



**USAID**  
FROM THE AMERICAN PEOPLE

EdData II Project

# **Conceptual Framework for Early Reading Fluency: Insights and Monitoring Indicators from Cognitive Neuroscience**

March 20, 2008

Helen Abadzi  
Habadzi@worldbank.org  
Independent Evaluation Group, World Bank

## About the presentation

- This presentation was prepared for a USAID Education Sector Professional Development Course on early grade reading, Washington, DC, May 12, 2008. The training was organized by the Bureau of Economic Growth, Agriculture, and Trade (EGAT) for the Education Sector Council's Training for Education Sector Teams program.
- Dr. Abadzi is a consultant to RTI International on the USAID EdData II project, Contract No. EHC-E-00-04-00004-00.

# Assessment

- At a national level, can give a baseline of children's current reading levels, identify gaps in the curriculum, provide information for planning teacher professional development, and provide information for goal setting.

## Independent Evaluation Group (IEG)

### Project performance assessment reviews in primary education

- Comoros 1997
- Burkina Faso 2000
- Chile 2000
- Madagascar 2001
- Senegal 2001
- Brazil 2002
- Romania 2002
- Guinea 2003
- Honduras 2003
- Niger 2004
- Yemen 2004
- Uruguay 2005
- Argentina 2006
- Mozambique 2007
- Egypt 2007

## Independent Evaluation Group findings: The schools of the poor often teach very little

- Some schools closed
  - about 30% of the time in Mali -1999
- Teachers often absent
- Few if any books in class
- Class time spent in little activity
  - copying
  - engaged in incomprehensible material
  - playing outside
- Poorer students cannot read well until the end of primary (if then)
- Principals, ministry officials, supervisors, donor staff complacent
  - Reading is trivial!!!
  - We are interested in the big picture!!

## Limited knowledge of memory issues in the educational community

- Colleges of education teach about Vygotsky, Piaget, John Dewey etc. rather than human memory
- The science behind education is not well known
- The memory experts are in the psychology department
  - And they don't understand education !
- Memory research in school settings is rare

## Without knowledge of memory functions, inefficient methods may be promoted

- *Learning involves modification of people's long-term memory*
- *But memory mechanisms are unconscious*
- *People often unaware of them*
- *Some popular methodologies go against the way memory works*
- *New international education graduates know little about these issues!*

# The neuroscience of reading

Memory principles

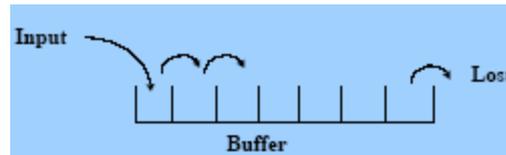
Letters = Object recognition

Language issues

# Reading determines the efficiency of educational systems

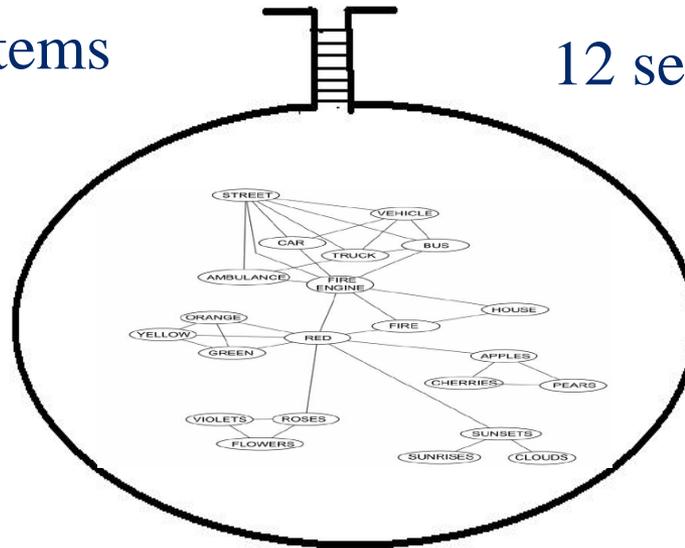
- World Bank Independent Evaluation Group:
  - In low-income countries children often learn to read in grades 4-6 (if ever) rather than grades 1-2
- Until they do, they cannot learn info from books
- They cannot solve verbal math problems
- May drop out illiterate or graduate illiterate
- May get to grade 7 with reading speed of grade 3 and drop out of secondary

# Short-term memory: Crucial for reading comprehension



About 7 items  
4 pictures

12 seconds at most



Long-term memory

## To read an average sentence in an “average” language, roughly 7 items in 12 seconds...

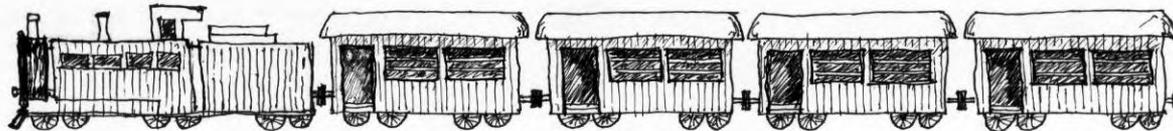
- students must read at least a word per 1-1.5 second
- with 95% accuracy (correlates .87 with speed)
- 7 words in 12 seconds = 45-60 words per minute!  
(need some processing time also)

## To get through the narrow opening, the mind creates chunks of information

- Letters and other small items become larger pieces,
- pass as one through working memory
- Small items must be chunked and practiced to the point of fluent performance
  - We must act in milliseconds!
  - Vast implications for reading, math calculations, motor skills
- This is how children decode ever larger units – from syllables to words
- How do students get to fluency?

# A cumulative process

- Sophisticated skills, higher-level knowledge are created from ever-larger chunks practiced to the point of automatic recall



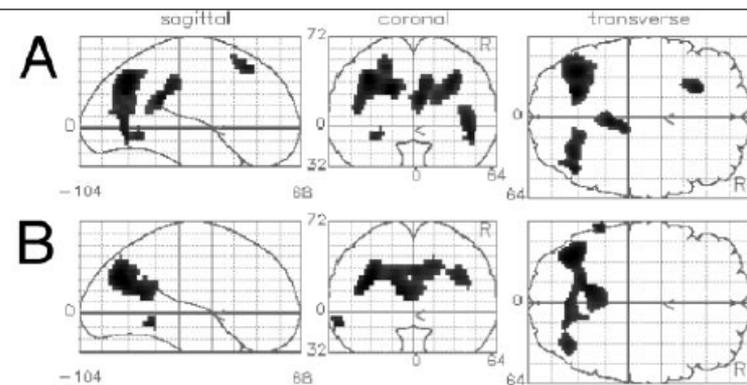
# Brain imaging changed the landscape of reading assessment



