenyan learners (e.g., Stephen et al., 2018).

Given the above, the present study tested the feasibility and impact of implementing a student-centered ePortfolio (ePEARL) designed to support the phases of self-regulation in Kenyan secondary classrooms. Previous ePEARL research conducted in Canadian classrooms (Abrami et al., 2013; Meyer et al., 2010) suggested that implementation of ePEARL, especially with a competency-based curricular context, would offer benefits for Kenyan students and their teachers. For instance, after having used ePEARL in English Language Arts classes, the Canadian students improved in both writing skills (word choice, sentence structure, writing conventions) and self-regulation strategies (setting goals, selecting strategies for task completion and using feedback and self-observations to improve on work). Focusing on student-centered learning, ePEARL also challenged the teachers into accepting classroom practices that go above and beyond teacher-centric forms of classroom instruction.

Together with exploring the practicality of implementing ePortfolios in the Kenyan secondary school context, this research studied whether and how the use of ePEARL can help students' learning outcomes. Specifically, the following two research questions were addressed:

- *Does using ePEARL frequently have effects on the change of secondary students' perceptions of self-regulation) and exam scores from pre- to post-test?*
- *Does use of ePEARL predict the variation in students' learning outcomes as measured by their exam scores? Do students' self-regulatory beliefs contribute to this variation?*

## Method

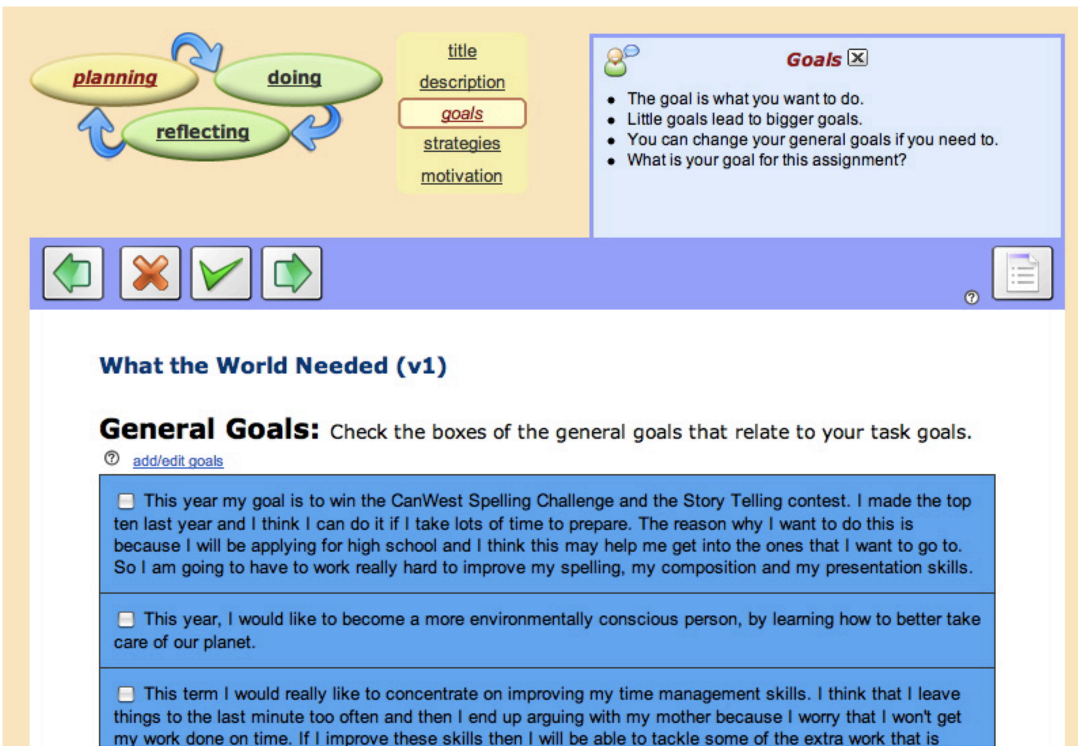
The following section summarizes how this research was completed and contains a brief description of the ePEARL process portfolio, study design, instruments and measures and analyses used to generate the results. A short overview of the ePEARL training and implementation context has also been included.

### *ePEARL*

Electronic Portfolio Encouraging Active and Reflective Learning (ePEARL) is a student-centered web-based process and showcase portfolio designed to foster and enhance student self-regulation along the three cyclical phases of forethought, performance and self-reflection (Zimmerman & Schunk, 2011). Three levels of ePEARL are geared to students in early elementary (Level 1), late elementary (Level 2) and high schools (Level 3). Level 1 is designed to introduce young students to the basic concepts of SRL. Levels 2 and 3 enable students to personalize their portfolio environment and develop their SRL skills further by addressing the following iterative phases:

(1) Planning: Setting general learning goals for a school term or year (see Figure 10) along with specific task goals, defining strategies that will be used to reach these goals, addressing motivation to complete a given task,
(2) Doing: Creating new or revising existing work. ePEARL offers a text editor and an audio recorder for the creation of work. Students may also attach videos, slideshows, podcasts, scanned images or photographs of paper-based work as representations of their learning. They can edit work, save multiple versions, and send work to a presentation folder to store it through their school years and export it when needed.
(3) Reflecting: Reflecting on the original goals and strategies and on the level of satisfaction of their work and sharing it to obtain feedback from teachers, peers, and parents.

Figure 1. ePEARL general goals




The ePEARL environment offers multimedia support materials for teachers and students to develop a better understanding of the what, why and how of the self-regulation processes supported by the tool. The research team created a series of "jump start" lessons and a virtual tutorial to help support teachers' implementation of the SRL features within ePEARL. Additionally, just-in-time supports are embedded within the software through help buttons that both students and teachers could access. They provide definitions of SRL terminology, sample responses, and hyperlinks to the virtual tutorial. The teacher materials demonstrate and model student-centered skills and instruction, provide explanations of those skills, and elaborate the skills through additional support resources.

The ePEARL software is available at no cost to educators and may be explored at http://www.concordia.ca/research/learning-performance/tools/learning-toolkit/epearl.html

***Study Design***

We designed this study in partnership with I Choose Life Kenya and conducted it in the secondary schools involved in the Jielimishe Girls Education Challenge initiative led by the organization. The study unfolded over two years, 2018 and 2019, as a nonequivalent two-group pretest posttest where two groups under observation, ePEARL-users versus non-users, emerged from the same classes. Measurements were taken before ePEARL instruction and then after it. The student exam scores became available after the students completed their school exams in the end of terms 1 and 3 of each school year. Since in 2018 the implementation unfolded in term 2, these served as pre- and posttest measures of achievement. In 2019, the implementation started in terms 1 and 2, therefore only term 3 exam scores were used. The 2018 student data on self-regulation were collected before the intervention in May and then again in October after the software was used for terms 2 and 3 of the school year whereas the 2019 surveys were collected once at the conclusion of the ePEARL intervention.

### *Study Sample*

The participation of secondary students and their teachers was secured after the partner staff approached the schools' headteachers and teachers for their willingness to be part of the project. Students were in secondary one in 2018 and secondary two in 2019. Their age varied between 14 and 19 with an average of 16.7 years old. Gender was split equally across the sample. There were important fluctuations in the number of participants throughout the study from year to year. By the end of 2018, of 140 student-participants from four classes the complete data were available for 79 students. In 2019, 172 students in four classes used ePEARL as part of their instruction whereas 124 students who completed all the measures. Overall, 137 students completed some measures in both years and their data were used for analyses. Multiple reasons accounted for the fluctuations. For instance, in the first year of the pilot, one school decided to reduce the class sizes. In both years, some students were sent home and not allowed to complete their term exams for failing to pay school fees or other school-related expenses. Important turnover of students during the school year also contributed to the reductions in the sample.

The teacher-participants had a university undergraduate degree. Their teaching experience ranged from 1 to 19 years, with the average of 11 years. The teachers specialized in more than one subject area including English and Literature, Kiswahili, Physics, Biology, Chemistry, Geography, Business Studies and History.

### *Instrumentation*

To measure a possible shift in students' perceptions of their use of self-regulated learning strategies between the pre- and posttests, the *Student Learning Strategies Questionnaire*, SLSQ version 3 (CSLP, 2014) was used. As an update of the original SLSQ (Abrami et al, 2008), version 3 reflects more comprehensively the dimensions of self-regulated learning. Rated on a four-point frequency scale, 37 items inquire of students (SLSQ) about their ability to set learning goals, monitor and correct their performance, and reflect on the learning outcomes. Specifically, the items reflect six underlying self-regulation constructs, such as (1) Planning (task analysis and self-motivation beliefs), (2) Doing (self-control and self-observations), (3) Reflecting (self-judgement and self-reaction), (4) Predicting one's success (self-efficacy), (5) Reasons to succeed (self-determination) and (6) Feelings about the task (task value).

The *ePEARL Implementation Assessment Protocol* (CSLP, 2010) was used to analyze student portfolios and to code the extent of ePEARL use. The following codes were assigned: "1" for low use (e.g., student logged into ePEARL, left some traces (e.g. personalized the front page) but did not work on an artifact), whereas "2" was assigned when one artifact was created with a task goal, and some reflection was added; and "3" was assigned to portfolios where multiple versions of an artifact or artifacts were created, including task goals, strategies and some form of reflection. These designations were made by considering the following items: number and/or versions of artifacts stored in the student portfolios, date range of use, and nature of ePEARL use (for storage only or use of SRL features).

*Kenyan exam scores* were a measure of learning growth in the subject area where ePEARL was part of instruction. Term 1 exam scores served to set a baseline and term 3 exam scores served as the post-test. In each exam (in each subject), a maximum score of 100 points can be achieved. The term exams are administered and scored by teachers in secondary schools. We created a composite variable which was a merger of scores students obtained in the subject where ePEARL was used as part of classroom instruction. For instance, in 2019 this variable included students' scores in English, Business studies, Biology and Physics.

### *ePEARL Intervention*

A three-day ePEARL training of the participating teachers unfolded early in the school year. The session focussed on the components of self-regulated learning (SRL), the importance of SRL development with schoolchildren, and ePEARL use to support the development of SRL. Since the teachers were expected to use ePEARL with lower secondary students, ePEARL level 2 was the focus of training. One day of training was allotted to hands on activities on how to integrate the software in classroom teaching where teachers worked in pairs to prepare a lesson plan they could implement when they were back to their classrooms. In addition, the teachers were given access to a range of pedagogical material, including lesson plans, activities, job aids, and virtual tutorials demonstrating and explaining the self-regulation features of ePEARL and helping integrate them into the instruction. Since authentic implementation of ePEARL by classroom teachers was in the focus of the project, the decision to use these support materials was left at the teachers' discretion. The ICL trainers were expected to support their teachers by modeling instruction, team-teaching and holding thematic ePEARL-related workshops. Each teacher was provided an ePEARL account that allowed them to start their own portfolio in order to explore and understand the portfolio features and how to integrate them in their instruction. Yearly, in term 1, one half-day training workshop was held at a partner's premises. In term 2, school visits were rendered to the two implementing schools to support teachers and students in using the software.

The implementation of ePEARL varied from year to year and by class. The four classes used ePEARL for different subjects: English Language and Literature, Business Studies, Biology, and Physics. In year one the students used the eportfolio around four weeks of term 3. In year two, two of the four classes did their ePEARL work for about 6 weeks in terms 1 and 2 and the other two classes worked on their portfolios only for three weeks in term 1. The problems with the school computer lab that was not functional during terms 2 and 3 of 2019 accounted for brief implementation. A handful of students from a participating class used ePEARL level 1 the beginning level of process portfolio designed for early elementary.

### *Data Analyses*

All student scores were entered manually using SPSS for Mac OS X (version 24) and verified for accuracy. Students' data were analyzed by year and those cases with missing data were excluded from the analyses. Six composite scores were created on the SLSQ data to reflect the underlying concepts of self-regulation. Data screening procedures suggested no marked departure from data normality. In addition to the descriptive analysis, Repeated Measures (RM) MANOVA and Hierarchical Multiple Linear Regression (MLR) analyses were run. Specifically, to analyze the 2018 pre- and posttest data, two RM MANOVA one-way models were used including testing time (pretest-posttest) as the within-subject variable and treatment (frequent ePEARL versus little or no-ePEARL) as the between-subject factors. The dependent variables were the set of six SLSQ aggregated scores and the exam scores. The two-block MLR model was run on the 2018 and 2019 data. Students' ePEARL use and their perceptions of self-regulation were the predictors whereas the criterion variable was the exam scores that merged the results obtained in the subject where ePEARL was used for classroom instruction. On 2019 posttest data the analysis of mean group differences was performed.

### Results

The analyses yielded some important results which we present below to address each of the research questions that guided this two-year pilot study.

### *Student ePEARL Use, Exams Scores and Self-regulation*

First, we addressed the first research question: *Does using ePEARL change secondary students' perceptions of self-regulation and exam scores from pre- to post-test when compared to students who barely used an ePortfolio for classroom learning?*

A summary of scores available in both years including means and standard deviations on each of aggregated SLSQ subscales and exam scores is presented in Table 1. The data suggest that after learning with ePEARL, students ($N_{2018}=28$; $N_{2019}=73$) reported more frequent reliance on the majority of self-regulation strategies and also scored higher on their end-of-the-year exams.

Table 1. SLSQ subscales and exam scores: means and standard deviations

| *Self-regulation & Exam scores* | *2018* | | | | *2019 (post-test)* | |
|---|---|---|---|---|---|---|
| | *Frequent use of ePEARL (N=28)* | | *Little or no use of ePEARL (N=51)* | | *Frequent use of ePEARL (N=73)* | *Little or no use of ePEARL (N=51)* |
| | *Pre* | *Post* | *Pre* | *Post* | | |
| SLSQ: Planning a task | 29.04*(1.86)* | 31.4*(3.73)* | 29.76*(2.95)* | 31.76*(2.31)* | 30.14(3.69) | 29.81(3.32) |
| SLSQ: Doing a task | 20.7*(1.97)* | 23.19*(2.16)* | 21.03*(2.19)* | 20.92*(2.12)* | 19.09(3.69) | 18.5(3.17) |

| | | | | | | |
|---|---|---|---|---|---|---|
| SLSQ: Reflecting | 13.92*(1.56)* | 14.16*(1.76)* | 12.81*(2.27)* | 13.05*(2.36)* | 15.14(2.27) | 14.55(2.30) |
| SLSQ: Predicting one's success in the task | 15.76*(1.78)* | 15.75*(2.75)* | 15.52*(2.12)* | 15.82*(2.43)* | 16.45(2.94) | 15.41 (2.84) |
| SLSQ: Reasons to succeed | 10.14*(1.28)* | 10.89*(1.22)* | 10.66*(1.54)* | 10.84*(1.21)* | 10.54(1.41) | 10.70(1.87) |
| SLSQ: Feeling about the task | 21.59*(2.6)* | 21.83*(3.01)* | 21*(2.58)* | 20.74*(3.21)* | 22.36(2.19) | 22.74(2.57) |
| *SLSQ: Total score* | 112.58(7.23) | 116.98(7.70) | 110.78*(8.3)* | 114.27*(7.76)* | 113.73(11.34) | 111.72(10.13) |
| *Kenya exams* | 41.36*(14.84)* | 52.78*(19.29)* | 40.29 *(16.3)* | 42.9*(17.76)* | 45.26(18.59) | 40.27(21.65) |

Two two-way Repeated Measures models were run on the 2018 data including testing times as the within-subject variable and ePEARL use as the between-subject factor. The statistically significant Pillai's trace criterion on a combined score of self-regulation perceptions overtime was $F(6, 78)= 2.48$, $p= .03$ and the partial eta squared of 0.16 indicated important difference between the students who used ePEARL frequently and the students who hardly used ePEARL to complete their tasks. The 2018 exam scores analysis also revealed the disparity between the students who frequently used e-portfolio (N=28) and those whose use of the portfolio was scarce or non-existant (N=51). On the combined exam scores, the over-time difference between the students in the two conditions was $F(1, 77)=4.33$, $p= .041$; partial $\eta^2 = .05$ favoring gains of the students who used ePEARL to complete their class assignments.

By and large, the 2019 posttest results from 124 students echo the pattern of group differences captured in 2018. The average post-test scores of the students who learnt with ePEARL are higher than those who hardly used ePEARL albeit statistically non-significant. For the exam scores and the self-regulation total score, the group difference coefficients were $F(1, 123)=1.03$, $p=.29$ and $F(1, 123)=1.89$, $p=.17$ respectively.

Next, we addressed the second question: *Can the extent of ePEARL use predict the variation in students' learning outcomes as measured by their exam scores? Do students' self-regulatory beliefs contribute to this variation?*

To answer this question, we built a two-step regression model where the end-of-year exam scores were the criterion variable whereas *ePEARL use* was the predictor variable. The latter was the ordinal variable created for the students who completed some work in their portfolio (e.g., traces exist). As described earlier in this manuscript, for this end, we assessed students' ePEARL work for the use of self-regulation features on a scale from 1 "low use" to 3 "high use". The six aggregated self-regulation scores were also added as the predictor variables into the model.

It is important to note that the proportion of high and low ePEARL users changed over time; in 2019 the number of high and moderate users nearly tripled in comparison to 2018 whereas the numbers of low-end users declined two-fold. Specifically, in 2018 and 2019, the portfolios of 13 and 38 students were assigned the highest value of "3" respectively. As part of their class assignment, these students created multiple versions of one or more artifacts. They identified task goals, selected task strategies and also added some form of reflection. The value of "2" was given to the work of 12 and 35 students who created one artifact with the task goal and added some reflection to it. The lowest value of use "1" was assigned to 25 and 13 students' portfolios who logged into ePEARL, left some traces (for instance, personalized their home page) but did not attempt to complete any task using the ePEARL features.

The results of the multiple regression completed on the 2018 and 2019 data are presented in Table 2. In both years the extent of ePEARL use was a significant predictor that alone accounted for the variation in the end-of-year exam scores explaining 15% and 9% of variance respectively.

Table 2. Summaries of the hierarchical regression models and predictor standardized coefficients

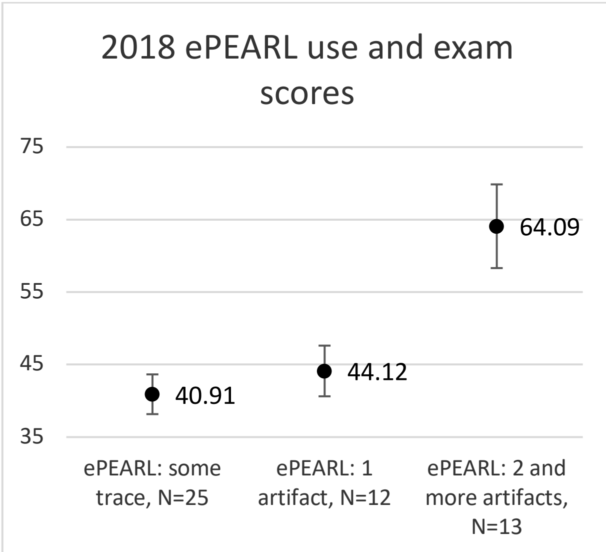
| *2018 (N=50)* | | | | *2019 (N=86)* | | | |
|---|---|---|---|---|---|---|---|
| Model 1 (1, 48) | $R^2 = .15$ | $R^2_{change} = .15$ | $F_{change} = 8.51^{**}$ | Model 1 (1, 84) | $R^2 = .09$ | $R^2_{change} = .09$ | $F_{change} = 8.34^{**}$ |
| $ß_{ePEARL\ use} = .39^{**}$ | | | | $ß_{ePEARL\ use} = .30^{**}$ | | | |
| Model 2 (6, 42) | $R^2 = .44$ | $R^2_{change} = .29$ | $F_{change} = 3.67^{**}$ | Model 2 (6,78) | $R^2 = .15$ | $R^2_{change} = .06$ | $F_{change} = .87$ |
| $ß_{ePEARL\ use} = .29^{*}$ | | | | $ß_{ePEARL\ use} = .36^{**}$ | | | |
| $ß_{planning} = .08$ | | | | $ß_{planning} = .21$ | | | |
| $ß_{doing} = .48^{**}$ | | | | $ß_{doing} = .05$ | | | |
| $ß_{reflecting} = -.02$ | | | | $ß_{reflecting} = -.03$ | | | |
| $ß_{predict\ success} = -.16$ | | | | $ß_{predict\ success} = -.17$ | | | |
| $ß_{reasons\ to\ succeed} = .14$ | | | | $ß_{reasons\ to\ succeed} = .14$ | | | |
| $ß_{feel\ about\ task} = -.13$ | | | | $ß_{feel\ about\ task} = -.002$ | | | |

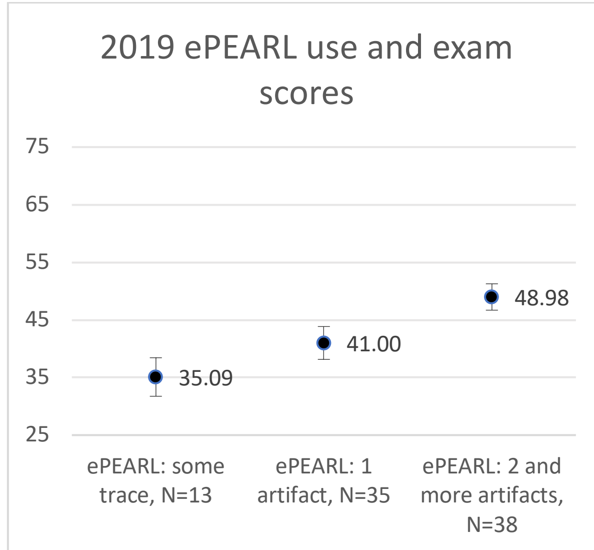
* < 0.05; ** < 0.01

When added to the regression model, a combination of the six self-regulation factors was a statistically significant predictor of the student exam scores in 2018 only. The pattern of results implies that together with the extent of ePEARL use, students' perceptions of strategies they apply when performing the task were the strongest predictors of students' achievement. Specifically, one-standard-deviation increase in the use of the portfolio and performance-monitoring strategies will lead to .29 and .48 standard deviation improvement in student end-of-year exam scores respectively.

To demonstrate visually that the extent of learning with ePEARL consistently and significantly predicts students' performance, we added a graph where students' average exam scores in both years varied as a function of e-portfolio use. Graph 1 shows that the highest exam scores were obtained by the students who created more than one artifact and made fuller use of the ePEARL features.

