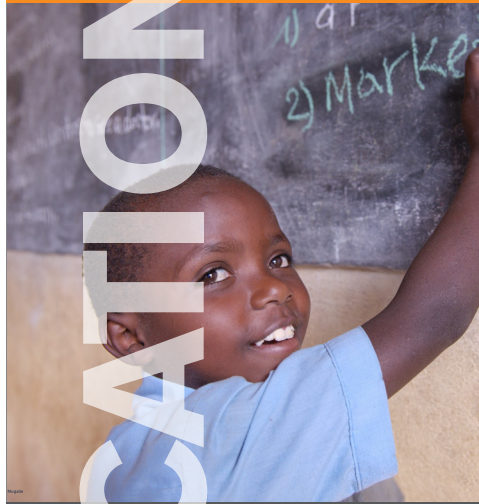




Education  
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EDUCATION

# Building a Bridge Between Literacy and Numeracy for Better Results in Rwanda

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EDC's basic education programs in low-resource contexts support the development of learners who can use language to explain and analyze the world around them and who have the foundational skills to think critically and solve the range of problems they will encounter in school and life. Integration of early literacy and mathematics instruction promotes the development of thinking and decision-making skills and lays the foundation for later success. The Literacy, Language and Learning (L3) Initiative's effort to bridge literacy and math in Rwandan primary education is one promising example. L3 materials and pedagogy enriched the learning landscape and promoted the integration of math and language. Over the life of the initiative, L3 teachers developed a deeper understanding of numeracy and literacy concepts and how they can be used in a range of every-day applications, while L3 students showed significant improvement in both literacy and math.

readrightnow!



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## Background

Rwanda's 2013–2018 Education Sector Strategic Plan<sup>1</sup> is shaped by national aspirations and international goals. Literacy and numeracy are recognized as vital skills that will enable young Rwandans to participate as equals in a growing knowledge and technology-based economy. The Strategic Plan intends to 1) improve quality and learning outcomes across primary and secondary education; and 2) train qualified, suitably skilled, motivated teachers and trainers to meet the demands of expanding educational access. EDC's five-year, USAID-funded Literacy, Language, and Learning (L3) Initiative partnered with the Rwanda Education Board under the umbrella of the Strategic Plan to strengthen teaching and learning so that children will leave primary school with solid literacy and numeracy skills.

In 2011, when L3 began, oral reading fluency and comprehension levels in Kinyarwanda were low for early grade students. Students were learning some of the mechanics of reading, but many were not reading with sufficient comprehension to support their learning in other subject areas. Students could correctly answer simple math questions, but that they did so very slowly. Instruction across subjects and grades was almost exclusively whole-class instruction, focusing on memorizing and application of rules and procedures. Textbooks contained strings of look-alike problems, and mainly focused on drill and practice activities. Teachers agreed that children should acquire reading and math skills in early primary school, but noted that there were limited materials and professional development opportunities to enable them to improve their practice or to provide opportunities for children to practice their skills.<sup>2</sup>

For learning outcomes to improve, critical early literacy and numeracy skills needed to be developed within a broad, balanced and enjoyable curricular experience. Students also needed ample time to practice reading and mathematics using appropriate reading and learning materials to support their learning. L3, therefore, focused on providing teachers with adequate resources to support early grade practices that develop students' foundational literacy and numeracy skills, and on helping teachers to use classroom time as productively as possible.

1 MINEDUC, 2013. "Education Sector Strategic Plan 2013/14-2017/18." Kigali, Rwanda.

2 Joseph DeStefano et al., 2012. "Early Grade Reading and Mathematics in Rwanda: Final Report." Research Triangle Park, NC: RTI International.



