



Literacy for All in 100 Days?

A research-based strategy for fast progress in low-income countries

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Global Partnership for Education

GPE Working Paper Series on Learning No. 7

May 30, 2013

This document is a perpetual draft, updated as new research becomes available. It exclusively represents the author's personal views and does not imply endorsement of the World Bank or the Global Partnership for Education.

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Executive Summary

In low-income countries many students are marginalized very early and remain illiterate. In grades 1-3 they attend rarely, though they may officially drop out in grade 4. Many others graduate from primary school without having learned letter values. The worrisome outcomes, despite much donor investment in low-income countries, have prompted scrutiny of the methods, and textbooks used to make students literate. This document offers insights from cognitive neuroscience and evidence suggesting that students can be taught basic literacy within the first semester of grade 1, if taught in consistently spelled languages. Teaching students at risk of dropout to read as early as possible enhances equity.

However, the reading methods used in many countries are complex and hard for teachers to execute. They pertain to high-income countries and to certain western European languages. English but also French, Portuguese, Dutch have complex spelling systems. English in particular requires three years of learning time. (French requires about two). Reading instruction for English is expensive and complex. Lists of whole words must be learned, vocabulary and early training in predictions are needed in order to make sense of words that cannot be sounded out. Learning must be started at kindergarten, parents must help at home, and many weaker students require remedial instruction. Since English is an official language in many countries, the travails of learning to read in this language have been considered the normal fate of reading.

By contrast, the eastern side of Europe speaks languages that are spelled consistently. In languages such as Russian, Albanian, Greek, Serbian, Turkish (but also German and Spanish) basic reading instruction requires much simpler procedures. For centuries reading was taught by untrained teachers through syllabaries that presented letters systematically (phonics) showed the derivative combinations in pattern analogies (see some examples below). Teaching the reading strategy and letters (just basic forms in syllabic scripts) requires only about 100 days. In the above countries of Europe, reading is typically taught in grade 1, it is widely “known” that first graders typically decode by Christmas.²

Like Spanish, Russian, or Albanian, the vast majority of the world’s languages are spelled consistently. With phonics instruction in transparent orthographies decoding may be achieved in 3-4 months of consistent work; by contrast, English has a three-year learning timeframe.) Students pronounce just the letters contained in a word, so they depend less on vocabulary knowledge or on predictions to decipher text; they also have less need of parents reading to them at home. And when students put words in their working memory fast enough and know the vocabulary, they typically understand (Share 2008, 1999). Consistently spelled languages need simpler classroom activities.

Barring learning disabilities, nearly all students could be made basically literate in the first semester of grade 1 by using local languages. After automaticity, literacy transfers to more complex spelling systems of the same script. Therefore, reading fluency in an African language

² Also in Scandinavia, there is an established tradition among parents that teaching literacy should take place in school, and that children receive literacy instruction at 7 years of age (ie, Grade 1). That is, reading is not directly taught in kindergarten (Furnes & Samuelson 2011)

greatly facilitates fluency in English, French, or Portuguese. Also research can help optimize the 20th century methods.

Reading is not rocket science but the underlying cognitive neuroscience definitely is. Reading piggybacks on a face recognition system. This has strict *neurological requirements involving reactions in milliseconds, and these must be met before comprehension becomes possible*. The requirements are pretty rigid and there are few alternative options. And these requirements may block early and irreparably the education of those who don't get help. It's as if children set out for school but encounter a mountain right outside their front door. Those who fail to learn the sound-letter combinations or small letter units cannot go on to texts of greater complexity. They can neither catch up on their own nor skip the elementary gaps and learn more advanced material.

For students not exposed to print earlier, the tasks are not trivial. Some deficits surprise middle-class people. For example, students must be taught to go downwards on a page; otherwise they cannot go on reading. Some students can manage with the current conditions, but many more will benefit if taught through the ways the brain was set up to automatize reading.

Each letter must be taught explicitly, particularly in local languages that are usually spelled consistently; letters must be well sized and spaced, and that students should be able to tell the specific targets apart from others nearby; they should practice patterns, blending letters into syllables. Sustainable textbooks should exist in local languages, written in big and broad letters that help inexperienced students perceive print fastest. The textbooks should have lots of text for practice, perhaps 4000 words. Students should spend perhaps half the time in independent reading in class, while getting even a few seconds of help from a teacher or peer.

By the end of 100 days in various languages and scripts (excluding English, French, Chinese, or Khmer), some students should be barely decoding while others could be reading 100 wpm. But there should be no student reading 0 letters or 0 words per minute. Of course the course should not end in 100 days. From then on, students must further practice to increase speed, learn vocabulary, write, describe, engage in literal and higher-order comprehension. But the strategy and necessary components for reading will have been completed. Strictly speaking, if a child dropped out in the middle of grade 1 and somehow continued practicing, that child might not remain illiterate.

Probably more students than currently observed can learn from classroom activities, but the limiting factor is teachers' ability to deliver the requisite training. To teach weaker students, the memory functions of teachers must also be taken into account. Teachers with limited education often read slowly, so their probability of carrying out instructions is commensurate to their information processing speed and efficiency. However, memory issues are rarely considered by reading specialists who prescribe various methods. Teachers are routinely expected to use quickly and monitor game cards, reading boards, the performance of multiple students in large classes, keep track of time also and to switch prescribed tasks every few minutes. They may not easily automatize long sequences and execute them effortlessly within the class hour. Thus, crucial components may be dropped.

A parsimonious routine is needed that teachers with limited education can automatize and implement realistically within one instructional period. Governments must choose the smallest

set of “non-negotiable” variables that have the biggest impact on perceptual learning, automaticity, consolidation. The routine ought to require limited training time and limited expertise to supervise. The solutions should increase the probability that teachers will carry out certain procedures even when the supervisors are not there. Activities have been tentatively identified empirically, but innovative measures, such as reaction time, may be needed for greater precision.

Overall, reading methods must be resilient to the vicissitudes of implementation. Many activities work well in higher-income countries or small pilots, but at scaleup they sink. Governments and donors should train up to existing capacity, rather than try to raise capacity to the requirements of complex methods.

Transfer Strategy to the Official Language for Multilingual Societies

Low-income countries with high illiteracy among students typically teach in English, French, Portuguese, or sometimes Arabic as a language of instruction. It is important for the poor not to fall behind while learning to read in local languages.

Keeping up with the curriculum is achievable by splitting the usual two-hour daily program of language arts into two: (a) reading in local languages as described above, and (b) instruction in oral English, French, Portuguese as needed. Language instruction can be optimized through various methods (which are beyond the scope of this document). Most simply, teachers may use the contents of the grade 1 textbooks that typically exist in various countries. In that case, only the teacher needs the textbook. Research shows that fluency in a consistently spelled language greatly facilitates fluency in English, French, or Portuguese (Walter 2010 for Kom; August et al. 2005 for Spanish; Ledesma and Morris 2005 for Tagalog).

In grades 2-3 after students have become fluent readers in local languages, they need an explicit bridging course on how to read in the official languages (when the script is the same). Research shows that following this route, literacy in the spelling system of the official language will be greatly facilitated.

Literate school in 100 days – A remediation program

The above procedures can be used as a remediation tool for the illiterate students in grades 2-6. Older students in particular, have longer working memory and better executive control, and they would be able to do this program in less time than that needed by first graders. In principle, students would become fluent in a local language, then receive a bridging course to read in the official language, and then be reinserted in their respective grades to gain more practice by reading their grade-level textbooks. Potentially by giving two waves a year, entire schools could become free of illiteracy in 2-3 years. By scaling up the program, entire countries could thus perform.

Literacy in 100 Days? An “Emergency” course based on Neurocognitive Research

The implications of the research cited in this document have been operationalized in a basic reading course. It would be taught in consistently spelled languages and pitched at lower-scoring

students, first graders or older children who have remained illiterate. The course would have a specific time in the curriculum and not be mixed with language arts. It would focus on splitting words to the smallest readable phonemes, blowing up the print so that it is easily distinguishable early on, and getting enough practice for speed to build up and comprehension to take place.

The course of course covers an entire school year. But in most languages and scripts of the world, the reading strategy and essential letters would take no longer than 100 days. (For syllabic scripts, such as Amharic or Bengali probably the essential syllabi components would be taught. Compound combinations and conjoint consonants) would probably be taught in grade 2. However, syllabic scripts typically have means to stop inherent vowels. (In Hindi that would be halant, in Bengali hashonto). Therefore students could get practice throughout grade 1 on basic combinations and still read be able to read most words, albeit written less elegantly.

To conduct a course realistically doable by little-educated teachers, a minimal number of maximally effective and most likely doable activities. In the spring of 2013, research suggested the following:

- **Detailed, synthetic phonics instruction** with only **one new letter taught per day at most**; the most common letters would be taught first, with revisions every five days to accommodate absent students; writing on various media to consolidate memory of movements;
- **Textbooks optimized for extensive reading practice**; attention to letter size and spacing, about 4000 words with few if any pictures. Avoidance of early calligraphy (popular in Africa) until the visual word form area has been sufficiently activated.
- **Directing student attention** to the letter being taught with few words, using pointing gestures that students will learn as a routine.
- Systematic instruction in **patterns and analogies** of letter combinations;
- **Practice** to speed up reaction time to letters and words; lots of it, independently.
- **Brief corrective feedback for all** students (even for 10 seconds per day), partly through help by the better students;
- **Brief instructions or scripted lessons** for teachers; training at least partly through observational learning, visualization, and detailed planning for critical behavior sequences;
- Frequent and specific **supervision**, partly by school directors who would also be trained through audio visually based techniques;

Writing would initially get limited practice during the first 50-100 days, for reasons discussed further in the text. Similarly phonological awareness has been greatly emphasized in English-language methods, but its benefits for consistent scripts are less pronounced (Georgiou, Parrilla, and Papadopoulos 2009).

Day to day monitoring of reaction speed to be tried through computerized psychophysics tests and portable eye-tracking equipment. Final results would monitored through quick and inexpensive **one-minute reading fluency tests** – given by teams of enumerators rather than teachers themselves.

For multilingual countries, a subsequent module would be necessary to bridge students into the spelling of the official language if written in the same script (English, French, Portuguese, Khmer, Lao, etc.). If the script of the official language is different, that must be automatized separately, and time must be made in the country's curriculum for that.

Many methods work in a boutique situation but fail on scaleup. One way to deal with the vicissitudes of implementation is to monitor to ensure that pilot classes include less competent teachers and students and then to measure and monitor carefully modifying the method so as to retain the activities that are most effective yet feasible for little-educated teachers to carry out. If nearly 100% of the students learn to read though easy activities (following the "Eastern Europe" models), then a drop to 80% upon scaleup would still be very satisfactory.

If the courses are implemented approximately as expected (and this is always uncertain), the weaker students ought at least to be able to decode by the end of the first module, while the better off students would be reading fluently. Variance among students is inevitable as are subsequent inequalities, but it is hoped that early systematic intervention will provide basic decoding for all. In principle, no child should be left behind reading 0 words per minute.

Results

Some governments agreed to implement this advice, and school-level pilots showed greatly improved student performance compared to control schools:

In Cambodia, performance improved from one year to the next in all measures. For example, letters by minute rose by over 100% (30 to 63), words per minute by 63% (23 to 35), and comprehension by 70% (48% to 68%; Schwartz, 2013).

In the Gambia, and only 50% of the lessons taught on average. Still, the percentage of first graders knowing at least 80% of the letters was 69% in the Pulaar language and 57% in Wolof (target was 85% of children; Zafeirakou, 2013).

Following six months of application in grade 2 in Egypt, word and text reading fluency rates doubled in comparison to rates obtained two years earlier (from 7 to 15 and from 11 to 21 words per minute respectively; syllable reading tripled from 10 to 28 syllables per minute. By contrast, the same measures in control schools improved only by about 27%. The percentage of students reading 0 correct words was cut by half in project schools (from 44% to 21%) while in control schools it improved only by 10% (USAID, 2012). The Cambodian and Egyptian programs have been scaled up nationwide by the third year of implementation.

Pointing, spacing, chunking, speeding: Counterintuitive research suggestions for reading in various scripts

You are looking at this page, and its messages come across effortlessly. You do not even notice the font size and shapes unless they become *too unusual*. How did you achieve this proficiency level? How did your brain manage to do this?

In higher-income countries, all learn to read except children with significant learning disabilities. In such countries, teachers are well educated and show up for work, reading materials are plentiful, and weaker students get help from teachers and parents. There is time to review, to present material in different ways, and there is even time to have fun and explore meaning early on. Thus in such countries students may be able to learn reading early through the whole-word or whole language approach.

By contrast in low-income countries textbook procurement fails, instructional time is used poorly, teachers are poorly trained, and they are also often absent. Students may themselves attend sporadically and forget letters from one class to the next. Parents are often illiterate and cannot help children at home learn what they miss in school. Faced with a mass of poor achievers, teachers may only work with the few better students (Lockheed and Harris 2005; Abadzi and Llambiri 2011). The rest behind must essentially self-instruct from a broadcasting teacher, seeing letters from a distance and getting virtually no feedback.

Not surprisingly 80-90 percent of second and third graders in some countries cannot even read a single word and may know few if any letters (RTI 2009, 2010, 2011a, 2011b). And many do not persist until they can somehow learn. Every year hundreds of thousands drop out illiterate in the early grades. How much students learn is closely linked to the probability of staying in school, so quality is linked to access.³ Along with those who never attend school, about 67 million children are growing up without learning how to read.⁴

One reason for the failure is the complexity of reading methods currently in use. The models disseminated in the donor community pertain to high-income countries and to certain western European languages. English but also French, Portuguese, Dutch have complex spelling systems. English in particular requires three years of learning time (French requires about two). Reading instruction for English is expensive and complex. Students must learn sight-read lists of words along with vocabulary and prediction skills to make sense of strangely spelled words. They must start reading in kindergarten and get monitoring to ensure that they read at grade level; about 10-15% require remedial instruction. Since English is an official language in many countries, literacy has been viewed as a naturally complicated process.

By contrast, the eastern side of Europe speaks languages that are spelled consistently. In Czech, Russian, Albanian, Greek, Serbian, Turkish (but also German and Spanish) instruction requires much simpler procedures. In earlier decades reading was taught by untrained teachers through

³ UNESCO, 2005, p. 28. Also the Kenyan HALI project showed that literacy intervention was associated with reduced dropout. Only 2% of the intervention-group children in the younger classes had dropped out of school by the 24-month follow-up, compared to over 5% of the control group (Brooker et al. 2013).

⁴ www.globalpartnership.org

syllabaries that unwittingly obeyed building-block learning principles. In such languages, basic instruction requires only requires only about 100 days. In the above countries of Europe, it is widely “known” that first graders typically decode by Christmas.

Like Spanish, Russian, or Albanian, the vast majority of the world’s languages are spelled consistently. Barring learning disabilities, **nearly all students could be made basically literate in the first semester of grade 1** by using local languages. After automaticity, literacy transfers to more complex spelling systems of the same script. And research can help optimize the 20th century methods.