Graph. 1. Average exam scores by the extent of ePEARL use




***Students' ePEARL Artifacts***

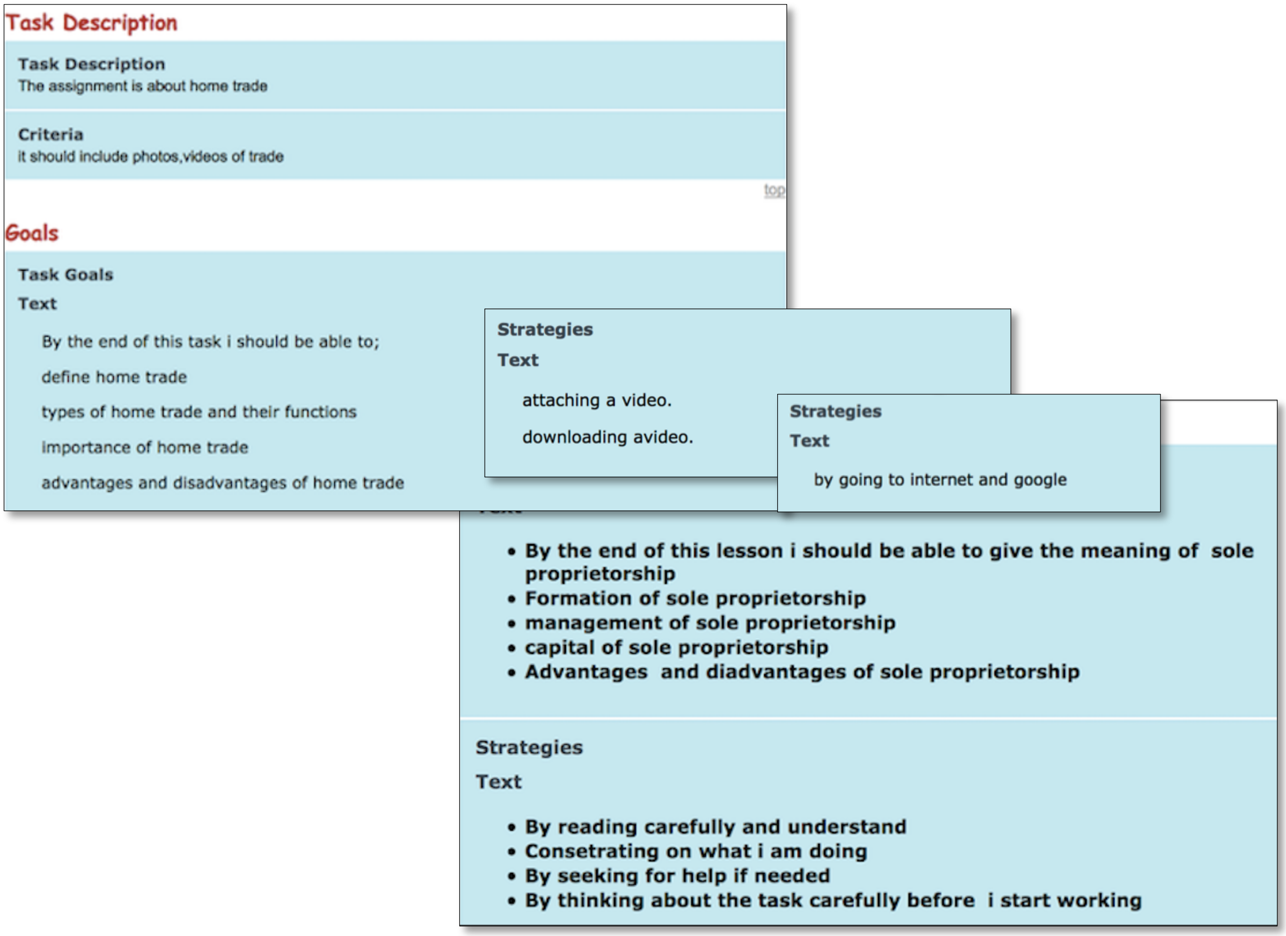
In 2018, 50 grade-one students completed some work in their ePortfolio; of those 33 students continued using ePEARL in the following year, whereas 53 grade-two students started their ePEARL portfolio in 2019. Among students who worked in in both years, the majority created two and more artifacts. Some of these artifacts were versions of the same task. At a minimum, students formulated one task goal and identified a strategy they were to rely upon in order to compete the task. This section offers a summary of students' uses of ePEARL to complete their assignments in Business Studies, English, Physics, and Biology and is organized along the three phases of self-regulation-- forethought, performance and reflection.

*Forethought*

In both years, students' planning activity was limited to setting task goals. It is important to note that students predominantly used ePEARL to complete their class assignments that were driven by simple questions requiring students to reproduce their existing knowledge (i.e., provide definitions, put together a list of items). The nature of the assignments is reflected in the task goals the students set in their ePEARL. "Define the meaning of…", "identify the importance of…", "identify forms/types of…", "list advantages/disadvantages of ..." are the examples of verbs used by students for setting task goals.

The portfolio analysis shows that some students identified the strategies they intended to use to achieve the task goals. A few examples of task goals and selected strategies and criteria from both years are shown in Figure 2 below.

Figure 2. Task criteria, goals and strategies

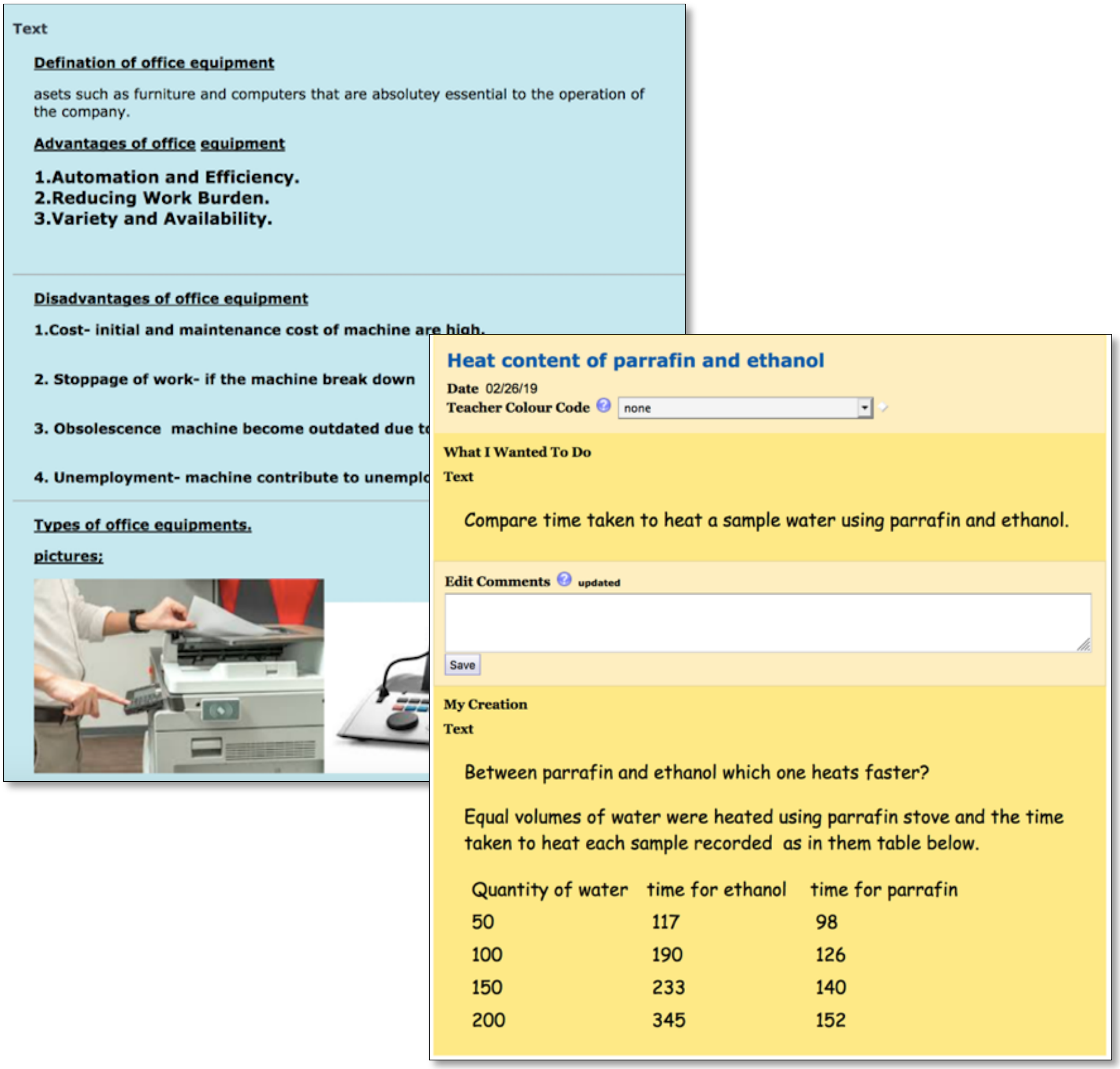



It is important to note that the type of strategies changed over the years. If downloading video and attaching photos was the dominant strategy for the task completion in the first year of the pilot, the following year strategies became more diverse and comprehensive. It appeared that many if not all choices at the planning phase were heavily guided by the teacher. For instance, the goals might have been teacher formulated, since their wording was similar the portfolios of different students from the same class. The selection of strategies and how these were worded directly reflected the task criteria set by the teacher.

*Performance*

It was natural that in order to comply with the teacher-set requirements, most students incorporated images and also attached audio and/or video files to their artifact(s). Every student artifact contained some text using the text-editor. In their writing, students relied on paraphrasing and summarizing but they seldom referenced the primary sources. Figure 3 offers examples of the students' creations using ePEARL levels 1 and 2.

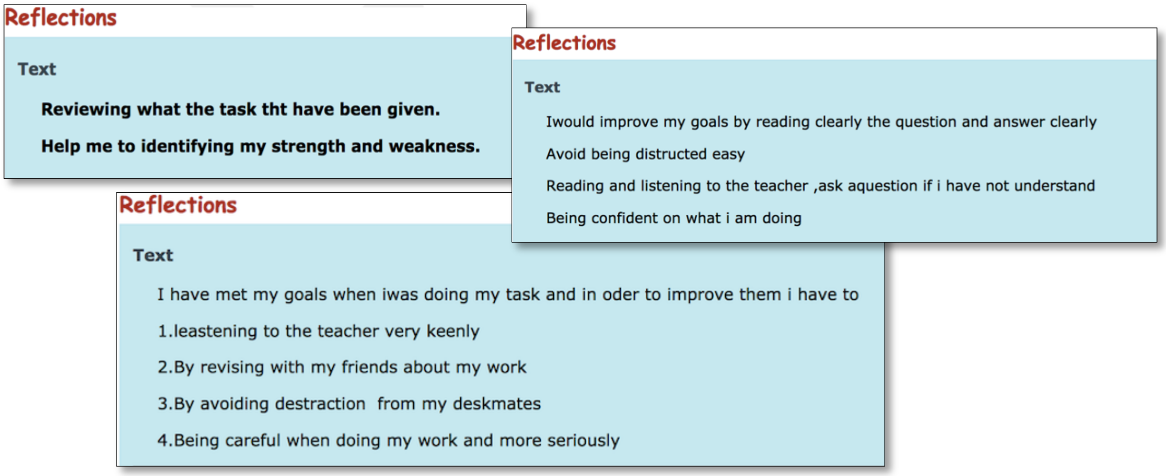
Figure 3. PEARL creations




*Reflection*

The students left their comments in the reflection section of ePEARL. In both years the reflection statements echoed the task strategies the students selected at the planning phase of their ePEARL work. Therefore, the deliberations were quite generic offering some thought on the facets of their work that could be improved and how these improvements could be achieved. A few examples of students' reflective comments can be seen in Figure 5 below.

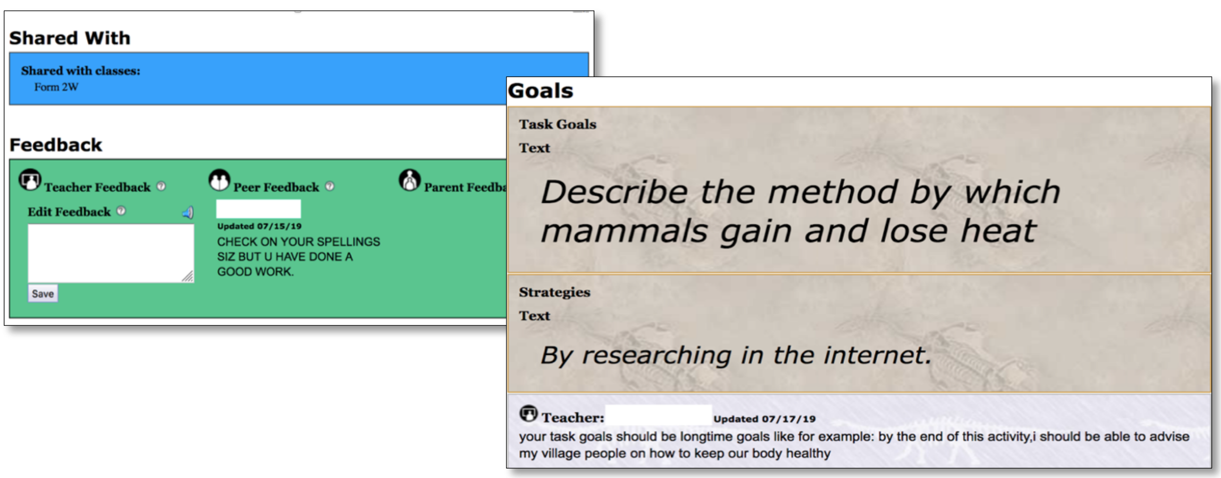
Figure 4. ePEARL reflection




*Other ePEARL features*

All students shared their work either with the whole class or with a few selected peers. A few students moved their work to the presentation folder providing "[they had] done it well" as a justification. Despite sharing, few students commented on each other's work and when they did, the feedback was rather basic. Teacher feedback on the use of the ePEARL features was only restricted to goal setting, even though there are many opportunities for the provision of feedback.

Figure 6. ePEARL feedback




## Discussion

The intention of this project was to test the feasibility and potential of using ePEARL for instruction in the context of secondary public schools in Mombasa, Kenya. The results we obtained in this small-scale two-year study imply benefits for those students who used ePEARL to complete their class assignments. After learning with ePEARL, the students' achievement and perceptions of their self-regulation skills improved, when compared to their peers who hardly used the electronic portfolio tool or did not use it at all. More frequent and comprehensive use of ePEARL features to complete a class assignment translated into higher student achievement in the respective subject area, as measured by the end-of-year exam scores. These encouraging findings from the software use in Kenyan secondary classrooms also complement the positive evidence of ePEARL effects generated in Canadian late elementary contexts (e.g., Abrami et al., 2013).

Viewing these results from a socio-cultural perspective may add value for the prospects of ePEARL utility in Kenyan secondary classrooms. The research on cultural heterogeneity suggests that there exist cultural variations in how strongly people feel about their self and how these perceptions may affect their success in school and later life. For instance, in their study of cross-cultural differences Scholz et al. (2002) emphasized that collectivistic cultures tend to report lower self-efficacy beliefs because of the priorities given to group abilities rather than individual abilities. Mpofu (1994) explained that in collectivistic cultures such as those in Africa, Asia, the Middle East “private thoughts and feelings about the self and others are not considered pertinent to an individual's view of the self” (p. 342). Therefore, it might be that instruction developing individual self-concept and academic self-efficacy, might provide the critical leverage to boost academic performance and enable students’ self-development in collectivistic contexts where prominence is given to family and group characteristics (e.g., Ansong et al., 2019; Ongowo & Hungi, 2014). From this standpoint, the results suggest that the use of ePEARL might be an intervention that could help individual student aspire to succeed both within school and beyond, and advance along the lines of the national objectives set by Kenya Vision 2030. The fact that the software also draws on the broadened understanding of self-regulation including socially-shared self-regulation and co-regulation (e.g., Winne et al., 2010) may reinforce the contextual relevance of ePEARL.

The findings of this study are also promising because they were obtained in the context of authentic instruction where the implementation of ePEARL was driven and directed by the classroom teachers themselves. While systematic research found that self-regulation programs were most beneficial if the strategies were taught by researchers rather than by classroom teachers (Dignath et al., 2008), these results imply that ePEARL can be effective in the hands of Kenyan regular classroom teachers. They were able to use the eportfolio to support their students’ learning in the real-world context of Kenyan secondary school where classes are large, turnover is high, support is low, technology is unstable and access to it is limited, and many teachers and students lack technology proficiency. Despite these challenges, the teachers persevered as they valued the ePEARL pedagogy and anticipated it to be successful, as compared to seeing the challenges of implementing ePEARL quite low. Indeed, according to the value-expectancy model (e.g., Wozney et al., 2006), teachers’ perceptions of the tool and its associated outcomes as worthwhile for themselves (professional development opportunity), and their students (improved achievement and attitudes) and teachers’ expectations of success between the use of ePEARL and the desired effects, might have overweighed the perceived physical and psychological costs of implementation such as preparation time, effort, etc. However, it also might be that some teachers used the software to give a learner-centered feel to their instruction and thus believed their teaching became more aligned with the current educational trends in Kenya without significantly altering the ways they teach. For instance, in our study, oftentimes the teachers opted for tasks based on a simple question to complete which it was enough for students to reproduce existing knowledge. The students were driven by the teacher-set goals and modalities rather than articulated their own understanding of the task and selected ways of how to complete it as well as reflected on the process and its outcomes. Yet, the complexity of the processes that ePEARL supports at all three phases requires that the tool should be used for important learning where the value of effortful expenditure of time is apparent. After all, ePEARL was not designed for learning which is viewed by the learner as easy to accomplish, already well-learned but is best used when the task is moderately difficult, has an element of novelty, and is perceived as valuable to achieve (Abrami, 2010). Learners should see the added value that ePEARL has on their learning and that the amount of time and effort invested is equal to the progress.

However, educational change takes time and we realize that even minimal shifts in teaching practice might be indicative of an important step forward on the way to lasting improvement in instructional practice. Given the impending curricular reform of secondary school in Kenya, many changes in teaching practice are imminent. Since teachers are at the center of any effort to produce positive effects on student learning, further strengthening of the professional development aspect of an intervention is critical so that teachers can fully embrace the pedagogical sophistication offered by the learning technology. We see the support system as the way to continue strengthening contingencies between ePEARL implementation and student learning progress and reducing the perceived disincentives of teaching with technology. Since the capacity of teachers involved in implementation vary, addressing the teachers' needs in technical, pedagogical and content knowledge is critical (e.g., Mishra & Kohler, 2006). Specifically, in addition to helping teacher adopt computer technologies, the support should target teacher's understanding of the core principles of ePEARL and raise their autonomy in applying these principles to instruction. Further, reinforcing the aspect of collegial support would create an opportunity for teachers to take ownership of their professional development and to sustain ongoing learning by peer coaching. For instance, helping establish and maintain connections between teachers implementing ePEARL in different schools by means of technology (McAleavy et al., 2018) would be another hoped for outcome when the support system enables teachers to share and validate their ideas and approaches, obtain timely advise from a colleague – in other words, helps the creation of a shared knowledge base about their ePEARL practices.

The strength of this research includes the integration of the tools as part of authentic, unscripted classroom practice, and the length of the project which was conducted over two years where we were able to replicate the year one results. This suggests that more frequent and comprehensive use of ePEARL translated into higher achievement. The weaknesses of this research relate mostly to research design. Specifically, a planned quasi-experiment with control condition would allow us to avoid teachers priming their non-using students in their classes with self-regulation strategies and thus tempering the effects of ePEARL. Student attrition and long-term failure of a school computer lab also affected the results. Although less controllable, when feasible, these factors could be moderated by make-up data collection and seeking stronger commitment from the partner and schools to maintain their computer devices operational.

In conclusion, this initial small-size test of ePEARL in Kenya showed that in teachers' hands technology for student-centered learning positively impacted student learning outcomes. This is especially encouraging as a first step as there are additional considerations that if implemented, could lead to further enhancements in both teaching and learning in low-resourced contexts.

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Appendix D.

# The Sustainability and Scalability of Digital Tools for Learning: The Learning Toolkit Plus in Kenya

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**Abstract**

This paper explores factors that have potential to increase the likelihood that a technology-based approach to teaching and learning (LTK+ software) endures and expands beyond initial research. This project evolved from a pilot study in 12 primary classes to spread to more than 500 primary and secondary classrooms in five areas of Kenya. Based on research about scalability and sustainability of educational interventions and value-expectancy-cost theory, an exploratory "funnel-type" survey was designed and used to interview a range of actors involved in the LTK+ implementation. To categorize and analyse the narratives, a combination of an a priori and data-driven coding approaches were used. We then organized factors into discrete and finite categories and built a model exploring the relationship between expectancy-value-cost beliefs and the specific factors associated with implementation and sustainability. The model explained an important portion of variance in the self-reported intent to stop or continue using the LTK+ with the most contribution from national and local policies professional development and students. These findings are important in the context where no research-proven principles exist to building sustainable and scalable educational interventions in developing countries.

*Keywords:* teaching and learning, educational technology, sustainability factors, scaling, Sub-Saharan Africa

# The Sustainability and Scalability of Digital Tools for Learning: The Learning Toolkit Plus in Kenya

Education has been recognized worldwide as a key component of social systems that enables countries' sustainable development. To date significant progress has been made on bringing education to children. Yet, the global reference targets first set by the UN Millennium Goals (UNO, 2000) and succeeded by the Sustainable Development Goals (UNESCO, 2015) are not being achieved as fast and effectively as intended. After one-third of the period planned for the achievement of the goals has elapsed, the "world is far off track" on achieving international commitments to ensure quality education for all children and youth (UNESCO. IUS, 2009). Around the globe 250 million children lack basic literacy and numeracy even though more than half of them spent at least four years in primary school (World Bank, 2018). Research on educational practices has generated a rich knowledge base with the potential to improve teaching and learning and to optimize functioning of educational systems. However, to have real and widespread impact, the research-based strategies need to operate at scale and be viable in authentic environments of classrooms and schools. In this study, we explore factors that have potential to increase the likelihood that a technology-based approach to teaching and learning endures and expands beyond initial research.

## Related Literature

### Scaling and Sustainability of Educational Innovations in Developing Context

Issues of scalability and sustainability in education are not new. Rogers' Diffusion of Innovation theory (1962), educational change (Fullan, 1982), curricular reform (Goodson et al, 1989), school change (Argyris, 1993), and education systems change (Christensen, 1997) are just a few of the directions taken to study educational improvement. In 1993, Richard Elmore came up with a classic analysis of the challenges involved in producing significant change in instructional quality at scale. In the field of international development, it was an influential paper by Myers (1984) that explained why going to scale should be of interest in order for projects to have impact on educational policy and programming in contexts with limited resources and capacities. Since then, scaling and sustainability of successful interventions have gained a lot of traction in the global educational agenda and development research.