## Establishing a Bridge Between Literacy and Numeracy to Stimulate Thinking

Rather than looking at the curriculum as a set of isolated subjects, strategies, and skills, the L3 Initiative identified opportunities to develop higher order language and thinking skills across three subject areas: Kinyarwanda, English, and mathematics. Mathematics is a language that is used to predict and hypothesize, to interpret and analyze, to describe and clarify, to reason and explain, and to solve problems. These competencies are also required for reading, and supporting young children's oral language development and critical thinking skills has long been considered a practice that yields strong readers and writers later in life. Therefore, the L3 team designed a literacy and numeracy program that had a strong emphasis on oral language and required students to think deeply about reading, writing, and mathematical ideas through processes of critical thinking. The L3 program was comprised of mental mathematics games, oral language activities, word identification strategies, headline stories, interactive audio activities, interactive writing activities, read-aloud stories, and leveled texts. Drawing from the Rwandan curriculum and from EDC's Read Right Now!<sup>3</sup> and Think Math!<sup>4</sup> programs, each subject area was structured to enable teachers to scaffold learning activities that would encourage students to think for themselves, make connections with prior knowledge, transfer skills across subject areas and build students' problem-solving capabilities.

## Building Skill and Complexity: Mental Mathematics and Phonics

Research has shown that procedural fluency is essential for becoming efficient at basic operations and enabling learners to progress to more advanced and abstract problems. However, inappropriate teaching practice, such as rote learning or drill and practice in isolation of any meaningful context, may result in children developing negative attitudes toward mathematics.<sup>5</sup> When over-emphasized, drill and practice and poorly designed tasks such as "fill in the box" may lead to boredom and reduced attention, as well as stifle meaningful opportunities for higher order, critical thinking.<sup>6</sup> Phonics activities used to build foundational literacy skills likewise need to be embedded in a framework that makes sense of new knowledge and helps students extend and expand their thinking.

The L3 initiative trained teachers and provided explicit instructions on how to use classroom time to facilitate engaging and effective mental mathematics activities, which focused on practicing a specific math skill, rather than simply reciting tables. Short games such as 1, 2, 3 More Than or 1, 2, 3, Less Than, Double the Number, and Make a Pair to 10, required P1 learners to notice, think and manipulate numbers. Activities increased in complexity from grade to grade. In the same way, L3 designed activities for the language class that encouraged students to think about and manipulate language. Games like Elastic Word and Odd One Out required students to think about and manipulate sounds to develop their phonemic awareness. Read-aloud stories and leveled texts presented students with a variety of topics to think about, question, consider and discuss. Through scripted lessons teachers could guide students to think about the story, relate it to his or her own experience and try to see him or herself in the story. Through discussing read-aloud stories, students could brainstorm vocabulary, take clues from context and determine the meaning of new words.

<sup>3</sup> <http://rrn.edc.org>

<sup>4</sup> <http://thinkmath.edc.org>

<sup>5</sup> Ericsson, K. A., Krampe, R. T., & C. Tesch-Romer, 1993. The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Review* 100(3), 363-406.

<sup>6</sup> Goldenberg, E.P., Mark, J., & A. Cuoco, 2010. The algebra of young minds: A mathematical-habits-of mind perspective on elementary school. *Teaching Children Mathematics*. 16(9) pp. 548-556.

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## L3 Kinyarwanda Mathematics Headline Story

### AGAKURU K'IMIBARE:



Isomero ryo ku ishuri rya Bwenge ryahawe amakarito 120 y'ibitabo by'imibare. Ryanahawe amakarito 150 y'ibitabo by'icyongereza. Muri buri karito hakabamo ibitabo 10. Mwabivugaho iki?

#### Dore bimwe mu bisubizo:

- Isomero ryo ku ishuri rya Bwenge ryahawe ibitabo by'imibare 1200.
- Iryo somero ryahawe kandi ibitabo hy'icyongereza 1500.
- Ibitabo by'imibare ni bike ku by'icyongereza.
- Umubare w'ibitabo by'icyongereza uruta uw'iby'imibare.

