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Challenges of monolingual and multilingual education: cognition, numeracy, and literacy skills in primary school children in India

Ianthi Tsimpli, Minati Panda & Anusha Balasubramanian

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Multilingualism and Multiliteracy: Raising Learning Outcomes in challenging contexts in primary schools across India (May 2016 – April 2020)

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Theo Marinis

Jeanine Treffers-Daller

University of Reading

Suvarna Alladi, NIMHANS

Minati Panda, JNU

Lina Mukhopadhyay, EFL-U

Partners and Consultants

Partners: British Council India
The Language and Learning Foundation
ASER

Consultants (Advisory Board):

Debanjan Chakrabarti,	British Council India
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Dhir Jhingran,	The Language and Learning Foundation

The trigger

Problem:

Causes of low learning outcomes of primary school children in multilingual India

Context:

Advantages to being bilingual or multilingual in attention and learning skills

Research question:

Why do some children in India not benefit from being bilingual or multilingual to the same degree as children in other contexts?

Background

Bilingualism has been shown to have beneficial effects on:

Cognitive control (e.g. Bialystok et al 2008; 2011)

a. working memory

b. Cognitive flexibility, allocation of attention resources and inhibition of inappropriate/incorrect response biases

Delay of dementia and cognitive decline in the elderly (Alladi et al 2013; 2014)

Creativity (Kharkhurin 2012, for adults; Leikin 2012, for children)

Creativity as a measure of *divergent* thinking: subconscious process involving a broad search for information and the generation of numerous alternative answers or solutions to a problem (Guildford 1967)

Background

- Reports from developing countries suggest that 221 million children are educated in a language they do not speak at home

→poor education quality, drop-out rates, low literacy outcomes (Cummins 2009)

→ Many EAL children in the UK are monoliterate in English.

Background

- Mother-tongue literacy for children attending schooling in L2 has revealed benefits in:
- The strength of the minority language in its mental (conceptual and processing) competition with the majority language
- Working memory
- Efficient transfer of basic and higher level literacy skills

Baker (2000), Cummins (2000),

Skutnabb-Kangas (2000),

Tsimpli (2017)

Previous findings

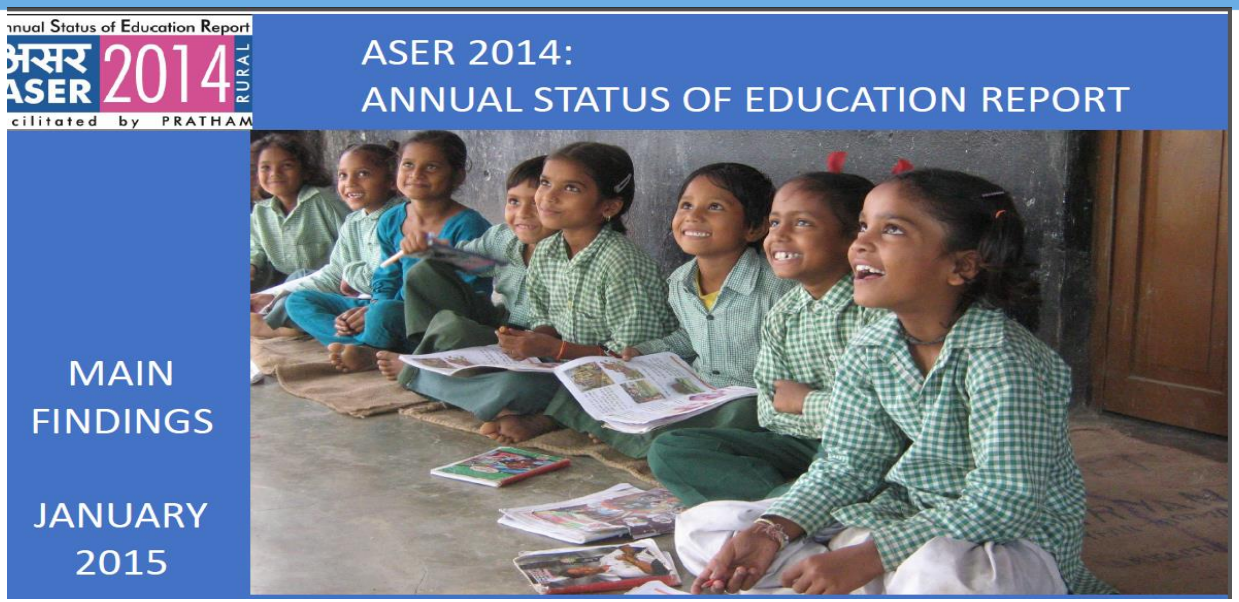
- Biliteracy effects on cognitive and language abilities in different groups of bilingual children with varied SES: *strongest cognitive advantage* in the group with *literacy skills in both the MT and the L2.*

(Dosi, Papadopoulou & Tsimpli, 2016)

- Bilingual children with bilingual education including MT literacy *outperform* bilinguals educated only in the L2 in the cognitive function of *updating*.