# Brain imaging techniques (since about 1995 )

- Example:
- Brain activation patterns of literates and illiterates

Example:  
Brain activation patterns of  
literates and illiterates

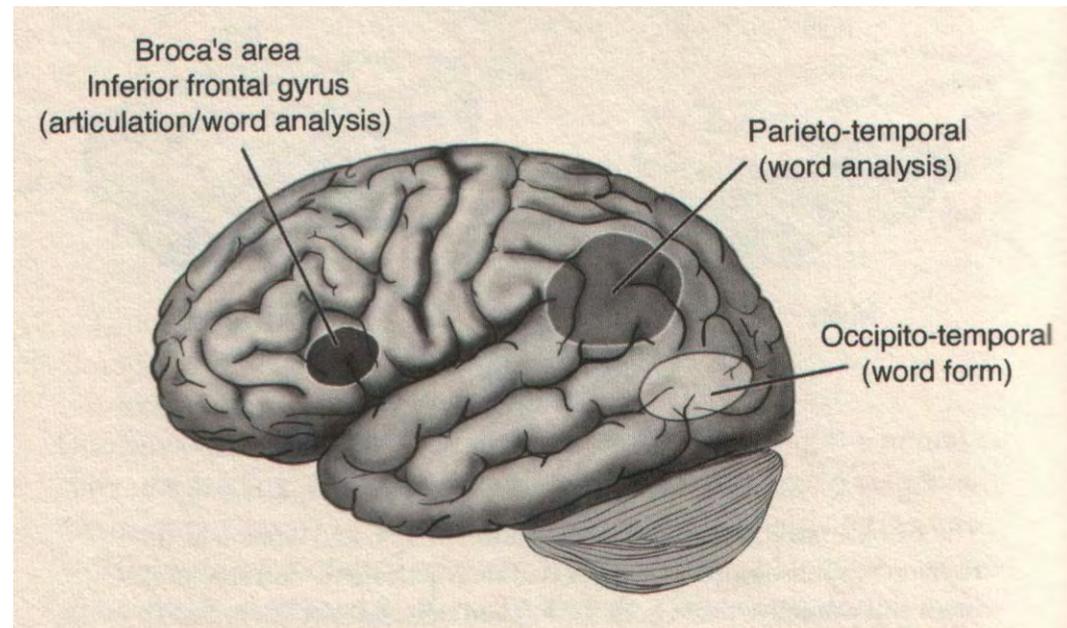


# A special brain area gets activated (fusiform gyrus, occipitotemporal lobe)

3 primary reading areas in the brain:

- 2 for single letters, slow reading
- 1 for automatic reading

All 3 are used simultaneously



# The brain becomes “programmed” for automatic reading

- Nerve “wiring” develops in children’s brains (“White matter” needed for reading and larger working memory-Nagy et al., 2005)
- The occipito-temporal pathway gets activated
- The brain identifies entire words rather than single letters
- Long and short words are read equally fast (silently)
- each word or phrase becomes an item
- Speed rises to 250+ words per minute
- People can’t help but read
- Pay attention to message rather than the print

# Reading automaticity (the literacy vaccine!)

## Almost an “on-off” switch

- Only through consistent pairing of sounds and letters
  - Textbooks
  - Feedback
  - Homework
  - Class time
- With practice children may pass from the off state to on in 6 weeks



# To the brain, letters are just objects

- Brain has rules for processing shapes
- Some characters are more visually complex than others
  - –Some languages have more letters than others
  - –Some letter combinations are more complex (psycholinguistic grain size)
- Various languages-scripts have different implications for reaching automaticity
- Automatic readers use rules that to beginners are incomprehensible

# We always need letters

- **We read by recognizing letters in a row, with known words and context hints handled separately**
- Letters account for 62% of the adult reading rate
- Words 16%, context 22%, individual variance 6%
- The processes are not redundant, they work on different words.
  - Like computer technicians fixing problems, letters are generalists
- Words are not usually recognized as wholes, the visual system must isolate and recognize the individual letters to get the word

## Implications:

- Methods that get children to read whole words are not efficient
- If the children read in one language, they can read in another (in same script).

Pelli, Dennis and Katharine Tillman. Parts, wholes, and context in reading: A triple dissociation. PLoS ONE, August 2007, e 680.