**L3 deliberately built strategy teaching and metacognitive practice into mathematics and literacy materials**

## Real-life Problems and Solutions: Headline Stories and Thinking About Text

Research has shown that teaching children different thinking strategies facilitates their learning and retention of basic literacy and numeracy facts. Genuine problems in real life are not mere exercises: they require analyzing a situation, putting ideas together, and finding solutions.<sup>7</sup> L3 therefore deliberately built strategy teaching and metacognitive practice into mathematics and literacy materials.<sup>8</sup>

It is essential that children learn from the early grades that mathematics means more than getting the right answer. When designing mathematical problems for early grade learners, it is important to model how to think mathematically, not just how to follow the rules and perform tasks. One method of promoting alternative ways of thinking in the L3 mathematics classroom was through daily headline stories, or word problems with some elements missing. For example, in a P1 class, an L3 teacher might present, "Michelle has 7 bananas, Mahezi has 3 bananas. What can you say about the situation? What questions can you ask?" instead of a traditional problem like "Michelle has 7 bananas, Mahezi has 3 bananas. How many bananas do they have together?"

L3 headline stories were constructed in such a way that they required students to think about mathematical ideas and connections and build students' problem-solving capabilities. The students were presented with real situations related to their own experiences and context and encouraged to develop strategies for solving the problems imaginatively by using prior knowledge, asking relevant questions, making predictions and identifying solutions. Prompt questions such as "How did you get that answer? Why do you think that? Explain how you came up with that answer? Did anyone have an alternative way to solve that problem?" or "What knowledge did you have to use to solve the problem?" were also carefully scripted into L3 teacher guides to encourage children to reflect and practice their thinking skills.

In parallel to this practice of metacognition in mathematics, students were invited during literacy instruction to make predictions from what they were reading, analyze characters, and make connections with their own lives. Questions such as, "What do you think Shema will do next? Has anything similar happened to you? Does this character remind you of anyone? If you were Shema how would you feel?" were scripted into the teacher guides, and teachers were trained to facilitate the resulting discussions. After reading, students reflected whether their predictions were confirmed or disproved and considered their own likely responses in similar situations.

<sup>7</sup> Cuoco, A., Goldenberg, P., and June Mark, 2010. Organizing a curriculum around mathematical habits of mind. *Mathematics Teacher* 103(9) pp. 682-688, May. Reston, VA: NCTM.

<sup>8</sup> Eilers, L. & Pinkley, C., 2006. Metacognitive strategies help students to comprehend all text. *Reading Improvement*, 43 (1), 13-29.

## Language Unlocks Thought: Math Problems, Read-alouds, Leveled Texts, and Interactive Audio

Oral language development was an essential element of the L3 program. Before L3, Rwandan students were often expected to write in mathematics before they had an opportunity to imagine, hypothesize, discuss or make connections to find an answer. Likewise, in language classes, students answered literal questions and rarely engaged in activities like prediction, analyzing characters, or solving problems. Research has shown that teaching children different thinking strategies facilitates their learning and retention of the basic facts. In the mathematics and literacy classrooms, it is essential that children do not become passive learners by simply responding to concepts that are presented to them but rather are challenged to develop their thinking and their language skills by engaging with and making sense of these concepts.<sup>9</sup>

L3 mathematics materials, leveled texts, and read aloud stories presented students with a variety of topics to think about, question, consider, and discussion. Through scripted lessons teachers could guide students to think about the story, relate it to their own experiences and try to see themselves in the story. This allowed students to be problem solvers, as opposed to simply being told the problem or the moral of the story.

To support L3 teachers' transition to more effective instruction, the Initiative also provided Interactive Audio Instruction (IAI) series in Kinyarwanda, English, and mathematics. The guided programs helped teachers initiate oral language activities in the literacy and numeracy classroom, while simultaneously modeling for teachers and children that their ideas were valuable and that often there was more than one way to look at a problem. IAI lessons also provided teachers with a consistent, in-class mentor or coach in the form of audio teachers who guided them through the implementation of new, evidence-based instructional practices.