Explanations for the above hark back to cognitive neuroscience principles. Memory research and brain imaging have opened doors to understanding reading in ways that were unimaginable. The insights from cutting-edge science lead to feasible methods for making basic literacy attainable for all. The story that emerges is the following:

Basic reading largely involves “low-level”⁵ neurological functions and reactions that must occur within milliseconds. Learning to read first and foremost involves perceiving the letters as distinct shapes, focusing on the right ones on a page or blackboard, and learning to distinguish each one instantly from the others. Our mind chunks letters into syllables progressively; bigger chunks of letters are formed incrementally by mastering and combining smaller chunks. Practice speeds up reaction time to letters until a certain brain region is activated. That region processes words as if they were faces and enables decoding of multiple letters simultaneously. Reading speed rises abruptly when activation exceeds a certain threshold. And speed is necessary because our working memory, which has limited capacity, must be able to retain a message long enough to make sense of it. Therefore texts can be understood only after the visual signs have been interpreted and mapped onto sounds, and after a minimum reading speed has been attained.

These processes are necessary for all humans and take place in all languages and scripts. Because they are prerequisite to tasks of greater complexity, they limit what the average student can learn in classrooms that teach very little. The students who fail to learn the sound-letter combinations or small letter units cannot go on to texts of greater complexity. They can neither catch up on their own nor learn more advanced material by skipping the elementary gaps. It’s as if children set out for school but encounter a mountain right outside their front door.

The poor outcomes of social promotion policies attest to this phenomenon. In many countries students are automatically promoted to the next grades, but illiterate students may not catch up on their own in higher grades. They need much time and practice in connecting specific letters and sounds (Reeves 2008), but remediation is rarely if ever available. (See chunking function below.) Without help and remediation, mainly the better-off or the brightest among the poor are able to perform.

⁵ Such functions include perceptual learning, chunking, automaticity, mapping letters to sounds. The term ‘simpler’ cognition is used as a placeholder, given the existence of the term “complex cognition” (Sternberg and Ben Zeev, 2001). “Lower-level” processes are not really simple, but they are executed with little or no awareness and constitute building blocks for tasks requiring conscious thinking.

Why are these neurocognitive issues not better known?

We can all relate to reading through our own experiences. One important reason for the limited insight to the reading problems of the poor is our own reading proficiency; it creates visual illusions. The brains of educated people have been “programmed” and sculpted since early childhood to read volumes of text effortlessly. Inevitably we tend to trust our own perceptions. It is difficult if not impossible to understand the viewpoint of learners, who may see only jumbles of squiggles.

For most middle-class people, even those learning in English, reading is a reasonably easy process. Children of literate parent grow up in a world rich with symbols and may learn to discriminate among letter shapes even without knowing their sounds. In school they may quickly learn to recognize larger chunks of print. With help, the mountain is quickly reduced to a molehill. Therefore perceptual learning variables have brief and limited importance, so they are not well known. Fast learning among the well-to-do may be why reading is commonly considered an activity involving comprehension and meaning rather than visual discrimination.

Since middle-class children usually learn letter combinations fast, theories have emerged about reading ‘naturally’, using whole language and authentic texts. And all but the profoundly disabled learn to read in the schools of high-income countries, so reading methods have been left up to individual teachers. Furthermore, reading in most high-income countries is not a separate subject but an activity mixed up with language arts. The result is ambivalence about how to teach reading, and this ambivalence has been transferred to education ministries and training colleges of low-income countries.

These middle-class biases must be overcome. The poor drop out early, and time is of essence for them. Nearly all students must somehow learn fluent reading very quickly when they start school. The instructional time limitations accentuate the importance of *learning efficiency*. Methods must be used that require the least amount of time, the fewest number of tries before students retain a concept. If students realistically get only two hours of school per day but teachers are given methods that require five, clearly most of the activities will not be carried out.

The research outlined in subsequent chapters suggests that in most languages and scripts basic literacy can be acquired early, even by the less able students. It is therefore possible to teach the poor effectively by focusing on these low-level variables. Speedy letter identification leads to comprehension when the language is known; the other way around is tortuous and time-consuming. The challenge is to disseminate the research and its applications and to clarify to educators the linkages between the lower-level variables and the higher-level text interpretation. Making students literate early, during the first semester of grade 1 as is typically done in eastern Europe, would promote equity.

Most languages of the world are spelled consistently. Exceptions include a small number of languages that use ancient spelling patterns despite changes in pronunciation. These are mainly English, French, possibly Portuguese, Tibetan (Dzongka, other Bhutanese languages), Irish, Thai, and to some extent Khmer. Some others, like Greek and Bengali, involve spelling complexities in writing, but are consistent in reading. Chinese ideograms follow different patterns and require at least four years of instruction, but the languages that use them are not

currently low-income. (Korea and Japan use ideograms, but Hangul and the Japanese kanas are spelled consistently and are mastered quickly.)

Teachers are subject to the same information processing limitations as students. To teach weaker students, given limited education levels of many teachers, the memory functions of teachers must be seriously taken into account. Poorly educated teachers often read slowly, and the probability of carrying out instructions may be commensurate to their information processing speed and efficiency. A parsimonious routine is needed that teachers with limited education can automatize and implement realistically within one instructional period. The routine ought to require limited training time and limited expertise to supervise.

Thus a minimal number of the most necessary, “non-negotiable” activities must be determined that have the greatest impact on consolidation. A number of them have been tentatively identified empirically, but some neuropsychological measures may be needed for greater precision. (See more below.) These would be the most likely to help consolidate learning, and enable nearly all students at least to decode in local languages “by Christmas,” despite systemic inefficiencies.

Determining a core routine to automatize reading in about 100 days is an essential part of the strategy, but not the only one. Subsequent sections outline a broader strategy to teach oral official language and to provide large-scale remediation in local languages in the countries that need it.

Much of the research cited in this report has been carried out with different populations and is therefore used translationally. It would be highly desirable to conduct targeted research and evaluations in order to specify the model better. Agencies such as DFID and USAID are beginning to engage in this process. In the meantime, however, technical advice to countries must proceed on the basis of the known material. Children are dropping out as this document is being written, and time is of the essence.

Literacy in 100 Days? A Essential “Emergency” course based on Neurocognitive Research

The implications of the above research have been operationalized in a basic reading course. It would be taught in consistently spelled languages and pitched at lower-scoring students, first graders or older children who have remained illiterate. The course would have a specific time in the curriculum and not be mixed with language arts. It would focus on splitting words to the smallest readable phonemes, blowing up the print so that it is easily distinguishable early on, and getting enough practice for speed to build up and comprehension to take place.

The course of course would continue after the 100 days to the end of the school year. But in most languages and scripts of the world, the reading strategy and essential letters would take no longer than that time. (For syllabic scripts, such as Amharic or Bengali probably the essential syllabi components would be taught. Compound combinations and conjoint consonants) would probably be taught in grade 2. However, syllabic scripts typically have means to stop inherent vowels. (In Hindi that would be halant, hashonto in Bengali). Therefore students could get practice throughout grade 1 on basic combinations and still read be able to read most words, albeit written less elegantly.

To conduct a course realistically doable by little-educated teachers, a minimal number of maximally effective and most likely doable activities. In the spring of 2013, research suggested the following :

- A week of preparatory activities on using print, phonological awareness, writing all letters.
- Reviewing the letter and main combinations of the previous day
- Teaching the simplest letter forms,
 - First lower-case letters, then capitals; learn calligraphy after automaticity
- Teach one letter per daily instructional hour maximum
 - o Use keywords to introduce the letter if that is convenient
- Link letter and sound closely and explicitly
- Draw students' attention on the letter, point to the letter
- Give analogies with the other known letters (ka ki ku ke ko, ak ik uk ek ok)
- Pronounce the syllables and underline with the finger when a word is read.
- Combine letters into syllables
- Spend about half the class time practicing reading
- Teacher passes by each students and gives corrective feedback, even for a few seconds.
 - o After about a month, the better students will be able to help the rest.
- Have frequent reviews of letters, perhaps every 4 letters.

Writing would initially get limited practice during the first 50-100 days, for reasons discussed further in the text. Similarly phonological awareness has been greatly emphasized in English-language methods, but its benefits for consistent scripts are less pronounced (Georgiou, Parrilla, and Papadopoulos 2009).

Day to day monitoring of reaction speed to be tried through computerized psychophysics tests and portable eye-tracking equipment. Final results would be monitored through quick and inexpensive **one-minute reading fluency tests** – given by teams of enumerators rather than teachers themselves.

For multilingual countries, a subsequent module would be necessary to bridge students into the spelling of the official language if written in the same script (English, French, Portuguese, Khmer, Lao, etc.). If the script of the official language is different, that must be automatized separately, and time must be made in the country's curriculum for that.

Many methods work in a boutique situation but fail on scaleup. One way to deal with the vicissitudes of implementation is to monitor to ensure that pilot classes include less competent teachers and students and then to measure and monitor carefully modifying the method so as to retain the activities that are most effective yet feasible for little-educated teachers to carry out. If nearly 100% of the students learn to read through easy activities (following the “Eastern Europe” models), then a drop to 80% upon scaleup would still be very satisfactory.

If the courses are implemented approximately as expected (and this is always uncertain), the weaker students ought at least to be able to decode by the end of the first module, while the better off students would be reading fluently. Variance among students is inevitable as are subsequent inequalities, but it is hoped that early systematic intervention will provide basic decoding for all. In principle, no child should be left behind reading 0 words per minute.

This document presents the relevant concepts in some detail and outlines a prototype reading program developed on the basis of the research.

Perceptual Learning and Memory: The Invisible Tunnels to the Literacy Fortress

Reading is a rapid interplay between visual perception and memory. Expert readers first recognize letter features, and within milliseconds they probe their memory for related words and for the prior knowledge needed to understand a text (Gabrielli et al. 2010). But to gain entry to this fortress of knowledge, children must first crawl fast through two narrow tunnels: visual perception and working memory. They elude our consciousness, so they are hard to pinpoint. But these tunnels stop a lot of students from progressing into the fortress of literacy and “reading to learn”.

Perceptual learning: Perceiving, distinguishing, linking shapes. Our brains have a genetically determined apparatus for visual perception. Letters are just objects, and initially they are recognized on the basis of brain parameters. Scripts have evolved over centuries to fit the properties of the human visual system (Changizi et al. 2004, 2005), so in principle the existing letter sets in the world can be learned by everyone. But different scripts pose varying demands on perception and discrimination, so the amount of instructional time and practice differs. Some scripts have more letters than others, or their letters may have more features. For example, vowelized Arabic is fairly simple to decode, but unvowelized Arabic requires predictions and dependence on vocabulary and syntax (for the Arabic, Urdu, Pashto, or Farsi languages). With experience people get habituated to density and automatize complex shapes, but initially these issues are very important.

Insights about perceptual learning suggest that letters might best be learned one by one and through the use of critical spacing and size. They should be in close proximity to beginners, and patterns should be used to improve detection.

Capacity challenges of working memory and the importance of speed. When letters get through the visual bottleneck and are recognized, they meet a new bottleneck, that of working memory. To understand, readers must hold a text in their minds long enough to recall relevant information about it, but they only have a few seconds; working memory for simple text may hold only about 7 items for about 12 seconds.⁶ So a message must be deciphered fast enough to fit within the short timeframe. Until speed increases to suitable levels, students may be unable to make much sense of the text.

⁶ Peterson and Peterson 1959, Miller 1956, Atkinson and Schiffrin 1968, Baddeley 1999. More recent working memory research points different timeframes for various tasks and lower capacity limits (Cowan 2004), but elementary fluency tests resemble the older protocols and still seem appropriate (e.g. Daneman and Carpenter 1980). Very roughly a minimum reading speed to understand a simple sentence of about seven words in about 12 seconds would be about 45 words per minute, but reading studies in multiple languages have shown that 50-60 words per minute are need to respond to 80% correct shallow questions of a simple text (e.g. RTI 2010, p. 43).

Insights about working memory lead to a realization that *all basic skills must be carried out rapidly*; otherwise chains of procedures cannot be executed (Cooper and Sweller 1987). This applies for reading as well as for math; time and practice must be given so that students can carry out the steps needed to process text, solve problems, or write ideas without thinking about them too much. Working memory capacity has implications for assessment. A minimum reading speed is needed in order to make sense of text, and estimates can serve as benchmarks.

The next sections discuss activities linked to the above bottlenecks.

Feature detection and Spatial Perception

Students must first learn to focus on the shapes drawn on paper or blackboard, distinguish figures from background, and then they must instantly discriminate among them. The better off children



have no difficulties or overcome them very quickly. But very poor students may lack experience with written symbols and may not understand their purpose. They may not know, for example, that they must proceed from one line to the next.

Some research suggests that spatial attention, that is ability to focus on letters, is linked to executive control and ultimately reading performance (Franceschini et al. 2012). The difficulty in latching on to the right letters and maintaining attention may affect the ability to learn letter-sound combinations in one “click” (see below).⁷

And it may be one reason why students seem to repeat verbally but when tested do not know the letter shape. Observers who do not know of this research often conclude that the teacher practices “rote memorization”.

Care must be taken at least in the first few weeks of instruction to make sure that the students are really focusing on the correct shapes. Drawing large letters without other shapes nearby, bringing the kids close to the blackboard on critical moments, asking them to draw the shapes, asking them to point to the blackboard or to the textbook (if they have one) ought to help. Children may also be asked to put their thumbs up if they understood and down if they did not. They may be asked to point to a flash card while voicing the sound and to put their fingers on a big letter printed on the textbook for this purpose (see below).

Difficulty latching onto the right letters may be common among young and perhaps developmentally immature students, but it is not very amenable to assessment with educational

⁷ Studies show that iron, zinc, and essential fatty acids help to build the brain’s white matter and maintain attention. But these require weekly or daily administration and are not practical for large populations, even with donor help.

tests, so it has not been studied. Clearly more research and experimentation are needed on this topic. Psychophysical methods are needed, that are rarely used in education.⁸

Habituation to density

Recognizing the particular shapes after focusing on them is the next obstacle. We always recognize letters from features, and these must be detected rigorously and individually (Pelli et al. 2006). Recognition is greatly facilitated when features are few and when the letters are well spaced. The number of features that must be processed is an important reason for suggesting that only one letter ought to be taught every day.

Dense script slows speed down because complex letter shapes and combinations create a bottleneck in visual recognition (Pelli et al. 2006). In the earliest stages, many items in daily schooling challenge the visual perception of those who are not habituated. Dirty blackboards, calligraphy, small and crowded print may delay perceptual learning among students who come to school with little prior exposure to print.