(Marinis, Bongartz and Tsimpli (under review)

Multilingualism in India



Although multilingualism is the norm in India, level of proficiency in the home language varies primarily as a function of whether education includes the home language or not.

(Panda & Mohanty 2013; ASER 2014)

Background information on learning outcomes in Indian schools

- ASER studies conducted with 600,000 children across India established that more than half of all children in Standard 5 could not read a Standard 2 level text fluently, and nearly half of them could not solve Standard 2 level subtraction task.
- Low literacy and numeracy can limit other important capabilities, e.g., critical thinking and problem solving
- Low educational achievement may lead to dropping out of school
- Teachers and schools in India are also well aware of these facts
- High dropout rate in schools affecting girls more than boys (Unesco's Education Report, 2015; Annual Status of Education Report Pratham, 2014).
- The gap between state and private schools is increasing every year.

Background: Indian languages

- More than one thousand indigenous languages belonging to four major language families (Indo-Aryan and Dravidian being spoken by the majority of the population followed by Austroasiatic and Sino-Tibetan languages).

- In our project, the languages of assessment tools are: Hindi, Telugu and English, although other home languages are included in the assessment of one cognitive task.


INDIA
States and Union Territories
N
TAJIKISTAN
AFGHANISTAN
PAKISTAN
CHINA
NEPAL
BHUTAN
BANGLADESH
MYANMAR
SRI LANKA
Srinagar
JAMMU & KASHMIR
Jammu
HIMACHAL PRADESH
Shimla
Chandigarh
PUNJAB
Dehradun
UTTARAKHAND
HARYANA
DELHI
New Delhi
Jaipur
RAJASTHAN
UTTAR PRADESH
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KERALA
Kavaratti
LAKSHADWEEP (INDIA)
Thiruvananthapuram
Polk Strait
ANDAMAN & NICOBAR ISLANDS (INDIA)
Port Blair
INDIAN OCEAN
LEGEND
International Boundary
State Boundary
Country Capital
State Capital
Map not to Scale
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(Updated on 2nd June 2014)

The research question

Why don't some children in India benefit from being bilingual or multilingual to the same degree as children in other contexts?

To answer the question, more questions to ask:

Is there a link between basic literacy and numeracy levels and MT education provision on the other?