# When should students be able to read?

*OECD reading study of 16 countries*

*Latin and Greek scripts*

*Seymour et al., 2003*

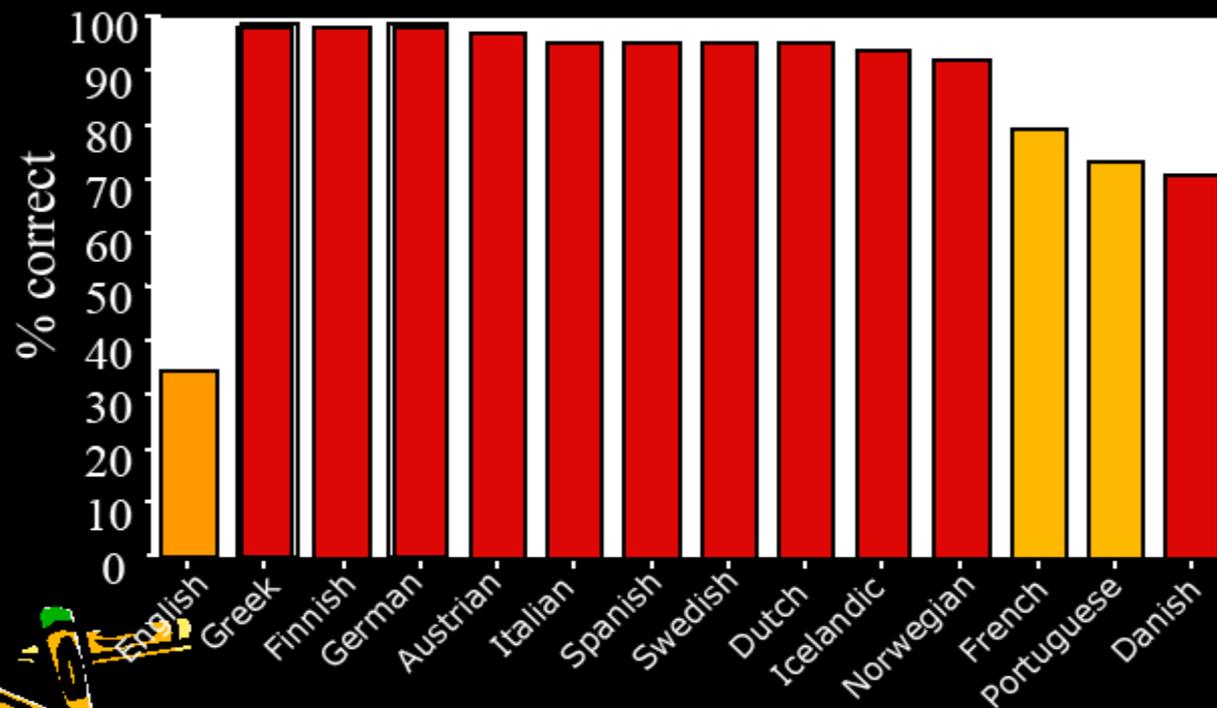
*Middle-class students*

*Best-case scenario:*

*Good time use*

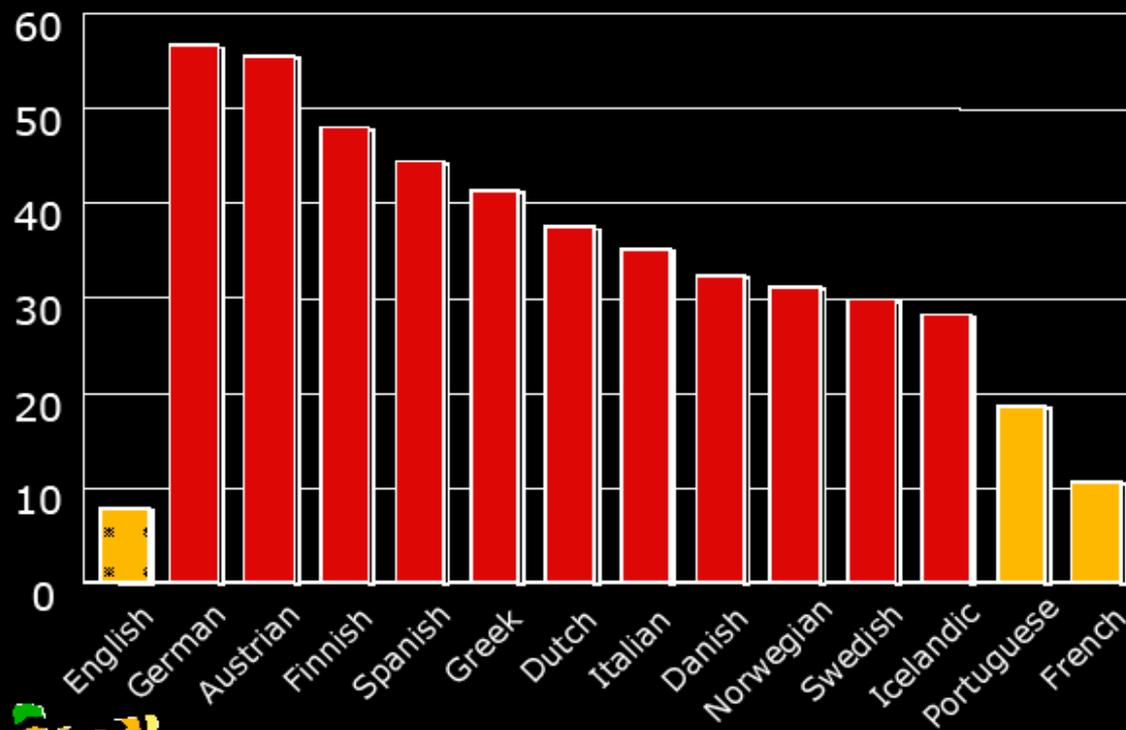
## Reading accuracy after 1 year of instruction

Reading lists of words



Seymour et al. (2003), British Journal of Psychology

### Items per minute when reading word lists



$$r_{\text{accuracy/speed}} = .87$$

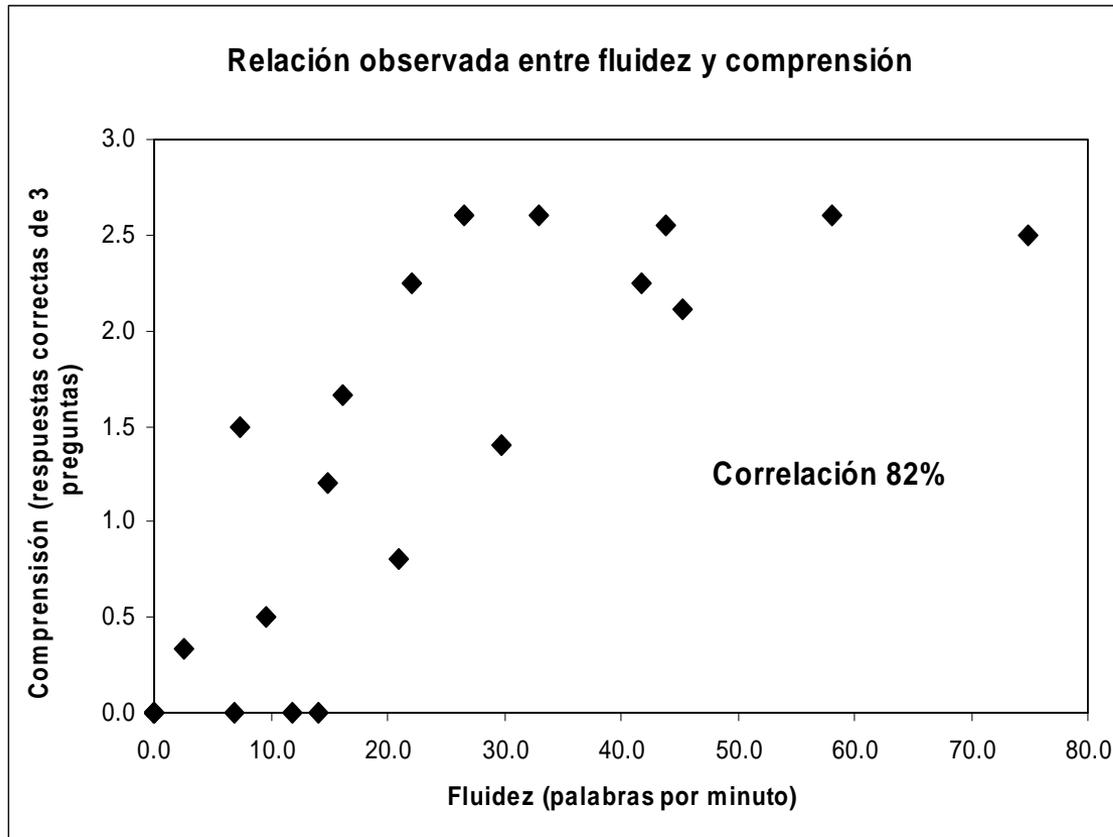
Seymour et al. (2003), British Journal of Psychology

# U.S. Oral Reading Fluency Norms connected text - Spring

• Grade	50th %ile	25th %ile	10th %ile
• 1	53	28	15
• 2	89	61	31
• 3	107	78	48
• 4	123	98	72
• 5	139	109	83
• 6	150	122	93
• 7	150	123	98
• 8	151	124	97

Hasbrouck and Tindal, "Oral Reading Fluency Norms: A Valuable Assessment Tool for Reading Teachers," *The Reading Teacher*, 59, 2006.