However, the ever-growing body of systematic evidence on effective pedagogical interventions in developing contexts tells us little about how to sustain and bring them to scale (McEwan, 2015; Evans & Popova, 2016; Conn, 2017; Kim et al., 2019). This comes as no surprise since the studies underlying this evidence were designed to explore whether an intervention performed as intended and not about how to make the intervention work for many and for a long time. Very few primary studies focused on the scaling of educational interventions. For instance, the only randomized trial (Bold et al., 2018) focused on transferring a tested intervention on teacher hiring practices to government implementation at national scale. It found that the NGO-enabled implementation on a modest scale produced higher student learning gains than that run by the government. Another example can be found in Piper et al. (2018) who reported a case of moving the large government-supported pilot to national scale. An example of vertical scaling path, the reading program has been institutionalized through national planning mechanisms and involvement of national and international stakeholder groups.

Given a dearth of research on scaling educational innovations, especially in the Global South, it is the evidence generated outside education that has been tapped for the benefit of educational innovations in developing contexts. By and large, these are areas such as industry and agriculture where scaling efforts focus on commercial success (McLean & Gargani, 2019). Suggesting that this knowledge is far from fully relevant to large educational change, the Millions Learning report by the Brookings Institution (Robinson et al., 2016) concluded that scaling quality learning outcomes for children and youth continues remains an abiding concern. This review of 14 cases of scaling quality education in low- and middle-income nations suggested that an effective innovation scales from the margins featuring design, delivery mechanisms, finance, and an enabling environment as the factors of successful scaling.

Research indicates that scaling is only successful when sustainable. Although the link between the scaling and sustainability is implied, the relationship between the two has yet to be clearly articulated. For instance, research on educational change treats sustainability as a pre-condition for scale whether small or large. Coburn (2003) insists that the scale is meaningful over time only if the implementation can be sustained in the adopting schools. The institutionalization process including rules and regulations and implementation becomes the key in order for the innovation to be integrated into the school structure and culture and to become a permanent part of it. Mioduser et al. (2004) underline the importance of the within-school spread. The big challenge in this process is to expand beyond the "islands of innovation" to "comprehensive innovation" that encompasses at least half of the teaching and learning in the school and most importantly affects its entire culture. After all, teachers are more likely to be able to sustain an intervention when it becomes the school's priority and the activities are aligned with it. This speaks to the existence of an interactive relationship between sustainability and adoption of innovations where innovations evolve over time through modifications based on teachers' needs and beliefs (Dede, 2006). In this process teachers reevaluate the degree and manner to which innovations are implemented, balancing implementation with perceived usefulness, costs and expectations.

**Value-Expectancy Framework**

Based on Shepperd's (1993) motivational analysis of productivity losses in groups, Abrami et al. (2004) and Wozney et al. (2006) applied expectancy theory to construct a unified view of the diverse issues that influence a teacher's decision to implement an educational innovation and persist in its use. The model posits that an educational innovation is more likely to be implemented if the perceived value of the innovation and the likelihood of success are high, and if these benefits outweigh the costs of implementation. That is, a teacher's decision about whether to implement an innovation depends on how highly they value the strategy, how successful they expect it to be, and how highly they perceive the costs of implementation to be. Value assesses the degree to which teachers perceive the innovation or its associated outcomes as worthwhile including benefits to the teacher (such as congruence with teaching philosophy, career advancement), and to the student (such as increased achievement, improved attitudes, enhanced interpersonal skills). Expectancy relates to teachers' perceptions of the contingency between their use of the strategy and the desired outcomes, and factors affecting these perceptions. These include internal attributions such as teacher self-efficacy and skill, and external attributions such as student characteristics, classroom environment and collegial support. Cost relates to the perceived physical and psychological demands of implementation; it operates as a disincentive to innovating and may include class sand preparation time, effort, and specialized materials.

**Influences on Sustainability and Scale**

Multiple influences may affect the delicate balance of components constituting teacher motivation to maintain improvements they achieved by implementing an intervention. The literature suggests that factors that influence processes related to implementation and sustainability are attributes of the innovation, those of its users, as well as the features of the environment including those of organization and outside them (Century et al., 2012). Evaluation research of ICT-based educational initiatives in developing countries, groups these factors into individual and organizational, technological, economic and political dimensions (e.g., Pouezevara et al., 2014; Rubagiza et al., 2011). Individual and organizational dimensions relate to the individual practitioner and school capacity to sustain the intervention, as well as the organizational context encompassing leadership, school community including collegial culture and students, individual and collective capacity, ownership and expectations. Since the capacity of actors involved in implementation vary, careful attention to both training and support is required to meet the existing needs in technical, pedagogical and content knowledge (e.g., Mishra & Kohler, 2006). Technological dimensions are concerned with the ICT needed to bring the educational intervention to teachers and students such as operation of infrastructure and equipment for the benefits of the project. Economic dimensions refer to costs and economic environment in which the innovation implementation unfolds. Political dimensions pertain to support for the intervention through local and national politics, policies and individuals.

This paper reports on the study of factors that impact a) teacher's beliefs, attitudes and motivation to persevere in implementing a technology-based approach for instruction and b) the potential of this innovation to endure and expand to new contexts. Namely, this approach is about teaching with the interactive multimedia software, the Learning Toolkit Plus (LTK+), to promote the development of essential educational competencies in the developing world context. In the status of research, the implementation of LTK+ evolved from a pilot study of 12 primary teachers and their 213 students (Abrami et al., 2016) to spread to more than 500 primary and secondary classrooms in five regions of Kenya.

## Method

### Instrument

The LTK+ Sustainability Interview Survey was designed in a funnel format to obtain the interviewees' perceptions from broader to specific ones in order to explore factors influencing LTK+ use. First, the survey was piloted with a handful of individuals involved in the LTK+ project implementation in Kenya since the onset of the research project, a few modifications were done to the survey to elicit more specific responses from the interviewees.

The current iteration of the survey begins with the two questions eliciting the interviewees' experiences with LTK+ tools/project: how they got involved with LTK+ and what they would have done differently to improve the software implementation. Then two global questions about LTK+ use are asked: a) What about LTK+ sustainability? What are the important reasons for continuing to use or stopping to use the LTK+ in future? and b) What about LTK+ scalability? What are the major challenges to widespread use of the LTK+ in Kenya?

We considered the expectancy beliefs in the larger context of potential influences on scalability and sustainability, often beyond a teacher' s control. Therefore, the survey explores the potential influences organized into eight categories including: political factors; economic and technology factors; organizational or school factors; teacher professional development factors; software factors; individual teacher factors; individual student factors; and other factors. Each of the specific factors includes prompts to further probe respondents' thinking. For instance, the question about software factors includes the following prompts: LTK+ fit with the curriculum; local context of stories and activities; narration and accents; interactivity of the tool; shortcomings, inadequacies and gaps of the tool(s).

### Sample

In total 43 individuals participated in the interview (15 in pilot and 28 in the main phase). Three interviewees participated in both phases of the survey; their pilot interviews were not included leaving narrations of 40 respondents in the analysis. Table 1 shows the split between categories of respondents where school practitioners were the largest category. Out of 11 teachers, nine were active users of the LTK+ tools, whereas two stopped using them. Among five school administrators, four were the head of the schools where use of LTK+ continued over many years. Six ambassadors were school teachers, one of them retired. One ambassador became a county education quality officer. Of the seven ambassadors, two were school-based ambassadors, in-house LTK+ resource.

Table 1. Categories of Interviewees

| Interviewees | Number of completed interviews |
|---|---|
| School practitioners: | |
| Head teachers, Deputy head teachers | 5 |
| Teachers | 11 |
| Ambassadors (master teachers) | 7 |
| Partners: | |
| I Choose Life staff (county coordinators, advisor, coach) | 4 |
| World Vision | 3 |
| Aga Khan Foundation, Development Network | 2 |
| Executive officers | 3 |
| Kenya project coordinators | 3 |
| Researchers | 2 |

**Analyses**

After the interviews had been transcribed, three respondents were selected at random and their responses were used to develop a coding system. At this stage, the first author developed the system and elaborated on differences between expectancy, value and cost statements. These codes and the coding system were reviewed by the three authors for finalization. Coding was completed with Hyper Research v.3.7.3. In addition to an a priori approach, data-driven codes were also generated. The second coder validated codes and their categorization on a randomly selected 10 interviews. The agreement rate evolved from 59% to reach 85%.

Next, SPSS v.24 was used to quantify and analyze the resulting data. For instance, for each of the factor categories, the sub-questions mentioned (or not) by a respondent and the valence of the response (positive, negative or no response) as influencing the sustainability of the LTK+ were accounted for. Then, the total positive, negative, and neutral responses were cumulated across respondents. Only a single response per category and each subcategory were recorded to maintain the respondent as the unit of analysis. Multiple responses per category or subcategory were combined to reflect the coder's best impression of the respondent's beliefs. Finally, path analysis (AMOS v.26) was run to explore the relationship between expectancy-value-cost beliefs and the specific factors associated with implementation and sustainability.

## Results

The findings of this study are reported by the survey questions. The summary of responses by factor is followed by the results from the path diagram.

### Reasons for Continuing to Use or Stopping to Use the LTK+ in Future

All 40 respondents answered this question with each offering from 2 to 14 ideas. According to the theoretical framework, the ideas were grouped into values, expectations and costs. Table 2 presents a summary of categories and subcategories.

Values related to benefits teachers saw after having used the LTK+ and was the largest category including 140 instances. Primarily, these were student benefits. For instance, their students became more motivated (N=14), improved skills (N=12), developed autonomy (N=12) and their absenteeism reduced (N=4). Benefits for the teachers included being able to motivate their students (N=11) and providing an opportunity for improving teaching expertise (N=10). The most frequently reported general advantages of the tools were their fit with the curriculum (N=6), comprehensiveness (N=4) and effectiveness for students' levels and abilities (N=4).

Table 2. Summary of Codes by Values, Expectations and Costs

| Categories (number of ideas) | Number of sources/respondents | Number of coding references | % of total coding references |
|---|---|---|---|
| *Values* | *39* | *140* | |
| Benefits to students (12) | 32 | 88 | 62.86 |
| Benefits to teachers (6) | 21 | 32 | 22.86 |
| General benefits (7) | 16 | 20 | 14.29 |
| *Expectations* | *39* | *111* | |
| External attributions (13) | 30 | 61 | 54.95 |
| Internal attributions (8) | 26 | 50 | 45.05 |
| *Costs* | *36* | *88* | |
| Psychological demands (5) | 7 | 8 | 9.09 |
| Physical demands (16) | 35 | 80 | 90.91 |

Expectations were categorized according to the internal or external attributes that teachers assigned in their perceptions. The most frequently reported internal attributions were "if teachers see value in using the tool" or "if the tool is not perceived as an add-on" (N=16); and if teachers are intrinsically motivated (N=10). Curiously, non-teacher interviewees indicated that technology use might be contingent on the teachers' age as younger teachers might be more tech savvy (N=5). Attributions to external sources were more frequent and related to school context: if headteachers are encouraging and do not hamper use (N=23); if support is accessible (timetabled) (N=13); if electricity is stable (N=12); if LTK+ support is scheduled (N=6). Expectation of a financial reward was also mentioned (N=4).

Costs related to using LTK+ was the smallest set including 88 instances where 91% were assigned to physical demands. These were: using the software after classes or during lunchtime since LTK+ is not part of the curriculum and other programs are given priority during formal class time (N=22); having plan B if technology fails (N=15) or there is no electricity (N=9); or managing technology use in big classes (N=7).

**Major Challenges to Widespread Use of the LTK+ in Kenya**

Forty interviewees provided between 1 to 18 ideas each about the impediments to scaling LTK+ tools in Kenyan schools (Table 3). Unreliable technology and infrastructure in schools (N=38) and lack of technical support at schools (N=17) were most frequently reported school-related challenges whereas rival programs and tools supported or owned by government (N=15) pertained to the system-related set of factors.

Table 3. Summary of Codes by Challenges to Scale

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *40* | *218* | |
| LTK+ related (3) | 8 | 9 | 4.13 |
| School-related (20) | 39 | 100 | 45.87 |
| System-related (9) | 13 | 17 | 7.80 |
| Teacher-related (24) | 29 | 92 | 42.20 |

Among teacher-related challenges, the most frequently reported were technophobia and lack of ICT skills (N=29) and lack of interest to technology-based programs (N=19).

**Factors**

***Political Factors***

Thirty-five respondents commented on political influences on viability and scale up of the LTK+ tools in Kenyan schools (Table 4). Each provided from 1 to 8 comments. Curiously, teachers offered considerably fewer opinions than school administrators and partners. Of the 121 instances, 65 focused on the positive influences whereas 56 were formulated as impediments. We grouped policy-related factors into those pertaining to the context for the intervention, progress of engagement of local and national governments with the LTK+ implementation and the potential outcomes of this engagement.

Table 4. Summary of Codes by Political Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *35* | *121* | |
| General educational system policies (20) | 31 | 46 | 38.01 |
| Local government (3) | 14 | 15 | 12.4 |
| Engaging government (5) | 20 | 20 | 16.53 |
| Benefits for the project (12) | 29 | 40 | 33.06 |

According to the interviewees, LTK+ should be part of the national curriculum (N=20) and, consequently, should be included on the Kenyan cloud and authorized as the Digital Literacy Program content accessible on the government-provided tablets. The role of government for sustainability and scale of the intervention is paramount (N=20). However, the respondents felt that government is protective of those initiatives they have developed from the beginning (N=5). This is why building the government's trust in the value and relevancy of the LTK+ (N=4) and getting them onboard (N=4) is critical for sustainability and scale.

In regards to engaging the government, the respondents recommended a number of strategies that can help the national educational authorities buy into ownership of the LTK+. Primarily, these are communication strategies, such as being persistent in demonstrating the evidence of impact; showing the government that the LTK+ is a means to achieve the objectives of the Digital Literacy Program (DLP) and the Competency-based Curriculum (CBC). It was felt that using the LTK+ on the DLP tablets would be well aligned with the implementation of the government ICT education policy (N=11). As a tool for computer-based instruction, the LTK+ software would meet the DLP monitoring criteria (N=5), as well as offer truly interactive content to complement the static DLP learning materials. At the same time, the respondents noted inconsistencies between the digital policies and their implementation in educational practices. They reported the ICT training offered at the national scale to teachers was insufficient (N=6) and there is an inadequate system in place to monitor and evaluate the ICT instruction (N=6). Thus, to reinforce and monitor the implementation of Kenya ICT policies, the government themselves need to embrace evidence-based, effective uses of technology.

In addition, more efforts should be taken to engage with the local governments and communities (N=9). In this regard, the following strategies were mentioned: showcasing and advertising the outcomes that can be achieved by using the LTK+ tools and helping to educate communities on effective uses of ICT. On another note, with the simultaneous roll out of multiple programs, it is important that researchers are able to tone down their expectations of success in terms of government involvement and support.

### *Economic and Technology Factors*

All interviewees commented on the potential influences of economic and technology factors (Table 5). A computer-based pedagogical intervention might be affected by the school economies such as limited school budgets to cover many expenses (N=12) and ever-growing costs such as technology repairs and electricity bills (N=13). In this context, the government's funding and support towards ICT in schools is critical (N=15), as are parent contributions to school budgets (N=11), although funds for technology should be earmarked (N=11). Poverty as a system-related factor affecting implementation was mentioned once.

Table 5. Summary of Codes by Economic and Technology Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total economic factors* | *35* | *88* | |
| System-related (5) | 19 | 21 | 23.87 |
| School-related (10) | 48 | 67 | 76.14 |
| *Total technology factors* | *37* | *125* | |
| Devices (10) | 30 | 39 | 31.20 |
| Infrastructure (5) | 16 | 21 | 16.80 |
| Support (8) | 53 | 57 | 45.60 |
| Modernization (4) | 5 | 8 | 6.40 |

Perceptions about technology factors varied. For instance, student-computer ratio of 3 or 4 students per one device seems to be an acceptable index of access to technology for 13 respondents. One interviewee noted that this ratio was optimal in big classes where the teacher would be exhausted if she had to attend to each student working on her own device. Yet, five respondents found this indicator too high to adequately expose their students to the tools, suggesting that it should be one student per device.

Further, instable infrastructure and electricity supply (N=13), no Internet access (N=3), limited network capacity of DLP servers (N=3) and charging capacity of the DLP tablets (N=6), and lack of peripheral devices/headphones (N=10) were reported to slow down implementation. The respondents' opinions about technical service and maintenance available to schools were mixed: 10 respondents were satisfied whereas 12 were not happy. Limited tech support to the DLP tablets may have impacted the choices some school administration made, i.e., keeping computers in storage because they fear to be personally accountable for broken devices.

***School Factors***

As Table 6 shows, the question about school and organizational factors stirred the most reactions (N=300). Each interviewee shared an opinion offering from 1 to 15 ideas that were mostly positively shaped. These pertained to leadership, concerted actions and coordinated activities on implementation, school-based expertise and available technology.

Leadership was the critical factor for implementation (N=25). This quality was naturally sought from the school administration who is primarily expected to encourage implementation (N=14), to visit and observe classes (N=7), and to follow up when the LTK+ is not being used and thus apply pressure to do so (N=5). To be leaders, school administrators should not only understand the importance of technologies for teaching and learning (N=14) but they need to be trained in the LTK+ (N=7) and leadership strategies (N=5). Training might be a strategy to address administrators' resistance to change (N=7).

Table 6. Summary of Codes by School Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *40* | *300* | |
| Administration and leadership (26) | 47 | 132 | 40.67 |
| Concerted actions (23) | 45 | 113 | 37.67 |
| Scheduling (6) | 20 | 27 | 9.00 |
| Expertise (13) | 25 | 35 | 11.67 |
| Available technology (1) | 1 | 3 | 1.00 |

It takes a whole school to implement a successful ICT programme, encouraging a concerted effort to build ownership (N=15), collegial decision-making about its implementation (N=9) and the involvement of parents (N=16). Implementation and support activities should be time-tabled. This includes uses of the LTK+ whether in the school lab or regular classroom (N=11), time for teachers to learn the tools (8), to share (N=10) and to support each other (N=6). School-based ambassadors are viewed as a symbol of growing internal expertise capable of adequately supporting implementation (N=16). Students also have their say in their viability of a computer-based intervention—as they demand the use of ICT.

A number of school-level impediments related to policies, such as the schools' limited capacity to decide on budget priorities (N=4), and lack of available funds to hire a technician (N=3). Dealing with a miscellany of devices ranging from desktop computers to laptops and tablets was reported to add pressure on a classroom teacher (N=3).

### *Teacher Professional Development Factors*

Thirty-five respondents shared their opinions about teacher professional development factors, 98% of which were positively shaped (Table 7). The number of comments varied from 1 to 15 per interviewee with four respondents (not teachers) providing one-third of all comments. Training was reported central in the model of LTK+-related professional development (N=10). The comprehensive nature of LTK+ training was noted suggesting that it can make up for the gaps in the DLP training and also target multiple stakeholders involved in implementation, including school administrators (N=4) and ambassadors (N=6). Training students in the LTK+ so that they could fully support each other and the teacher in their use of the software was also suggested.

Table 7. Summary of Codes by Professional Development Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *35* | *131* | |
| Training: general (10) | 14 | 19 | 14.51 |
| Training: outcomes (16) | 21 | 32 | 24.43 |
| Training: modes (5) | 19 | 24 | 18.32 |
| Training: accreditation (4) | 7 | 11 | 8.40 |
| Follow-up support (14) | 21 | 45 | 34.35 |

The content and desired outcomes from training have been also commented (N=32). In addition to developing an understanding of the tool and how to use it, training should emphasize the fit between the LTK+ tools and other programs; training should also present the comprehensive view of the LTK+ teaching logic; and improve instructional flexibility and capacity to make informed decisions about which tool to use. It should target a range of broader skills, including managing group work, teaching with ICT and reflecting on teaching.

Format-wise the training should be continuous and incremental, conducted in smaller groups in-school, and offered with certification in LTK+ pedagogy. The latter is valued (N=11) as the evidence of professional growth, as a means to promotion, with marks on teacher appraisal or as a symbolic reward. There was an expressed need for structured follow-up (N=17) to complement the three-day training model with ambassadors as the critical component (N=9). To support teachers in small schools and remote areas, building an LTK+ networking environment was suggested (N=8).

***Software Factors***

In regards to the LTK+ software, the interviewees' comments were predominantly positive and pertained either to a particular tool or the entire collection (Table 8). They highlighted the unique place that the Toolkit takes in the instructional landscape and, therefore, its potential to bridge the existing gaps in the curriculum (N=14). Specifically, the LTK+'s flexibility makes it distinct in comparison to the prescriptive approach used in previous national programs (e.g., TUSOME). Furthermore, the LTK+ targets specific skills versus general nature of the traditional instruction. Also, some LTK+ tools develop cross-curricular skills that are not explicitly addressed in the current curriculum (e.g., self-regulation). Finally, the LTK+ offers a wide range of resources in English and some in Kiswahili.

Table 8. Summary of Codes by the Software Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *40* | *235* | |
| Bridges gaps (7) | 22 | 14 | 5.96 |
| Inadequacies (14) | 25 | 42 | 17.87 |
| Effectiveness (13) | 28 | 42 | 17.88 |
| Content (13) | 22 | 38 | 16.17 |
| Fit (7) | 32 | 48 | 20.42 |
| Design and features (19) | 22 | 35 | 14.90 |
| Student-centeredness (5) | 10 | 16 | 6.81 |

The other aspects reported include the LTK+ content, fit with curriculum, impact on learning outcomes, student centeredness, and interface design. The fit between the LTK+ and educational context including the Competency-Based Curriculum, its goals and teaching schemes was reported most frequently (N=46). The tools were noted for being both well aligned with the paper-based national programs (e.g., PRIEDE) and reinforcing these programs as interactive learning technology that works on the government-provided tablets. The LTK+ interactive content was commented to offer more than existing curricular materials and textbooks (N=21); the embedded resources enable to teach students of different abilities and offer ideas for discussions and for inquiry. The extension activities outside computer use allow to maximize student exposure in big classes. International materials expose students to other language and cultural contexts.

The most frequently commented features were interactivity and game-like design, potential for differentiated instruction; and interoperability of the software on various devices and platforms. Student-centeredness of the tools turned important (N=10) as they support student autonomy, enable learning at one's own pace, sharing work and teaching each other.

LTK+ effectiveness was commended (N=27). Not only the tools generate evidence of learning progress, but they enable teachers to motivate students, stimulate interest yielding important learning gains. After being exposed to the tool(s), younger students outperform older ones. Further, students continue to be interested in using LTK+ even after they used it for some time.