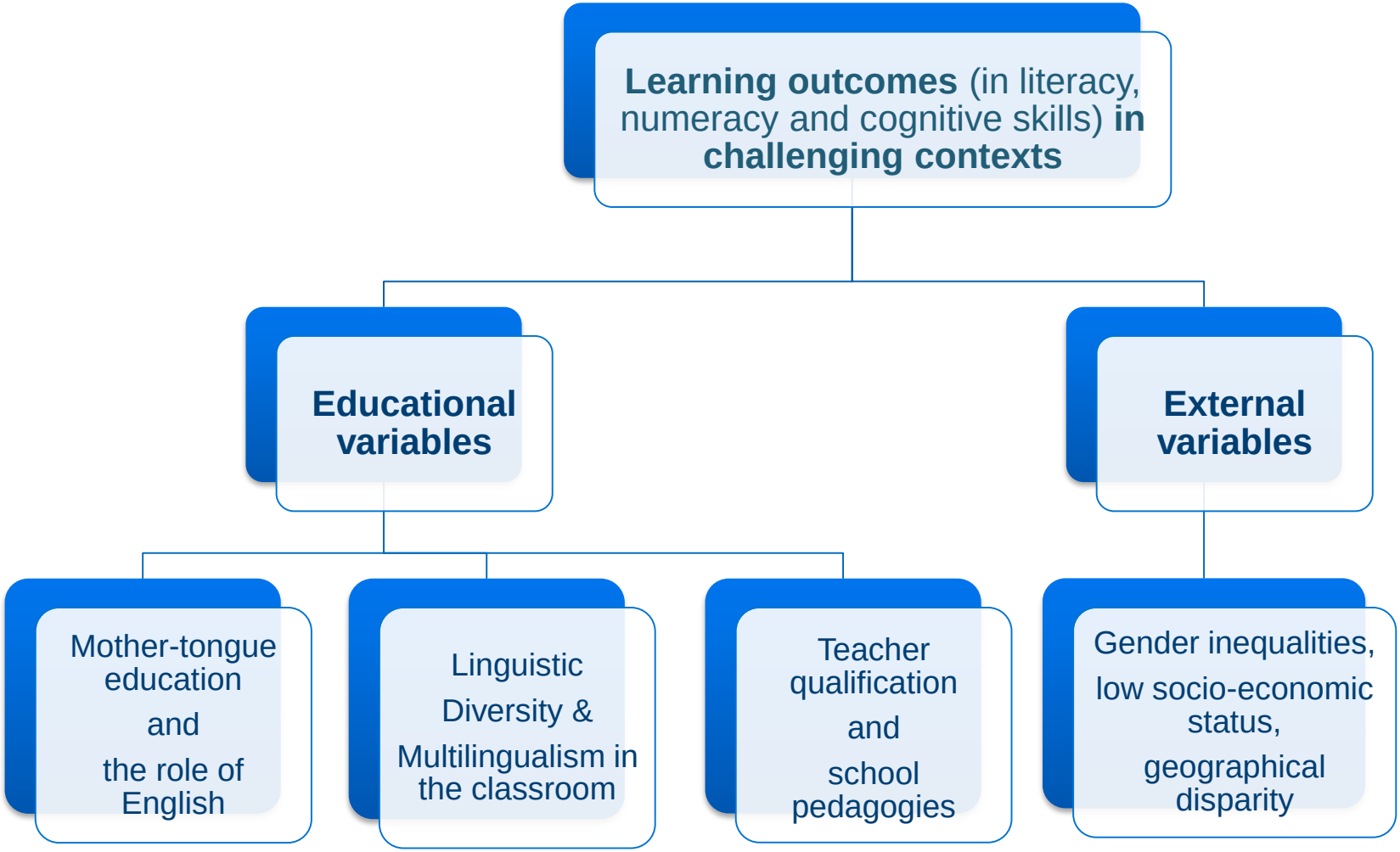
What is the *cognitive* profile of Indian children educated in challenging contexts? Are memory and attention skills affected by educational elements and how does demographic information (parental literacy and educational levels, home resources) affect them further?

Are numeracy skills, mathematical ability and math anxiety related? Is the link between maths anxiety and the development of numeracy skills more evident in girls than boys (thus leading to higher drop-out rates for girls)?

Questions (cntd.)

- Is MT literacy (in Multilingual Education) a positive factor for critical thinking and problem solving skills?
- Are critical thinking and problem solving skills in the medium of instruction transferrable in the child's use of English for similar tasks?
- What is the *relative contribution* of lack of MT education to low education levels in comparison with socioeconomic and geographical factors affecting educational outcomes for school children in urban slums and remote rural areas?
- To what extent do factors related to teaching methods and teacher training affect learning outcomes in literacy and numeracy?

RESEARCH FOCUS



Impact

- Capacity-building: at least 15 junior researchers working on the project at the moment; trained and actively engaged in research ethics, design, methods, data entry and analysis.
- Policy-makers, educational charities, practitioners and teachers actively engaged; upcoming dissemination event in Delhi (13-14/7/2018).

RESEARCH DESIGN

Comparative study employing qualitative and quantitative methods

Across 3 States
Bihar
Hyderabad
New Delhi

1800 children
from low SES
Primary school
(Standards 4 and 5)

In rural, urban and slum school settings

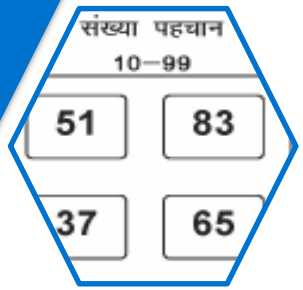
Headteachers
Math and Language Teachers

Experimental tasks
(Basic literacy and numeracy,
Critical thinking,
Problem-solving,
Memory and Cognitive tasks)

Mixed-methods data analysis

Baseline Task
Non-verbal IQ

School Surveys,
Class observations,
Child questionnaires



Geographical and social factors

- Urban (Delhi, Hyderabad) vs. Rural (Bihar)
- Bihar is one of the less developed and educationally disadvantaged areas of India (Tsujita, 2009, Unesco EFA Report).
- Urban areas: Children living in slum vs. non-slum areas
- Urban slums are settlements with inadequate access to safe water, sanitation and infrastructure, poor structural quality of housing, overcrowding and insecure residential status.
- Urban slums (where 17% of urban citizens in India live) include a large number of internal migrants who may speak other MTs or varieties of the regional language.