# Without fluency and accuracy there is no comprehension (Peruvian data)



# New monitoring indicator from neurocognitive research

- 60 words per minute for all
  - In just about every language and script:
- By the end of grade 1 students should “crack the code”
- By the end of grade 2 at the latest students should read common words fluently
- Students in grade 7 (1st secondary year) should read about 120-150 words per minute and give a summary of what they read

## How children should read – Cuba grade 2



## Los cinco burros

Don Tomás compró cuatro burros. Montó en uno y volvió a su casa.

Por el camino los contó : uno, dos y tres. No contaba el que montaba.

35 words per minute

Ya en su casa dijo a su mujer :

-Mira, he comprado cuatro burros y traigo sólo tres. Me han robado uno.

-¡Qué raro! -dijo la mujer-.

Tu no ves más que tres, pero yo veo cinco.



## Reading fluently enough to understand ... 60 wpm correctly?

- Rural Indonesia grade 2
  - simple spelling rules, good class time use
- Rural Niger – best 6th grader, graduating in 3 weeks
  - Study only in French, time use uncertain



## Students becoming fluent late may always read slowly, have limited comprehension

- If they finally learn reading in grade 6
  - They get no more books by grade 8
- They will read little secondary school
  - University or teacher training colleges
  - They cannot read fast enough to consult sources
  - Or read volumes of text
  - At 110 words per minute, it takes 5 minutes per page

## When visual patterns are complex, basic reading needs more time and money

- (Psycholinguistic grain size theory)
- English reading takes 2.5 times longer to acquire over German, Turkish, Spanish (4 months or so needed)
- French and Portuguese also take longer.
- Indian languages – regular spelling, complex scripts
  - High error rates in south Indian scripts
- Arabic – easy with vowels, difficult otherwise
  - Perennially slower reading, high error rates
- Urdu, Persian problematic for the poor

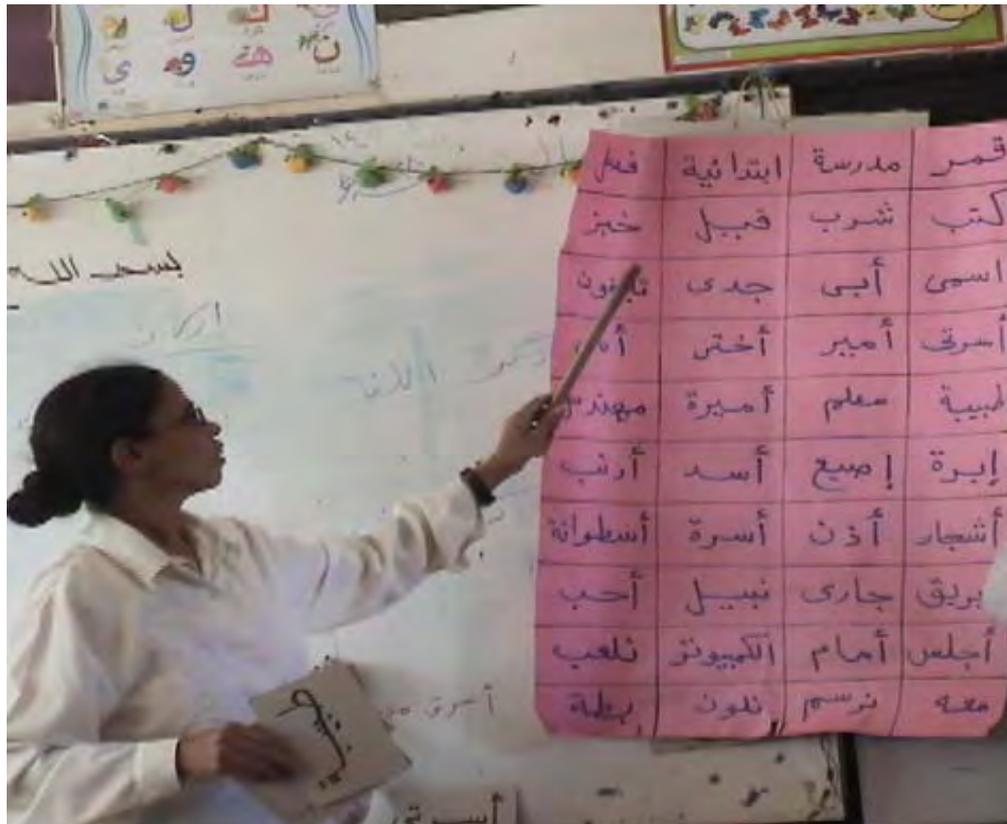
# Complex visual patterns in various languages and scripts (psycholinguistic grains)

- English  
through, caught, bake, often, saw, sew
- French  
Ils etaient, oiseau, mois, etant
- Bengali  
jomi – earth  
boithak – meeting  
koThin - difficult

জেমি  
বৈঠক  
কঠিন

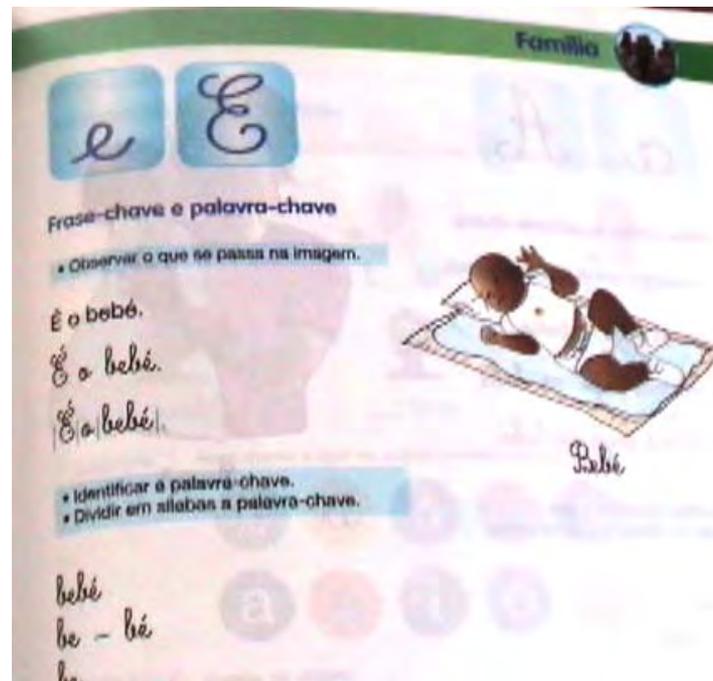
## Egypt: Grade 1 whole-word reading “active learning” class