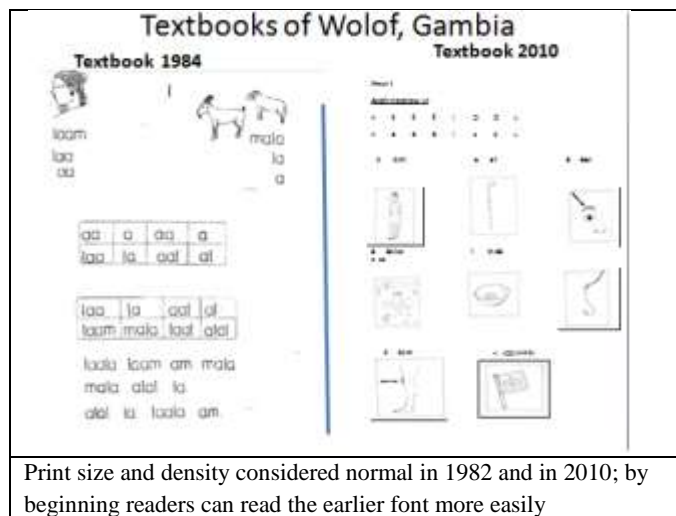
		Uncrowded large letters for beginning readers
A	ando la pera. La bambina asc illo è magro. La quercia si tro fiore è rosso. La bambina ave ola. Il ragazzo non ha né capp stanno saltando sopra il muri no seduti e guardano verso la terrazza potrebbero vedere tu tetto della casa si vede anche to, ma non il bicchiere. L'elef o sul ramo dell'albero. La bar i è verde. I ragazzi raccolgono	Once upon a time there was a land with a good king named Midas 24 point font double spaced, 3 spaces between letters, 3 pts spacing between letters
B	Il ragazzo che lo è magro. La q ella città. Non so è rosso. La baml stella, dentro cu l ragazzo non ha	

With some practice, people adapt quickly; some distinctions may only require a total of two hours of exposure.⁹ As literacy and media have spread more widely in the world, our visual systems have adapted to smaller dense print. Thus, adults judging textbooks print may find letter sizes reasonable. The habituation is evident when 19th or early 20th century textbooks are compared to those published more recently. (See illustration in Arabic.) Earlier texts may conform more closely to the critical spacing and critical size parameters of the visual system.

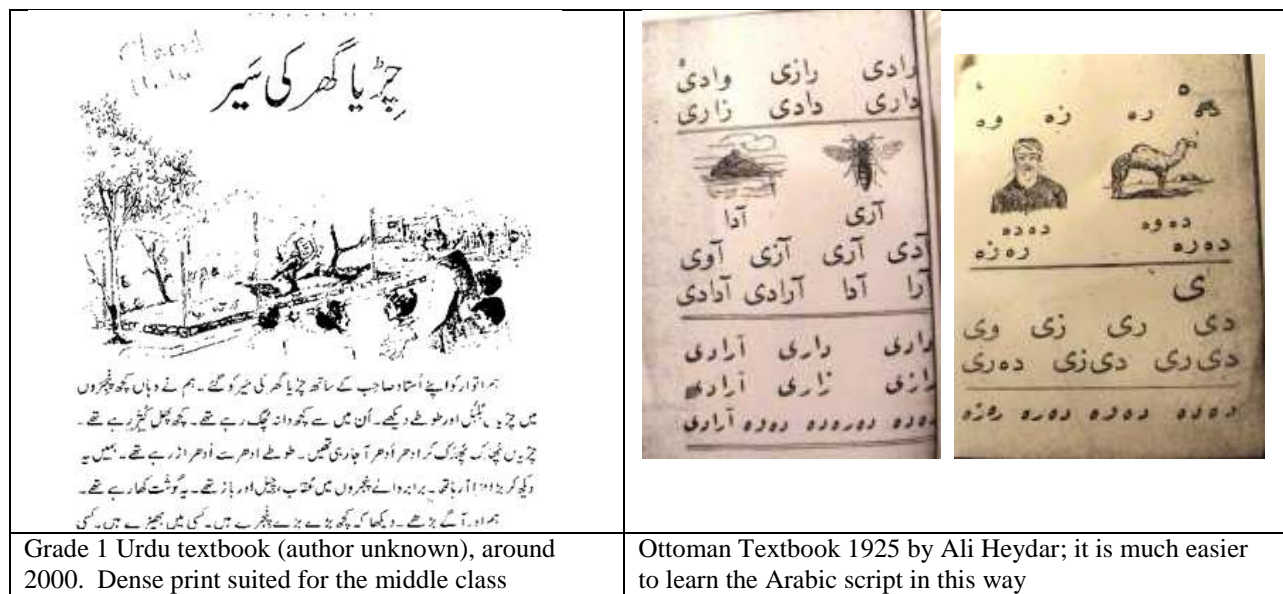
⁸ Psychophysics quantitatively investigates the relationship between physical stimuli and the sensations and perceptions they affect. Psychophysics also refers to a general class of methods that can be applied to study a perceptual system. Modern applications rely heavily on threshold measurement, ideal observer analysis, and signal detection theory. (Wikipedia)

⁹ Research showed that degraded faces recognized a year later (Hussain et al. 2011) just as people recognize handwriting that sometimes greatly deviates from printed script.

Print sizes approximated 24 point courier fonts, were double-spaced and had larger spaces between each word (Pelli et al. 2006).



Students who have never seen books need practice and experience before being able to read dense text comfortably. Such students may get more benefits from large and widely spaced letters, similar to those of the earlier decades.



Chunking and the Advantages of Teaching Letters One by One

As mentioned earlier, the various letter features must be detected rigorously and independently, and the volume to be detected creates a bottleneck. This is an important problem for

inexperienced readers. Efficient reading instruction would suggest minimizing the number of the features that must be detected when experience is limited.

Languages with spelling complexities (such as English, French, Portuguese, or Khmer) require deciphering multiple letters simultaneously; these large “psycholinguistic grains” also require more practice (Ziegler and Goswami 2005). The spelling irregularities of English in particular make it an unusually difficult language for fundamental reading (Share 2008). Some Asian syllabic scripts are visually quite complex (Changizi et al. 2005). Despite spelling consistency such scripts would require more practice than smaller alphabet sets, such as Latin, Cyrillic, Armenian, or Dhivehi.

Reading studies confirm the predictions of perceptual research. They also show that learning the linkages between specific letters and sounds is faster than learning the links between letter groups and multiple sounds (e.g. McCutchen et al. 2002; McCutchen and Berninger 1999; Moats and Foorman 2003; Spear-Swerling and Brucker 2004; Zorzi 2005). Students who get extra practice home can learn reading from methods that teach multiple letters quickly or focus on entire words. But the limited engagement time of poorer students suggests that synthetic phonics (which present fewer letter features at a time) would be more efficient in low-income classrooms and for lower-scoring students (Wyse and Goswami 2008).

Our minds are set up to learn by composing small chunks into larger chunks. This is achieved through practice, which helps chunk letters together and reduces reaction time (Miller 1956). Longer and complex chains of skills can only be developed after smaller chains have been formed (Keele 1973; Schmidt and Lee 2005). Chunking has received limited research attention, perhaps because in higher-income countries students progress fast from letters to words. But this chunking function may explain why those who fail to master smaller pieces usually cannot go on to bigger ones. Since low-income students tend to practice less, they may read letters one by one and with hesitation for a long time. They may be slow in blending letters into syllables.¹⁰

To teach the weaker students, it would be useful to isolate and teach the smallest possible chunks first. These would be letters, or various signs used in syllabic scripts. The research does not offer clear guidance on how small the chunks must be, that is how many letters should be introduced at any one time, but **it may be wise to teach at most one letter per daily reading hour**. Capitals would be taught separately from small letters in scripts where these exist. Because small chunks must form first, learning during the first few days is crucial. If students fall behind in the first few days, they may be unable to catch up.

To facilitate the work and arrive quickly at larger chunks, it is useful to study the frequencies of the letters in a language and teach the most common ones first (Trudell and Klaas 2009).

¹⁰ Gough and Tunmer proposed in 1986 the Simple View of Reading according to which reading comprehension (RC) is equal to the product of two separate components: decoding (D) and linguistic comprehension (C), thus $RC = D \cdot C$. Decoding refers to the ability to read printed nonwords by applying the grapheme-phoneme correspondence rules, and linguistic comprehension refers to the ability to interpret sentences and discourses presented orally. Fluency (i.e. speed, accuracy, and proper expression) is a separate contributor due to the visual word form activation. It is a mediator between decoding and reading comprehension (Silverman et al. 2013).

Scope and sequence of the Jola language of the Gambia



Fourteen weeks: Reading for All!					
Scope					
	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	INTRO- parents	a	b	k	i
Week 2	Revision a b k i	t	u	n	d
Week 3	Revision t u n d	l	j	w	e
Week 4	Revision l j w e	m	y	o	f
Week 5	Revision m y o f	h	aa	s	oo
Week 6	Revision h aa s oo	r	ii	p	uu
Week 7	Revision r ii p uu	c	ee	g	á
Week 8	Revision c ee g á	áa	n	ɛ	ó
Week 9	Revision áa n ɛ ó	óo	i	ii	U
Week10	Revision óo i ii ée	Uu	é	ée	nk
Week11	Revision Uu é ee nk	ng	nd	nt	nj
Week12	Revision ng nd nt nj	nc	nf	mb	mp
Week13	Revision nc nf mb mp	ny	nw	ni	ns
Week14	Revision ny nw ni ns	mm	nn	ɛɛ	nn

“Impressing” Students During Letter Presentations

Sound-letter correspondences ought to be learned early and specifically. Long-term potentiation is a neural-level process which enables stimuli to be linked permanently in memory (e.g. Arai et al. 2009), and the students ought to receive opportunities to enhance its occurrence.


Teachers should present a letter *using as few words as possible* to minimize distractions. It is useful to point to the target letter and pronounce the sound with no verbiage in between in order to “impress” children with it. The sound is “bbbb.” A large b on the board or a flash card will increase the probability all will connect sound and letter, particularly those sitting further away.

Children should repeat and touch the letter on their books to ensure that they are not mindlessly saying the sound. The teacher could approach the back rows and direct questions to specific children rather than wait for volunteers. Without such specificity, students often miss the precise links between name and sound. Students easily memorize sequences. Their voices may assuage teachers, but most students may be in fact illiterate.

Some children repeat what is written on the blackboard without looking at the letters	Is this child really reading or pointing to a memorized order of a text?
	

Pronouncing the sound rather than name and omitting extraneous vowels is crucial. Teachers often pronounce extraneous letters (be + a = ba) or create complex graphics that may not make sense to beginners.

Many methods use a keyword to introduce letters, while others go from a sentence to a word and then to the letter. These seem reasonable practices when executed orally. For example a teacher may say: “What is xxx? This is how you write it.”

	
Lingala textbook from Congo DRC, 1976. Unclear whether the lines between letters helped students	




Pattern Detection for Faster Progress

The mind seeks patterns and learns them easily (Devlin 2010, p. 169), and children are expert pattern detectors. This helps them learn much from their environment informally, without explicit instruction. Specific instruction and practice in analogies and systematic patterns may facilitate chunking and eventual automaticity.

This advantage was discovered by teachers of earlier eras. For example, Greek textbooks of 1860 and 1863 contain such combinations in their first few pages (Koromila 1863). Teaching must include explicit instruction on the rules and change patterns related to various sounds and parts of speech. These include comparisons (ka ba za da la, also ak ab az ad al) and contrasts (such as ka ki ku ke ko).¹¹

Vowel consonant analogies in the Roman and Arabic scripts						
	a	e	i	o	u	Letter Fatha Qasra Dhamma
B	ba	be	bi	bo	bu	ب با بے بی بو بۇ
C	ca	ce	ci	co	cu	س کا کے کی کو کو
D	da	de	di	do	du	د کا کے کی کو کو
F	fa	fe	fi	fo	fu	ف کا کے کی کو کو
G	ga	ge	gi	go	gu	ج کا کے کی کو کو
H	ha	he	hi	ho	hu	ح کا کے کی کو کو
Etc						etc

The utility of analogies was discovered in multiple countries:

		
<p>"Tablets" Greek literacy book 1860</p>	<p>Russian Golden primer of 1915 (McEneaney 1997)</p>	<p>Ottoman Turkish textbook, 1925, p.7 (Ali Heydar)</p>

¹¹ Though old textbooks usually presented analogies systematically, many also introduced 3-4 letters at one time, creating visual complexity.

How to teach one letter at a time? Single letters that function as words are exclamations (a! e! i! o! u!) and could be learned in the first few days along with the culturally relevant movements, given that emotional expressions may help retain these letter shapes (Nielson et al. 2006, Wagner Cook et al. 2009). If the first letter is a, the second can be a consonant that produces common combinations with the first (e.g., if it is b, then students can decode aba baba, bab, baab). The addition of a k can make some meaningful words (example, kaba in Wolof), but with these three letters one can make aba, kab, bak, etc. Longer combinations may result in visual crowding, so maybe 3-4 letters ought to be used only. Textbooks in the early pages could have multiples of these in random repetition as practice.

Phonological and Tone Awareness

One pattern that students must understand early on is how to map letters onto sounds. Much research has linked phonological awareness to reading achievement. Teaching students to identify the beginning and ending sounds is important. Particularly useful for consistently spelled languages is word segmentation (e.g, Durgunoglou and Oney 1999). Students ought to receive such exercises, which are oral, during the early stages of instruction.

This skill is harder to teach to students and teachers than it appears. UK teachers, for example had difficulty learning it for English (Stainthorp, 2003). People easily break words down into syllables, but they take longer to segment words into sounds. Phonological awareness is clearly a desirable skill, but it may be hard to scale up. Also there are some doubts regarding its value when explicit phonics are used in consistent orthographies (Georgiou, Parilla, and Papadopoulos 2008). For example, phonological sensitivity appears to be more important for reading in English than in Greek (Manolitsis et al. 2009).

Tone awareness. Many East Asian and African languages are tonal. In Africa these include languages such as Hausa, Mandinka, Mooré, Fongbe, or Yoruba. In some languages, meaning really depends on the correct tones, while in others it is less important.

Asian tonal languages typically mark tones in various ways. Thai and Lao write Sanskrit numbers on top of certain letters and also reserve certain letters or combination for certain tones. (Tibetan does the latter.) Vietnamese uses the Roman script and enters tones as accents.

In writing African languages, tones are often not marked or are marked inconsistently. This may be due to the fact that many were written down by Europeans who were not sensitive to tones. In some language, the “functional load” of tones is low, that is not every word has tonal alternatives. In principle, textbooks of tonal languages should mark them, but tones add visual complexity early on. It may be visually simpler to learn reading without them at the outset, but text may have to be controlled. Piloting is needed to gauge how well students will understand words if tones are not marked. Under all circumstances, students ought to learn early on to identify tones pertinent to their language.

Morphological Awareness for Languages with Spelling Complexities

Due to pattern detection and phonological awareness, *morphological awareness* exercises have been found to be beneficial (Bowers et al. 2010). In Spanish, for example, students would receive specific practice on prefixes like de- or -ión (de-mostrar, de-cifrar, de-cidir, vide, di-vide; mis-ión, vis-ión, cuest-ión). Common prefixes and suffixes would also use the most frequent letter combinations in a language. After basic instruction in all letters, morphological awareness may help students recognize more patterns and increase speed.