Urban slums

- School attendance rates for children living in Delhi slums is around 54% compared to attendance ratios in Delhi schools overall which was 90% in 2004 (Tsujita, 2009). Currently, attendance ratios are higher.

- Around 73% of slum children attending Std I in Delhi schools are over-aged (school capacity and administrative issues)

→ Inequalities in education provision

The project's design

- Short longitudinal design

- Assessing the development of language, literacy, numeracy, cognitive functions, critical thinking, and problem solving over two years in the same groups of children who differ in

(i) MT education/ literacy provision,

(ii) in education sites: remote and non-remote rural India and urban slum vs. non-slum

Innovations

- a) large range of tasks directly assessing children's cognition and metacognition and external factors (e.g., SES, geographic factors, teacher training and qualifications) on children's learning outcomes.
- b) the recruitment of a large number of children across three different states, which makes the study representative and
- c) the development of language, literacy, numeracy and critical thinking tasks in Hindi and Telugu.

Battery of Tasks: 1. Surveys and questionnaires

- *Language* questionnaire – Child (Demographic info, Language use info, socioeconomic variables)
- *Headteacher* questionnaire (demographics of the school, school curriculum and instruction, teaching practice and attitude)
- (Maths & Language) *Teacher* questionnaire: training, qualifications, language attitude (e.g. translanguaging), teaching and learning methods and materials
- *Classroom observation* tool (Teaching environment, observation of teaching activity, teaching content and strategies, teaching practices and good practice indicators)

The battery of tasks: 2. Cognitive

- **Raven's Progressive matrices** – non-verbal IQ

- Flankers – inhibitory control (EF task) – non-verbal
- N-back – Updating (complex working memory) – non-verbal

- Semantic fluency - verbal

Semantic fluency

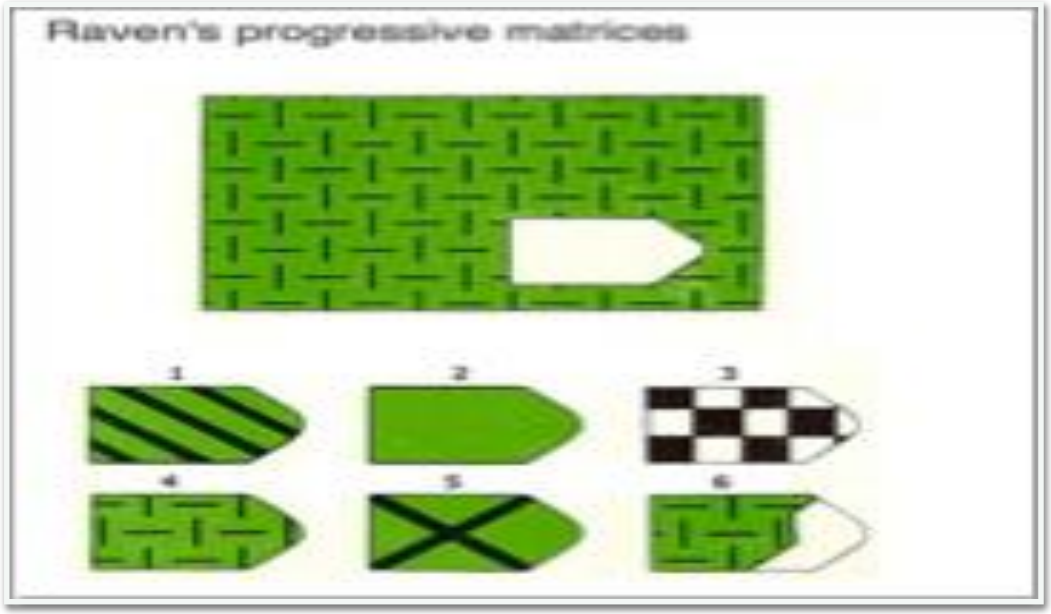
- a measure of verbal functioning and cognitive flexibility. (Memisevic et al.,2017)

- In this task, children have to name as many members of a specific semantic category in 1 minute.