- Without vowels, children may identify entire words as particular shapes

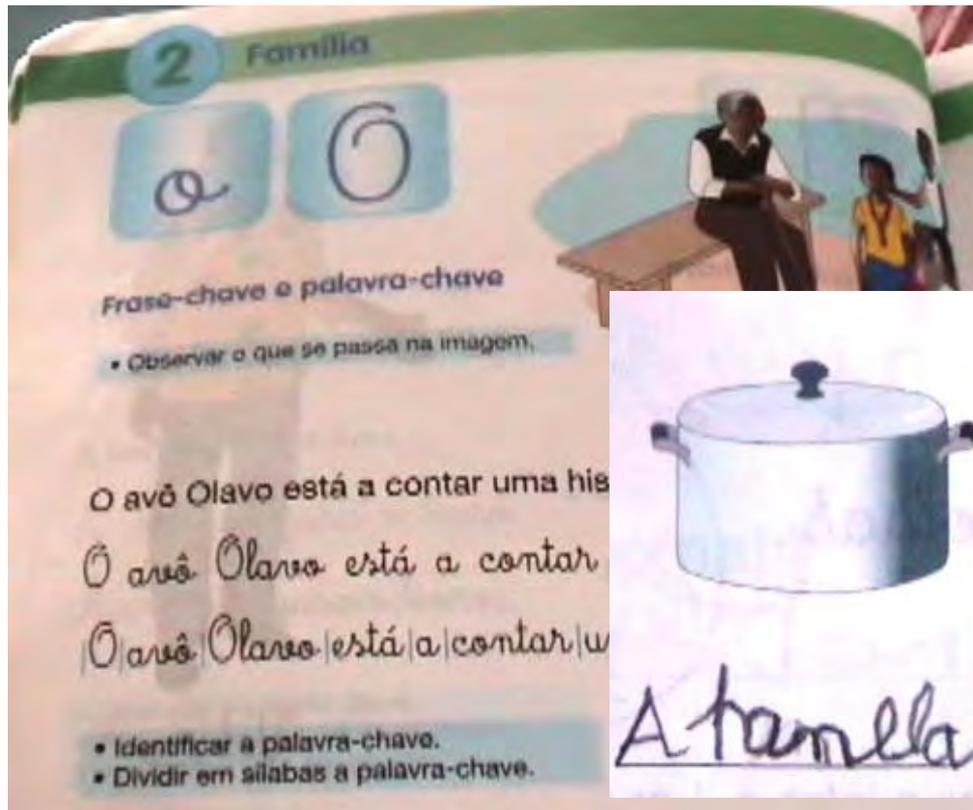


# Simple visual patterns made complex

- Misguided belief that text interpretation will lead to recognition of letters (Mozambique)



# Result: Students just “sketch” letters (Mozambique)



2 Família

o O

Frase-chave e palavra-chave

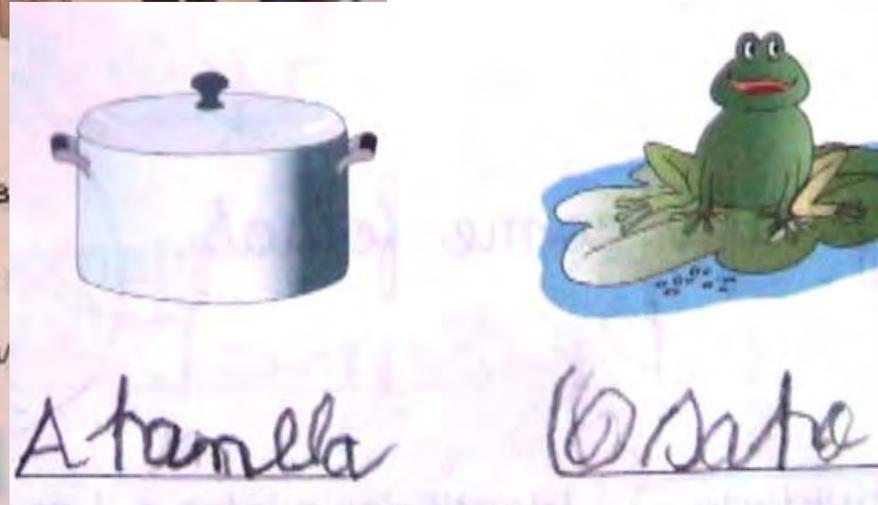
- Observar o que se passa na imagem,

O avô Olavo está a contar uma história.

O avô Olavo está a contar

Olavo|está|a|contar|u

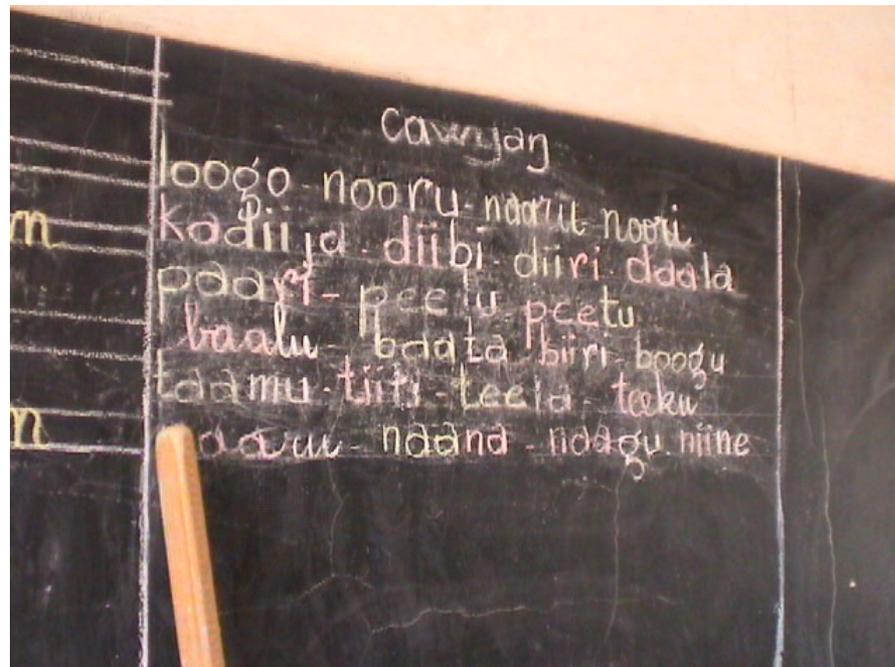
- Identificar a palavra-chave.
- Dividir em sílabas a palavra-chave.