Interviewees also commented about inadequacies they noted in LTK+ tools. Lack of fit with the local language context, including accent; no access to the tools from home; lack of reading activities for older students; and ambiguity in the meaning of some concepts introduced in a tool were reported as weaknesses.

***Individual Teacher Factors***

Thirty-five participants commented about the teachers who would be inclined to teach with LTK+ (Table 9). Interestingly, the teacher-interviewees gave minimum of opinions on the matter. Overall, the comments about the individual teacher factors were positively shaped focusing on dispositions and skills that the teacher-user of LTK possesses. A few described the circumstances of those teachers who would abstain from teaching with LTK+.

According to the comments, teacher dispositions are the leading factor (N=29). The LTK+ teacher possesses professional interest (N=12) and confidence, also in using ICT (N=11); ability and readiness to get out of the comfort zone (N=7); and passion (N=5). Teacher readiness to do extra work (N=6), commitment (N=3) and persistence (N=3), were also noted as drivers of sustainable use. On the opposite side of the spectrum are the teachers described as passive (N=7), technophobic (N=6) or questioning the purpose of teaching with ICT (N=3). Fatigue that teachers experience under the pressure to implement multiple programs may also factor in(N=2).

Table 9. Summary of Codes by Individual Teacher Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *35* | *175* | |
| Self-determination (1) | 1 | 1 | 0.57 |
| Self-efficacy (4) | 18 | 22 | 13.57 |
| Dispositions (29) | 48 | 104 | 59.43 |
| Skills and abilities (11) | 21 | 31 | 17.71 |
| Self-efficacy sources (2) | 9 | 9 | 5.14 |
| General observations (2) | 2 | 2 | 1.14 |
| Teacher age (1) | 6 | 6 | 3.43 |

Contrary to the factors arising from affective domain, teacher capacity and skills were reported less frequently and include ability to use ICT and integrate it in instruction (N=12), and ability to train others (N=4) and self-teach (N=2). The arrival of new generation of tech-savvy teachers was noted as a potential turning point for a large-scale acceptance of technology-based interventions such as the LTK+ tools (N=6).

***Individual Student Factors***

The comments about student factors that may affect uses of LTK for teaching were rare (Table 10). The 19 respondents who were either a teacher or a school administrator expressed between 1 and 7 ideas.

Table 10. Summary of Codes by Individual Student Factors

| Categories (number of ideas) | Number of sources | Number of coding references | % of total coding references |
|---|---|---|---|
| *Total* | *19* | *70* | |
| Disposition (6) | 11 | 16 | 22.86 |
| Skills and abilities (9) | 13 | 16 | 22.86 |
| Benefits for students (7) | 23 | 38 | 54.29 |

These rather related to the gains students got as a result of learning with LTK+ tools and included the increase in student autonomy (N=10) and engagement (N=9) and interest to learning (N=6). Progress in students' social skills, perseverance, capacity to peer-teach and even readiness to teach teachers were reported as were the improvements in student learning (N=6) where low-achieving students seem to have benefited the most (N=4). Some stated that weaker students required more time to learn with the tool implying that more advanced students were held back whereas others suggested that neither the student level nor baseline differences matter, instead it is for the teachers who should be able to manage (N=3). At the same time, the interviewees suggested that to succeed with LTK+, students should be tech savvy and excited by ICT (N=11). For instance, secondary students did use their lunch break to do the ePEARL work in the computer lab (N=2).

**Factor Effects**

We also investigated what factors might have influenced the teachers' intent to continue or stop using LTK in their practice. First, we applied expectation-value framework which reduces teaching with technology to a simple teacher motivation equation (Wozney et al., 2006). The composite variable of the teacher Motivation to Sustain LTK+ Use was created by aggregating the number of coding references within each of the three categories of value (M=3.05, SD=2.22), expectations (M=2.75, SD=1.90) and costs (M=2.13, SD=1.59) per respondent and letting them enter the equation expectancy + value -- cost of use. The resulting motivation mean score and the standard deviation were 5.25 and 3.76 respectively (Table 13). We calculated continuous composite scores for the 8 factors (teacher, student, PD, school, policy, economic, technology and software), by combining together the subcategories within each factor. We hypothesized that the factors directly predict practitioner's intent to continue or stop using LTK+.

Additionally, we assumed that Teacher Factors can be directly predicted by Professional Development, Student and School Factors and serve as an intervening variable between the three sets of factors and teacher motivation to sustain LTK+ Use. The correlation coefficients support this assumption (Table 13) showing significant positive relationship between a) PD and School Factors and Teacher Factors, and b) Teacher Factors, PD and School Factors and the dependent variable of Sustain LTK+ Use.

Table 13. Means, Standard Deviations, and Correlations of Eight Factors and Motivation to Sustain Using LTK

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | M | SD |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Motivation to sustain use of LTK | | | | | | | | | 5.25 | 3.76 |
| 2. Economic Factors | .154 | | | | | | | | 2.20 | 1.85 |
| 3. Technology Factors | .092 | .462** | | | | | | | 2.90 | 2.45 |
| 4. Policy Factors | .231 | .070 | .302 | | | | | | 1.85 | 1.61 |
| 5. Software Factors | .107 | -.025 | .208 | .204 | | | | | 5.55 | 3.49 |
| 6.School Factors | .322* | -.124 | -.109 | -.113 | .141 | | | | 7.30 | 3.81 |
| 7. PD Factors | .363* | .017 | .039 | -.011 | .047 | .297 | | | 3.15 | 3.11 |
| 8. Teacher Factors | .351* | -.058 | .254 | -.018 | .096 | .483** | .444** | | 4.33 | 3.94 |
| 9. Student Factors | .297 | .068 | .092 | -.051 | .066 | .111 | .009 | .449** | 0.65 | 0.98 |

**p< 0.01; *p< 0.05

AMOS path analysis generated support for the hypothesized model. The overview of the model fit, the chi-square index, was 25.905 (df=24), p=.358. The Goodness-of-fit indices also implied a reasonably well-fitting model. The Comparative Fit Index (CFI) that takes sample size into account was robust (0.96) exceeding the min cut-off value of 0.95. The RMSEA index (root mean square error of approximation) was 0.045 with p=.458 and the confidence intervals of 0.000 and 0.140. Such combination of RMSEA and confidence intervals suggest an acceptable precision of the model in reflecting the fit to the population. There was no evidence of the model misfit: two modification indices (MI < 20; parameter change < .10) suggested that the hypothesized model is appropriately described; the highest standardized residuals was 1.88 below critical value of 2.58. The hypothesized model with standardized coefficients is in Figure 1 representing the measured composites, residuals and relationships between the variables.

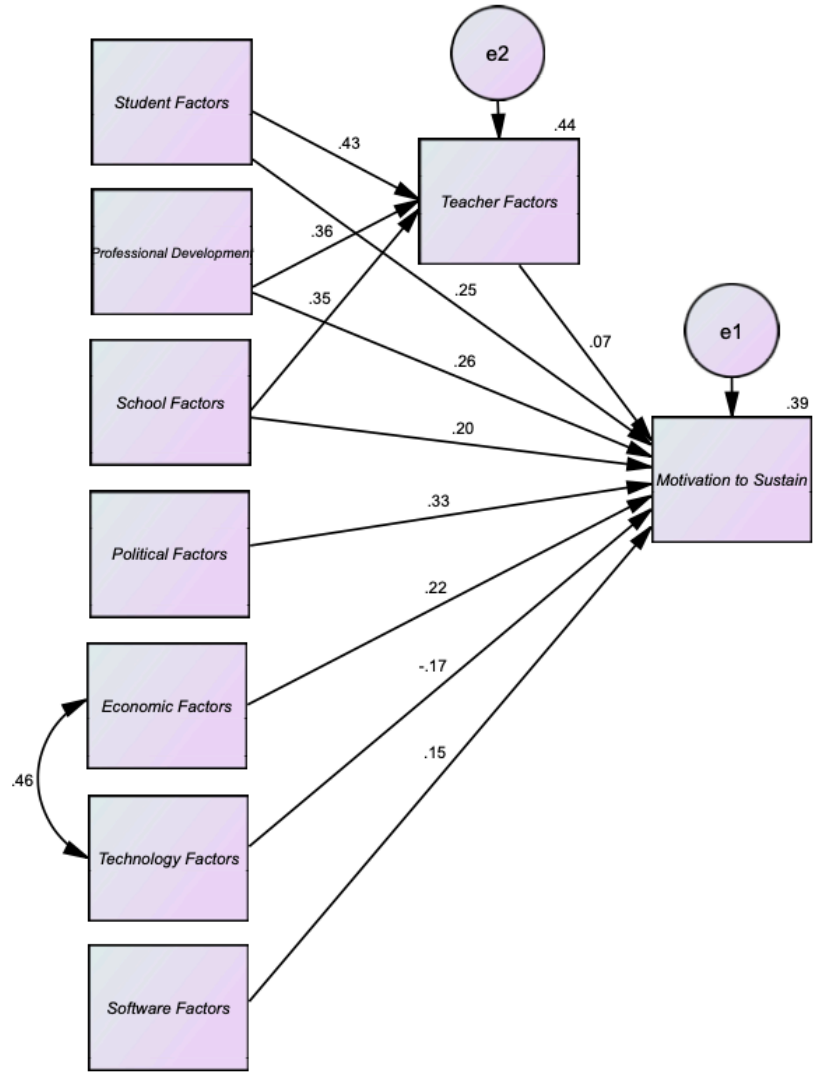


Figure 1. Effects on Teacher Motivation to Sustain Use of LTK Path Model

Table 14 summarizes the model effects. Namely, the 8 factors accounted for 39% of the variance in the motivation to sustain use of LTK+. The effects of the 7 exogenous factors within the model were mixed. Increased motivation to sustain the use of LTK+ was significantly predicted by Policy and Professional Development factors, the standardized coefficients were 0.34 and 0.27 respectively, whereas the remaining 5 factors did not have significant direct effects.

Table 14. Decomposition of Effects

| | Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PD | Student | School | Teacher | Policy | Economic | Technology | Software |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Standardized direct effects | | | | | | | | |
| *Teacher Factors* | 0.359* | 0.431** | 0.355* | | | | | |
| *Motivation to sustain* | 0.265* | 0.245 | 0.204 | 0.065 | 0.335* | 0.220 | -0.172 | 0.151 |
| Standardized indirect effects | | | | | | | | |
| *Motivation to sustain* | 0.023 | 0.028 | 0.023 | | | | | |
| Standardized total effects | | | | | | | | |
| *Motivation to sustain* | 0.288* | 0.274* | 0.227 | 0.065 | 0.335* | 0.220 | -0.172 | 0.151 |

**p< 0.01; *p< 0.05

Except Technology factors whose effect was negative, the other factors' influences were positive. Student, School and Professional Development factors each had a strong direct significant effect collectively explaining 46% of variance of the only moderator, Teacher factors. The respective β coefficients were 0.43, 0.35 and 0.39. Yet, Teacher factors did not contribute to the variation in a teacher's intent to sustain the use of LTK+ (β=0.065). After controlling for the mediator, the indirect effects of the Student, School and Professional Development factors on the intent to sustain use were positive but small and not statistically significant. The total effects were statistically significant for Policy, Professional Development and Student Factors implying that each one-point increase in reporting them–would rise motivation by 0.34, 0.29 and 0.27 per unit respectively. Except for the strong and significant relationship with Teacher factors, School influences did not turn significant for the motivation to sustain the use of LTK+. Neither did Economic, Technology and Software Factors.

**Discussion**

This paper reports the findings from the interviews of 40 teachers, school headteachers, and partners involved in implementing LTK+, an evidence-based learning technology, that spread from a dozen of classes to a few hundred of public primary and secondary classrooms across Kenya. In this interview we explored perceptions and experiences in order to understand the factors believed to influence adoption and further use of this educational technology.

The individual teacher's agency in making the difference in the classroom, the school, and eventually, the whole system is the cornerstone of this study. Our prior research on technology-based educational innovations confirmed the importance of the motivational disposition of innovators (Wozney et al., 2006). In particular, teachers who have high expectations of successful implementation, who see minimal costs to implementation, but see the value-added of implementation are those who persevere. However, insuring a quality and efficacious educational implementation, and then finding ways to sustain and scale the innovation, are subject to many challenges and opportunities. Among the factors we explored, Policy, Professional Development, Student and School factors explained an important portion of the self-reported intent to continue using the LTK+ tools.

*Political* context turned out the most influential antecedent of teacher motivation. As determined decisions and actions taken by government, unions, parents and other interest groups, educational policies shape the direction and development of the entire education system and, therefore, practices of schools and teachers. Indeed, for teachers to sustain an intervention, its pedagogical objectives and implementation resources had to be aligned with national policies, curriculum and local educational priorities. Such alignment was especially important in Kenya context since the implementation rolled out in the time of the massive curricular reform including nationwide targeted initiatives (TUSOME, DLP, PRIEDE). In practice, LTK+ training and support emphasize how the LTK+ tools are not in rivalry with the above programs but rather a complementary effective vehicle to achieve the nationally-owned educational objectives. We have taken action for the LTK+ tools to be encompassed in the list of instructional materials approved by the national educational authorities.

*Professional development* factors had important and universal effects on teacher motivation as well as skills and dispositions. Our practices rely increasingly on rigorous and constantly evolving training and follow-up support including the institute of roving and school-based ambassadors and a rich system of scaffolds embedded in and supplemented to all LTK+ tools. Since the capacity of actors involved in implementation vary, both training and support addressed the teachers' needs in technical, pedagogical and content knowledge (e.g., Mishra & Kohler, 2006). The sought-for outcomes did not limit to mere adoption of computer technologies but targeted teacher's understanding of the core principles of the LTK+ pedagogy and autonomy in applying these principles in instruction to encourage new modes of learning and teaching. Regular meetings to share experiences and plan teaching with LTK+ ensured teacher gains from peer learning. Having expert users of LTK+ tools themselves, participate in these meetings benefited teachers and, especially, neophytes. Not only did they modelled school contexts but they addressed the uncertainties of those just starting out by illustrating their own success in beginner-like contexts. According to Bennell and Akyampong (2007), professional development is an important motivator also because it offers an opening for teachers to escape drudgery of their classrooms whereas certification, LTK+ training certificates recognized by the Teacher Service Commission, may contribute to the progression of teacher career.

The influence of *student* factors was consistently important on both teacher motivation and ability to sustain LTK tools in their teaching. It is students' experiences with the tools that increased their autonomy, engagement and interest to learning and drove their teachers' enthusiasm and intent to continue using the tool. Further, since students were quite vocal about their teachers' use of the software for teaching, this might have prompted teachers to improve their capacity and efforts to integrate technology.

The influence of *school* on teacher dispositions was important. In this regard, addressing the needs of the school community, providing adequate and timely in-school support, creating ownership and managing expectations are the actions critical for teacher capacity to adopt technology in their practice. Research argues that successful initiatives are linked to the extent to which the school community takes responsibility for them (Pouezevara et al., 2014). Including the use of LTK+ into schools plans and schedules explicitly confirmed the alignment between the curriculum and the tool and also demonstrated the commitment of the school leadership to the intervention. This commitment translated into allocating school pedagogical, technological and financial resources to support implementation such as liberating teachers, scheduling computer lab sessions, paying bills for electricity and maintenance. At the same time, many headteachers may remain either passive or against implementation of ICT. Mingaine (2013) reports perceptions of technology as costly; it consumes limited funds that schools have, as well as distract teacher' s time, without evident short-term returns.

Despite the important contribution of student and professional development, *teacher* factors turned out to have little direct effect on a teacher intent to use the LTK+ tools. Whereas teacher skills and abilities make the natural case for training and professional development, also a motivator, teacher dispositions are a special case that can potentially drive the intent to change practice but only to a limit. While many teachers become involved in implementing technology because they feel their personal effort is worthwhile regardless of whether or not they receive support from the system, yet a longstanding change cannot be maintained through teacher commitment alone (Salinas et al., 2017). For if the effort must be sustained for too long, it is likely that the enthusiasm of these teachers will wain and they will no longer be able to sustain a complicated process of the innovation use. As a result, teachers may assign greater importance to the external agency, that of the centralized system and its policies, rather than their own capacity and skill.

In conclusion, the usefulness of these findings is three-fold. First, this study generated results that are practical in the context where the existing research is far from providing evidence-based principles to build sustainable and scalable educational interventions in developing countries (MekiKombe & Herman, 2017). And even more so, since the research tends to follow the evolution of relatively large initiatives into educational mainstream while assigning little interest to how an intervention proven successful with a handful of teachers and students grows to reach many in dire need of it. Second, the tested model validated the results from the qualitative interviews, suggesting paths associating a range of external and internal factors with sustainable uses of LTK+ tools where motivation served a shortcut for durable implementation. Although it is also likely that other factors not included in this model, measurement error, coder bias, and small sample size, also had their effects. Third, the model points to the priority directions for technology-based pedagogical innovations to endure and expand in developing context such as seeking support from the local and national governments and enhancing teacher professional development in order to strengthen individual and collective capacity to implement and endure innovation. Finally, the results of this study suggest the need to advance our research agenda. For instance, since spreading beyond a few schools raises strategically different issues for the project, it will be necessary to learn how we can effectively thread the LTK+ related ideas throughout the local and national educational authorities to establish long-term support and ensure that the activities fit the short- and long-term strategies of the authorities even if their priorities change.

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# Appendix E

## THE LEARNING TOOLKIT FOR EARLY YEARS EDUCATION (ECDE) TOTs & TEACHERS
## Report on the 2019 ECD Project
## Prepared by Rose Iminza, Nov. 28, 2020

### PREAMBLE

The CSLP (Centre for the Study of Learning and Performance) is a research centre that develops non-commercial interactive web-based educational tools bundled together in the Learning Toolkit Plus (LTK+). Used in learning environments around the world, these tools teach young students' specific skills (e.g. reading and writing, information literacy, math) as well as how to become strong, self-directed learners.

### *CSLP Goal:*

The primary goal of our work is the advancement of knowledge and its wide-scale application in order to have a sustained effect on how schools operate to promote essential educational competencies.

For this reason, the LTK+ Kenya is running a series of professional Development sessions in partnership with several educational organisations in Kenya and beyond. One such training was a workshop for Early Childhood Development Education (ECDE) teachers in Mombasa. The focus for the training was to enhance the preparation of the Pre-Primary` teachers in a way that they can use technology to teach and use the Learning toolkit to promote literacy skills within the Competency based Curriculum framework.

### Training Focus

This 3 day training was launched on the 13$^{th}$, November 2018 and officially closed on 15$^{th}$ November 2018, setting off the ECDE teachers to go implement the ABRA/READS program. The training targeted early years teachers from the County of Mombasa in Kenya. It attracted 20 teachers and 5 trainers all working in the Department of Education, IT & MV 2035, County Government of Mombasa.

The LTK has 5 different tools, this training focused on two of the tools namely ABRACADABRA (*A Balanced Reading Approach for Children Always Designed to Achieve Best Results for All*) and READS (*Repository of eBooks And Digital Stories*) as these are relevant to the early years literacy progam in tandem with the Competency Based curriculum (CBC) recently introduced in Kenya.

READS is a database of over 600 free stories some with multiple languages of the same book from 23 different countries. ABRACADABRA is a free children's literacy software developed by researchers at Concordia's Centre for the Study of Learning and Performance (CSLP). It is a highly interactive, early literacy web-based and off-line tool that supports beginning readers through dozens of engaging activities and digital stories. It helps children in the elementary years develop skills in phonological awareness, reading fluency, comprehension, and writing in line with the Competency based curriculum.

## HIGHLIGHTS OF THE TRAINING

### Technology and Equipment

The CSLP computers (MacBook) were used centrally during the training. The IT department connected the 14 refurbished MacBooks to the Academy's server as this was the training site. The LTK 2018 version was installed and bookmarked on the CSLP MacBook's. It was the first time the MacBook were connected and used in a training. Using these computers was very effective as we did not have any major apprehensions throughout the training except for the out of date browsers on the machines. The MacBooks connected fast allowing the teachers to follow the activities with the trainer instantaneously. The participants worked on the tasks in pairs and small groups whilst presenting to the whole class whenever required to.

Together the trainees developed lesson plans which were used to jumpstart the implementation once the teachers returned to school.

Default accounts were used for logging in for both the dummy student and teacher accounts.

For the teacher module, the old version was used as it addressed the assessment and teacher module pieces. Teachers while exploring were able to appreciate the resource available to them in the module. Teachers who have been exposed to the software before, found the new version more exciting to use as they felt navigation was better with this version. It can be concluded that the use of this technology was the most successful in comparison to all the trainings held before where we used alternative computer devices. There were minimal interruptions emanating from technology and its connectivity.

### Target Participants/Schools

The schools targeted for this training were ECDE centres in the County of Mombasa. This was as a result of a formal request by the Director, Department of Education, IT & MV 2035 Mr. Bwanaheri Salim. The county officer showed great enthusiasm in the ABRA program after visiting some of our Grade One classes.

Initially 20 participants from 10 private and 10 public ECDEs had been identified and selected for the training as seen in the table. However, 11 private and 9 public school teachers attended the three day ABRA & READS training completing successfully. At least four schools (2 public and 2 private ECDEs) were selected from each of the *city* jurisdictions (Kisauni, Changamwe, Likoni and Mombasa) of the Mombasa county. One teacher was selected from each of the schools. For each *city* an Education County official was selected to attend. In total 5 (1 male and 4 female) county education officials attended the training together with the teachers. Their overarching role being support and monitoring the teachers at the implementation.
The selection of participating schools and teachers was done by the directorate of Department of Education, IT & MV 2035 in consultation with the LTK PD Coordinator on logistics and planning.