Category	Home language (Day 1)	School language (Day 2)
Living	Birds	Animals
Non- living	Household objects	Fruit

Raven's Progressive Matrices

- To measure the children's general nonverbal abilities.
- 36 items administered in 3 sets (12 items in each)



Battery of tasks: 3. Literacy

- ASER (Basic literacy):

Letter naming, single word reading, reading of sentences, reading of passages and a couple of comprehension questions.

- Administered in the school language and English.

- Narrative retelling (measure of 'higher' literacy, complex language, lexical diversity) – *Multilingual Assessment Instrument for Narratives - MAIN*

(Gagarina et al, 2012; Gagarina, Klop, Tsimpli & Walters, 2016)

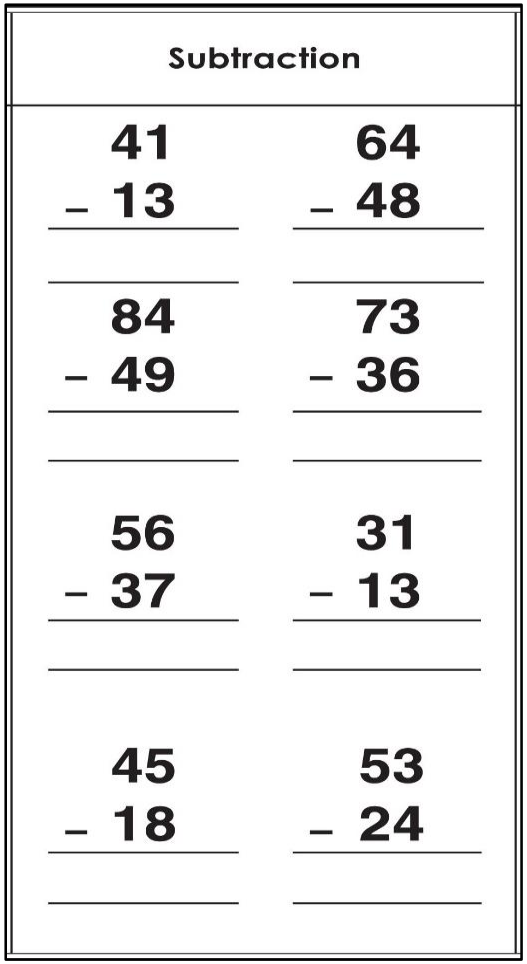
Battery of Tasks: 3. Numeracy

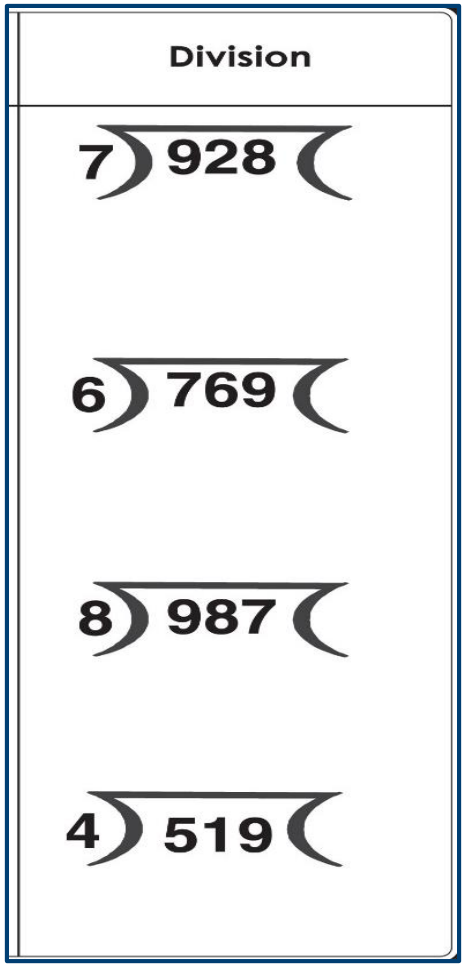
- To examine children's numerical understanding - their critical and problem solving skills.

1. ASER (basic) Numeracy Test
2. Maths Word Problem Tests and Meta-cognitive tasks
3. Maths Anxiety Scale Test

- Are there gender differences in any of the above?
- Is there a correlation between any of the above and Raven's?