<p>ette</p> <p>poulette maquette</p> <p>minette salopette</p> <p>bichette assiette</p> <p>fourchette galette</p> <p>alouette pirouette</p> <p>toilette brouette</p> <p>violette valisette</p>	<p>eu</p> <p>pleurer bleu</p> <p>peureux heureux</p> <p>valeureux feu</p> <p>courageux jeu</p> <p>chanceux menteuse</p> <p>rieuse curieux</p> <p>jeunesse deux</p>	<p>eur</p> <p>heure tricheur</p> <p>beurre valeur</p> <p>malheur voleur</p> <p>saveur rêveur</p> <p>dormeur fleur</p> <p>peur sauveur</p> <p>vendeur douceur</p>
<p>gn</p> <p>montagne châtaigne</p> <p>musaraigne magnifique</p> <p>cagnotte frognon</p> <p>Pologne vigne</p> <p>chignnon agneau</p> <p>signal soigne</p> <p>éloigner témoignage</p>	<p>gue</p> <p>fatigue figue</p> <p>ligue guépard</p> <p>langue mangue</p> <p>tangue dingue</p> <p>blague longue</p>	<p>gui</p> <p>guilis guitare</p> <p>guimauve guidon</p> <p>guirlande</p>
<p>ien</p> <p>chien tiens</p> <p>rien gardien</p> <p>viens mien</p> <p>bien retiens</p> <p>martien</p>	<p>ill</p> <p>myrtille jonquille</p> <p>faucille vrille</p> <p>millet piller</p> <p>grappiller papillon</p> <p>chenille grille</p> <p>gorille</p>	<p>in</p> <p>lapin sapin</p> <p>malin chemin</p> <p>jardin requin</p> <p>matin moulin</p> <p>pantin Martin</p> <p>poussin patin</p> <p>lutin pépin</p>

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Martin, Marlaïne, 2009. [Apprendre à Lire en Famille\(Broché\)](#) Editions Instant Present

Morphological awareness exercises could be introduced after the essential letter instruction. They can facilitate pattern detection, chunking, and speed. These should have value in the languages that have more complex spelling. For example, French instruction could benefit from morphological awareness exercises (see Martin 2009).

Increasing response speed to letters – The importance of practice

If people read only letters in series, they would not be able to process much text. But several weeks of practice build in the brain the white matter necessary to transmit messages fast (Keller and Just 2009).¹² Thus practice activates an area in the left occipitotemporal area of the brain called the visual word form (McCandliss et al. 2003, Shaywitz 2003, Dehaene et al. 2010). This area specializes in the recognition of faces, and its use facilitates the identification of four or more letters at the same time, almost as if they were features of faces (Dehaene and Cohen 2010). All humans seem to use this area during proficient reading, including blind students reading Braille (Reich et al. 2011). Thus the key to fast and effortless reading seems to be sufficient activation of the visual word form.¹³

The use of a shape or face recognition device for reading has certain implications. Letters are processed in parallel and students see entire words at a glance. Not only are entire words recognized, but there is also perceptual constancy; people recognize faces that have been altered, just as people recognize scribbling. One implication is that calligraphy, which is taught early on in much of Africa, should be taught only after students have become fluent readers. Then the letters will be seen as alternatives to the typical letters rather than a whole new script.

Once experienced readers learn a word, sounding it out is no longer necessary. A visual dictionary gets created, and readers rely on it to recognize words (Glezer, Jiang, and Riesenhuber 2011). Thus, people can get to read hundreds of words per minute without sounding them out. Middle-class students may transition to fluency within a few days in grade 1, but children receiving inadequate instruction and practice may be stuck in intermediate stages for years. For future performance, the visual word form ought to become sufficiently activated in grade 2. In high-income countries students usually process text fast, so it fits within the capacity of their working memory, and the capacity limits of this mechanism are not easily experienced. But in low-income countries students may recognize text slowly, if at all, and they may have little knowledge to retrieve quickly. Then the capacity limits of working memory become a real obstacle. If we read too slowly, by the end of a sentence we may forget the beginning.

Research with adults learning new scripts suggests that letters must be seen and decoded about 3000 times before reaction time to them levels off (Pelli et al. 2006). So practice should be extensive, not just a few sentences as it commonly happens.

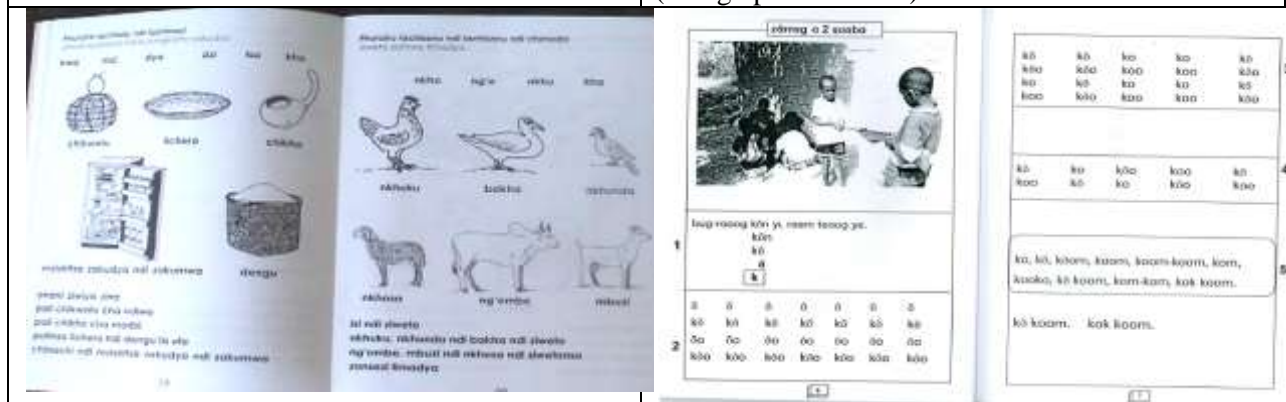
For students not exposed to print earlier, certain tasks are not trivial. Some deficits surprise middle-class people. For example, students must be taught to go downwards on a page, otherwise they cannot go on reading.

¹² A US study using diffusion tensor imaging showed that the brains of dyslexic 8-10 year olds receiving 100 hours of instruction improved in terms of white matter quality, and students' decoding skills improved as well (Keller and Just 2009).

¹³ Commonly literacy is thought of as developing in various stages, such as the five stages proposed by Jean Chall. However neurocognitive research suggests that the major stages are two: Before sufficient visual word form activation and afterwards. Strangely, knowing a language is not a prerequisite automatizing reading. Many people in the world become fluent readers in scripts like Arabic, Hebrew, Sanskrit for religious without knowing the grammar of the associated languages.

Malawi –Chichewa reader – multiple letters in one page and little practice. Outcomes are poor

Burkina Faso, Solidar Swiss NGO:
Detailed phonics, analogies, much practice text
(though print is dense)



To reduce reaction time to letters, students ought to read a page of text per day, not just a few words. To achieve this during the first few crucial lessons when few meaningful words are formed, invented words that conform to the rules of a language are offered: aba, bab, baab, abba. Legal nonwords may help reduce reaction time to the first few lessons when the letter permutations are limited. Their use improves decoding skills (Cárdenas 2009) and may force students to decode rather than repeat familiar words from hearsay without reading them. After about the 10 most frequent letters are taught, the permutations ought to result in real words. There should be no further need for invented words.

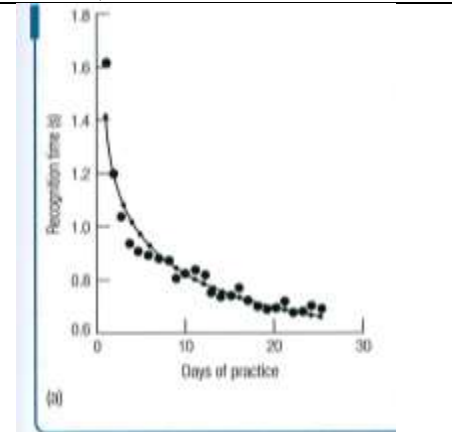
Students seem attuned to make sense of words. Skilled adults get specialized responses to words within 250-200 msec of exposure and arrive at the meaning within 500 msec from the time they start reading a word (Alison et al. 2002, Grainger and Holcomb 2009; Gabrielli et al. 2010). So it is important to separate exercises of meaningful and invented words and tell students that the latter combinations do not make sense.

For all these reasons, independent practice is very important. It speeds up letter identification towards the eventual attainment of automaticity. At slow speeds people tend to read aloud and keep their finger under the text, but with automaticity silent reading is enabled. Perhaps half the class time should be spent in this activity, which the better off students may do at home.

Students should read aloud or silently until they read fluently and effortlessly. They can read texts all together, alone, in small pairs, reread the same text after some time, take books home to read to parents. Because they easily learn sequences of words by heart, **they should read extensive texts, totaling thousands of words**; not just a few sentences as is commonly done. A grade 1 textbook might have 4000 words. (see subsequent section)

Research shows that repeated reading reduces the effects of visual crowding (Huckauf and Nazir 2007). It also improves speed and accuracy (Dowhower 1987, 1991). Students should read until they instantly identify each letter and read fluently, effortlessly.

Learning curves illustrate the power of practice (shown here is typing speed increase)




Sentences practice effect reduced reaction time from 1.4 secs to 0.7 sec in 25 days. Pirolli and Anderson (1985); Anderson p. 188

If feasible, students should get **homework** to read at home every evening to stabilize memory before sleep and should read to their parents. However, in the poorest circumstances, students may have no electricity or place to do it. It is thus important to plan for it in class.




Executive control may be a significant obstacle in the early reading days. Students unaccustomed to mental effort may stop after a few tries, and teachers must get them to persist. Students early on also make many mistakes, so corrective feedback is needed on errors.

With phonics instruction in transparent orthographies decoding may be achieved in 3-4 months of consistent work (Nikolopoulos et al. 2006, Aro and Wimmer, 2003; Ellis et al., 2004; Seymour et al. 2003). Unlike English, students pronounce just the letters contained in a word, so they depend less on vocabulary knowledge or on predictions to

decipher text; they also have less need of parents reading to them at home (Share 2008; Georgiou et al. 2008, 2009).

<p>EnEn goo - 4 revision: kaba, baba</p> <div style="display: flex; align-items: center; justify-content: center;"> i  I </div> <div style="text-align: center; margin-top: 20px;"> kaki </div> <div style="margin-top: 10px;"> <p>i k ik k i ki</p> <p>i b ib b i bi</p> <p>i a ia a i ai</p> <p>k ka kak kaki</p> <p>kaki kak ka k</p> </div> <p><small>[Enfants : liez seule les mots Fonghé suivants]</small></p> <p><small>Mettez plus des mots ou phrases qui se forment avec les lettres déjà enseignées</small></p>	<p>kaka</p> <p>bai bakaki</p> <p>kai</p> <p><small>[Enfants : Liez les mots inventés s'ils sont nécessaires]</small></p> <p>iki ibi bib bik kib</p> <p>aki abi aki kik ika</p> <p>iba ka ibi ak aki bi</p> <p>abi bi aka ib iki ibi</p> <p>bib bik kib aki abi</p> <p>aki kik ika ibaka</p> <p>babi kaki kika iab</p>
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For these reasons, phonics practice of consistently spelled languages can bring about rapid improvement, even when scripts are visually complex. For example, the Pratham non-governmental organization (NGO) of India successfully taught syllabic scripts to illiterate fourth graders in 6 weeks by dedicating one hour per day for reading and one hour for math. At the end of six weeks, about 85% of the students had progressed from halting or no reading to fluency (Banerji et al. 2005). Similarly, the Intervida association of six community-run schools in Peru increased students' reading rate by 22 percent on average (11 words per minute) in four months once it was decided to focus on practice (World Bank 2008).

		
<p>Whole-language approach, where picture substitute for longer words. Advantage unclear, but preparation is complex (Institut de l'Education Populaire, Mali)</p>	<p>Synthetic phonics and pattern analogies in Mozambique Progresso NGO</p>	<p>Boscher method in French, 1950s http://www.flickr.com/photos/taffeta/4710349280/in/photostream/</p>

The Importance of Brief Corrective Feedback to All Students Daily

Middle-class students constantly get corrective feedback, either from parents or from teachers. But in low-income countries classroom observations often show that few students are participating in instruction at any given time (e.g. IEG 2008, 2009a, 2009b, 2009c, Schuh More et al. 2009). Teachers in low-income environments often stand by the blackboard, address students at large, call for volunteers, and interact mainly with the few who know the answers. Corrective feedback is crucial because the nervous system must determine whether an action is correct (Salamone and Correa 2002, Galvan et al. 2006). The better students may gradually concentrate at the front, while weaker students may sit silently in the back. Children that escape teachers' attention may never learn to read (Lockheed and Harris 2005, Llambiri 2005).

Focusing on the few best students was perhaps a reasonable teacher decision when materials were nonexistent and only few could learn from limited instruction. Thus, teachers may have prior probabilities in their minds regarding the percentage of students expected to learn. *"If the student cannot learn, we send him home"*, said a senior teacher from Mali at a 2009 workshop. But to educate "all" students, teachers must somehow interact with all.

Teachers in high-income countries are expected to give individual attention to students' learning needs. But this is usually impossible in countries with a long tradition of selectively attending to the best. However, some experiences, notably from the Bangladeshi NGO Gono Shahajjo Shangstha¹⁴ suggest that it may be possible to systematize the checking of all students' knowledge and offering of brief corrective feedback. The teacher could hear each child read three or four lines for a few seconds per day during a time others are practicing. Teachers could be taught to do this systematically row by row starting from the back. Even with large classes this is feasible.

After a few weeks, the better students can monitor the others. The three or four best students could also be identified and set to work with the weaker kids at the same time. Students who missed classes should be paired with others who know or briefly taught to catch up. If carried out as planned, this activity should leave no child behind.

Gambia: independent reading, teacher passing by each child	Bangladesh: teacher listening to a child read for one minute per day (Gono Shahajjo Shangstha NGO)
	

Writing Encodes Letter Memory into Movements – But Has Different Development

Movements help consolidate the memory of associated information (Dijkstra et al. 2009) so extensive writing practice would help establish the automaticity and speed children will need later to express concepts on paper quickly, before they forget them.

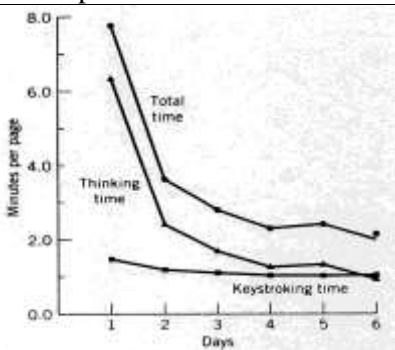
Students will remember the letter shapes and sounds much better if they write them down multiple times. In low-income countries is often scarce, but students can write on slates, ground, in the air with finger, on table. (Teaching them to write on the air may be too time-consuming.) Paper ought to be used if available because it constitutes evidence for parents and teachers, and students can also study what they wrote. At an early stage, before students produce written text, teachers could dictate letters, syllables, and words for students to write.

Copying practice ought to create procedural memory for letter shapes. Teachers often give students copying tasks, particularly when students know little and cannot do much more. However, children can easily copy a lot of text without knowing letter values, as if it were art; so

¹⁴ www.gssbangladesh.org

mere observation that they can do this does not constitute evidence that they can read. And writing is also a time-consuming task that may slow down daily routines.

Execution speed increases in this example not due to movement speed but due to rapid knowledge of the next step



Procedural memory research suggests that speed increases as a result of cognitive speed rather than motor speed (Schneiderman 1984). Research in sports psychomotor performance training favors *decision training over behavioral training* (Vickers, 2007). Recognition may be emphasized in the acquisition and practice of psychomotor skills and targeted for part-task training that then leads to improved performance of the overall skill (Williams and Ward, 2003).