9 Hartman, H.J., 2001. Developing students' metacognitive knowledge and strategies. In H.J. Hartman (Ed.). *Metacognition in Learning and Instruction: Theory, Research, and Practice*, (pp. 36-68). Dordrecht, The Netherlands: Kluwer Academic Publishers.

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### L3 Kinyarwanda Leveled Reader

7

Nuko bazana akariri gakoze mu mbaho, bashyiraho Mbayiha, bamujyana ku ivuriro.

8

Ku ivuriro bamuhaye umuti, bamuha imbago zo kugenderaho. Mbayiha yaje koroherwa basubira mu rugo.

## Teacher Training to Integrate Literacy and Math

It was imperative that current and preservice teachers participating in L3 understood the process by which early literacy and numeracy skills are acquired and are subsequently developed and consolidated in first and second language acquisition. L3's teacher training program focused on equipping early grade teachers to:

- Infuse language, thought and meaning into literacy and numeracy instruction
- Use open-ended, challenging tasks that motivate students to engage in problem-solving in a meaningful way
- Enhance students' understanding appreciation and enjoyment of reading, writing, and mathematics.

Through regular and sustained professional development opportunities, including the IAI programs, teachers became familiar with the various strategies and methodologies that can be used to teach literacy and numeracy, both as discrete areas and across the curriculum.

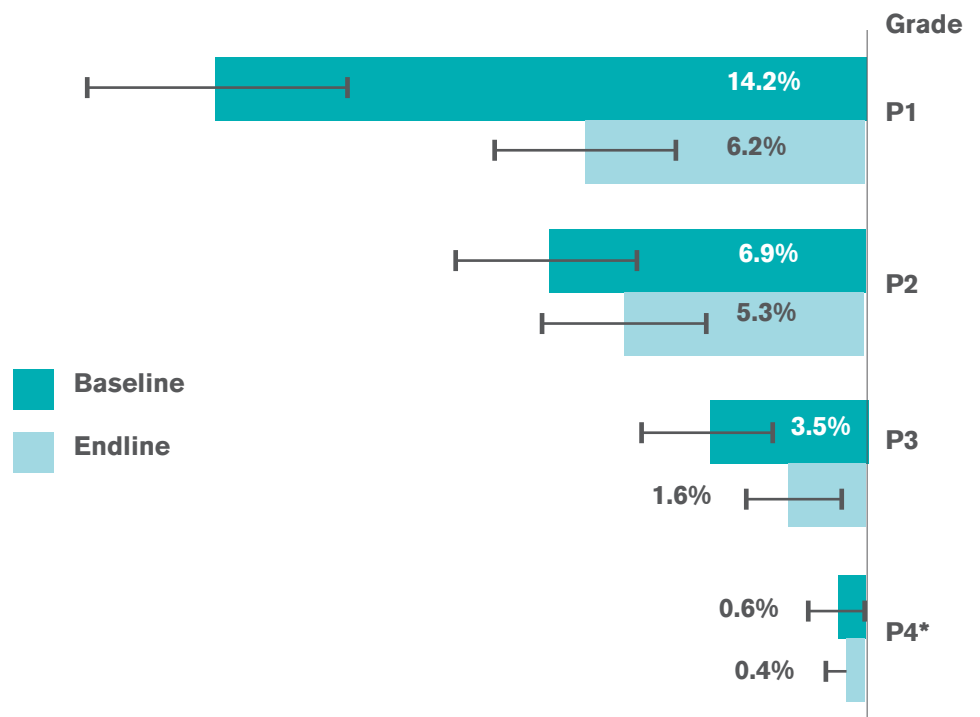
### Results

L3 was implemented in all Rwandan public schools between 2014 and 2016, reaching a population of 2.5 million students. The Initiative conducted baseline and endline literacy and mathematics assessments with a random sample of learners drawn from a nationally representative sample of schools, and a complementary evaluation of changes in classroom practices. Over the life of the Initiative, teachers who received training and received L3 materials and Interactive Audio support reported having a deeper understanding of numeracy and literacy concepts. They better understood how