The child tried to draw an O: “O sapo”

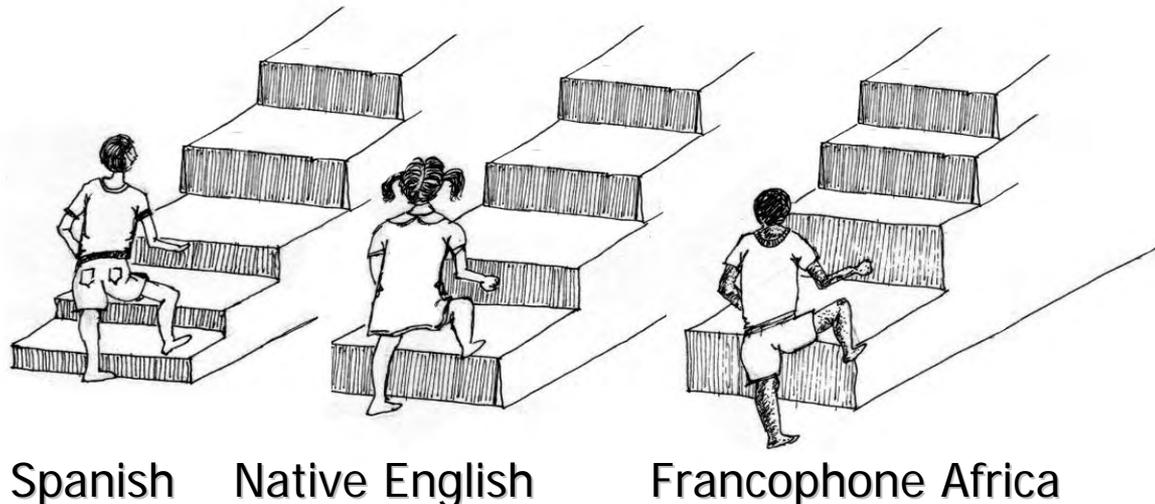
# African languages have regular spelling

- Can be automatized in a few months
- Fluency to other languages transfers within the same script



# Spelling complexity and reading automaticity: Implications for English, French, Portuguese

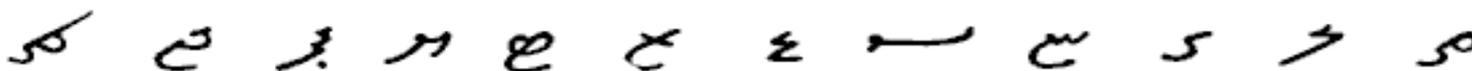
- Schooling through a foreign language requires extra time and practice, which the poor may not get
- Do African countries really have the budget?



# Dhivehi – possibly the simplest functioning alphabet in the world



dhaalu	faafu	meemu	vaavu	alifu	kaafu	lhaviyani	baa	raa	noonu	shaviyani	haa
dh	f	m	v		k	lh	b	r	n	sh	h
[d]	[f]	[m]	[v]	∅	[k]	[l]	[b]	[r]	[n]	[ʃ]	[h]



chaviyani	javiyani	paviyani	yaa	taviyani	zaviyani	daviyani	seenu	gnaviyani	gaafu	laamu	thaa
ch	j	p	y	t	z	d	s	gn	g	l	th
[ç]	[ʝ]	[p]	[j]	[t]	[z]	[d]	[s]	[ŋ]	[g]	[l]	[tʰ]



sukun	oaboafili	obofili	eybeyfili	ebefili	ooboofili	ubufili	eebeefili	ibifili	aabbaafili	abafili
'	oa	o	ey	e	oo	u	ee	i	aa	a
[ʔ]	[o:]	[o]	[e:]	[e]	[u:]	[u]	[i:]	[i]	[a:]	[a]

# Amharic

Exact spelling but much larger matrix with some pattern irregularities

More time needed to acquire automaticity, fluency

	hoy	lāwe	hāwt	may	śāwt	re's	sat	š	qaf	qaf									
ሀ	hā	ለ	lä	ሐ	hā	መ	mā	ሠ	śā	ረ	rā	ሰ	sā	ሸ	śā	ቀ	qā	ቁ	quā
ሁ	hu	ሉ	lu	ሐ	hu	ሙ	mu	ሠ	śu	ሩ	ru	ሰ	su	ሸ	śu	ቀ	qu		
ሂ	hi	ሊ	li	ሐ	hi	ሚ	mi	ሢ	śi	ሪ	ri	ሲ	si	ሸ	śi	ቂ	qi	ቃ	qui
ሃ	ha	ላ	la	ሐ	ha	ማ	ma	ሣ	śa	ራ	ra	ሳ	sa	ሸ	śa	ቃ	qa	ቄ	qua
ሄ	he	ሌ	le	ሐ	he	ሜ	me	ሣ	śe	ራ	re	ሴ	se	ሸ	śe	ቂ	qe	ቅ	que
ሀ	ha/ø	ለ	la/ø	ሐ	ha/ø	ሞ	ma/ø	ሠ	śa/ø	ረ	ra/ø	ሰ	sa/ø	ሸ	śa/ø	ቀ	qa/ø	ቃ	qua
ሀ	ho	ሎ	lo	ሐ	ho	ሞ	mo	ሠ	śo	ረ	ro	ሰ	so	ሸ	śo	ቀ	qo		
	bet	tāwe	č		hārm	nāhas	ñ	'ālf		kaf									
በ	bā	ተ	tā	ቸ	čā	ገ	hā	ገ	huā	ነ	nā	ኘ	ñā	አ	'ā	ከ	kā	ከ	kuā
ቡ	bu	ቱ	tu	ቸ	ču	ገ	hu			ኑ	nu	ኘ	ñu	አ	'u	ከ	ku		
ቢ	bi	ቲ	ti	ቸ	či	ገ	hi	ገ	hui	ነ	ni	ኘ	ñi	አ	'i	ከ	ki	ከ	kui
ባ	ba	ታ	ta	ቸ	ča	ገ	ha	ገ	hua	ና	na	ኘ	ña	አ	'a	ከ	ka	ከ	kua
ቤ	be	ቲ	te	ቸ	če	ገ	he	ገ	hue	ኔ	ne	ኘ	ñe	አ	'e	ከ	ke	ከ	kue
ብ	ba/ø	ቲ	ta/ø	ቸ	ča/ø	ገ	ha/ø	ገ	hua	ን	na/ø	ኘ	ña/ø	አ	'a/ø	ከ	ka/ø	ከ	kua
ቦ	bo	ቶ	to	ቸ	čo	ገ	ho			ኖ	no	ኘ	ño	አ	'o	ከ	ko		