Though used translationally, the procedural memory research suggests that writing may be carried out more efficiently after students know the order of the letters to be written. Thus in the first 100 days of an “emergency” course, writing can be emphasized less.

What about comprehension?

Comprehension is the ultimate goal of reading, but comes only after the early obstacles are overcome. To comprehend while reading people must first “lift the print off the page” and then go through the various steps needed to make sense of the text.

In consistently spelled languages, students ought to make sense of simple text and render its meaning without further instruction (Georgiou et al. 2008, 2009) unless they have unusually limited working memory. However, in more complex spelling systems, notably in English and possibly French, students must rely on vocabulary to predict the meaning of words they cannot spell out. This situation has created a widespread impression that vocabulary development is essential for reading. Better vocabulary is always desirable, but students learning in consistently spelled languages do not need large numbers of words to automatize text. The particularities of English have also led to an emphasis on teaching comprehension. However, research has shown that fluency is needed instead. Struggling English readers who practiced recognition to the point of automaticity answered more comprehension questions than students who merely were instructed on word meanings (Tan and Nicholson 1997).

Text interpretation and prediction do benefit from instruction, but these are higher-order functions and pertain to more advanced literacy levels.

Working memory has serial position effects, that is the beginning and the end are recalled more easily (Gupta et al. 2005). When students read relatively slowly and close to working memory limits, they tend to miss the content in the middle. Thus, when people retell content while reading at low speeds the results may be inaccurate (Cohen et al. 2009). On the other hand, when the text is complex, re-reading it slowly and carefully helps focus on chunks of it and improves comprehension.

Language of instruction issues

Obviously learning to read in a language known by a child offers many benefits, including faster identification of letters within known words (word superiority effect; e.g. Changizi et al. 2004, 2005). A vast volume of research on language of instruction exists that documents the benefits of teaching children in a language they understand (e.g. Thomas and Collier 1997).

However, it is often inconvenient to teach children in their own language. Multilingual societies present logistical complexities with respect to teacher assignments, textbooks, and linguistic decisions. In urban areas it is also uncertain which language(s) to use in a school. And where the number of languages is large, only a few can be used for instruction. Complex political issues may arise with linguistic minorities. Also parents, mindful of status and employment possibilities, may demand instruction in official languages. Thus almost all African countries and as well as in some East Asian countries, teach children to read in English, French, or Portuguese. These languages unfortunately have complex spelling systems that require learning larger psycholinguistic grains all at once. When children also lack language knowledge, the limited time of low-income schools ensures that only the most privileged learn to read.

It is possible, however, that linguistic conflicts may be less frequent than one might expect. In Africa people commonly use two or three local languages with relatives and neighbors, and many of the languages are closely related (Prah and Brock-Utne 2009). And students may be acquiring local languages in the playgrounds of multilingual schools. Young children need interaction to learn languages (Nation and Waring 1997, Putnam 1975), in contrast to a formal language that may only be spoken by a teacher who “broadcasts” to all. Thus, a consistently spelled language taught at a time when children still learn languages may address the logistical difficulties of teaching in all languages.



One small study lends support to this hypothesis. Pulaar-speaking children in Cameroon scored higher in English and math after they had studied in a Kom language school than Pulaar speakers studying directly in English (Walter 2010). Surely more research is needed on the children’s command of local languages, and detailed local knowledge is also needed in the political contexts of various countries. But it is possible that that under certain circumstances, children could become literate in a language that is similar to their own, one they know partially or one they can learn from interaction at the playground or at the market. Careful linguistic mapping and community consultations would be needed to use the optimal number of languages necessary to serve all students.

If children are literate in their first language, they will find it easier to learn to read in a second language (August and Shanahan 2006; Walter 2010 for Kom; August et al. 2005 for Spanish; Ledesma and Morris 2005 for Tagalog). Automaticity in the same script transfers from one language to another, so for instance, reading fluency in an African language greatly facilitates fluency in others of the same script. In fact the reading advantage of local languages vs. disadvantages of official languages concerns English, French, and Portuguese. A consistently spelled language is needed as a bridge due to the spelling complexities of these languages.

How to teach reading to native speakers of English or French Creoles?

In countries like Sierra Leone, Liberia, or the Nigerian Delta children speak dialects derived from English. Making them literate in English is very hard, because the difficulty inherent in English is made worse by the poor mapping of native sounds into English spelling.

There have been movements to write English dialects phonetically and teach children to read in what becomes a consistent spelling system. (French Creole has been written that way for decades in Haiti, also a version exists for St. Lucia). One example is the Jamaican patois (patwa), through a system refined by the University of West Indies (see below).

 <p>Peter liked to watch his granny lighting the fire. One day he said, 'Can I light the fire, Granny? Please let me try.'</p> <p>'No, Peter, she answered. 'When you are older you can do it for me. Fire is a good thing. Without it we could not cook our food. But it can be a bad thing also.'</p> <p>'When will I be older, Granny?' Peter asked.</p> <p>'One day,' said Granny, 'one day. Then I will teach you and you have to be very careful. See, when I am lighting the fire I don't use too much kerosene oil. If you use too much, the fire will blaze up. So, you must never, never try to light the fire until I tell you. Do you hear me, Peter?'</p>	 <p>Piita did laik fi wach im grani kech di faiya. Wan die im se, "Mi kyan kech di faiya, Grani? Mek mi chrai no, pliz."</p> <p>"Nuo, Piita," shi se, "Wen yu ton, biga yu kyan du i fi mi. Faiya a gud sitn. If i neva de de, wi kudn kuk wi fuud. Bot i kyan bad tu."</p> <p>"Wen mi a go ton big, Grani?" Piita aaks.</p> <p>"Wan die," Grani se, "wan die. Den mi wi tiich yu bot u av fi main wa yu a du. Yu si, wen mi kech di faiya i no yuuz wol iip a korsiiin ail. If yu yuuz wol iip, di ya a go bliez op. Yu fi neva eva chrai kech di faiya mi se so. Yu ier, Piita?"</p>
<p>Standard English and Jamaican Creole: kids succeed if they start from the consistent spelling system of the local dialect and transfer fluency to standard English (H. Devonish, University of the West Indies)</p>	

One pilot in Jamaica showed that students performed better if they if they start from the consistent spelling system of the local dialect and transfer fluency to standard English (H. Devonish, University of the West Indies). This method could be piloted in counties where Creoles are spoken in hopes of giving students the same advantage as obtained by various local languages.

Textbook Design for Practice and Fast Attainment of Automaticity

To attain automaticity, students need many pages of legible text to practice. Students in the U.S. who score at the 98 percentile may read 4.7 million words per year, or 67 minutes per day, while those scoring in the 10th percentile may read 51,000 words per year or 1 minute a day (Anderson et al. 1988). Therefore, each student ought to receive a book to take home for practice and homework. During class, the students need to get time to practice reading, even if they are reading letter by letter in the beginning. Practice reduces reaction time to stimuli, as shown by learning curves formulated decades ago. And the earlier stages of reading ought to produce relatively rapid increase in fluency.

However, the schools of low-income countries often face “print poverty”. Procurement and distribution problems may be severe, so reading practice is often limited to texts written on the blackboard. Therefore the average students may not be able to read books (Glewwe, Kremer, and Moulin 2009). But even when textbooks can be realistically published, scant knowledge of reading processes results in tragic mistakes.

For example, a Chichewa language textbook (Malawi Institute of Education 2006) only has 55 pages of text, introduction of multiple letters, and a total of about 500 words for practice. It is unknown how many words in a textbook would bring about automaticity even among the weaker students. But this amount seems insufficient.

Worldwide, textbooks produced in the 21st century are short, with big pictures on each page and often just 2-3 lines of text. This may be an accommodation for the tendency of the middle class to buy reading books, thus making lengthy reading texts in class unnecessary. Examples are the French textbook of Cote d’ Ivoire (Ministry of Education 2006) and the Chichewa textbook of Malawi (Malawi Institute of Education 2006). Both introduce whole words and whole sentences at the first lesson, with little emphasis on individual letters and syllables. Such books may be acceptable for middle-class children whose parents will buy supplements and will help them read, but in low-income countries these are the only reading materials available, and only the brightest may be able to decode them.

By contrast, earlier syllabaries had more text, possibly because in the early 20th century available reading books were few. For example are the Greek grade 1 readers of the early 1900s. They had about 4000 words in about 190 pages with large fonts (e., g. Gianelli and Sakka 1955). Each page explicitly introduced a letter (capitals separate from small letters when dissimilar) as well as common diphthongs. Letter introduction covered about 60 lessons, and then the second half of the book consisted of stories.

As mentioned earlier, textbooks ought to facilitate rapid visual discrimination and be printed with 24 point courier fonts, double-spaced with three spaces between each word. Research also suggests that picture size can be minimized because children attain visual acuity early (Martelli et al. 2002). Research on colors in the early grades has been limited. Many people believe that children are attracted to them, but the advantage of colors in actual reading acquisition has not been studied. One study on color coding suggests that its use may not be efficient before age 12

(Madrid and Crognale 2000). To minimize expenditures while using paper efficiently, books could be printed in black and white.

Textbooks should present each letter and include systematic combinations. Every page in a beginning reader should maximize text amount. Visual perception studies suggest that in grades 1-2 letters should be at least 24 point fonts courier, double-spaced, with 3 spaces between letters. The utility of pictures before automaticity is dubious, so few pictures other than keywords would be needed. To maximize practice despite print scarcity, textbooks should have around 4000 words (about 150 pages, depending on format). Analogies and texts may best be written in linear sequence, so that teachers with limited or no training may follow the books page to page.

As mentioned in an earlier section, most frequent letters should be given first, and real or artificial words made only with those. The small letters should be taught separately from the capitals, all one by one.¹⁵ Reviews should be set after about 4 letters. Because of visual crowding, shorter words are initially preferable, so in the case of, say Bantu languages, it may be useful to put spaces initially between constituent segments. In consistently spelled languages, there is essentially no limitation to the words that can be written after the lower case letter set has been taught (in the Roman or other alphabetic scripts). Unlike the grade-level texts needed for English and French, vocabulary must be controlled only for familiarity.





Burkina Faso: grade 2, 2007. Textbook scarcity makes it hard for students to spend sufficient time with texts

¹⁵ Calligraphy, cursive script is popular in Africa; but it should be avoided until the visual word form area has been sufficiently activated, and students see the calligraphic letters as alternatives to the prototypes.

To facilitate fluency and vocabulary depth after basic automaticity, reading books are needed in local languages for fun and information. These are rarely available in schools, but several have been developed in various countries, from South Africa to Mali. Copyrights may be purchased, and textbooks may be adapted for expediency. An important part of a country's reading strategy would be to make reading books available for sale at accessible prices in local languages. Examples are an initiative to distribute 100 million books to 100 million students.

Experiences in Benin show that teams of teachers can prepare such textbooks within a week. Local languages often have few materials, but, many stories already exist that can be relatively quickly adapted. Given the research on repeated reading, students should engage in this activity, but teachers may not do it consistently. To reduce the needed number of steps, textbooks could repeat some texts, particularly when they are brief.

An equally important aspect is to ensure that textbooks are delivered to schools and on time. The challenges inherent in this task are well known, and measures must be taken to deal with them early on. Without textbooks, reading activities inevitably revert to writing limited texts on the blackboard that students quickly memorize and mindlessly recite without identifying letters.

Mozambique – whole language in Portuguese with calligraphic letters	Students just sketch the letters without learning sounds
	

Skills and Training Implications for Poorly Educated Teachers

In principle low-scoring students could be taught a lot more by expert teachers. But teachers often fail to carry out expected tasks. The deficiencies are legion. Some are well known, but others are not.

Many efforts have been made worldwide to increase teacher capacity in many subject areas. And results have not been very good. Pre-service and in-service teacher training efforts have produced limited results and limited behavioral changes (e.g. UNESCO 1998). Many reasons for poor outcomes are understood: Limited prior education, which makes it hard to retain much new content; training duration that is too brief given what teachers know and is condensed in a few days, therefore “expires” (see Pashler et al.). Other issues are also important due to information processing reasons: lack of textbooks for student teachers, poor time use in training classrooms, and curricula that offer little actual guidance on how to teach.

As with students, using better educated teachers as a reference point obscures the areas of training needs. Reflective practice and academic knowledge have been important drivers of training. But perhaps the most important teacher variables tend to be non-conscious. People rarely sense them from their experience. Here are a few variables that may explain some difficult issues.

Ease of recall. Concerns and emphasis have centered on teachers’ knowledge. However, knowing certain pieces of information is insufficient. Many items that we know can only be

recalled under certain circumstances. Thus lecturing and one-time demonstrations may not suffice to help them execute later and in an environment different from where training has been given (memory is encoded for time and space).

Much more important than actual knowledge is the *ability to recall that piece within milliseconds from the time that is needed*. Practice and a collection of facts are needed that must be recalled enough to fit the *working memory span*. Because information is limited and comes slowly, teachers of limited education may have difficulty retaining and subsequently executing multi-step methods with multiple options. This is called cognitive overload.

One related skill is the ability to *tell how much time has passed* in a class hour. Teachers may or may not have watches but they need to be able to estimate time accurately. They also need to map curricula in a school year and not fall behind.

No knowledge about reading instruction. As mentioned earlier, teachers in low-income countries may get little or no training on how to teach reading. They would have to be trained on a large scale for reading.

Furthermore, teachers often move, and trained teachers are inevitably replaced by untrained ones. Despite the many training efforts, many teachers shift jobs and remain untrained. Many do want to learn how to do their work. For this reason, it may be useful to integrate brief instructions at the end of the textbooks.

For the above reasons, it is important to create a daily routine with a minimal number of steps, that can be comfortably carried out within an instructional hour. It is also important to train teachers to monitor time and to experiment with intrinsic incentives that will increase the probability of executing the tasks when no supervisor is watching. Other topics to teach would be the rationale for showing up on time, making good use of class time, attending to all rather than to the best few, and getting a sense of how much time elapses. Relevant research is available, and experiments can be carried out to optimize processes. Also, teachers being trained to teach in local languages must learn to read those, since they have probably not done this. A number of the teachers may know multiple languages, so knowing the vocabulary of each and the textbook contents would be important.

Research offers few suggestions on how many steps teachers of various ability levels can automatize. One potential proxy variable of this and perhaps of their ability to read teachers' guides would be reading speed and performance in extracting a message and performing it. This may be a monitoring function, but it is also an important item for future research.

To facilitate training of little-educated teachers, observational learning research can be applied. Teachers may watch multiple times brief edited videoclips of desirable behaviors and practice what they see, along with discussions of the rationale. The technology to create these and to play them even in areas that lack electricity is now fairly simple, but the process must be tried and fine-tuned for large-scale implementation.

The above challenges make it important to have a body of supervisors or coaches who would visit teachers on a regular basis. Ideally, one supervisor should be appointed for every 12 or 15

teachers who will visit about once every two weeks. Supervisors are often teachers with years of experience, who may be taken out of classrooms where they teach effectively. The costs and logistics of steady visits are an important component of programming.