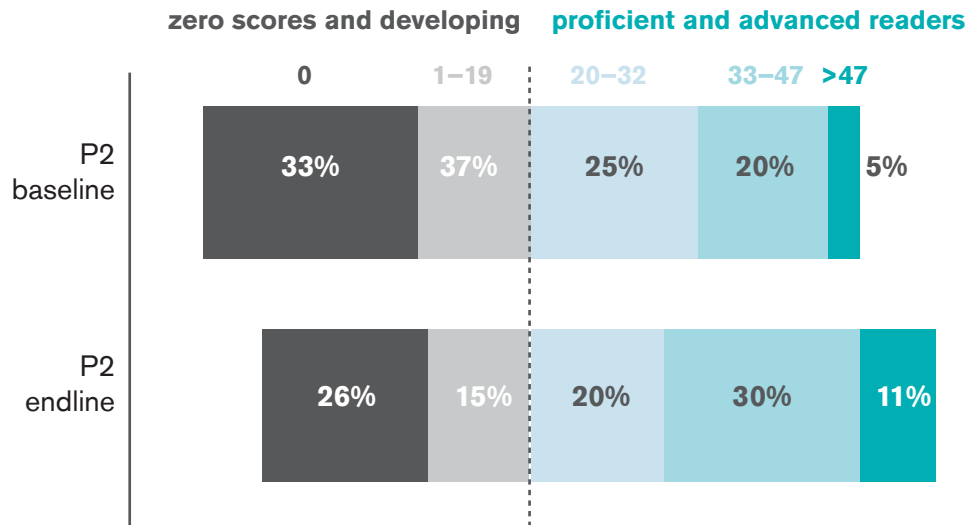
Over the life of the Initiative, teachers who received training and received L3 materials and Interactive Audio support reported having a deeper understanding of numeracy and literacy concepts.



Reduction in Mathematics Zero Scores by Grade, Baseline to Endline



## Change in Percentage of P2 Readers by WCPM/Proficiency, Baseline to Endline



these concepts can be used in a range of every-day applications to enable children to explore, hypothesize and reason logically; make connections with everyday situations; and strengthen their ability to use a variety of methods to solve problems.

L3 students also demonstrated significant improvements over the life of the initiative. P1 learners' mathematics performance increased significantly from baseline to end line. By the end of L3, the number of learners scoring zero in math was halved from 14% to 7%. P1 results were particularly strong, with an increase in overall math performance means of 12 percent, from 26% to 38% correct. And whereas boys had significantly outperformed girls before the Initiative, the gender gap was dramatically narrowed by the end of the effort. Literacy performance also improved, with sharp reductions in zero scores and increases in the percentage of students demonstrating proficiency in reading fluency and comprehension. P1–P3 learners showed significant gains in Kinyarwanda, while P4 learners showed significant improvements in English after 1 year. Findings at end line found a significant relationship between reading skills in Kinyarwanda and reading skills in English.<sup>10</sup>

## Conclusion

L3's integrated language and numeracy program; innovative instructional materials for mathematics, English and Kinyarwanda from P1 through to P4; and emphasis on developing critical thinkers enhanced the quality of Rwanda's national literacy and numeracy programs. The L3 emphasis on metacognition in both math and literacy, linking oral language and textual analysis, and problem solving across content areas produced significant results. These experiences will benefit others in this sector as they move forward with the important work of improving early grade outcomes. L3's results make a case for the development of a broader evidence base on the relative and intersecting impact of math and literacy programming through which policies, interventions and future investments in literacy and numeracy education may be developed.

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<sup>10</sup> Education Development Center, 2017. FARS/MARS Endline Report. Kigali, Rwanda: Author.



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# read right now!

The Rwanda Literacy, Language and Learning (L3) Initiative is an application of EDC's Read Right Now! early grade and youth literacy initiative. Read Right Now! is an adaptable, evidence based literacy program for low capacity and resource-lean environments.