	h	wäwe	‘äyn	zäy	ž	yämän	dänt	ğ	gäml	
ኸ	hä	ወ wä	ዐ ‘ä	ዘ zä	ሯ žä	የ yä	ደ dä	ጀ ğä	ገ gä	ጎ guä
ኹ	hu	ዉ wu	ዑ ‘u	ዙ zu	ሰ žu	የ yu	ደ du	ጀ ğu	ገ gu	
ኺ	hi	ዐ wi	ዒ ‘i	ዘ zi	ሯ ži	የ yi	ደ di	ጀ ği	ገ gi	ጎ gui
ኻ	ha	ዐ wa	ዓ ‘a	ዘ za	ሯ ža	የ ya	ደ da	ጀ ğa	ገ ga	ጎ gua
ኼ	he	ዐ we	ዔ ‘e	ዘ ze	ሯ že	የ ye	ደ de	ጀ ğe	ገ ge	ጎ gue
ኽ	ha/ø	ዐ wa/ø	ዐ ‘a/ø	ዘ za/ø	ሯ ža/ø	የ ya/ø	ደ da/ø	ጀ ğa/ø	ገ ga/ø	ጎ guä
ኾ	ho	ዐ wo	ዐ ‘o	ዘ zo	ሯ žo	የ yo	ደ do	ጀ ğo	ገ go	

	täyt	č	päyt	šädäy	däppä	äf	psa
ጠ	tä	ጩ čä	ጰ pä	ጱ šä	ፀ zä	፩ fä	ፒ pä
ጡ	tu	ጩ ču	ጰ pu	ጱ šu	ፀ zu	፩ fu	ፒ pu
ጢ	ti	ጩ či	ጰ pi	ጱ ši	ፀ zi	፩ fi	ፒ pi
ጣ	ta	ጩ ča	ጰ pa	ጱ ša	ፀ za	፩ fa	ፒ pa
ጤ	te	ጩ če	ጰ pe	ጱ še	ፀ ze	፩ fe	ፒ pe
ፒ	ta/ø	ጩ ča/ø	ጰ pa/ø	ጱ ša/ø	ፀ za/ø	፩ fa/ø	ፒ pa/ø
ፑ	to	ጩ čo	ጰ po	ጱ šo	ፀ zo	፩ fo	ፒ po

# Kannada – high error rates

## Complex forms, multiple visual patterns

Half-consonant combinations and vowel combinations result in a matrix of about 300 characters that must be automatized

Some are unpredictable

ಅ	ಆ	ಇ	ಈ	ಉ	ಊ	ಋ	ೠ	ಎ	ಏ	ಐ	ಒ	ಓ	ಔ
a	ā	i	ī	u	ū	ṛ	ṝ	e	ē	ai	o	ō	au
[ʌ]	[a:]	[i]	[i:]	[u]	[u:]	[ri/ru]	[ri:/ru:]	[e]	[e:]	[aj]	[o]	[o:]	[aw]

### Vowel diacritics

ಕ	ಕಾ	ಕಿ	ಕೀ	ಕು	ಕೂ	ಕೃ	ಕೄ	ಕೆ	ಕೇ	ಕೈ	ಕೊ	ಕೋ	ಕೌ	ಕಂ	ಕಃ
ka	kā	ki	kī	ku	kū	kṛ	kṝ	ke	kē	kai	ko	kō	kau	kaṃ	kaḥ

ಕ	k	[k]	ಖ	kh	[kʰ]	ಗ	g	[g]	ಘ	gh	[gʱ]	ಜ	ɳ	[ŋ]
ಚ	c	[tʃ]	ಛ	ch	[tʃʰ]	ಜ	ɟ	[dʒ]	ಝ	jh	[dʒʱ]	ಞ	ɲ	[ɲ]
ಟ	t	[t]	ಠ	ʈ	[tʰ]	ಡ	ɖ	[ɖ]	ಢ	ɗh	[ɖʱ]	ಣ	ɳ	[ɳ]
ಠ	t	[t]	ಠ	ʈ	[tʰ]	ದ	d	[d]	ಧ	dh	[dʱ]	ನ	n	[n]
ಪ	p	[p]	ಫ	ph	[pʰ]	ಬ	b	[b]	ಭ	bh	[bʱ]	ಮ	m	[m]
ಯ	y	[j]	ರ	r	[r]	ಲ	l	[l]	ವ	v	[v]	ಳ	ʃ	[ʃ]
ಶ	ʃ	[ʃ]	ಷ	ʃ	[ʃʰ]	ಸ	s	[s]	ಹ	h	[h]			

ಕ್ಕಾ ಗ್ಗಾ ಚ್ಚಾ ಟ್ಠಾ ತ್ತಾ ತ್ರಾ ತ್ಯಾ ದ್ದಾ ನ್ನಾ ಬ್ಬಾ ಮ್ಮಾ ರ್ತಾ ಲ್ಲಾ ಳ್ಲಾ ಸ್ಥಾ ಸ್ಪಾ ಸ್ವಾ  
 kka gga cca ṭṭa tta tra tya dda nna bba mma rta lla ḷḷa stha spa sva

## Voweled Arabic – small “grains”

### Unvoweled Arabic – large “grains”

- وَإِذِ ارْتَحَلُوا شَرْقًا وَجَدُوا سَهْلًا فِي أَرْضِ شِنْعَارَ فَأَسْتَوْطَنُوا هُنَاكَ
- فَقَالَ بَعْضُهُمْ لِبَعْضٍ: «هِيَ نَصْنَعُ طُوبًا مَشْوِيًّا أَحْسَنَ شَيْءٍ». فَأَسْتَبَدَّلُوا الْحِجَارَةَ بِالطُّوبِ، وَالطُّيْنَ بِالزُّفْتِ

يولد جميع الناس أحراراً متساوين في الكرامة والحقوق. وقد وهبوا عقلاً وضميراً وعليهم أن يعامل بعضهم بعضاً بروح الإخاء.