To apply this approach at country-wide levels, parsimony is crucial. Many methods work great in higher-income countries or small pilots, but at scaleup they sink. Unsuccessful methods may demand a lot of processing capacity by teachers and supervisors: quick use and monitoring of game cards, reading boards, monitoring the performance of multiple students in large classes. Some methods expect teachers to keep track of time also and to switch prescribed tasks every few minutes. Teachers of limited education may not easily automatize such sequences and execute them effortlessly within the class hour. Thus, crucial activities may be dropped.

Teachers need to be trained specifically for these activities, and they also need to understand why they matter. One important aspect is to discuss the “*for all*” aspect of teaching to read. Often the weakest children are the ones most likely to give up, stopping work after reading a few words. There is a need for monitoring that teachers are not used to giving to the weakest. In fact, consultations with them and videos may be important in increasing attention to this critical issue.

Trainees may receive instructions to execute various procedures when they return to their class, but observations suggest that they may not do so. Perhaps the need to recall and carry out multiple tasks at the same time fills their working memory beyond capacity and result in “cognitive overload” (Feldon 2007). Those teachers with more limited education and fewer automatized skills may be more vulnerable to this phenomenon. They must become able to carry out the requested procedures automatically. One mechanism is observational learning.

Using Observational Learning Paradigms. Strangely, there is no such thing as an untrained teacher. People are biologically set up to model actions of people who have the same goal, and teachers watched their own teachers for years. The research suggests that instructional behaviors may be more effectively taught through audiovisual role modeling and visualization (forward self-review; Dowrick 2010). These methods have rarely been used in low-resource environments, and they are more complex to create than mere lectures.

However, the cost of technology has dropped significantly in the past years. Camcorders are prevalent everywhere through cell phones, and editing software is in every computer. Palm-top projectors running on batteries can be taken to areas that have no electricity. Initial trials with brief instructional video clips were conducted informally in Liberia and the Gambia in 2011, and more detailed plans were underway to pilot this methodology in 2012.

Brief visually based training would cover the issues presented in the earlier sections of this article. Teachers would be shown how to interact with students in the back rows, how to listen to each child read a few lines, how to deal with absent students systematically, how to write with large and clear letters on the blackboard. They can learn to carry out fluently a consistent schedule of daily routines, which helps students anticipate the next activity (Stronge 2009).

Research on the timeframe of the human reward system offers some improvement options that could be put to a better use. These are:

Value of proximal goals. A long timeframe for the achievement of goals (e.g. the nine months of a school year) could distract teachers and encourage them to waste time. By contrast, proximal goals that are achievable help create a sense of self-efficacy (Bandura 1997). Such findings suggest that the school year, at least for the early grades could be divided into modules of a few weeks with specific goals to be achieved by the end. Research does not offer clear advice on the timeframe in which goals are considered proximal, so experimentation is needed. However the 100 days could be a sufficiently proximal goal.

Autonomous extrinsic incentives. Many economists support pay for performance, i.e. distributing money to the schools or teachers who succeed in teaching all their students at least to decode by the end of the initial modules (for example “cash on delivery” for 20 words per minute). Without close monitoring however, people may just game the system (Frazer 1998). Also, research on worker motivation suggests that money can bring about “controlled motivation”, the lowest type of external incentives. A more appropriate incentive state might be autonomous external motivation or inherently intrinsic motivation (interest and enjoyment of the task; Gagné and Deci 2005). Intrinsic incentives such as those mentioned above, therefore could be a more usable start.

On which tasks should teachers be trained? Some of the topics below have been rarely dealt with in the past.

- Learning how to read and write in the national languages teachers they will use; understanding all the vocabulary used in the texts.

- Elaborating on the meaning of “Education for All”: the importance of teaching basic skills to all and not just to the better few as is customarily done.

- Interacting with all students in the class, not just the best; ask questions to the back of the class, and not only of the students who volunteer to answer; (Llambiri 2004); give 3 seconds to the pupils before asking other pupils and give corrective feedback.

- Coming to school on time and leaving at the end of the classes; using all the time available for teaching; avoiding, for example, the copying tasks or leaving students unattended.

- Learning to estimate the passage of time in one teaching hour and in the school year; For example, which day of the week will the following letter fall? How to visualize the reading course from September to June or whatever (50 days, by when they will finish the lower case letters, then 100 days.) Learn to make up for lost time.

- Change teaching practices which were necessary when there were no books (where the teacher writes a small text on the blackboard, and the pupils repeat it, without necessarily knowing to read or understand.)

- Being told what results to expect at each stage, so that they can get reinforcement; ie. all the students ought to be able to read each letter after it has been taught explicitly.

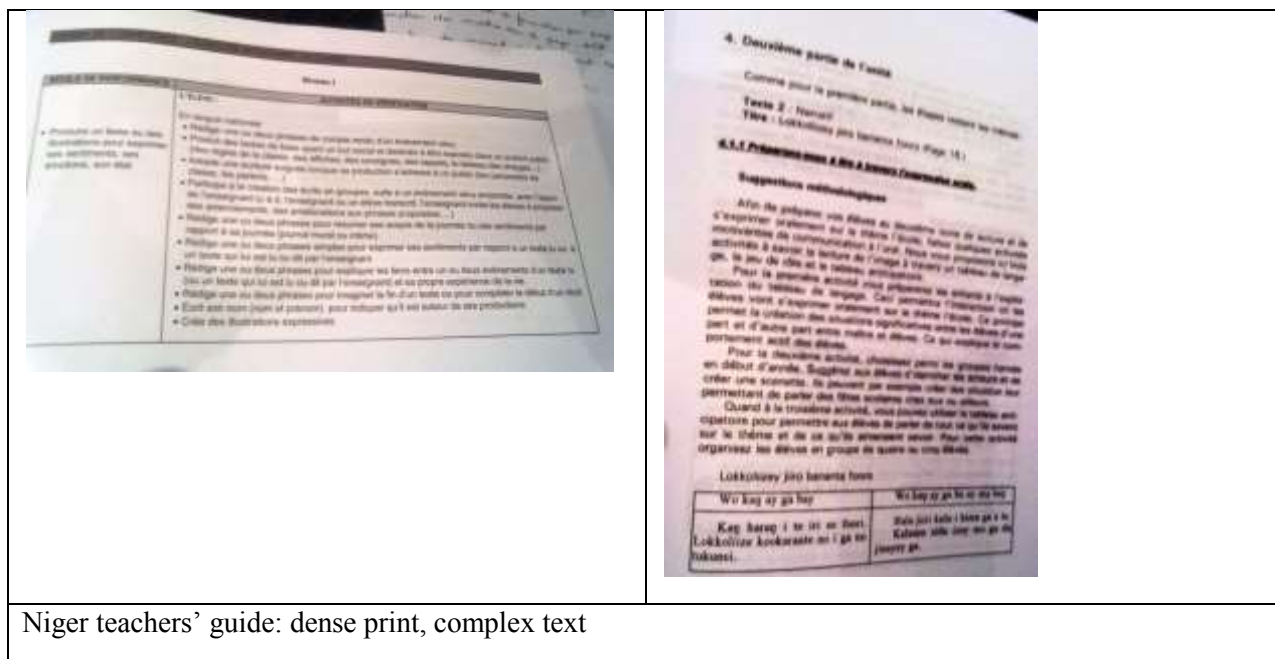
- Treating the pupils with respect; not hitting them or harassing them.

- Giving homework, which types will help students learn faster

In the process, effective intrinsic incentives should be used to encourage teachers to carry out the method even when no one sees them. Rewards could be lifelong respect, good memories for pupils, who will speak well of them in the future. Proximal goals, short-term intrinsic incentives also would be needed: relief or pleasure at completing the instruction of all letters, pleasure at the students knowing them.

Audiovisually based training could be used for teachers, but also for school principals and supervisors, who often fail to supervise. Establishing a few critical variables for supervising teachers and demonstrating those on video would help them detect patterns of more and less effective teaching and actually make this work interesting.

Cascade training is one important source for inefficiency in teacher training. To combat that, DVDs of the material and videos could be developed for 5 day training course and packaged in flashdrives. Thus they could prevent degradation by cascade, if used as expected. Technology has facilitated the execution of such tasks even in areas where electricity is unreliable.



Niger teachers' guide: dense print, complex text

Scripted Lessons or Succinct Guides for Teachers

The idea of giving teachers scripted lessons to read has gained popularity. It may be indeed useful for higher grades and languages with more complex spelling, such as English or French. But there are concerns about the utility of these by teachers. One reason is that scripted lessons and guides are often written in dense print by people who read much faster than teachers.

It may be desirable to include brief instructions to teachers in the textbooks, using a different color ink. The instructions may also be placed at the end of the book, in order not to confuse students. There may be teacher and student versions of the book, though that level of complexity may be excessive.

Teachers guides are often given under the assumption that teachers will take the time to read them and do so with sufficient speed to understand and retain their instructions and then to remember and transform them into procedures and instructions for students. Somehow teachers' guides also assume that teachers have a good sense of how much time passes in class and can control it, ie. change activities after five minutes.

Teachers' guides typically are dense and with complex topics, clearly made by and for people who read fast. But if teachers have gone to school without textbooks, they may be reading only 80-100 wpm and not be very habituated to dense text.

Teachers are typically expected to develop their own lesson plans, but even when these are done, they may be rarely carried out. To increase the probability that teachers will carry out the expected activities it may be advisable to plan centrally and prepare a series of "scripted" lessons. These have been a feature of Direct Instruction for decades in the U.S. and elsewhere (Adams and Engelmann 1996). Teachers can read instructions to students rather than try to reconstruct them. Practicing with the students may also teach teachers content and methodology.

As sample of a scripted lesson is given below (AIR 2003)

<p>T : « Today, class, we have a new word we can read by blending the sounds of the letters together to make a word.</p> <p>T : « This word is « me ». [Point]</p> <p>T : « The first sound is /mmmmm/ »</p> <p>T : « The second sound is « eeee ». [Draw your finger until you want to stop the sound.]</p> <p>T : « Slowly » [Draw fingers slowly under the letters] 'mmmmmmmmmm »</p> <p>T : « Quickly » « me »</p> <p>T : The meaning of the word is « point to yourself and/or say your name ».</p> <p>T : « Your turn. The sound of the first letter is ? » [Point to /m/]</p> <p>S : « mmmmmm »</p> <p>T : The sound of the second letter is ? »</p> <p>S : « eeeeeeee. »</p> <p>T : Slowly [draw finger under letters]</p> <p>S : « mmmm' 'eeee »</p> <p>T : Fast</p> <p>S : « me »</p> <p>T : « The meaning ? »</p> <p>S : (point to themselves [accept any reasonable answers, such as the child's name])</p>

Governments ought to prepare for the eventuality that teachers will not be trained. A textbook ought to contain whatever a teacher needs to minimally carry on its work if it is followed in a linear fashion. Short guidelines could be written at the back of the book.

Need for community sensitization to facilitate instruction

Parents who do not understand the literacy process sometimes are opposed to using a local language for instruction. One sometimes hears parents say "my child knows our language; I am sending him to school to learn English". There is a need to communicate clearly the advantages of the local language instruction. A social negotiation process could be used to identify the local lingua franca of a multilingual region and reach agreement with a community on what the

language of instruction ought to be. (The Solidar Swiss NGO in Burkina Faso has developed extensive experience and guidelines.)

One way to convince parents is to report student progress. Creating reading competitions among schools can generate enthusiasm and highlight the importance of reading fluency. Teachers may also be given prizes if they manage to make their entire class meet the reading goal.

Sometimes donor staff from high-income countries wonder whether students are bored by meaningless reading. Perhaps middle-class children who are used to meaningful texts and interesting activities may be bored, but low-income children may not have experienced activities along a wide range of interest, and they may not find drills boring. To the contrary, decoding letters successfully may be reinforcing. And these exercises are expected to last only a few days.

A Preliminary Week of Reading Preparation

Students who do not know what books are for and who are not used to print may not understand the nature of symbols they will see when instruction starts. It is useful to carry out some preparatory activities. These can be:

- Reciting and tracing the letters. Potentially reciting them in order to get a sense of how many they are and therefore how many categories to open in their minds (if this works as expected). After the letters have been taught for reading, students ought to get explicit instruction on the drawing movements.
- Showing how a book is opened. Children may find the first and the last letter in a page, learn to turn pages.
- Showing how a book is used, reading a story to students
- Phonological awareness exercises, notably on segmenting words into letters or syllables; tone awareness, where that is necessary.

Measurement of Reading Performance

Reading achievement can be measured in terms of letter sounds correctly identified overall as well as in terms of letter-reading speed (random automatized letter naming). Words per minute in connected text would also be measured, along with comprehension questions. In the second half of the year writing and dictation could be included.

Monitoring the rate of implementation during instruction is very important. Supervisors ought to record the lesson number taught during visits to classes, note whether teachers carry out the expected behaviors, and spot check students' knowledge.

One innovative measure to be introduced is reaction time to letters and words. With computer displays (programmed through matlab), the milliseconds needed for stimulus identification can be monitored from day to day. Thus the rate of progress towards automaticity can be documented. This would be an important research aspect of a reading program that would help fine-tune interventions.

Of course it would be highly desirable to conduct targeted research and evaluations in order to specify the model better. But children are dropping out as this document is being written, and time is of the essence. Hopefully research will be conducted as part of evaluations that will accompany interventions.

Reading Targets

After completing the first stage of 100 days, approximately 85% of children should be able to name about 80% of letter sounds. By the end of year 1, nearly all students should be reading, albeit at various speeds. There should be practically no students reading 0 words, as is currently common.

By the end of grade 2, students should be reading 45-60 wpm in local languages

By the end of grade 2, the students should know enough grammar and vocabulary to be able to understand perhaps 75% of the content in that grade 2 textbook

By the end of grade 2, the students should know how to apply the essential rules of reading in English or French; (Some empirical research suggests that students fluent in a transparently spelled language may build in their heads transformations of the spelling patterns).

Because speed is closely related to comprehension in the lower grades, its measurement is the simplest way to monitor achievement. Extensive studies have shown that in various languages and scripts, students reading 50-60 words per minute answer correctly 80% of simple comprehension questions (Abadzi 2008, Research Triangle Institute 2010, 2011). Despite apparent differences, the languages of the world conform to the same human capacity constraints, so one large European study showed that they could be compared in terms of words per minute (Seymour et al. 2003). By developing some conventions it is possible to compare words per minute rough across languages and language families (see Abadzi 2011).

Testing would include timed reading of letters and a simple 60-word passage along with five “shallow”, fact-based comprehension questions (Research Triangle Institute 2009, 2010). The learning outcomes would be measured in terms of letters per minute and words per minute read correctly. To In the first few weeks, reading speeds may be lower than those needed to understand passages well, but the most important early goal would be to leave no child unable to decode. Thus there should be practically *no students reading at 0 words per minute*.

How do people know if a child reads fluently? Children may read haltingly, letter by letter: t h i s i s t h e . As they get better and approximate 45-60 words per minute, they may sound fluent but read with a flat voice, which suggests partial understanding. As they get more practice, their reading sounds like natural expressive speech (called prosody). When children sound like that, they probably understand well what they read. Teachers, inspectors, parents, can count words per minute with a watch.