The criteria used to select the participating schools was as follows, The school;

- had to be an ECDE centre within the county of Mombasa
- should have computer technology with LAN
- private schools in a position to purchase/create a server / LAN in the school lab

- if public- school should be those with the LTK software already installed and in use Grade 1,2 and 3 teachers.
- 

*1. Participating Private schools*

| School | Participanting teacher's name |
|---|---|
| 1. Qubaa primary school | Ibtisam Ahmed |
| 2. Busy Bee primary school | Jecinter Nzisa |
| 3. Abraar primary school | Zahra Ibrahim |
| 4. Victory Jr. primary school | Elizabeth Murunde |
| 5. Mt. Everest primary school | Faith Mburu |
| 6. Iyale Miritini primary school | Alice Saghe |
| 7. Nyali Primary primary school | Ann Munyiva Muasa |
| 8. KenCada primary school | Mildred Olang |
| 9. Gibbs Mtopanga school | Leah Nyambura Kariuki |
| 10. Mt. Sinai primary school | Mejumaa Matao |
| 11. Bububu Elite Acad. | Orone Roselyne |

2. *Participating Public School*

| School | Participating Teacher's name |
|---|---|
| 1. Ganjoni primary school | Grace A.Ondele |
| 2. Central primary school | Jesica Ouma |
| 3. St. Augustine preparatory school | Grace Kiama |
| 4. Mombasa primary school | Bimishi Mwidani |
| 5. Bamburi primary school | Ruth Agutu Mbagu |
| 6. Mtongwe primary school | Mwanapazia Mohamed |
| 7. Mikindani primary school | Fatuma Farahani |
| 8. Kisauni primary school | Eshikumo M Samira |
| 9. Mwijabu primary school | Getrude Siro |

*3. Participating County Education officers*

- Supervisor- Nune Adan
- QAS&C office Mwanamwinyi Juma
  Zainab Sunkar
  Hephzibah Masese
  Edwin Chombo

Due to budgetary constraints it was not possible to have all the 45 teachers from the above 20 selected schools attend. This is about 10% of the teachers out of the possible 825 ECDE teachers in the County of Mombasa. In an ideal situation, selecting two teachers (from each school)

attending provides an opportunity for in-school peer planning, teaching and support the trained teacher per school but this were not possible.
The model adopted for peer-support was cluster-based so that the trained teachers can easily visit each other and continue to learn and support one another in the presence of the County officer (mentor). The county officials played a monitoring and support role alongside monitoring the Competency-based curriculum (CBC) implementation. This model was meant to aide in the cascade to the other teacher in the select ECDE centre and have ECDE teachers using the LTK to implement the CBCs digital literacy component effectively.

Attendance summary

| Date | Male | Female | Comments |
|---|---|---|---|
| 13/11/2018 | 1 | 25 | 100% |
| 14/11/2018 | 1 | 25 | 100% |
| 15/11/2018 | 1 | 25 | 100% |

***N/B*** *one additional County officer attended the training. One of them being the officer in charge of training, monitoring and supervision of education in the county.*

Except for Likoni Primary, the attendance was 100% on the three days.

### Schedule and session plan (Also see appended session plan)

The training was held at the PDC hall on 13th, 14th and 15th. Being full day (18 hours) training, the sessions commenced formally at 830am and ended at 430pm with reflections.

The Director, Department of Education Mr. Bwanaheri Salim opened the training at 815 on the first day while his deputy Md. Muriithi formally closed the training at 430 pm on the last day. While opening the director emphasised, the importance of digital literacy for 21st century learning and how the department of ICT and education is passionate about ensuring that the children's care includes learning with technology. While closing Md. Muriithi reiterated the plan to implement the software and why the training was important for developing the requisite skills and knowledge for the teachers.

### Content & Concepts

Focus was on READS and ABRACADABRA aand the teacher Module which has rich resource for lesson preparation and assessment. The CBC Designs was used to align the skilling to the Competency based Curriculum implementation, ABRA checklist, were used to draw appropriate linkages from ABRA and the curriculum.

### Methodology

Experiential approach was used, this included a variety of cooperative learning strategies such as gallery walks, jig-saw, roulette and think pair-share. This was modelled through the training to help the teachers borrow some strategies to use in their own classrooms. The participants were grouped into 6 groups of 4 participants in each group. Two laptop/ computers were assigned between two participants within a group. This was meant to model how favourably the teachers can maximize the devices available to them in their schools and to also experience the shareability available in the software such as the multiple loggin component.

Throughout the training, group accountability was emphasised. The activities were carried out in pairs, group and whole class. Non-permanent grouping was used, with participants engaging with different people every now and then. The introduction activity also exposed the teachers to engage with their colleagues from the different schools and with the characters used in the software for example on day two each teacher adapted a name of a character in ABRA. This approach enhanced collegiality as was evidently seen in the conversations during the final reflections.

Modelling and demonstration were strongly used. Apart from the facilitator demo, the teachers were encouraged to demonstrate learned concepts at every stage. Emersion into the software was used extensively in the training where participants after introduction to the software, were assigned guiding questions to help them deepen their understanding and exploration of the tools.

Lesson planning was a strong component of the training. This aided in situating ABRa within the CBC curriculum. For lesson planning the participants were provided with ABRA activity checklist, CBC curriculum designs, and writing materials besides the software. Lesson planning and micro-teaching played a major role in deepening the LTK concepts and especially in embedding the activities in of the lesson in line with CBC.

### Micro-teaching

For the micro-teaching, the groups were reshuffled. Using the fishbowl, groups were assigned to plan around the PP1 or PP2. One officer was assigned a group to not only participate but also to oversee the planning. Whole class feedback was given to each group at the end of every lesson presentation. This was to aid in deepening the practice and getting different perspectives of ABRA and how to integrate it as a digital literacy tool. For this task, the individual groups had the liberty to select the concept they felt comfortable to plan around.

By and large the strands selected were reading and listening in both the PP1 and PP2 groups also. From the **listening strand** the sub-strands concepts demonstrated were; listening for comprehension, letter sounds, and active listening. Whereas in the **reading strand** selected concepts/activities were letter recognition, summarizing a story, reading practice, syllable counting and rhyming. The task required groups to prepare a lesson plan together as a group, presented the lesson plan to peers, subsequently micro-teach the lesson for 20 minutes and get feedback.

### Participants' enthusiasm during training

The participants in this training were a set of enthusiastic individuals, who were ready to challenge themselves beyond the norm. Although a good majority were using computer technology for the first time, they were eager to learn more with each day. Despite the transport problem (strike by public service vehicles), most teachers were in as early as 7 am eager to have more practice with the software before the sessions begun. On all the training days, we endeavoured to complete at 430pm so that the teachers can find their way home early enough. But despite the training ending at 430pm, many teachers stayed on longer, learning from each other and continuing with the practice.

The excitement and commitment were evident in their interactions, interest while performing the session activities and in the way, they arrived as early as 7am to practice before the sessions begun. There was a lot of enthusiasm, diligence and cooperation in delivery of assigned tasks. The participants agreeably learnt from each other and from the feedback given by the facilitation team.

### Implementation of ABRA & READS

There was a lot of excitement an d enthusiasm by the teachers to try out the soft ware in their classrooms. Most wanted to have the software installed on their personal gadgets so that they could use the software to use with their own children at home. However, Due to reasons such as absence of sufficient technology in the school only about 8 teachers from 8 schools were able to implement the use of ABRA & READS in their classrooms as shown in the below table. Except for one private school (Busy Bee school) the rest were from public schools that already had technology in place.

| SN | ECDE school on the ABRA program | Pre-Primary I class | Pre-Primary II class | Total number of participating learners |
|---|---|---|---|---|
| 1. | Mwijabu School ECDE Centre | 50 | 42 | 92 |
| 2. | Mikindani School ECDE Centre | 30 | 27 | 57 |
| 3. | Mombasa School ECDE | 30 | 33 | 63 |
| 4. | Kisauni School ECDE Centre | 30 | 86 | 106 |
| 5. | Ganjoni School ECDE Centre | 58 | 56 | 114 |
| 6. | St. Augustine School ECDE Centre | 32 | 43 | 75 |
| 7. | Busy Bee School ECDE Centre | 33 | 43 | 76 |
| 8. | Bamburi School ECDE Centre | 11 | 14 | 25 |
| **Total** | | **274** | **344** | **618** |

This eventually translated to about six hundred and fourteen (614) girls and boys out of a possible 94,000 learners in the ECDE in Mombasa County were exposed to the software. Unfortunately, population of exposed users is a drop in the ocean as compared to the non exposed learners in the county.

The teachers we observed in class were particularly in praise of the Alphabetics module of the ABRA as *"…the sounds, letters and words were brought to life*." one teacher said. The alphabetics Module resonates with the CBC 'English Activities learning area for both Pre-primary 1 and Pre-primary two. The learners at this level were exposed to the thematic strands on Listening, Speaking, reading and writing as they explored the software. Most of the teachers found ABRA *life changing* in their own understanding of concepts around phonics, phonological awareness and phonemic awareness and how best to deliver these concepts to the learners by way of technology. The learners showed great interest in the 'game' of learning as they interacted with the 17 Alphabetics activities.

Over the following several months of the year 2019, teachers who did not have the technology made several visits to the academy and the County education department requesting for an intervention with their schools to help them roll out the program. However, due to the lack in resources, there was little or no assistance offered to the teachers. That left only 8 schools out of 20 to implement.

The training was significantly successful with minimum challenges. Some have been highlighted here and a potential solution provided moving forward.
At the onset, there was the option of hosting the training in one of the LTK schools as we did not have training space and enough laptops. However, after a series of discussions, a solution was arrived at to use the refurbished MacBook's for the training.

Challenges and opportunities during the training and implementation

**Technology**: there was a challenge in accessing audio stories from READS. Participants were only able to access the non-audio stories.  Some stories from the 'country' category could not open on some machines but could on others. Secondly, the online teacher resource was not loading well and took a bit of time. We therefore reverted to the older version of the teacher zone to access the teacher resources.
Default accounts were used during the training thus not allowing for modelling of the ideal situations in their classes. We however emphasised that login in and out for the learner was mandatory and must be modelled to the learners from onset.

**Access to venue:** unfortunately, during training, there was an interruption in the public transportation, making it problematic for the teachers to travel to the academy for the training. But undeterred the attendance was at maximum with majority arriving well before 8am ready for the training. Training ended on time to allow the teachers enough time to find means back home.

**Implementation:** All ECDE centres have two classes PP1 & PP2 due to budgetary constraints, only one teacher was invited for the training from each centre. Only one participant was selected from each ECDE centre. We hope that this trained teacher will induct and mentor the colleague that missed the training. Also that the cluster-based support would aid in peer to peer enrichment.
The envisaged implementation in January of 2019 was delayed in the private centres as Installations of the software never happened. The public schools also required additional and upto date software soon This update was done but later in the year therby affecting the implementation of the ABRA.  Nonetheless, this did not dumpen the teachers enthusiasm as they occasionally borrowed the Macbooks from the academy to take to their classes.
A WhatsApp group was formed for continued peer Support and feedback. The discussions between the teachers were animated at the onset, there is some quiet as most are away on holiday. But we anticipate an awakening in the new year.

*The role of the County officers after the training*
Six county education department officers attended the training.  It was envisaged that the officers will form a backup and teacher support system. It is envisioned that the officers with the

support of Mary will support, monitor and assess the implementation of ABRA and READS in the County ECDE centres within their jurisdiction (cities).
Mary will coordinate with them

- By weekly cluster (city) meetings at a venue of their choice and with purpose of planning and feedback/review.
- Monthly reflection/retraining and planning meeting at the Aga khan academy or the County venue.
- School visit and support session for the trained and untrained teacher alongside the CBC monitoring visits.
- Untrained teacher visiting observing and learning from the trained teacher either across schools or in-school.
- Trained teacher in the public school to work closely with the Grade 1, 2, 3 teachers already implementing ABRA in their classroom.
- Encourage the use of ABRA in linking to other Learning areas such as Environmental activities,
- They will also be required to hold regular cluster meetings for planning and review.

### *Demand by more schools and Counties*

Due to the success of the the program in the implementing schools(as you will see in the testimonies in the annex) albeit only eight, there is tremendous demand for training of more teachers and expanding the use of the software to other County governments besides Mombasa.
Whereas the County education directorate desired to have all the ECDE teachers in the Mombasa county trained, the question of hardware still remained unanswered. In the recent past, there have been talk to have a few more County ECD's equipped with a fully fitted computer lab. This is yet to be realised despite the demand. The other alternative is to have the centres use tablets as they may be a cheaper option. However, this is yet to be realised. Yet if it were, then we are assured of greater learning outcomes in this county and the other interested counties.

Counties that have shown great interest in having the LTK (ABRA/READS) program rolled out in their County ECDE centre's are Embu, Kakamega, Trans Noia and Lamu.

## ANNEXES

## TESTIMONIES FROM ABRA BENEFICIARIES

### 1. Testimony from Bimishi Mwidau a seasoned ECDE, ABRA user working for the County Government of Mombasa

My name is Bimishi Mwidau, I am an ECDE teacher at Mombasa Primary School centre. I have used the ABRA in my class for the last two years having used another LTK tool called ELM.

In 2018, I was amongst the lucky few teachers to be selected to attend the ABRA training by the Agakhan professional Development Centre in partnership with the Department of Education. They thought there was need for early years learners to be equipped with digital skills which go cor-current with competency-based curriculum competency.

We went through an exciting 3 days training sessions on how to learn about the software we learnt about assorted pedagogical techniques, which materials to use and also ways on how manage classes which dont have enough gadgets and a lot of things we could use in our class to make learning fun. After the program started learners really enjoyed and learning was now fun and real. And truly ABRA has made learning very fun! The learners always ask to go and play ABRA games even when it is not time for the lesson.

Days were different ,my teaching changed completely as i was always a learner and am still a learner because i believe its a life long process.My learners were now able to atleast recognize letters of the ablphabets,letter sounds and names for al the twenty-six letters of the alphabets.

My ABRA Journey has been a very successful one,it has molded me be a 21 st Century ,improved my social networking,making new friends whom were ready to learn from me and vice versa. My learners love school very much and love me because of ABRA. Because of that the parents are happy. Although we do not have enough computers before Corona I had started peer teaching my co-teachers how to use ABRA so that all our children love schooling at Mombasa Primary ECDE.


ools in the county are using the software

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and writing skills

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public schools, including Ganjoni, Mikindani, Mwijabu, Bamburi, St Augustine and Kisauni.

Education officer Mary Nyale, who has been implementing the project since 2010, said all the teaching aids are installed in the digital literacy programme.

Unlike regular classrooms, where students follow lessons on the blackboard under the guidance of the teacher, with Abracadabra, the teacher spends only a few minutes to introduce the topic, then leaves the rest of the learning time to the software.

Sofia Mpenga, a pupil at Mombasa Primary School, shows President Uhuru Kenyatta how to use Abracadabra, a digital literacy tool.

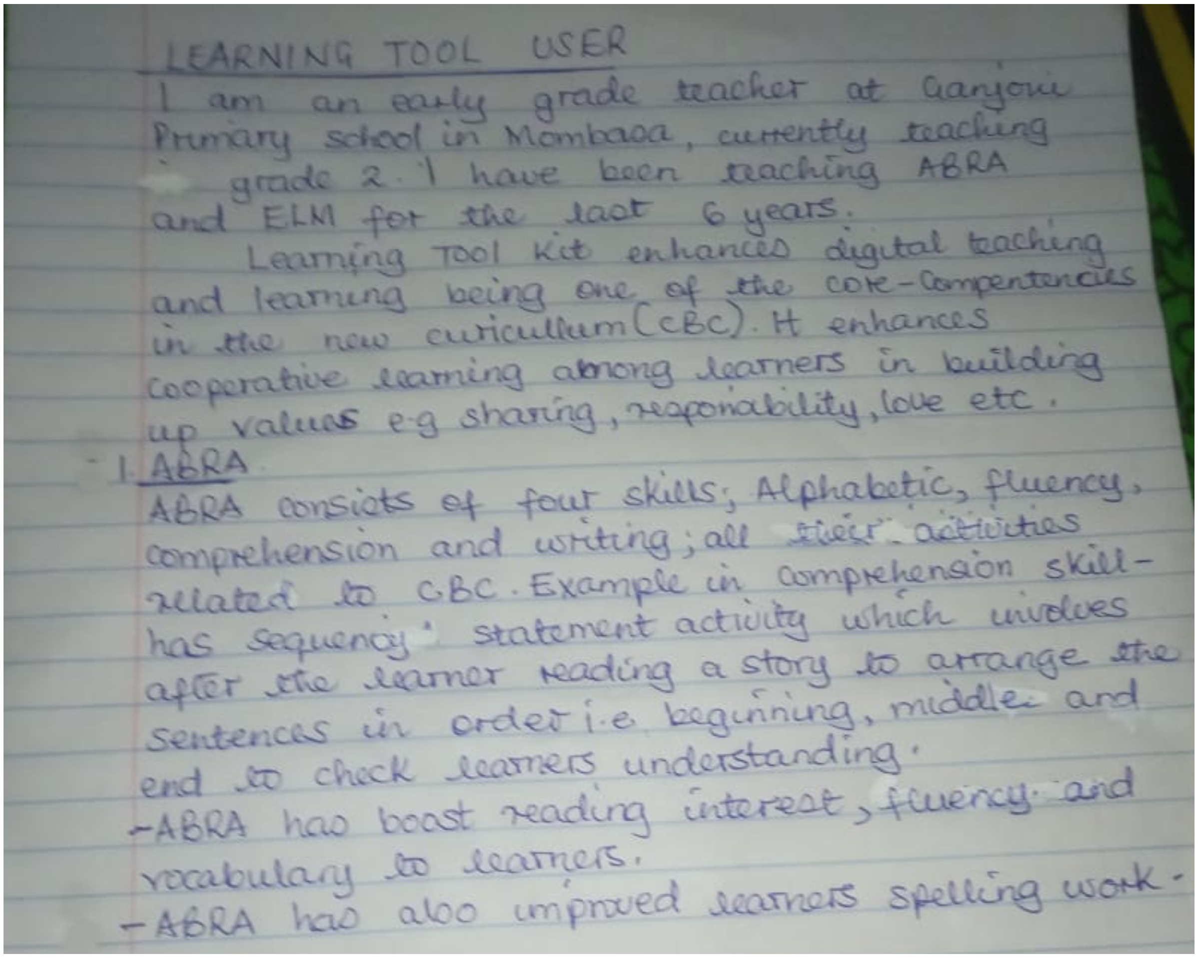
PHOTO | PSC

Best memories ever and made me a happy teacher,when my learners meet the President Uhuru Kenyatta ,Governor of Mombasa Hassan Ali Joho and team of Governors all over Kenya during the ACK internatonal trade fair Mombasa.

IT was a mark for the department as we were awarded best department which caters for young learners.

Last but not least i wish to send a bouquet of flowers to the ABRA team for introducing me to the amazing program.

2. Testimony from Mary Kacheru of Ganjoni Primary a seasoned early grades teacher and user of the LTK



LEARNING TOOL USER

I am an early grade teacher at Ganjoni Primary school in Mombasa, currently teaching grade 2. I have been teaching ABRA and ELM for the last 6 years.

Learning Tool Kit enhances digital teaching and learning being one of the core-Compentencies in the new curicullum (CBC). It enhances cooperative learning among learners in building up values e.g sharing, responsibility, love etc.

1. ABRA

ABRA consists of four skills; Alphabetic, fluency, comprehension and writing; all their activities related to CBC. Example in comprehension skill-has sequency statement activity which involves after the learner reading a story to arrange the sentences in order i.e beginning, middle and end to check learners understanding.

-ABRA has boast reading interest, fluency and vocabulary to learners.

-ABRA has also improved learners spelling work.

3.Testimony from Ruth Mbago and ECDE teacher at Bamburi school ECDE centre using ABRA for the first time after the training

My name is Ruth Mbago, an ECDE teacher at Bamburi Primary School. I have a teaching experience of thirteen years. Teaching is my hobby and I love being with the young children.

Children that we teach in class, comes from different backgrounds and social status, its my duty to make these children look the same while they are in school or class, which sometimes becomes so hard because some finds it hard to open up and socialise with others.

In 2018 December, I was introduced to ABRACADABRA where I was taught on how to incorporate it in language activities at school. At first I thought it was not possible since I had children who are not exposed to digital life so I did my lesson plan and arranged on how I was to take them in to the computer lab.

While we were in the lab, we made rules and introduced the children of pre-primary 1 to the gadgets. It was amazing as the learners were happy and earger to learn more.
Since then ABRA has made it very easy for me to facilitate learning. For sure I have achieved the following

- Learners enjoy peer teaching and sharing experiences
- Learners cooperate in activities assigned to them.
- All learners have equal opportunities to participate
- Learners have greatly improved in reading and fluency in language. ABBA is such a great teacher.

4. Testimony from county government of Mombasa Department of Education & ICT Directorate of quality assurance and child care

# COUNTY GOVERNMENT OF MOMBASA

## DEPARTMENT OF EDUCATION & ICT
## DIRECTORATE OF QUALITY ASSURANCE AND CHILD CARE
## REPORT ON LEARNING TOOLKIT 2020

**REPORT ON LEARNING TOOLKIT**

**PREAMBLE**

Learning Toolkit was introduced to Mombasa by the Concordia University through Agakhan Academy. Teachers of lower primary in Mombasa Municipality (before devolution) were trained on the programme by Professor Phillip Abrami and his team in collaboration with the Agakhan Academy. The programme has shown great potential for improving teaching and learning of English and technology skills in children.

In order to improve teaching and learning of English in the ECDE centres, the unit developed interest on the programme. The unit of Quality Assurance and Standards and Child Care approached the programme coordinators in Agakhan academy on behalf of the Department of Education and ICT and requested them to roll it down to ECDE. Professor Phillip, who is the founder of the programme accepted our invitation to attend the Public Service week where the programme was showcased. He was interested to see how the learners implemented their learning skills.

**Training of teachers**

On realizing the gap and lack of proper academic transition the unit requested the coordinators and the sponsors to lower the program to ECDE. Professor Phillip Abrami and Prof. Anne Wade accepted our request and came up with an ECDE teacher training curriculum for ABRA & READS.The Program started with the training of 25 people. Among these 20 were teachers and 5 were officers from this office. Teachers completed training and started implementing the Program.

*A training Session at Agakhan Academy*

**Trainees Graduation**

According to the procedures of the Program the trainee had to go through a special assessment system as the implemented the Program. After the assessment period only 8 trainees qualified for graduation after successfully implementing the program in their classrooms. Twelve (12) trainees failed to graduate due to lack of proper technology and facilities in their schools.

**Teachers' participation on the program**

All the teachers who got trained on the program developed a great interest and ensured effective implementation in their respective schools. This was established during routine assessment of teachers on pedagogy where the following was noted:

- The practicing teachers were doing well in teaching English thru use of ABRA activities
- The other teachers were also interested with the program and offered good cooperation to those implementing the program.
- Schools were always willing to participate in the showcasing activities.
- Learners were very much interested in the programme

As clearly indicated that ICT is the basic of Competency Based Curriculum (CBC) the Learning Toolkit program created a good background for learners in strengthening their competencies. Thanks to Concordia we had this opportunity!

**Showcasing of the program**

After the agreement with coordinators of the program, the department was granted permission to showcase it in order to sensitize other stakeholders on the program. This was allowed and it was for the first time showcased at Mombasa Devolution week in 2018 where it was blessed by the attendance the governor of Mombasa His Excellency Hassan Ali Joho and his deputy who camped at the education stand to watch the young learners exploring their learning skills.