## Urdu – multiple difficulties/multiple issues

- Few vowel signs even in grade 1
- Vowels are not predictable as in Arabic
- Extensive practice necessary
- Need to learn the visual pattern of each word separately

بادوب انصیب ہے بادوب ہے انصیب

Class  
Urdu

## چڑیا گھر کی سیر



ہم اتوار کو اپنے اُستاد صاحب کے ساتھ چڑیا گھر کی سیر کو گئے۔ ہم نے وہاں کچھ پنجروں میں چڑیاں، بلیں اور طوطے دیکھے۔ اُن میں سے کچھ دان چمک رہے تھے۔ کچھ چل گیز رہے تھے۔ چڑیاں بھدک بھدک کر ادھر ادھر آ جا رہی تھیں۔ طوطے ادھر سے ادھر اڑ رہے تھے۔ ہمیں یہ دیکھ کر بڑا مزا آ رہا تھا۔ ہر ابرو والے پنجروں میں عقاب، چیل اور باز تھے۔ یہ گوشت کھا رہے تھے۔ ہم اور آگے بڑھے۔ دیکھا کہ کچھ بڑے بڑے پنجرے ہیں۔ کسی میں بھیڑیے ہیں۔ کسی میں چیتے، شیر اور کسی میں بچھو۔ یہ بھی گوشت کھا رہے تھے۔ ہم جنگلی جانوروں کو دیکھ کر بڑے خوش ہوئے۔ اسٹا میں ایک شیر کے دھاڑنے کی آواز آئی۔ ہم سب شیر کے پنجرے کی طرف لپکے۔ شیر کو دھاڑتے دیکھ کر بڑا مزا آیا۔ پاس ہی ایک پنجرے میں بندرتھے۔ وہ

# Devanāgarī alphabet for Hindi

सभी मनुष्यों को गौरव और अधिकारों के मामले में जन्मजात स्वतंत्रता और समानता प्राप्त है।  
उन्हें बुद्धि और अंतरात्मा की देन है और परस्पर उन्हें भाईचारे के भाव से बर्ताव करना चाहिये।

अ	आ	इ	ई	उ	ऊ	ए	ऐ	ओ	औ	अं	अः	अँ	ऋ
a	ā	i	ī	u	ū	e	ai	o	au	aṅ	aḥ	āṁ	ṛ
[ʌ]	[a]	[i]	[i:]	[u]	[u:]	[e]	[æ:]	[o]	[ɔ:]	[aŋ]	[aḥ]	[ā:]	[r]
प	पा	पि	पी	पु	पू	पे	पै	पो	पौ	पं	पः	पाँ	पृ
pa	pā	pi	pī	pu	pū	pe	pai	po	pau	paṅ	paḥ	pāṁ	pr

क	ka [kə]	ख	kha [kʰə]	ग	ga [gə]	घ	gha [gʰə]	ङ	ṅa [ŋə]
च	ca [tʃə]	छ	cha [tʃʰə]	ज	ja [dʒə]	झ	jha [dʒʰə]	ञ	ña [ɲə]
ट	ṭa [tʰə]	ठ	ṭha [tʰʰə]	ड	ḍa [dʰə]	ढ	ḍha [dʰʰə]	ण	ṇa [ɳə]
त	ta [tə]	थ	tha [tʰə]	द	da [də]	ध	dha [dʰə]	न	na [nə]
प	pa [pə]	फ	pha [pʰə]	ब	ba [bə]	भ	bha [bʰə]	म	ma [mə]
य	ya [jə]	र	ra [rə]	ल	la [lə]	व	va [və]		
श	śa [ʃə]	ष	ṣa [ʃə]	स	sa [sə]				
ह	ha [ɦə]								

Additional consonants (only used in loanwords)

क्व	qa	ख्ख	kha	ग	ga	ज्ज	za	ड	ra	ढ	rha	फ	fa
-----	----	-----	-----	---	----	-----	----	---	----	---	-----	---	----

Common conjunct consonants

क्ष	kṣa	ज्ञ	jña	त्क	tka	त्र	tra	द्व	dva	श्र	śra	द्य	dya
द्द	dda	त्त	tta	ड्ढ	ḍḍha	द्भ	dbha	द्म	dma	ह्म	hma	ह्य	hya

Special ra forms

रु	ru	रू	rū	र्प	rpa	प्र	pra	ट्र	ṭra
----	----	----	----	-----	-----	-----	-----	-----	-----

# How to teach complex scripts in 1-2 years to the poor?

- Lots of practice, build up letter recognition speed - phonics
- Automate the common patterns that enable students to read most material
  - Students in English learn the most common words
- Teach the more rare signs later
  - E.g. postpone certain half-consonants of Indian languages (or use “halant”?)
  - Keep Arabic, Urdu, Farsi voweled
  - Keep the Arabic letters on a straight line
- Get children practice with feedback!
- Textbooks to take home with much text for all
  - Not just a few “generative words” to bring from home

# Conclusions

How to educate the poor most efficiently?

## Get to reading fluency in grades 1-2 at most

- Practice to automatize “low-level” processes that the middle class takes for granted
  - much feedback, extensive practice with books - phonics
  - Use easily spelled African languages before reading English
  - Understand, adjust visual and spelling complexities of various scripts
- Use time well, all scripts can be taught decently in 1-2 years!

# Suggested monitoring indicators

- Reading fluency and comprehension
  - 60 words per minute for all by the end of grade 2
    - 3 comprehension questions answered correctly
  - 120-150 words per minute by the end of grade 6
    - Summary of paragraph
- Instructional time used for learning
  - 80% goal
- [math: story is not as clear]

## Controversies and concerns

- Educational philosophy vs. neurocognitive research outcomes
- How to disseminate the lines of reasoning?
  - Philosophical debates – needed but they delay decisions
- Reading automaticity sounds too mechanistic to some
- How to monitor these “concrete” benchmarks and learning outcomes early on
- Should the poor be taught differently from the middle class?
- How to undertake necessary research on memory effects in classroom?
- Cultural issues? (and what does that mean?)

# To serve the poor in low-income countries, international educators need to learn cognitive neuroscience basics

- ✓ *Colleges of education urgently must prepare suitable courses*
- ✓ *Professors must learn to teach them*
- ✓ *Students must demand them!*