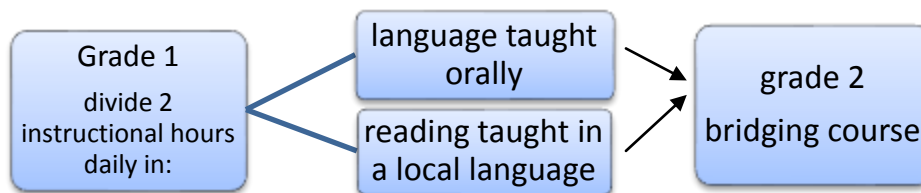
There is a need to be conservative about the ease of teaching all students in consistently spelled languages. Even high-income countries like Germany and Spain have 3-5% of dyslexic students. Diseases and malnutrition may raise the incidence of reading disabilities, but in most low-income countries their incidence has not been assessed. It is unclear how many of the illiterate children would learn if taught with more time and care. Thus some failures may be due to such reasons rather than reading methods. It may be wiser to set a goal of 83% of students decoding (down to

-1 standard deviation of a theoretical normal curve of ability). This is why a 80% goal is discussed in this document.

Transfer Strategy to the Official Language for Multilingual Societies

Low-income countries with high illiteracy among students typically teach in English, French, Portuguese, or sometimes Arabic as a language of instruction. It is important for the poor not to fall behind while learning local languages.

Keeping up with the national curriculum on language arts can be achieved by splitting the usual two-hour daily program of language arts into two: (a) reading in local languages as described above, and (b) instruction in oral English, French, Portuguese as needed. Language instruction can be optimized through various methods (which are beyond the scope of this document). Most simply, teachers may use the contents of the grade 1 textbooks that typically exist in various countries. In that case, only the teacher needs the textbook.



In grades 2-3 after students have become fluent readers in local languages, they need an **explicit bridging course** on how to read in the official languages (when the script is the same). Research shows that following this route, literacy in the spelling system of the official language will be greatly facilitated.

Literate school in 100 days – A remediation program

The above procedures can be used as a remediation tool for the illiterate students in grades 2-6. Older students in particular, have longer working memory and better executive control, and they would be able to do this program in less time than that needed by first graders. In principle, students would become fluent in a local language, receive a bridging course to read in the official language, and then be reinserted in their respective grades to gain more practice by reading their grade-level textbooks. Potentially by giving two waves a year, entire schools could become free of illiteracy in 2-3 years. By scaling the program, entire countries could thus perform.

Table 1: Fiction and reality about reading activities

Flawed assumptions, ineffective approaches	Practices more likely to teach students effectively
Reading comes naturally	Reading uses brain circuits developed for different purposes; explicit instruction is needed
If you show the picture of an object picture and write its name below, children will link the two and retain the relevant letters	Children usually have excellent visual memory, but may be unable to retain individual letters by linking them to a picture Also students must decode text rather than guess, and pictures encourage guessing
Students can learn calligraphy at the same time as regularly printed letters	Perhaps high-income children can do this, but the causal chain suggests that calligraphic letters are recognized only after sufficient visual word form area activation. Students must first learn the prototypical letter shapes;
Students should not be taught through “rote memorization”	Much of the vaunted “rote memorization” consists of students repeating disconnected segments. Some scripts do need rote memorization (syllabic matrices), and then teachers must ensure the matching between shape and sound.
Textbooks need relatively little text, the rest will come from reading books	Reading books in many languages are scarce To attain automaticity, volumes of text are needed, perhaps 4000 words in grade 1
Grade 1 textbook should have lots of pictures Pictures are attractive	Students must decode text rather than guess When reading letter by letter, students may hide the pictures. Until automaticity, their working memory may lack sufficient space to accommodate them.
Books should be kept at school because students will spoil them	Pristine books – illiterate children; no opportunities for home practice
For students to improve in reading, countries must be flooded by books	Flooding classrooms with books probably only benefits those who can read already.
Somehow students will learn to read, will improve	Students need specific direction to read independently; they initially make mistakes that require correction, and they must even be told that the next line must be read.
People merely decode and do not really read unless they understand. Thus meaning must be emphasized early on	Students can become automatic without knowing a language (e.g. in koranic Arabic). But automaticity is needed to understand sentences. Students must learn vocabulary to progress in knowledge acquisition.
Teachers will remember the instructions given during training and will carry them out	Teachers’ working memory is limited like everyone else’s. Highly experienced teachers have automatized many procedures, but these may easily be executable by others
Children will be bored by texts of ‘strict’ phonics	There is no evidence that poor children are bored. However, middle class parents expose their children to varied activities, so they may find the syllabic textbooks tedious.

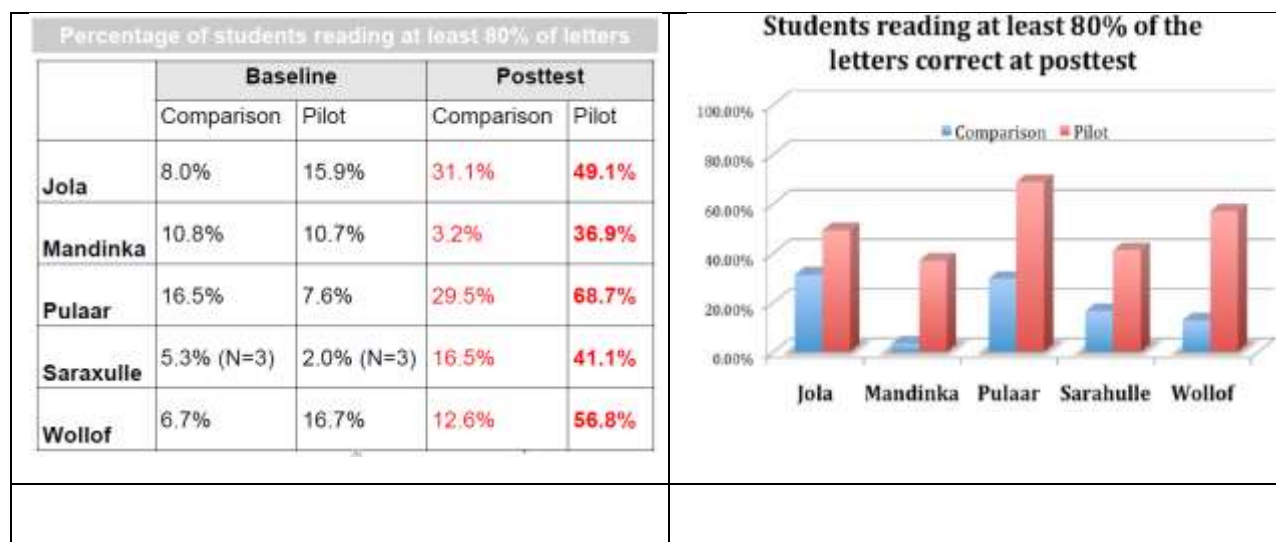
Results of reading pilots using the methodology described in this document

Methods should be resilient to poor implementation. They ought to be highly effective in pilots and make nearly 100% of students literate. Thus they might withstand the vicissitudes of national implementation.

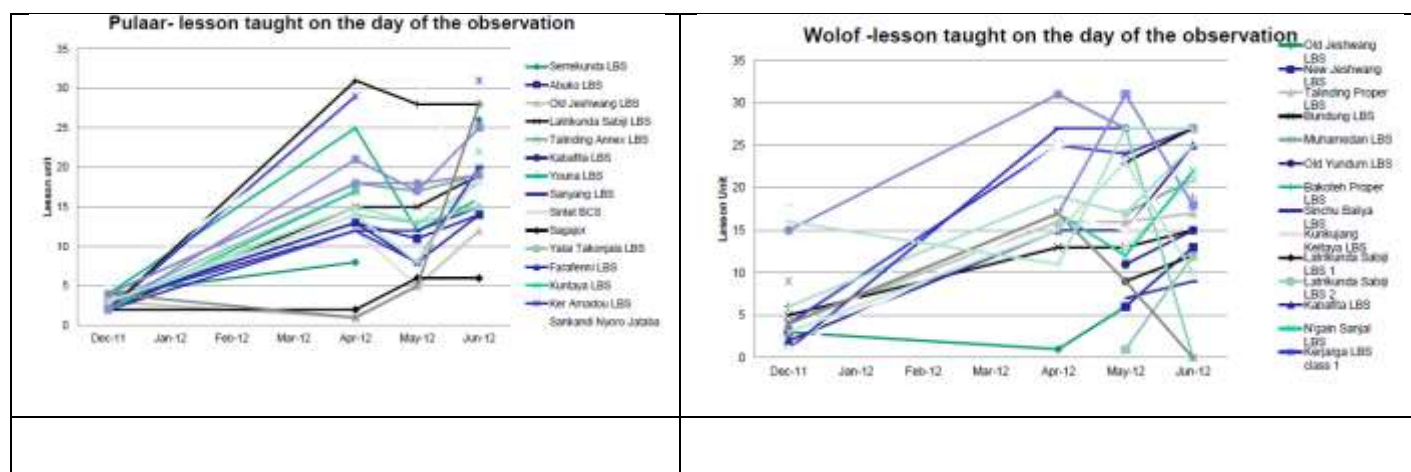
GPE has already provided demand-driven technical assistance to Cambodia and the Gambia. Results have been impressive in comparison to controls, and also to other methods.

Gambia

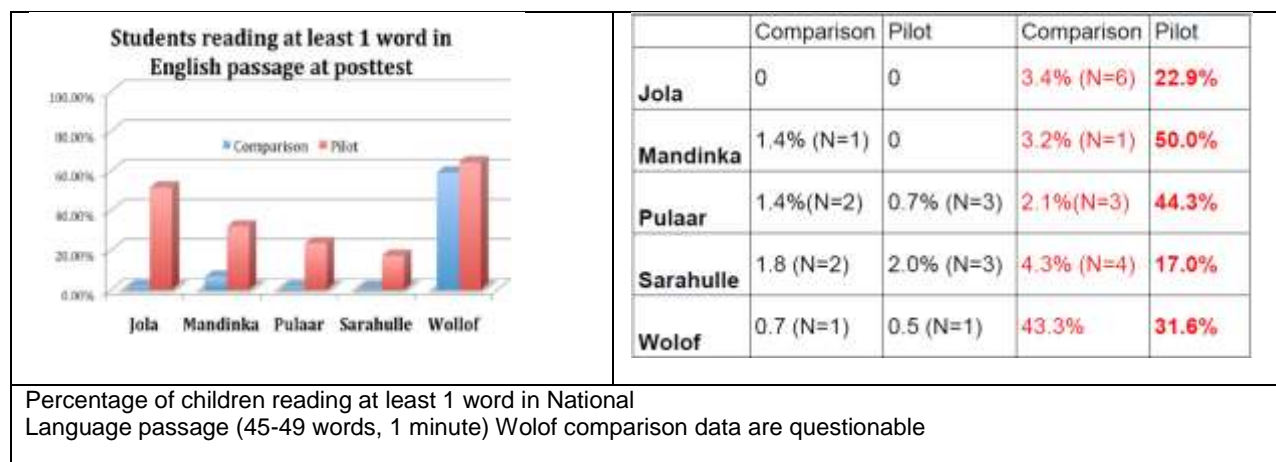
In the *Gambia*, a pilot was applied to 125 schools, but only 50% of the lessons were implemented on average. Still, the percentage of first graders knowing at least 80% of the letters was 69% in the Pulaar language and 57% in Wolof (target was 85% of children). The pilot was expanded and may become national in another year.



The above effects were obtained although only half the classes were conducted on average. Implementation was affected by a program of mainly oral English, which trained teachers intensely.

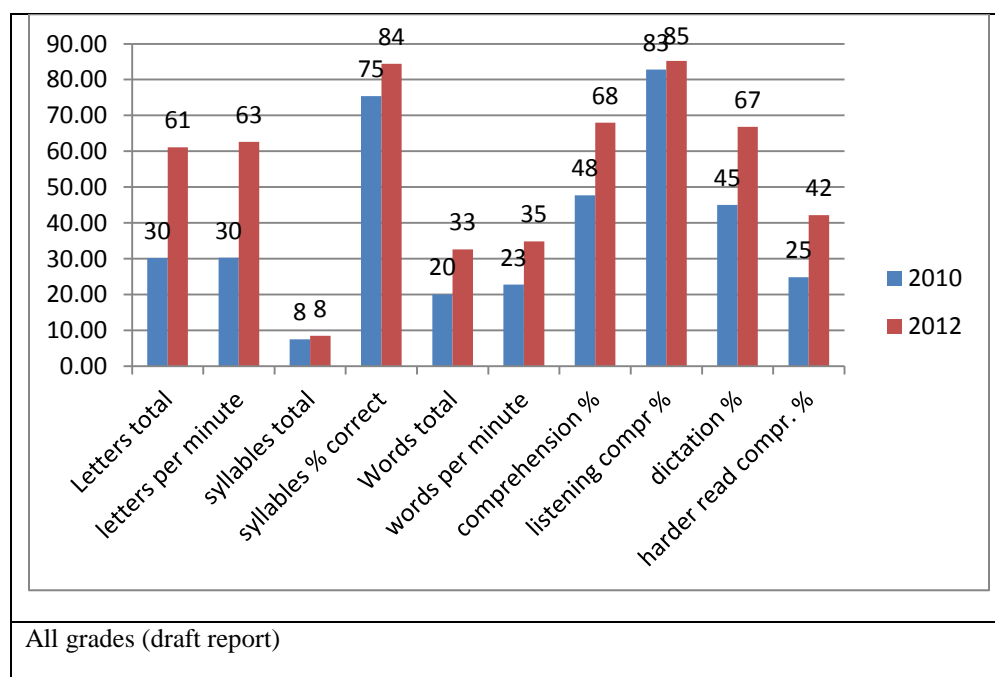


Effects on English reading in the Gambia: All students in the Gambia studied English along with local languages, but those who studied only English performed poorly. Students who studied reading in local languages became much competent at reading English than the control groups. There was some tendency to show better performance in English according to the performance in the languages studied. These data provide empirical evidence that learning a local language written in the same script will facilitate reading in the official language.



Cambodia

In *Cambodia*, a pilot application to 100 schools improved performance from one year to the next in all measures. For example, letters by minute rose by over 100% (30 to 63), words per minute by 63% (23 to 35), and comprehension by 70% (48% to 68%). After one year of trial, the method was scaled up to the entire country.



Gradewise as well as a total, emphasis on learning the sound –letter correspondences resulted in large gains.