*A PP2 learning demonstrating ABRACADABRA*

We rolled out the program though with a few challenges as not all our ECDE schools had the technology. But a few public schools that had technology implemented successfully such that during the Mombasa ASK Show our stand was graced by a visit from His Excellency president of Kenya Hon. Uhuru Kenyatta and the governor of Mombasa His Excellency Hassan Ali Joho who was very impressed by what the children could do with ABRA. He enjoyed and liked the program due interaction of learners through the digital experience.



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public schools, including Ganjoni, Mikindani, Mwijabu, Bamburi, St Augustine and Kisauni.

Education officer Mary Nyale, who has been implementing the project since 2010, said all the teaching aids are installed in the digital literacy programme.

Unlike regular classrooms, where students follow lessons on the blackboard under the guidance of the teacher, with Abracadabra, the teacher spends only a few minutes to introduce the topic, then leaves the rest of the learning time to the software.

Sofia Mpenga, a pupil at Mombasa Primary School, shows President Uhuru Kenyatta how to use Abracadabra, a digital literacy tool.
PHOTO | PS

*His Excellency President Uhuru Kenyatta and Our Governor at our stand during the Mombasa ACK show*

They stayed at the stand for a long period enjoying the activities. This visit was captured in our local daily as a highlight of the Mombasa Agricultural show 2018. The president recommended that other counties in Kenya to consider such a program.

**Impact of and need for Expansion of the programme**

After the training of teachers, the programme was rolled out in some of our public and one private ECDE schools. Learners were very much interested and used it with happiness. Parents were also impressed with the changes they noted in their children. Learners could read with proper pronunciations. The learners developed confidence and positive attitude towards learning of English as a subject. It has laid a strong foundation for learners in approaching the Competency Based Curriculum (CBC) and basic English language. The LTK program has really assisted our learners in acquiring proper reading skills such that many schools have approached our office to include them in the program but we are handicapped in many ways. The department has requested the program coordinators to train more teachers so that the program takes effect in more schools than it is now.

**Recommendations**

We as a department wish that:

- More of our ECDE teachers should be trained on ABRA &READS.
- Teachers be trained in ELM as it is useful for teaching and learning mathematical activities.

- Software be installed in all schools with trained Abracadabra teachers.
- The department ensures that all public ECDE schools have enough computers.
- The department to try to find a way of installing internet in all public ECDE schools

  It is also recommended that in order to create a strong foundation for learners of the Competency Based Curriculum the programme should be expanded to reach all the ECDE learners in the county.

**Conclusion**

In conclusion, the programme has been of great importance to the county of Mombasa. It has assisted in improving reading capacity in the schools and improved ECDE status. Children graduate to Grade one more prepared than in the schools that do not use ABRA. This office extends its sincere gratitude to Agakhan Academy and Concordia University for their consideration in introducing the program to Mombasa. We are privileged to have this program, which has become the envy of other counties who up to now keep calling to ask us about how they can access the program. ABRA has attracted a lot of attention!

5. Testimony from the administration of St. Augustine Preparatory School. One of the ABRA schools

**SAINT AUGUSTINE'S PREPARATORY SCHOOL**

**TOM MBOYA AVENUE (TUDOR) P. O. BOX 98209 – MOMBASA.**

**TEL: 492936 (SCHOOL) 492931 (BOARDING)**

**ABRA IN MY SCHOOL**

I am writing to express my gratitude and support for the ABRA and ELM programs under the Learning tool kit (LTK) being implemented in my school for early years learners. As a teacher, administrator and the person in charge of curriculum implementation in the school, I can confidently say that the program has been of great importance to both the learners and the teaching fraternity. I have personally used the program in teaching the lower grade and on several occasion observed lessons being taught by the teachers in ECDE and lower primary.Teachers are happy to use this program to improve teaching of Literacy and numeracy which are foundational skills. Before LTK was brought, we had other technology programs running. Unfortunately, no was for early years more specifically pre-primary. ABRA and ELM are the first that cater for early years education which makes us very delighted as a school. It has given our school prominence in this region.

I can without any doubt of contradiction states that the program has among other things improved attendance, our children come to school regularly as they look forward to going to play in the computer lab. The teachers are happy with the improved participation and language formation by the learners. Because of ABRA children are able to stay focused on tasks since ABRA is made in such a way that each learner is assessed in real time and the teacher can use this information to gauge each learner. This LTK software encourages communication and collaboration in all learners even those in PP1 as they work in pairs.

The availability of LTK program has change the teaching methods from a teacher-focused to a more student-focused model of teachingthis has enabled learners to make theirown decisionsand takean active role in learning.

The presences of the LTK in the school has motivated parents and made them feel their children are in the right school, as a school we have received many applications of parents seeking to join the school in Preprimary in order to get the correct foundational skills. This is an indicator that learners are benefiting from the technological enhanced lessons. And our parents are happy.

**Successes of the LTK program in my school**

1. The pupils enjoy the program so much they have always been looking forward for an ABRA lesson. They always say they want to go to the computer lab to play the ABRA games.

2. The learners have also improved in their digital ability as most of them can now handle mouse and control it as they operate.

3. Teachers levels of interest and enthusiasm in using technology has gone up this is shown by the frequent visits of the computer Lab at time you can find teachers at the doorstep waiting for their colleagues to finish their lessons so that they can get in.

The LTK has made it easy to implement digital literacy and the teacher don't need to look for other resources for DL.

**Challenges of the LTK program in my school**

Our biggest challenge is we do not have enough computers in our lab as most are old and breakdown often. It is our desire that we get help to furnish our school with more.

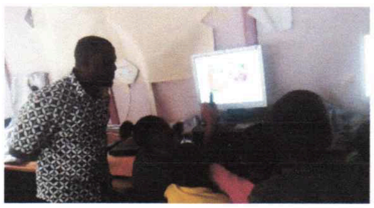
Secondly, only one ECDE teacher was trained from my school as I was made to understand that the resource to train the teachers were limited. We are happy that at least one of the ECDE teachers was trained. However, because we desire for uniformity in the ECDE, we hope that the Concordia team will consider training the remaining three ECDE teachers for uniformity and so that all the children can benefit from ABRA equally.

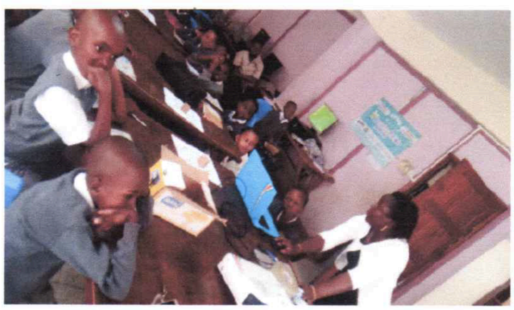
**In conclusion**

As a school we feel very privileged to have ABRA brought to us by Concordia University through Aga Khan Academy. We are thankful as our learners are able to get the correct foundational skills for literacy and numeracy.ABRA has put our school on the map amongst the giant performers. We sincerely, hope that you will train the remaining ECDE teachers for an even greater result.

LTK has excellent programsfor early literacy and numeracy and I hope to see more learners use it in my school even to help non-readers.

*Here are some pictures from my school on ABRA activities including lesson observation by me the deputy and an early year's teacher teaching ABRA in the computer lab while I observe.*





Abdi Adan
Deputy Headteacher
St Augustine Preparatory School


## B. ECDE TEACHER TRAINING

### A. TEACHER TRAINING SESSION PLAN

VENUE: Aga Khan Academy-PDC Hall

Date: 13th & 15th November 2018

**DAY 1**

| TIME | ACTIVITY | FACILITATOR |
|---|---|---|
| 8.00 - 8.30 am | Official opening<br>Welcome remarks<br>Opening remarks<br>House keeping | Director (EIT-MV) Mr. Bwanakheri Salim<br><br>RI |
| 8.30-9.30 am | Climate Setting<br>• Introduction<br>• Session Learning outcomes<br>• Expectations<br>• Key Inquiry question/Question | RI |
| 9.30 - 9.45 am | • About the Learning toolkit (Overview & Design features)<br>• Goals of literacy | RI |
| 9.45 – 10.30 am | • Identifying literacy skills in ECDE<br>• Exploring ABRA skills-linkages to ECDE literacy skills<br>• Log-in<br>• Navigating LTK | RI |
| 10.30 - 11.00 am | TEA BREAK | All participants |
| 11.00 – 12.30 pm | Understanding Alphabetics<br>Exploring alphabetics | RI |
| 12.30 - 1.30 pm | LUNCH BREAK | All participants |
| 1.30 – 2.00pm | Linkage- Lesson planning (Alphabetics) | RI/ MN |
| 2.00-3.00pm | Understanding Reading Fluency<br>Evidence & Fluency strategies<br>Exploring Fluency in ABRA | RI |
| 3.00 – 4.10 pm | Linkage- Lesson planning (Reading fluency)<br>Lesson Demos | RI |
| 4.10 – 4.20 pm | Session review | MN |
| 4.30 pm | Closure | |

DAY 2

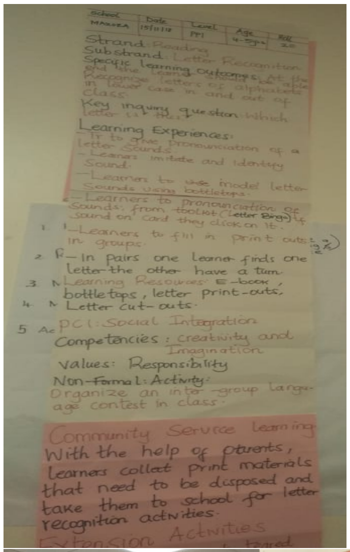
| TIME | ACTIVITY | FACILITATOR |
|---|---|---|
| 8.00 - 8.30 am | Recap of Day 1 and reflections | RI |
| 8.30-9.30 am | • Understanding Comprehension<br>• Comprehension strategies<br>• Exploring Comprehension in ABRA | RI/MN |
| 9.30-10.30 am | • Linkage to CBC | RI |
| 10.30 - 11.00 am | TEA BREAK | |
| 11.00 – 12.30 pm | Lesson planning (Comprehension)<br>Presentations and demos | |
| 12.30 - 1.30 pm | LUNCH BREAK | |
| 1.30 – 2.30pm | ABRA Lesson Demo (Writing) | MN |
| 2.30-4.10pm | Exploring writing in ABRA<br>Linkages to CBC designs<br>Identifying concepts linking | RI |
| 4.10 – 4.20 pm | Session review | MN |
| 4.30 pm | Closure | |

Day 3

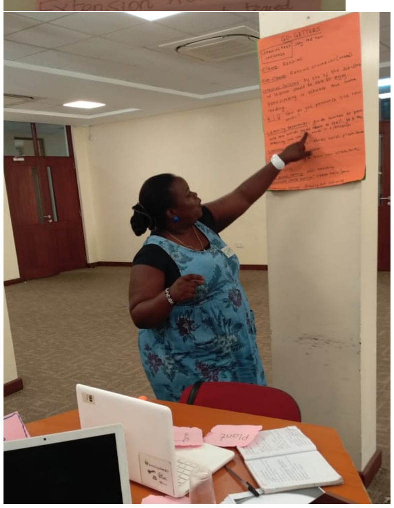
| TIME | ACTIVITY | FACILITATOR |
|---|---|---|
| 8.00 - 8.30 am | Recap of day 2 (Reflection roulette)<br>ABRA characters | <br>RI |
| 8.30-9.40 am | • Exploring READS<br>Search criteria | RI |
| 9.40 – 10.30 am | Teacher Module<br>• Log in (Old version)<br>• Exploring Teacher resources & use | EK |
| 10.30 - 11.00 am | TEA BREAK | All participants |
| 11.00 – 12.30 pm | Comprehensive CBC-ABRA linked Lesson planning | RI/MN |
| 12.30 - 1.30 pm | LUNCH BREAK | |
| 1.30 – 4.00pm | Micro-teaching and group feedback<br>Insights from a guest ECDE teacher (Naomi) | RI/MN<br>Naomi |
| 4.00-4.30pm | Official closing | RI/ Md. Mureithi (Deputy Director) |
| 4.30 pm | Closure | |

*Whole group picture at the end of the training*

READS demo.mp4




TR DEMO.mp4



Micro-teaching

Appendix F

# Project Instruments

Centre for the Study of Learning and Performance, 2018

**LITERACY INSTRUCTION QUESTIONNAIRE (v.3)**

Name ________________________________________
School ________________________________________
Grade level/Year you teach ______________________________
Years of teaching experience ______________________________
Technology available for your teaching the English language ____________________
________________________________________________
Hours of English your students have per week __________________________

Please check the most appropriate response when answering the questions about your lesson **"Never"** – 0 times; "**Rarely**"- 1- 3 times; "**Occasionally**" – 4-6 times; "**Frequently**" – 7-10 times; "**Very frequently**" – more than 10 times; **"I do not know"** what this activity means

| **During this term, in your English Language lessons, how often have your pupils been engaged in the following activities?** | | Never | Rarely | Occasionally | Frequently | Very frequently | I do not know |
|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | |
| 1. | Blending sounds into words | | | | | | |
| 2. | Sounding out words such as c-a-t (i.e. segmenting) | | | | | | |
| 3. | Rhyming | | | | | | |
| 4. | Decoding (i.e. pronouncing written words) | | | | | | |
| 5. | Spelling | | | | | | |
| 6. | Reading aloud (i.e. pupil is reading aloud) | | | | | | |
| 7. | Reading a text in a small group of same ability and interacting with each other while and after reading about words and ideas (i.e. guided reading) | | | | | | |
| 8. | Re-reading aloud the passage after a teacher modelled fluent reading of it (e.g. echo reading) | | | | | | |
| 9. | Silent reading | | | | | | |
| 10. | Defining or explaining the meaning of words | | | | | | |

| During this term, in your English Language lessons, how often have your pupils been engaged in the following activities? | | Never | Rarely | Occasionally | Frequently | Very frequently | I do not know |
|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | |
| 11. | Listening to the text the teacher is reading loud | | | | | | |
| 12. | Making predictions to anticipate what they are about to read | | | | | | |
| 13. | Asking questions to their peers about the text they have read or are reading | | | | | | |
| 14. | Monitoring their comprehension (e.g. re-reading, asking for help) | | | | | | |
| 15. | Answering teachers' questions orally or in writing | | | | | | |
| 16. | Summarizing a story orally or in writing | | | | | | |
| 17. | Identifying story characters, plot, setting after reading a story (i.e. story mapping) | | | | | | |
| 18. | Identifying the beginning, middle and end of the story (i.e. sequencing events from a story) | | | | | | |
| 19. | Reading in pairs and small groups | | | | | | |
| 20. | Using the language (words) the teacher provided to complete a writing task (i.e. guided writing) | | | | | | |
| 21. | Filling in worksheets | | | | | | |
| 22. | Retelling the story orally or in writing | | | | | | |
| 23. | Writing a journal/log | | | | | | |

If you use **computer technology** to teach English, please answer the following question:

| **During this term, how much time did you devote to the use of any computer technology in your English Language instruction? Name the software you and /or pupils used** | | Did not use at all | 5 hours or less | 6-10 hours | 11-15 hours | 16 hours or more |
|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 |
| 24. | | | | | | |
| 25. | | | | | | |
| 26. | | | | | | |

Please answer the following questions in regard to **Pupil-Teacher Interactions during this term:**

27. In your class who asks more questions? (Underline what applies)

    Male Pupils  Female Pupils  No Difference

28. Among the pupils who come to see you voluntarily, are there more ....? (Underline what applies)

    Male Pupils  Female Pupils  No Difference

29. How do you divide your pupils in groups during your lessons? (Underline what applies)

    By ability  By gender  By age  Randomly

30. Please rate your impressions about your ***female pupils*** in your English Language lesson:

| | Outstanding | Good | Satisfactory | Poor |
|---|---|---|---|---|
| Academic Results | | | | |
| Potential to Learn | | | | |
| Behaviour | | | | |

31. Please rate your impressions about your ***male pupils*** in your English Language lesson:

| | Outstanding | Good | Satisfactory | Poor |
|---|---|---|---|---|
| Academic Results | | | | |
| Potential to Learn | | | | |
| Behaviour | | | | |

**Please add other comments pertaining to your English Language instruction**:

______________________________________________

______________________________________________

______________________________________________

**Thank you for completing this questionnaire!**

Observer name: ______________________________________________________

Date: ______________________________________________________________

School name: ________________________________________________________

Location: ___________________________________________________________

Teacher name: _______________________________________________________

Grade: __________ Number of learners/pupils: _____________ Age range: ______________

Boys: _______ Girls: ________ Length of lesson: _______ (minutes)

ABRA class ☐ Control class ☐

***I. General Classroom Environment*** (tick what applies)

**Physical Context**

Classroom ☐ Computer Lab ☐ Computer Station/Center ☐ Mobile Lab(tablets) ☐

**Technology**

Learner/pupil-computer ratio: ______learners per computer

Technology works properly: Yes ☐ No ☐

Comment on what works/ does not work :

______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

Choose the statement describing the teachers' level of comfort with technology. The teacher:

- ☐ is avoiding technology and is anxious about using computers;
- ☐ knows the basics but is sometimes frustrated using computers and lacks confidence when using them;
- ☐ is confident in using the computer for specific tasks;
- ☐ can use many different computer applications; the computer as an instructional tool that she integrates into the curriculum.

Choose the level of learners' comfort with technology:

Very comfortable ☐ Somewhat comfortable ☐ Not at all ☐

**Teaching**

Instructions are clear: Yes ☐ No ☐ ______________________________

Activities are logically sequenced: Yes ☐ No ☐ ______________________________

Learners are given timely feedback: Yes ☐ No ☐ ______________________________

Learners interact with each other: Yes ☐ No ☐ ______________________________

***II. English Language Activities Structure***

**Word Level Activities** (all alphabetic or phonics based activities)

a. How much time is spent on word level activities?

___Less than 5 min
___5 - 15 min
___More than 15 min

b. What type of word level activities did you see?

____ Blending sounds into words
____ Sounding out words such as c-a-t (i.e. segmenting)
____ Pronouncing written words (i.e. decoding)
____ Rhyming

Other **Word Level Activities** (please describe)
______________________________________________
______________________________________________

| |
|---|
| Technology used: ☐ Yes ☐ No |
| Computers/tablets ☐ How many? ____ |
| Projector ☐ |
| Please name <u>ABRA activities used</u> (e.g., Blending Train, Rhyme Matching) |
| ______________________________ |
| ______________________________ |
| ______________________________ |
| ______________________________ |

c. Do learners/pupils work in pairs/small groups? Yes ☐ No ☐
d. How many learners are there per small group? __________

**Text Level Activities** (all fluency/comprehension types of activities)

a. How much time is spent on text level activities?
___Less than 5 min
___5-15 min
___More than 15 min

b. What type of text level activities did you see?
____ Pupil is reading aloud
____ Whole class is reading in a choir
____ Flash card work
____ Listening to the text the teacher is reading loud
____ Summarizing a story orally
____ Answering teachers' questions orally
____ Reading in pairs and small groups
____ Reading with expression
____ Making predictions to anticipate what the class is about to read
____ Identifying the beginning, middle and end of the story
____ Defining or explaining the meaning of words

| |
|---|
| Technology used: ☐ Yes ☐ No |
| Computers/tablets ☐ How many? ____ |
| Projector ☐ |
| Please name <u>ABRA activities used</u> (e.g., High Frequency Words, Story Elements ) |
| ______________________________ |
| ______________________________ |
| ______________________________ |
| ______________________________ |
| ______________________________ |
| ______________________________ |
| ______________________________ |

Other **Text Level Activities** (please describe)

______________________________________________________________________

c. Do learners/pupils work in pairs/small groups? Yes ☐ No ☐
d. How many learners are there per small group? _________

**Writing Activities**

a. How much time is spent on writing activities?
___Less than 5 min
___5-15 min
___More than 15 min

b. What type of writing activities did you see?
___ Answering teachers' questions in writing
___ Copying
___ Filling in worksheets
___ Retelling a story in writing
___ Dictation

| |
|---|
| Technology used: ☐ Yes ☐ No |
| Computers/tablets ☐ How many? ____ |
| Projector ☐ |
| Please name ABRA activities used |
| (e.g., Spelling Sentences) |
| ______________________________ |
| ______________________________ |
| ______________________________ |

Other **Writing Activities** (please describe)

______________________________________________________________________

c. Do learners/pupils work in pairs/small groups? Yes ☐ No ☐
d. How many learners are there per small group? _________

**Extension Activities** (activities that relate to or expand from a reading activity)

a. Was it an ABRA extension activity?
Yes ☐ (please name) ____________________________________ No ☐

b. What type of extension activities did you see?
_____Retelling (Retell a story read in class, etc)
_____Additional writing (Write your own story/ending, etc)
_____Creative arts (Drawing a story, etc)
_____Dramatic play (Skit, etc)

Other (please describe) ______________________________________________

c. What type of homework did the teacher assigned?
___Word Level
___Text Reading
___Writing
___Worksheets

Other (please describe) ______________________________________________

***III. Learners' Interactions with ABRA*** (***<u>for ABRA classes only</u>***, tick one that applies)

a. The learners are enthusiastic about doing ABRA activities.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

b. The learners effectively navigate ABRA.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

c. The learners are engaged in ABRA activities.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

d. When using ABRA, the learners attend to the given task.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

e. When in ABRA, the learners do the task on their own with little or no prompting from the teacher.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

f. When facing a technology problem, the learners help/support each other.
Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree ☐

Other manifestations of learners' engagement with ABRA (please describe)

________________________________________________________________

________________________________________________________________

***IV. Learner-Teacher interactions*** (***<u>for mixed-gender classes only</u>***)

a. In this class who asked more questions? (tick one that applies)
Male learners ☐ Female learners ☐ No Difference ☐

b. How often did the teacher call upon the learners? (tick one that applies)
Female learners: Very Frequently ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never ☐

Male learners: Very Frequently ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never ☐

c. How did the teacher divide the learners in groups during the lesson? (tick one that applies)
By ability ☐ By gender ☐ By age ☐ Randomly ☐ No groups ☐

d. When explaining and providing examples, the language the teacher tended to use was (check one that applies)
Masculine ☐ Gender neutral ☐ Feminine ☐

*e.* Please use the following scale to rate your impressions about the **female learners** in this class (tick one that applies*):*

| | *Outstanding* | *Good* | *Satisfactory* | *Poor* |
|---|---|---|---|---|
| *Performance* | | | | |
| *Behaviour* | | | | |

*f.* Please use the following scale to rate your impressions about the **male learners** in this class (tick one that applies*):*

| | *Outstanding* | *Good* | *Satisfactory* | *Poor* |
|---|---|---|---|---|
| *Performance* | | | | |
| *Behaviour* | | | | |

**V.** "When observing this classroom, I mostly see the following happening…" (tick one description that applies)

1.
*- Students are not attending to the task at hand. They are distracted and off-task.*
*- There is a lot of disruption and movement not related to the activity.*
*- The teacher cannot get the children to remain on task.*

2.
*- Students occasionally attend to the given task.*
*- There is occasional disruption and movement not related to the activity.*
*-Occasionally, when the students are off task the teacher is able to refocus the group with some effort.*

3.
*- Some students are attending to the given task.*
*- There is little off task behaviour.*
*- The teacher is able to guide students through the lesson with minimal diversions from the task.*

4.
*- Most students are attending to the given task.*
*- There is minimal or no off-task behaviour*
*- The teacher is able to guide students through activities effectively.*

5.
*- All students are involved in the given task.*
*- There is no off-task behavior.*
*- The children are discussing the task on their own with little or no prompting from the teacher.*
*- The students are providing the teacher with new directions in which to go by actively participating in the discussions and are providing the teacher with feedback.*

# Mathematics Teacher Questionnaire

This questionnaire is part of a study being conducted by the Centre for the Study of Learning and Performance at Concordia University in Montreal, Canada and Aga Khan Academy, in Mombasa Kenya. The goal of this study is to support the development of mathematics skills in young children. In that regard, we have developed a questionnaire to learn more about the context in which you teach mathematics to your class.

All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to the school or the school district administration. Participation in this project is voluntary and you are free to discontinue at any time. However, your professional experiences and opinions are crucial to helping us understand teaching from the educator's point of view. We would greatly appreciate your taking the time to complete our questionnaire.

If you have questions and concerns, please contact the LTK+ project coordinator Mr. Enos Kiforo at enos.kiforo@agakhanacademies.org.

We thank you for your participation in this study!

*Ethics certificate # 10000298*

1. What is your full name? ____________________________________________

2. What is your gender?

Male (1)

Female (2)

3. How old are you? ____________________________________________

4. What is your highest level of education?

Some high school (1)

Completed high school (2)

Some university or college (3)

Completed university or college (4)

Undergraduate university degree (5)

Graduate university degree (6)

Completed teacher college (7)

5. What is your undergraduate degree in? ______________________________

6. How many years were you in a teacher education program? __________________

7. List the mathematics education courses you have taken at the undergraduate and graduate levels. If you don't remember, write "I do not remember".

____________________________________________

____________________________________________

9. Since your graduation, have you attended any professional development workshops regarding teaching mathematics?

Yes (1)

No (2)

10. What topics were these workshops focused on?

____________________________________________

____________________________________________

11. Can you estimate the number of hours spent at these workshops regarding teaching mathematics? ____________________________________________

*Ethics certificate # 10000298*

12. How many years have you been teaching? ________________________________

13. What is your school name? _____________________________________________

14. What grade level/standard are you currently teaching?
    Kindergarten (1)
    Grade 1 (2)
    Grade 2 (3)
    Grade 3 (4)
    Other: _________________________________________ (5)

15. How many hours of Math instruction does your class have per week? _____________

16. Have you ever used any computer program to teach your class?
    Yes (1)
    No (2)

17. What computer program have you used?

    ____________________________________________________________________

18. How many learners are there in your class? _________________________________

19. How many girls? __________________________________________________

20. How many boys? __________________________________________________

21. How confident are you in early mathematics?
    Very Confident (1)
    Somewhat Confident (2)
    Neutral (3)
    Somewhat Unconfident (4)
    Very Unconfident (5)

22. Which of the following mathematical concepts do you usually teach to this grade level?

Counting (1)

Comparing (2)

Subtracting (3)

Adding (4)

Place value (5)

Geometry (6)

Patterns (7)

Decomposing (8)

23. Do you teach your class using PRIEDE curriculum?

Yes (1)

No (2)

24. What sort of computer equipment are learners in your class able to access?

Desktop computers (1)

Laptops or tablets (2)

DLP tablets (3)

All the above (4)

None (5) ***- If you chose "none", skip questions 25 – 32 and resume at 33***

25. If you have computers/tablets, are they:

In every classroom (1)

In a special computer lab (2)

Both (3)

26. If your school has a computer lab, how can you access it?

At any time (1)

According to the school schedule (2)

I have to coordinate with other teachers (3)

Other: ______________________________________ (4)

27. Are there enough computers/tablets for your entire class?

Yes (1)

No (2)

28. How many learners are there to a computer/ tablet? ____________________________

29. How reliable are the computers in your school?

Very reliable (1)

Somewhat reliable (2)

Neutral (3)

Somewhat unreliable (4)

Very unreliable (5)

30. How reliable is the electricity for the computers in your school?

Always available (1)

Available at certain hours a day (2)

Available under my control (3)

Unpredictable—over days (4)

Unpredictable—throughout any given day (5)

31. Does your school have a generator?

Yes (1)

No (2)

32. Is the generator available to support computer use?

Yes (1)

No (2)

I do not know (3)

33. Had you seen anyone else use ELM in the classroom before you joined this project?

Yes (1)

No (2)

34. If yes, who? ____________________________________________________________

35. How comfortable are you in your abilities to teach with computers?

Very Comfortable (1)

Somewhat Comfortable (2)

Neutral (3)

Somewhat Uncomfortable (4)

Very Uncomfortable (5)

*Ethics certificate # 10000298*

# Mathematics Teacher Questionnaire (end-of-year)

This questionnaire is part of a study being conducted by the Centre for the Study of Learning and Performance at Concordia University in Montreal, Canada and Aga Khan Academy, in Mombasa Kenya. The goal of this study is to support the development of mathematics skills in young children. In this regard, we are asking you to complete the questionnaire about your experiences in teaching mathematics to your class this year.

All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to the school or the school district administration. Participation in this project is voluntary and you are free to discontinue at any time. However, your professional experiences and opinions are crucial to helping us understand teaching from the educator's point of view. We would greatly appreciate your taking the time to complete our questionnaire.

If you have questions and concerns, please contact the LTK+ project coordinator Mr. Enos Kiforo at enos.kiforo@agakhanacademies.org.

We thank you for your participation!

*Ethics certificate # 10000298*

1. What is your full name? ______________________________________________________
2. What is your school name? ______________________________________________
3. This year, have you attended any professional development workshops about teaching mathematics?
   Yes (1)
   No (2)
4. What topics were these workshops focused on?
   ___________________________________________________________________________
   ___________________________________________________________________________
   ________________________________________________________________________
5. Were any of these workshops related to ELM instruction?
   Yes (1)
   No (2)
6. Can you estimate the total number of hours you spent at these workshops? _________
7. What grade level are you currently teaching? __________________________________
8. How many learners are there in your class? ___________________________________
9. How many girls? ___________________________________________________
10. How many boys? ___________________________________________________
11. How many hours of Math instruction does your class have per week? _____________
12. This year, have you taught your class using PRIEDE curriculum?
    Yes (1)
    No (2)
13. Which of the following mathematical concepts have you taught to your class in 2021?
    Counting (1)
    Comparing (2)
    Subtracting (3)
    Adding (4)
    Place value (5)
    Geometry (6)

*Ethics certificate # 10000298*

Patterns (7)

Decomposing (8)

Bar graphs and tables (9)

Number as displacement (10)

14. How confident are you in early mathematics?

Very Confident (1)

Somewhat Confident (2)

Neutral (3)

Somewhat Unconfident (4)

Very Unconfident (5)

15. This year, have you used ELM software to teach your Math class?

Yes (1)

No (2) ***- If you chose "no", skip questions 16 – 23 and resume at 24***

16. This year, how many hours per week have you used ELM to teach your Math class?

Less than 1 hour (1)

Between 1 and 2 hours (2)

More than 2 hours (3)

17. Which of the mathematics concepts have you taught using ELM this year?

Counting (1)

Comparing (2)

Subtracting (3)

Adding (4)

Place value (5)

Geometry (6)

Patterns (7)

Decomposing (8)

Bar graphs and tables (9)

Number as displacement (10)

18. Which of the ELM features and resources have you used this year?

ELM student activities (1)

Consolidation questions (2)

Offline lessons (3)

ELM reports (4)

Student plans (5)

19. How comfortable are you in using ELM to teach mathematics?

Very Comfortable (1)

Somewhat Comfortable (2)

Neutral (3)

Somewhat Uncomfortable (4)

Very Uncomfortable (5)

20. This year, have other teachers from your school used ELM in their classes?

Yes (1)

No (2)

21. This year, have you received in-school support in using ELM for Math instruction?

Yes (1)

No (2)

22. How satisfied are you with the quality of in-school ELM support?

Very satisfied (1)

Somewhat satisfied (2)

Neutral (3)

Somewhat unsatisfied (4)

Very unsatisfied (5)

23. To what extent do you agree with the following statements?

| *The use of ELM ...* | *Strongly disagree* | | *Neutral* | | *Strongly agree* |
|---|---|---|---|---|---|
| was effective because I implemented it well | 5 | 4 | 3 | 2 | 1 |
| eased pressure on me as a teacher | 5 | 4 | 3 | 2 | 1 |
| was effective for my students of all abilities | 5 | 4 | 3 | 2 | 1 |
| demanded too much time to be spent on technical problems | 5 | 4 | 3 | 2 | 1 |
| made me feel comfortable in teaching Math | 5 | 4 | 3 | 2 | 1 |
| was successful because I was trained | 5 | 4 | 3 | 2 | 1 |
| took a lot of time and effort | 5 | 4 | 3 | 2 | 1 |
| benefited me and my students, therefore I will teach with ELM next year | 5 | 4 | 3 | 2 | 1 |

24. What other software have you used to teach mathematics?

____________________________________________________________________________

____________________________________________________________________________

25. What sort of computer equipment have the learners in your class used to learn mathematics this year?
    - Desktop computers (1)
    - Laptops/tablets (2)
    - All the above (3)
    - None (4) ***- If you chose "none", skip questions 26 – 28 and resume at 29***

26. If you used a computer lab, how have you accessed it?
    - At any time (1)
    - According to the school schedule (2)
    - I had to coordinate with other teachers (3)
    - Other: ____________________________________ (4)
27. In your class how many learners are there to one computer/ tablet? ________________
28. How reliable has your lab (computers/tablets) been this year?
    - Very reliable (1)
    - Somewhat reliable (2)
    - Neutral (3)
    - Somewhat unreliable (4)
    - Very unreliable (5)
29. How comfortable are you in your abilities to teach with computers?
    - Very Comfortable (1)
    - Somewhat Comfortable (2)
    - Neutral (3)
    - Somewhat Uncomfortable (4)
    - Very Uncomfortable (5)

Observer name: ________________________________________________

Date: ________________________________________________

School name: ________________________________________________

Location: ________________________________________________

Teacher name: ________________________________________________

Grade: _________ Number of learners/pupils: ____________ Age range: ________

Boys: _______ Girls: ________ Length of lesson: _______ (minutes)

ELM class ☐ Control class ☐

***I. Classroom Environment*** *(tick what applies)*

Classroom ☐ Computer Lab ☐ Computer Station/Centre ☐ Mobile Lab(tablets) ☐

**Educational technology**

Projector ☐

Other technology ____________________________________

Learner/pupil-computer ratio: ______learners per computer/tablet

Technology works properly: Yes ☐ No ☐

Comment on what works/ does not work :

________________________________________________________________

________________________________________________________________

**Teacher and learner comfort with technology**

Tick the statement describing the *teachers'* level of comfort with technology.

The teacher:

- ☐ is avoiding technology and is anxious about using computers;
- ☐ knows the basics but is sometimes frustrated using computers and lacks confidence when using them;
- ☐ is confident in using the computer for one specific task;
- ☐ uses different computer applications; the computer is an instructional tool that she integrates smoothly in her teaching.

Tick the level of *learners'* comfort with technology:

Very comfortable ☐ Somewhat comfortable ☐ Not at all ☐

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**Adding**

Technology used: ☐ Yes ☐ No

*ELM Adding activities* (tick all used)
Activity 1 ☐ Activity 2 ☐ Activity 3 ☐
Activity 4 ☐

*Teacher integrated the ELM lesson plan*
Yes ☐ No ☐

a. How much time was spent on adding activities?
- ___less than 5 minutes
- ___5-10 min
- ___more than 15
- ___whole lesson

b. If not ELM adding activities, what type of adding activities did you see? (tick all that apply)
- ___ determining the missing addend by adding objects
- ___ counting on or up (using a finger pattern, etc)
- ___ solving problems based on part-whole understanding
- ___ writing equations representing adding

Other adding activities:

________________________________________________________________

**Subtracting**

Technology used: ☐ Yes ☐ No

*ELM Subtracting activities* (tick all used)
Activity 1 ☐ Activity 2 ☐ Activity 3 ☐
Activity 4 ☐ Activity 5 ☐

*Teacher integrated the ELM lesson plan*
Yes ☐ No ☐

a. How much time was spent on subtracting activities?
- ___less than 5 minutes
- ___5-10 min
- ___more than 15
- ___whole lesson

b. If not ELM subtracting activities, what type of subtraction activities did you see? (tick all that apply)
- ___ removing objects from a pile
- ___ counting down (using a finger pattern, etc)
- ___ solving problems based on part-whole understanding
- ___ writing equations representing subtraction

Other subtracting activities:

________________________________________________________________

**Decomposing**

Technology used: ☐ Yes ☐ No

*ELM Decomposing activities* (tick all used)
Activity 1 ☐ Activity 2 ☐ Activity 3 ☐
Activity 4 ☐

*Teacher integrated the ELM lesson plan*
Yes ☐ No ☐

a. How much time was spent on decomposing activities?
- ___less than 5 minutes
- ___5-10 min
- ___more than 15
- ___whole lesson

b. If not ELM decomposing activities, what type of decomposing activities did you see? (tick all that apply)
- ___ finding all pairs of numbers that sum to a given number
- ___ solving problems based on part-whole understanding
- ___ writing equations representing a decomposition of a number
- ___ addressing recognition of either or both the vertical or horizontal pattern in a table of decompositions of a number

Other decomposing activities:

________________________________________________________________

## I. *Mathematic Activities*

**Counting**

| Technology used: ☐ Yes ☐ No |
|---|
| *ELM Counting activities* (tick all used) |
| Activity 1 ☐ Activity 2 ☐ Activity 3 ☐ |
| Activity 4 ☐ Activity 5 ☐ |
| *Teacher integrated the ELM lesson plan* |
| Yes ☐ No ☐ |

a. How much time was spent on counting activities?
___less than 5 minutes
___5-10 min
___more than 15
___whole lesson

b. If not ELM counting activities, what type of counting activities did you see? (Tick all that apply)
___ counting physical objects
___ keeping record while counting
___ one-to-one counting/enumeration
___ counting up/down
___ counting by twos, etc
___ applying ordinal terms
___ associating numeral with a count of objects

Other counting activities:
_______________________________________________________________

**Comparing**

| Technology used: ☐ Yes ☐ No |
|---|
| *ELM Comparing activities* (check all used) |
| Activity 1 ☐ Activity 2 ☐ Activity 3 ☐ |
| Activity 4 ☐ |
| *Teacher integrated the ELM lesson plan* |
| Yes ☐ No ☐ |

a. How much time was spent on comparing activities?
___less than 5 minutes
___5-10 min
___more than 15
___whole lesson

b. If not ELM comparing activities, what type of comparing activities did you see? (tick all that apply)
___ determining whether cardinalities are the same
___ determining which cardinality is smaller/bigger
___ practicing different ways of saying/writing that cardinalities are the same, bigger or smaller
___ comparing neighbouring numbers
___ playing games that involve keeping score
___ mental comparison of number words

Other comparing activities: _______________________________________________________________

**Number line**

| |
|---|
| Technology used: ☐ Yes ☐ No |
| *ELM Number line activity* ☐ |
| *Teacher integrated the ELM lesson plan* Yes ☐ No ☐ |

a. How much time was spent on patterns activities?
___ less than 5 minutes
___5-10 min
___more than 15
___whole lesson

b. If not doing Number as Displacement activity in ELM, what type of number line activities did you see?
______________________________________________________________________________
______________________________________________________________________________

### *III. Mathematic Instruction*

Please use the scale of 1 to 5, where 1 means "not at all" and 5 means "very frequently", rate the behaviours you can observe in a math class (items 13-18 pertain exclusively to classes where ELM is used)

| | **During this Math class, I observed the following...** | Not at all | Rarely | Occasionally | Frequently | Very Frequently |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1. | The learners were engaged in Math activities. | | | | | |
| 2. | The learners provided support for each other. | | | | | |
| 3. | The teacher was enthusiastic about teaching Math. | | | | | |
| 4. | The teacher provided clear directions. | | | | | |
| 5. | The teacher used mathematical language when giving instruction. | | | | | |
| 6. | The teacher checked on the learners' understanding during instruction. | | | | | |
| 7. | The teacher checked on progress during work time. | | | | | |
| 8. | The teacher circulated and provided feedback. | | | | | |
| 9. | The teacher addressed learners' mistakes adequately. | | | | | |
| 10. | The teacher allowed the learners who mastered the basics to take on more challenging tasks. | | | | | |
| 11. | The teacher encouraged dialogue between learners during activities. | | | | | |
| 12. | The teacher encouraged class discussion to consolidate learning. | | | | | |
| 13. | When using ELM, the learners attended to the given task. | | | | | |

**Place Value**

a. How much time was spent on place value activities?
___ less than 5 minutes
___5-10 min
___more than 15
___whole lesson

b. If not doing place value activities in ELM, what type of place value activities did you see? (tick all that apply)
___building a number (digit cards or blocks)
___place value worksheets
___number line-up

Technology used: ☐ Yes ☐ No

*ELM Place Value activities* (tick all used)
Activity 1 ☐ Activity 2 ☐ Activity 3 ☐
Activity 4 ☐

*Teacher integrated the ELM lesson plan*
Yes ☐ No ☐

Other place value activities: ____________________________________________

**Geometry**

a. How much time was spent on geometry activities?
___ less than 5 minutes
___5-10 min
___more than 15
___whole lesson

Technology used: ☐ Yes ☐ No

*ELM Geometry: Identify shapes activities* (tick all used)
Activity 1 ☐ Activity 2 ☐ Activity 3 ☐

b. If not doing place value activities in ELM, what type of geometry activities did you see?
______________________________________________________________
______________________________________________________________

**Patterns**

a. How much time was spent on patterns activities?
___ less than 5 minutes
___5-10 min
___more than 15
___whole lesson

Technology used: ☐ Yes ☐ No

*ELM Translate Pattern activity* ☐

b. If not doing Translate Patterns in ELM, what type of pattern activities did you see?
______________________________________________________________
______________________________________________________________

**Data**

a. How much time was spent on data activities?
___ less than 5 minutes
___5-10 min
___more than 15
___whole lesson

Technology used: ☐ Yes ☐ No
*ELM Bar Graphs and Tables activities*
*Activity 1* ☐ *Activity 2* ☐

b. If not doing Bar Graphs and Tables in ELM, what type of data activities did you see?
______________________________________________________________
______________________________________________________________

| **During this Math class. I observed the following…** | | Not at all | Rarely | Occasionally | Frequently | Very Frequently |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 14. | When in ELM, the learners did the task on their own with little or no prompting from the teacher. | | | | | |
| 15. | The learners were able to effectively navigate ELM. | | | | | |
| 16. | The teacher support to the learners using ELM was adequate. | | | | | |
| 17. | The ELM activities were related to other activities in this lesson. | | | | | |
| 18. | The teacher used the consolidation questions offered in the ELM lesson plan for discussion. | | | | | |
| 19. | Technical problems were addressed/resolved timely. | | | | | |

***IV. Learner-Teacher interactions*** (***for mixed-gender classes only***). Please tick one that applies.

a. In this class who asked more questions?
Male learners ☐ Female learners ☐ No Difference ☐

b. How often did the teacher call upon the learners?
Female learners: Very Frequently ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never ☐

Male learners: Very Frequently ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never ☐

c. How did the teacher divide the learners in groups during the lesson?
By ability ☐ By gender ☐ By age ☐ Randomly ☐ No groups ☐

d. When explaining and providing examples, the language the teacher tended to use was …
Masculine ☐ Gender neutral ☐ Feminine ☐

*e.* Please use the following scale to rate your impressions about the **female and male learners** in this class:

| | *Outstanding* | *Good* | *Satisfactory* | *Poor* |
|---|---|---|---|---|
| *Female performance* | | | | |
| *Female behaviour* | | | | |
| *Male performance* | | | | |
| *Male behaviour* | | | | |

***V. Overall Teaching and Student Engagement***

"When observing this classroom, I see the following happening…" (tick one description that applies)

| |
|---|
| *- Students are not attending to the task at hand. They are distracted and off-task.*<br>*- There is a lot of disruption and movement not related to the activity.*<br>*- The teacher cannot aet the children to remain on task.* |

| |
|---|
| *- Students occasionally attend to the given task.*<br>*- There is occasional disruption and movement not related to the activity.*<br>*- Occasionally, when the students are off task the teacher is able to refocus the group with some effort.* |

| |
|---|
| *- Some students are attending to the given task.*<br>*- There is little off task behaviour.*<br>*- The teacher is able to guide students through the lesson with minimal diversions from the task.* |

| |
|---|
| *- Most students are attending to the given task.*<br>*- There is minimal or no off-task behaviour*<br>*- The teacher is able to guide students through activities effectively.* |

| |
|---|
| *- All students are involved in the given task.*<br>*- There is no off-task behaviour.*<br>*- The children are discussing the task on their own with little or no prompting from the teacher.*<br>*- The students are providing the teacher with new directions in which to go by actively participating in the discussions and are providing the teacher with feedback.* |

**Notes:**

## *Teacher Exit Interview Protocol (LTK+ software)*

Length: 30 min

**General**: Your experience using XXX this year

- If you were to sum up your use of XXX with your students this year in a few words, how would you describe it?
- If compared with last year, did you feel more comfortable?
- What were your expectations about using XXX for … this year?
- What did you find was most valuable about using XXX?
- What did you find the most frustrating or difficult?
- What did you do when faced with an obstacle or a challenge?

**Classroom management**:

- How often did you use XXX? centre or Lab?
- How did you organize your class for the XXX activities (whole class, individual)?

**Teaching and teacher's perceptions**:

- Did you use the support materials (lesson plans)? To what extent?
- Does using of XXX influence your teaching in any way?
- Did XXX help you work towards particular curricular goals?
- What did you like about the XXX software? What did you dislike?
- What about your students? (likes and dislikes)

**Conclusion:**

- What would you say is the most important thing for a new user to have in order to successfully integrate XXX in their teaching? (materials, supports, training, networks, etc.)
- Is there anything else that you would like to add about using XXX with your students this year?