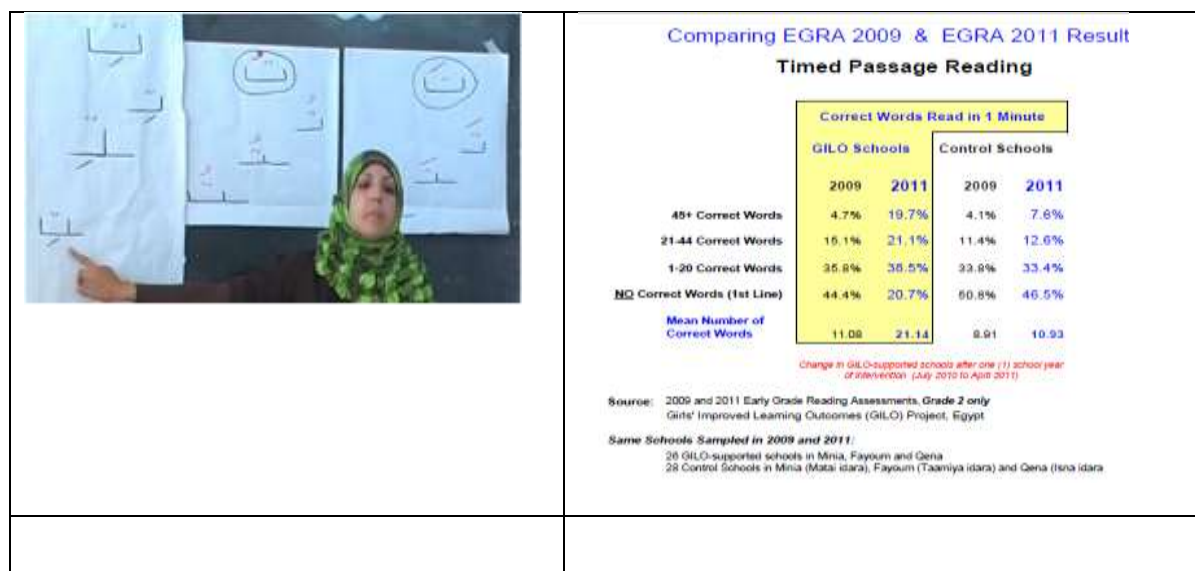
Grade	1	2	3	4	5	6
Letters per min	31	42	65	74	80	83
Syllables %	55	74	91	94	96	96
Words per min	11	20	35	44	48	51
Reading comp %	12	46	80	87	91	92
Listening comp %	66	76	87	92	94	95
Words %	22	40	69	83	87	90
Harder reading comp %	0	0	45	57	75	77
Dictation %	15	46	75	83	90	91

Egyptian USAID GILO project

GPE also provided some technical advice to a USAID project in *Egypt* developed along the same principles. Within six months of application in grade 2, word and text reading fluency rates doubled in comparison to rates obtained two years earlier (from 7 to 15 and from 11 to 21 words per minute respectively; syllable reading tripled from 10 to 28 syllables per minute. By contrast, the same measures in control schools improved only by about 27%. The percentage of students reading 0 correct words was cut by half in project schools (from 44% to 21%) while in control schools it improved only by 10%.

EGRA Measures	Mean Scores, INTERVENTION Schools		% Change	Mean Scores, CONTROL Schools		% Change
	2009	2011		2009	2011	
Syllable Reading	9.76	28.47	+ 192%	8.55	10.10	+ 18%
Word Reading	7.35	15.50	+ 111%	5.56	7.45	+ 34%
Oral Reading Fluency	11.09	21.14	+ 91%	8.92	10.93	+ 23%

The program has been expanded to the entire country.



Qualifications for reading specialists in low-income countries

Many universities train reading specialists, and many teachers who have spent years in this profession want to help students learn to read. Also many people have helped their own children and feel that they could do a good job. Unfortunately the vast majority nearly all specialists have been trained in Anglophone countries (secondarily in French) and learned to use materials developed for high-resource schools. Thus they may teach reading through complex methods developed for English and expect teachers to execute procedures that the much better educated teachers of higher-income countries can do. This may prove detrimental to student learning.

Advisors on reading must show an understanding for perceptual learning variables and be able to distinguish them from language topics. Often reading specialists talk at length about language and meaning but display limited understanding of the prerequisites of automaticity. Some may even disparage this concept or believe that students should not be reading fast. Therefore the expectations of specialists or trainers from high-income countries become a significant obstacle to students' literacy.

Specialists from high-income countries also expect teachers to have broad ranges of skills. They may assume that teachers can read fast and create voluminous training manuals; they may also expect teachers to carry out complex activities and make fast decisions (e.g. AIR 2003). Without advice and understanding of the challenges in low-income countries reading advocates may promote complex methods that may require more time and resources. Such tendencies reduce rather than improve the chances of the poor except the very few bright ones who would learn under any circumstances.

Over time, reading specialists have had a background in linguistics, international education, reading from usually Anglophone faculties of education, or experience in the teaching of reading from various countries. These specialties do not include a background in perceptual learning, or the cognitive neuroscience of reading. Potentially more useful may be psychology department graduates with specialization in reading or cognitive psychology. However these often lack

exposure to low-income countries and to spelling systems other than English. For all these specialties, training would be needed. The Global Partnership for Education is preparing e-courses with this material to demonstrate the issues convincingly.

Conclusions and Implications for Implementation

Currently learning to read in low-income schools is like winning a lottery. Few students will manage, and often it is unknown in advance who will be the lucky winners. All methods teach some proportion of the students, but the more complex the method, the smaller that proportion will be.

Reading does not have to be a lottery. In the European countries which use consistent spelling systems, reading performance has been viewed traditionally as a modest and attainable skill, even with just a couple of years in school. The goal, therefore, is to enable the poorest to learn reading through a transparent system.

Scientific research shows that some fundamental prerequisites must be satisfied before students enter the world of meaning, reading for fun, and “reading to learn.” Students must first be able to distinguish letters, detect their salient features, associate specific shapes to sounds. Then they should decode letter groups fast enough to fit messages into working memory so that meaning can be extracted. And they must have in their cognitive networks the needed prior knowledge to understand the vocabulary, grammar, and context of the messages. Most important, they need independent practice and corrective feedback to increase reading speed, and space in class must be made for this.

In higher-income or higher-performance populations the perceptual and memory-related variables are learned fast. Currently, reading methods in low-income countries are configured along the perceptual standards of high-income countries. But it is unwise to expect that students will somehow skip these essential reading stages and focus on meaning and interpretation. The science implies that an earlier module must be inserted into reading instruction. For that, new textbooks are needed. In case textbooks exist that use the whole language approach and cannot be changed, an actual up-front supplement is needed.

In some respects the neurocognitive research that has influenced this methodology marks the evolution of constructivism into the 21st century. Cognitive science shows that students indeed build their own cognitive networks on the basis of prior knowledge and environmental stimuli, and learning research clarifies how this is done. When skills involve time-bound and “low-level” processes, it would be ethical and socially responsible to teach them in the most efficient way possible. On the other hand, learning that involves higher-order processes should be challenging and exciting. Thus, the greatest gift poor first graders can receive is the activation of the visual word form. This gift puts comprehension within the students’ reach. The invisible underground tunnels become passable, and the child walks into the fortress of knowledge.

The international education community is committed to overcoming the obstacles and help countries improve student performance. The Global Partnership for Education pledged on November 7, 2011 to halve the number of non-readers in 20 countries in 2012-2017. Similarly the United States Agency of International Development announced on November 18, 2011 a grand challenge to make All Children Reading. Other donors such as AusAid and DFID are

similarly committed to help children learn reading in the early grades. Thus the Global Partnership for Education must give interested countries the best advice available at the moment to facilitate their work.

Topics for Urgent Research

One reason why students continue to perform very poorly is lack of insights that could greatly facilitate learning in low-income countries. The vast majority of the studies and conclusions cited above use research translationally; the studies were carried out on different populations and age ranges. An essential assumption was made that human commonalities outnumber cultural and regional differences, particularly in the low-level neurocognitive variables that are so important for basic skills.

But even under this optimistic assumption, there are certain big gaps in research, particularly as applicable to the very poor. Therefore every topic discussed thus far would greatly benefit from targeted, applied research. Some topics are below.

Optimizing performance in the “low-level” variables needed for automaticity to happen

The most important variables to reading fluency are rarely visible and hardly ever researched in low-income countries. For example, there are no fMRI or ERP studies with students in low-income countries to monitor reading development and compare neural indicators with outward signs of reading. Knowing more about this and other processes can help optimize reading activities or choose those that speed up activation of the visual word form area.

-Spatial attention and its parameters ought to be understood better. What percentage of first graders are unable to latch on to the right letters on a display and how long does it take for them to adjust?

- What are the critical size and spacing of letters for beginning readers who are inexperienced with print? How long and/or in how many aggregate hours do students become habituated to more dense letters? Does age and development play a role? Psychophysical studies of crowding, typically done with adults in the US, ought to be conducted with low-income children. They will help define spacing parameters for textbooks and instructions regarding letter sizes in blackboards and proximity to them so that students identify the letters fastest.

- At what reading speed and after how many aggregate hours of practice is the visual word form area sufficiently activated in various spelling systems and scripts? How much longer do shorter vs. longer letter sets require on average? There are multiple technological solutions to obtaining answers for this question, some of which are quite simple.

- Due to the effects of perimetric complexity, students probably take longer to learn discriminations among the many similar (though decodable patterns) of large syllabic matrices, than, say readers of the Roman, Armenian, Dhivehi scripts. Researching these effects would help governments realistically estimate the amount of time and budget needed to make everyone literate.

- Students who study without textbooks, may eventually learn to read, but do so at a low speed (e.g. 80 wpm in grade 10). Which methods would increase speed most efficiently and in which

timeframes? Is there an upper limit of speed that older students can attain in a reasonable period of time?

- What is the incidence of dyslexia and learning disabilities that impact reading in various low-income countries? On one hand, English (and to a lesser extent French) bring out dyslexia in susceptible students, so those learning in a consistently spelled language would be less affected (see research by Paulesu et al.). On the other hand, poverty-related health problems may compromise brain development. Even general projections would help estimate what percentage of students can be realistically made literate through efficient methods. (The “eastern Europe” paradigm of students decoding by Christmas surely had exceptions.)

Script attrition

Automaticity is sometimes viewed as a vaccine against illiteracy; i.e. it is presumed that once students learn to read, they will not forget. A number of students drop out in the early grades or after a while attend too infrequently to learn much. To prevent illiteracy, reading instruction in the first semester of grade 1 is emphasized. But what happens to dropouts who have learned to read at various competency levels? A likely answer would shape policies to prevent dropout.

This topic has probably never been researched. A few studies have dealt with this matter peripherally. One old study (Hartley and Swanson, 1986) found that Egyptians who dropped out fluent readers in grade 4 maintained and improved their skills, while those who could not read well forgot what they knew.

So what are the underlying neurocognitive variables? If children do drop out, say, at the end of grade 1 after learning to decode, will they retain the skill? Students of similar ages may forget languages they learned, i.e. they are prone to “language attrition.” Does script attrition similarly exist? If so, what variables influence the permanence of automaticity? It could be: (a) Aggregate hours of practice; (b) Maximum reading speed attained; (c) Practice intervals; (d) Age at start, age at abandonment; (e) Or something else.

Early-grade writing instruction

Writing is a slower process that develops over a longer period than reading. Many issues exist that have been considered very little in low-income contexts. Constructivist philosophies have children doing “emergent writing” or producing texts when they can hardly read. When time is constricted, these activities may steal time from reading.

One conclusion from psychomotor research is that students may write faster if they learn to read well. But the relevant findings were obtained from adults. How valid are they for children? Maybe they should do little writing in the language classes until the middle of grade 1. On the other hand, writing is known to enhance procedural memory and consolidate reading. (However, those unable to use their hands do learn to read). So how do these apparently opposing tendencies square away? How much writing should the very poor be taught and when?

Innovative measurements of reading progress at early stages

Many of the variables discussed in this section cannot be measured with paper and pencil or with observational instruments. There is a need to use equipment and methods that have not been used thus far in international education. (These do get used in educational research of high-income countries.) These would include: (b) psychophysics measurements, delivered through computer displays; (b) eye trackers, particularly portable equipment; (c) event-related potentials; (d) more sophisticated brain imaging devices, available in countries such as India or South Africa.

Such equipment would enable researchers and implementers to monitor improvement from day, for example through reaction time to letters. It could also monitor how the gaze moves across the page of a book through eye tracking.¹⁶

Optimizing local language use to learning official languages with complex spelling



Eye tracker unit and processor
University of Rome

Evidence already exists that fluency in a consistently spelled language greatly facilitates fluency in English, French, or Portuguese (Walter 2010 for Kom; August et al. 2005 for Spanish; Ledesma and Morris 2005 for Tagalog). Some evidence was even offered in the Gambia pilot, shown above. However, the processes ought to be understood better and thus optimized. For example, it is sometimes hypothesized that students fluent in one language create tables of transformations in their minds for words in English or French. Thus they may more easily learn more complex patterns. The learning timeframe must also be explored.

One special case to be explored would be the effects of writing Creole dialects in consistently spelled patterns. To what extent would these subsequently interfere with standard English spelling? What features should the spelling systems have so that they support standard English and avoid interference?

In some countries, bilingual books have been used, with texts of two languages side by side. The benefits and potential costs of such books could be explored.

Language of instruction effects

Countries with large numbers of languages are often advised to do literacy in a small subset of regional lingua francas. People often learn these from the environment, such as commercial

¹⁶A portable eye tracker with a dedicated computer and software for this purpose would only cost about \$12,000 (See example in mirametrix.com/products/eye-tracker/)

transactions. However, the parameters of learning languages from the environment are unknown. On average how much do students learn across time? How does little or no language knowledge affect their reading automaticity?

Some people ask why it is worth going to a regional lingua franca rather than straight to English. Clearly the consistent spelling matters, so one small study showed benefits. But how big are they and what are the costs? It is known that languages are learned from interactions, and this is why children cannot learn a language from a TV. However, does a broadcasting teacher in a class constitute an intermediate situation? These issues must be explored.

Optimizing the performance of little-educated teachers

There is a host of studies to be undertaken with teachers that are rarely part of teacher education studies for populations with limited knowledge. These concern working memory and cognitive overload, levels of education and reading fluency, effective incentives, sense of timing, automaticity in math, perseverance in receiving training. These are briefly mentioned

- Which variables would predict the probability that teachers will carry out teacher training instructions when they return to schools?
- Given the educational limitations of teachers, How many tasks can they perform simultaneously? What tasks seem to overwhelm working memory and create cognitive overload? How many students' educational achievements can they keep in mind at the same time?
- How is reading fluency related to the probability of reading and acting on the instructions found in teacher guides?
- Given various reading speeds, what are the optimal amounts of text that should be in teacher guides?
- What timeframe offers teachers effective proximal goals? (e.g. 100 days)
- How best to train teachers to perceive time in a class hour, in a month, a semester, a school year?
- Which incentives function effectively for little-educated teachers in various country contexts?
- How can teachers be effectively and quickly trained in math automaticity?
- How effective is the use of cell phones for this and other training functions? Which are the cheapest cell phones that can function in this capacity? Which font sizes work best?
- How to optimize the observational learning research and related techniques? What is the "dosage" of videoclips, optimal duration, optimal number of repetitions over time that will enable teachers to carry out automatically and with little effort the various instructional sequences?

How to make instruction more "learner centered" and "active" in low-income classes?

In high-income countries there are definitions of teacher or learner centeredness and strategies that are based on attention to individuals. In low-income countries, teacher vs. student centeredness may be defined differently. Many teachers focus only on the few students who can do the job and ignore others. Thus, helping teachers interact with all even occasionally ought to be a "student centered" methodology.

Another aspect of student centeredness and active learning during reading classes would be corrective feedback to teachers. Again, few teachers interact with all, and if they interact with weaker students, they spend no time explaining errors. There are many options to research this topic.

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