**ABRACADABRA IMPLEMENTATION 2020, TERM 3**
***TEACHER***
***SCHOOL***
***CLASS***

| ACTIVITIES | | | Week 1 Aug. 31-Sept. 4 | Week 2 Sep. 7-11 | Week 3 Sep.14-18 | Week 4 Sep. 21-25 | Week 5 Sep. 28-Oct.2 | Week 6 Oct. 5-9 | Week 7 Oct. 12-16 | Week 8 Oct. 19-23 | Week 9 Oct. 26-30 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALPHBETICS | Letters, Sounds and Words | 1- Matching Sounds | | | | | | | | | | |
| | | 2- The Alphabet Song | | | | | | | | | | |
| | | 3- Word Counting | | | | | | | | | | |
| | | 4- Same Word | | | | | | | | | | |
| | | 5- Syllable Counting | | | | | | | | | | |
| | | 6- Animated Alphabet | | | | | | | | | | |
| | | 7- Same Phoneme | | | | | | | | | | |
| | | 8- Letter Sound Search | | | | | | | | | | |
| | | 9- Letter Bingo | | | | | | | | | | |
| | | 10- Word Matching | | | | | | | | | | |
| | | 11- Word Families | | | | | | | | | | |
| | | 12- Rhyme Matching | | | | | | | | | | |
| | | 13- Blending Train | | | | | | | | | | |
| | | 14- Auditory Blending | | | | | | | | | | |
| | | 15- Auditory Segmenting | | | | | | | | | | |
| | | 16- Basic Decoding | | | | | | | | | | |
| | | 17- Word Changing | | | | | | | | | | |
| Fluency | Reading | 18- High Frequency Words | | | | | | | | | | |
| | | 19- Tracking | | | | | | | | | | |
| | | 20- Expression | | | | | | | | | | |
| | | 21- Accuracy | | | | | | | | | | |
| | | 22- Speed | | | | | | | | | | |
| | | 23- Reading Practice | | | | | | | | | | |
| Comprehension | Understanding the Story | 24- Prediction | | | | | | | | | | |
| | | 25- Comprehension Monitoring | | | | | | | | | | |
| | | 26- Sequencing | | | | | | | | | | |
| | | 27- Summarizing | | | | | | | | | | |
| | | 28- Vocabulary | | | | | | | | | | |
| | | 29- Vocabulary (ESL) | | | | | | | | | | |
| | | 30- Story Response | | | | | | | | | | |
| | | 31- Story Elements | | | | | | | | | | |
| Writing | | 32- Spelling Words | | | | | | | | | | |
| | | 33- Spelling Sentences | | | | | | | | | | |
| | | **READS** | | | | | | | | | | |

**ELM IMPLEMENTATION 2020, TERM 2**
***TEACHER***
***SCHOOL***
***CLASS***

| STEPS (ACTIVITIES) | | Week 1 May 4-8 | Week 2 May 11-15 | Week 3 May 18-22 | Week 4 May 25-29 | Week 5 June 1-5 | Week 6 June 8-12 | Week 7 June 15-19 | Week 8 June 22-26 | Week 9 ne 29-July | Week 10 July 6-10 | Week 11 July 13-17 | Week 12 July 20-24 | Week 13 July 27-31 | Week 14 Aug.3-7 | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COUNTING | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| | STEP 5 (ACTIVITY 5) | | | | | | | | | | | | | | | |
| COMPARING | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| ADDING | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| SUBTRACTING | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| | STEP 5 (ACTIVITY 5) | | | | | | | | | | | | | | | |
| DECOMPOSING | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| PLACE VALUE | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| | STEP 4 (ACTIVITY 4) | | | | | | | | | | | | | | | |
| | STEP 5 (ACTIVITY 5) | | | | | | | | | | | | | | | |
| | STEP 6 (ACTIVITY 6) | | | | | | | | | | | | | | | |
| | STEP 7 (ACTIVITY 7) | | | | | | | | | | | | | | | |
| | STEP 8 (ACTIVITY 8) | | | | | | | | | | | | | | | |
| | STEP 9 (ACTIVITY 9) | | | | | | | | | | | | | | | |
| GEOMETRY: SHAPES | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| | STEP 3 (ACTIVITY 3) | | | | | | | | | | | | | | | |
| DATA | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| | STEP 2 (ACTIVITY 2) | | | | | | | | | | | | | | | |
| PATTERNS | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |
| Number Line | STEP 1 (ACTIVITY 1) | | | | | | | | | | | | | | | |

**READS Checklist: Term 3 2020**

School:

Teacher:

Class:

| | | Languages - Use ✓ | | | | Set-up - Use ✔ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Week 1: Aug. 31-Sept. 4** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 2: Sep. 7-11** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 3: Sep. 14-18** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 4: Sep. 21-25** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 5: Sep.28-Oct. 2** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 6: Oct. 5-9** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| | | Languages - Use ✓ | | | | Set-up - Use ✔ | | | | |
| **Week 7: Oct. 12-16** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 8: Oct. 19-23** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |
| **Week 9: Oct. 26-30** | **No. of books** | **EN** | **Kiswahili** | **Tribal** | **Total** | **Individual** | **Pairs** | **Group** | **Total** | **Titles - Examples** |
| Monday | | | | | | | | | | |
| Tuesday | | | | | | | | | | |
| Wednesday | | | | | | | | | | |
| Thursday | | | | | | | | | | |
| Friday | | | | | | | | | | |

## Student Learning Strategies Questionnaire

Together with Aga Khan Academy and I Choose Life - Africa, the Centre for the Study of Learning and Performance (CSLP), a research centre in Canada, has been working on a project striving to improve the learning of children in Kenya. This involves teachers and students using a digital portfolio called ePEARL, a computer program from the Learning Toolkit Plus suite. Whether you use ePEARL or not, we would like to know about how you are learning this year. This questionnaire will help us learn about the ways and strategies you are using in your class to help you with your work.

Please answer the questions on the next several pages. **There are no right or wrong answers.** Your answers are confidential (no one in your class or at your school will be told what you answered). Your teacher will not have access to your answers. You have the right to refuse to participate or to withdraw (that is, to stop answering the questions) at any time. However, your experiences and opinions are important and will help us understand learning from your point of view.

If you have questions and concerns, please contact the project coordinator Mr Hebron Mwagodi at hmwagodi@ichooselife.or.ke

Thank you for your participation!

What is your name? ____________________________________________________

How old are you? ______________________________________________________

What school are you in? ________________________________________________

What class/grade are you in? _____________________________________________

Do you use computers in your class work? ____________________________________

Are these desktop computers in a lab? __________ Laptops/tablets? _____________

Date: ______________________________________________________________

*Think about your typical experiences in school. Circle how often each statement applies to you at all stages of your work on an assignment. Select "I do not know" if you do not know what the statement means or how it applies to you.*

PLANNING **When I have an assignment…**

1. I begin by identifying my goals.

   Always Often Sometimes Never I do not know

2. I make a plan about how I will complete it.

   Always Often Sometimes Never I do not know

3. I am confident about doing it well before I begin.

   Always Often Sometimes Never I do not know

4. I think I will do well.

   Always Often Sometimes Never I do not know

5. I will feel great after I have done it.

   Always Often Sometimes Never I do not know

6. I try hard because my teacher gets upset otherwise.

   Always Often Sometimes Never I do not know



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

7. It is important for me to be interested in what I am doing.

Always Often Sometimes Never I do not know

8. My aim is to really understand what I have to do.

Always Often Sometimes Never I do not know

9. My goal is to show my teacher I am a good student.

Always Often Sometimes Never I do not know

DOING **When I have an assignment…**

10. I talk myself through the steps as I am working.

Always Often Sometimes Never I do not know

11. I imagine what my work will look like in the end.

Always Often Sometimes Never I do not know

12. I concentrate fully on my task.

Always Often Sometimes Never I do not know

13. I break down the task into smaller, easier parts.

Always Often Sometimes Never I do not know

14. I keep track of how well I am doing.

Always Often Sometimes Never I do not know

15. I try other strategies if I have problems.

Always Often Sometimes Never I do not know

16. I think about how well I have done my work once I am finished.

Always Often Sometimes Never I do not know



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

**REFLECTING**

## When I have an assignment…

17. And I do it well, it is because of my ability.

Always Often Sometimes Never I do not know

18. And I do it poorly, it is because of how much effort I used.

Always Often Sometimes Never I do not know

19. And I do succeed in it, it is because my teacher usually explains things well.

Always Often Sometimes Never I do not know

20. And I do it well, it is because I was lucky.

Always Often Sometimes Never I do not know

21. I feel unhappy about my performance.

Always Often Sometimes Never I do not know

21b*. And I do it well, it is because I used a computer.

Always Often Sometimes Never I do not know

21c*. I do not get resentful even if I do it poorly.

Always Often Sometimes Never I do not know

21d*. And it is difficult, it is because my teacher is to blame.

Always Often Sometimes Never I do not know

21e*. And I do it well, it is because the timeline was sufficient for me.

Always Often Sometimes Never I do not know



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

## HOW I KNOW THAT I WILL SUCCEED

**When I have an assignment…**

22. I keep on trying even if the task is difficult.

Always Often Sometimes Never I do not know

23. I will succeed because I do assignments well.

Always Often Sometimes Never I do not know

24. I will be able to do it because my teacher has modeled it.

Always Often Sometimes Never I do not know

25. I will be able to do it because people have told me I am a good student.

Always Often Sometimes Never I do not know

26. I soon start to feel excited about doing my work.

Always Often Sometimes Never I do not know

26b*. I can always copy from my friends when I am unable to do it on my own.

Always Often Sometimes Never I do not know

## WHY I WANT TO DO IT WELL

**When I have an assignment…**

27. It is important for me to complete the task on my own.

Always Often Sometimes Never I do not know

28. Working well with my classmates is important to me.

Always Often Sometimes Never I do not know

29. I try hard so I can feel good about myself.

Always Often Sometimes Never I do not know



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

29b*. I try hard because it will help me succeed on the national exam.

Always Often Sometimes Never I do not know

## MY FEELINGS ABOUT THE TASK

**When I have an assignment…**

30. I avoid making too large an effort because if I fail I will feel bad about myself.

Always Often Sometimes Never I do not know

31. I avoid trying so hard because I am scared of failure.

Always Often Sometimes Never I do not know

32. I think it is useful for me to complete it.

Always Often Sometimes Never I do not know

33. It is important for me to do well.

Always Often Sometimes Never I do not know

34. It takes too much effort to do it well.

Always Often Sometimes Never I do not know

35. It is something that is difficult to do well.

Always Often Sometimes Never I do not know

36. It is a type of task I have not done before.

Always Often Sometimes Never I do not know

37. I will try new strategies to succeed.

Always Often Sometimes Never I do not know

37b*. I understand better when the teacher teaches with computers.

Always Often Sometimes Never I do not know



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

37c*. I feel I get too much homework to do.

Always Often Sometimes Never I do not know

**Additional questions:**

1) Are there any items that are unclear and which do you suggest we should change?

2) Are there questions that we did not ask about your learning, which you think are important and should be asked?

**Thank you very much for completing this questionnaire!**



* Items marked with an asterisk have been added in 2018 and will be analyzed separately

March 26, 2019

Dear ePEARL teacher,

Thank you for participating in our research looking at the effect of ePEARL use on students' self-regulation and learning. Attached you will find a short questionnaire related to your ePEARL use to date. All information you provide will be kept strictly confidential and under no circumstances will your individual responses be released to the school.

We greatly appreciate your taking the time to complete our questionnaire. For additional information or any related questions, please contact Mr.Hebron Mwagodi at hmwagodi@ichooselife.or.ke

Sincerely,

Dr. Larysa Lysenko
LTK+ Research Coordinator, CSLP
Concordia University

**Questionnaire on ePEARL Use**

My full name:_______________________________________________

My school name: ____________________________________________

In my class, **over the last term**, students worked with ePEARL:

0 hours______ 1-4 hours ______5-6 hours______ 9-12 hours______ 13 or more____

When using ePEARL with my class, I would rate my access to technology as:

a. poor_____ b. acceptable _____c. good ____ d. very good _____ e. excellent ____

When using ePEARL with my class, I would rate pedagogical support as:

a. poor_____ b. acceptable _____c. good ____ d. very good _____ e. excellent ____

Given my experience with ePEARL so far, these are the three of the advantages I and my students have experienced using ePEARL:

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

Given my experience with ePEARL so far, these are the three challenges I and my students have experienced using ePEARL:

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

____________________________________________________________

**Thank you very much for taking the time to complete the questionnaire!**

***Ethics certificate 10000298***

**ePEARL Implementation Assessment Protocol v2 - 2009**

*The IAP will be used to determine which research classes have had enough exposure to ePEARL and related SRL processes to justify attributing change to exposure to ePEARL. This protocol was created by consulting action research literature on e-Portfolios, data from our pilot study (2006-2007), and the use of IAP v1 for the 2007-2008 research data. This table will allow a systematic and structured review of teacher and student use of ePEARL to ensure good quality data for analysis. Classrooms that are coded as "low" implementers may not be included in the final analysis.*

| | LOW | MEDIUM | HIGH |
|---|---|---|---|
| **IFQ – hrs/month** | Hrs. ≤4 | 5-12 | 13≤ hrs. |
| **Avg. # artifacts** | Artifacts ≤3 | 4-6 | 7≤ artifacts |
| **Date range of use** | Entries span less than 60 days | Entries span 61-120 days | Entries span 121 days or more |
| **Uses of ePEARL** | | | |
| **Planning: Goals & Strategies** | • 1 or no General Goals<br>• 1 or no Task Goals<br>• 1 or no Strategies | • **At least 2** General Goals<br>• **At least 3** artifacts have goals/strategies<br>• Goals & strategies may be vague, inappropriate, or may be attached to a grade/mark | • **3 or more** General Goals – some may have been revised<br>• **4 or more** artifacts have goals & strategies<br>• Goals & strategies are clearly defined and appropriate to the task |
| **Doing: Content** | • Storage only<br>• Incomplete entries | • Artifacts may be in only one subject area<br>• **At least 3** artifacts have content<br>• Content is missing in some artifacts | • Creative use of ePEARL (different attachments, well developed home page)<br>• **4 or more** artifacts have content included (attachments, text editor, audio files)<br>• Artifacts included from multiple subject areas<br>• Multiple versions of artifacts |
| **Reflecting** | • 1 or no reflections | • **At least 3** artifacts have reflections<br>• Reflections are brief and generally vague ("I liked it, I had fun") | • **4 or more** artifacts have reflections<br>• Reflections show deep thought about learning process and/or addresses goals & strategies |
| | | | |
| **Feedback** | • No feedback | • Teacher feedback in **less than 3** artifacts<br>• Feedback is evaluative only (gives a score)<br>• Feedback from peers has a lot of "chat" | • Teacher feedback on **4 or more** artifacts<br>• Feedback offers suggestions, asks questions, stimulates reflection<br>• Feedback from peers includes constructive suggestions |
| **Presentations Folder** | • Empty | • 1-2 items<br>• no reflection/selection reasons given or icons only selected | • at least 3 items with reflection/selection explanation included |

**LTK Sustainability Interview Protocol**
**V. 1.3; August 19, 2018**

Instructions for interviewer
Please ensure that the interviewee has read and signed *the permission sheet*. Inform the interviewee that her/his participation is voluntary and she/he is free to decline to answer any question and to terminate the interview at any time without prejudice. Please make sure that the interviewee understands that the information supplied in the interview will be treated as strictly confidential and reported anonymously without names or other identities and in aggregated form.

The interview will last about *45 minutes*. It starts with two questions in regard to interviewee's experience with LTK+. Then the interview will follow a funnel format where two global questions will be proceeded by the general categories in which specific questions have been embedded about factors enabling and challenging the implementation of LTK+.

Please *record the interview*, *take notes*, and *complete the end-of-interview impressions* immediately after the interview.

Say something like this to start the interview:

*"Thank you for agreeing to participate in this interview about the Learning Toolkit. I will start by two questions in regard to your experience with LTK+. Then the interview will follow a funnel format. I will continue with a couple of very broad questions before asking you a series of specific questions about factors enabling and challenging the implementation of LTK+s. You can say "I've answered that already" or "That is not at all important" if you wish. At the end, you will also be asked to rate the importance of the general categories and select the three most important for your context.*
*Do you have any questions before we start?"*

1. Name of interviewee____________________________________________

2. Position/organization___________________________________________
   (e.g., government, head teacher, teacher, LTK staff, etc.)

3. Date of interview_______________ Total time of interview___________

4. Name of interviewer____________________________________________

Instructions for interviewer: Read the following questions in each of the sections. Please do not explain questions or provide examples.

***Introduction. LTK+ Experience Questions***

5. When and how did you come to be involved with LTK+ /using LTK+?

6. What would you have done differently to help/to improve the use of LTK+ tool(s) in your class/school(s)/community? Provide maximum 3 suggestions.

***Global Questions***

In the context of your experience with LTK+, please comment on the following questions:

7. What about **LTK+ sustainability?** What are the important reasons for continuing to use or stopping to use the LTK+ in future?

8. What about **LTK+ scalability?** What are the major challenges to widespread use of the LTK+ in Kenya?

***General Categories***

Instructions for interviewer: Read each general category and it's sub-questions at one time and not as a series of separate questions.

9. What about **political factors** in LTK use? What role does government play in LTK use? National government support? Local government support? Competing programs (e.g., TUSOME, PRIEDE, RTL, etc.)?

10. What about **economic and technology factors** in LTK use? What role do financial factors play in LTK use? External funding and support? Computer and lab availability? Computer service contracts & maintenance? Technical support? Availability of electricity? Peripheral devices (e.g., headphones, printers, digital cameras, etc.)? Equipment upgrades and modernization?

11. What about **organizational and school factors** in LTK use? Head Teacher? Other teachers? Associations (BOM, KEPSHA, PTA)? Individual parent involvement?

12. What about **teacher professional** development factors and LTK use? Teacher ICT skills? LTK training? LTK follow-up support? LTK ambassadors and coaches?

13. What about **software factors** and LTK use? Fit with the curriculum? Local context of stories and activities? Narration and accents? Interactivity of the tool? Shortcomings, inadequacies and gaps of the tool(s)?

14. What about **individual teacher factors** and LTK use? What distinguishes teachers who are LTK users from those who are non-users? What do LTK users believe about LTK use versus non-users? Do users compared to non-users have different personal expectations for LTK use? Do users compared to non-users believe there are different personal costs for LTK use? Do users compared to non-users perceive the value of LTK use differently? Do users compared to non-users believe enhancements in teaching practices using the LTK are important?

**15.** What about **individual student factors** and LTK use? What impacts do LTK use have on students? Level of engagement? Degree of learning? Achieving school goals? Meeting national goals of education?

**16. Other factors:** What are additional factors that influence LTK use?

17. Instructions for interviewer: Using the five-point scale below, please ask the interviewee to **rate the importance** of each of the general factors for LTK use. Mark their responses directly on this interview sheet.

**Rating scale**

**A. not at all important**
**B. slightly important**
**C. somewhat important**
**D. moderately important**
**E. extremely important**

i. Political factors
ii. Economic and technology factors
iii. Organizational and school factors
iv. Teacher professional development factors
v. Software factors
vi. Individual teacher factors
vii. Individual student factors
viii. Other factors

18. Instructions for interviewer: from the list above ask the interviewee to select three factors that are most important to help/to improve use of LTK+

1. ______________________________
2. ______________________________
3. ______________________________

***Summary of the Interview***

<u>Instructions for interviewer</u>: Immediately after the interview, write your general impressions of the interview and the interviewee's most important points. Use as much space as you need.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

| ABRA use as measured by time (minutes) spent on ABRA activities June - July 2012 | | | | | |
|---|---|---|---|---|---|
| School name | **AKPS** | **GPS** | **CGPS** | **MPS** | **TMPS** |
| Number of students logged in | 38 | 66 | 21 | 36 | 25 |
| Matching Sounds | 51 | 27 | 13 | 39 | 1 |
| The Alphabet Song | 103 | 55 | 10 | 190 | 1 |
| Word Counting | 27 | 6 | 17 | 2 | 2 |
| Same Word | 37 | 13 | 5 | 2 | |
| Syllable Counting | 13 | 7 | 1 | 13 | |
| Animated Alphabet | 1 | 1 | 2 | | |
| Same Phoneme | 4 | 1 | 1 | | |
| Letter Sound Search | 20 | 1 | | | |
| Letter Bingo | 1 | 1 | | | |
| Word Matching | 1 | | | | |
| Word Families | 252 | 4 | | | |
| Rhyme Matching | 1 | | | | |
| Blending Train | 26 | | | | |
| Auditory Blending | 7 | | | | |
| Auditory Segmenting | 1 | | | | |
| Basic Decoding | 8 | | | | |
| Word Changing | 19 | | | | |
| **Alphabetics(total time per class)** | 572 | 116 | 49 | 246 | 4 |
| **Alphabetics( average time per student)** | 15 | 2 | 2 | 7 | 0 |
| High Frequency Words | 124 | 37 | 443 | 45 | 1 |
| Tracking | 1001 | 968 | 438 | 1065 | 22 |
| Expression | 8 | 26 | 9 | 5 | |
| Accuracy | 519 | 58 | 20 | 32 | 7 |
| Speed | 12 | 2 | 1 | | |
| **Fluency(total time per class)** | 1664 | 1091 | 911 | 1147 | 30 |
| **Fluency (average time per student)** | 44 | 17 | 43 | 32 | 1 |
| Prediction | 1 | 1 | 1 | | |
| Comprehension Monitoring | 8 | 4 | 3 | | 1 |
| Sequencing | 67 | 13 | | 10 | |
| Summarizing | 2 | 1 | 1 | 1 | |
| Vocabulary | 52 | 2 | | | |
| Vocabulary (ESL) | 35 | 4 | | | |
| Story Response | 236 | 6 | | | |
| Story Elements | 13 | 2 | | 1 | |
| Reading Practice | 1 | 92 | 13 | 13 | |
| **Comprehension (total time per class)** | 415 | 125 | 18 | 25 | 1 |
| **Comprehension (average time per student)** | 11 | 2 | 1 | 1 | 0 |
| Spelling Words | 426 | 48 | 3 | 161 | 434 |
| Spelling Sentences | 181 | 30 | 13 | 701 | |
| **Writing(total time per class)** | 607 | 78 | 16 | 862 | 434 |
| **Writing (average time per student)** | 16 | 1 | 1 | 24 | 17 |
| **TOTAL(average time spent by a student on ABRA)** | **86** | **21** | **47** | **63** | **19** |