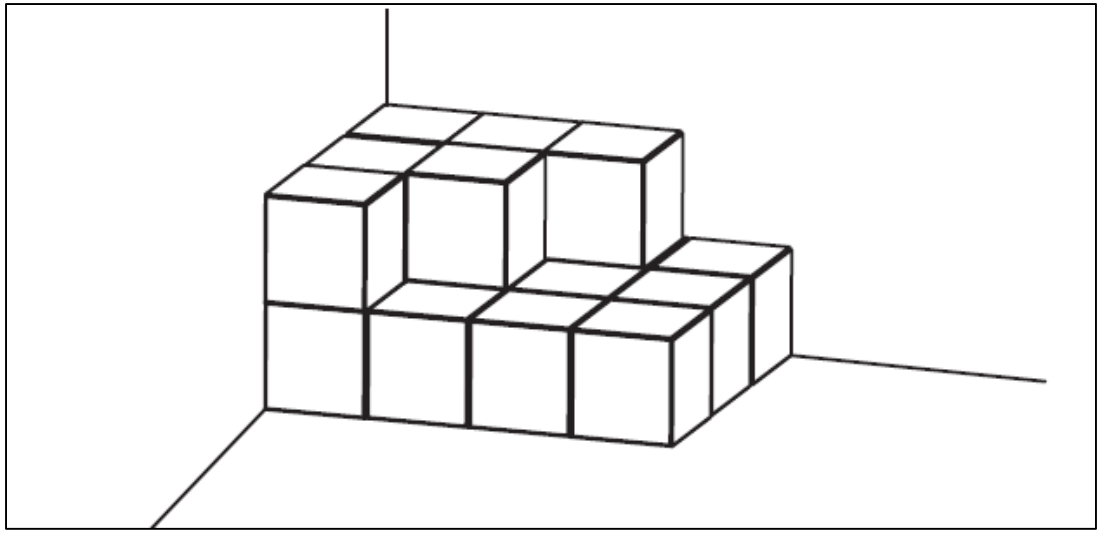
Basic Numeracy skills (ASER): Subtraction and Division





- Subtraction and Division tasks have a better discriminant value compared to Addition and Multiplication
- Division is the hardest of all four.

Mathematical skills: Word problems (Total: 6)



- Word-problems require good reading comprehension levels (Bjork & Bowyer-Crane, 2012).
- In our dataset, most children asked the experimenter to present the word problem orally in the regional language (Hindi or Telugu)

Question 1:
Sita stacks the boxes (image 1) in the corner of the room. All boxes are the same size. How many boxes has she used, in total? [Please tick/circle]

A	25
B	19
C	18
D	13

Meta-maths (Total: 3)

QUESTION 1

Here is how Nita solves two addition problems.

19	17
+13	+9
---	---
212	116

Do you think that the problems are solved correctly? If not, why is Nita wrong in her responses?

Answer:

1 Nita doesn't know how to add numbers
2 Nita doesn't know place value and carry forward of values
3 Nita was not attentive
4 I don't know
5 Any other

Meta-mathematics

- The task assesses *monitoring* mathematical problem-solving skills, perspective-taking, and postdiction judgements (i.e. identification of the error/ wrong strategy which led to the incorrect solution)

(cf. Jakobse & Harskambe, 2012)

Math anxiety scale (Devine et al, 2012)

1.9 Anxiety Scale	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
1. Having to complete a worksheet by yourself.					
2. Thinking about a maths test the day before you take it.					
3. Watching the teacher work out a maths problem on the board.					
4. Taking a maths test.					
5. Being given maths homework with lots of difficult questions that you have to hand in the next day.					
6. Listening to the teacher talk for a long time in maths.					
7. Listening to another child in your class explain a maths problem.					
8. Finding out you are going to have a surprise maths quiz when you start your maths lesson.					
9. Starting a new topic in maths.					

Participants (so far)

- Bi/Multilingual children (c. 900 children) in Delhi and Hyderabad in slum and non-slum areas
- Short longitudinal design -

    - Children in Std 4- to be tested again after 1 year in Std 5

- Differences between Delhi and Hyderabad:
- Delhi government schools are now all English-medium; in Hyderabad, there are English-medium and Telugu-medium schools.

→ Between 60 and 70% of children in both sites are reported to have a home language **different** from the medium of instruction.

Preliminary data from the Delhi site (Minati Panda's research team; JNU)

Participants: Bi/multilingual Children in Year 4

Groups	Boys	Girls	Total (N=344)
Slum	43	80	123
Non-slum	104	117	221

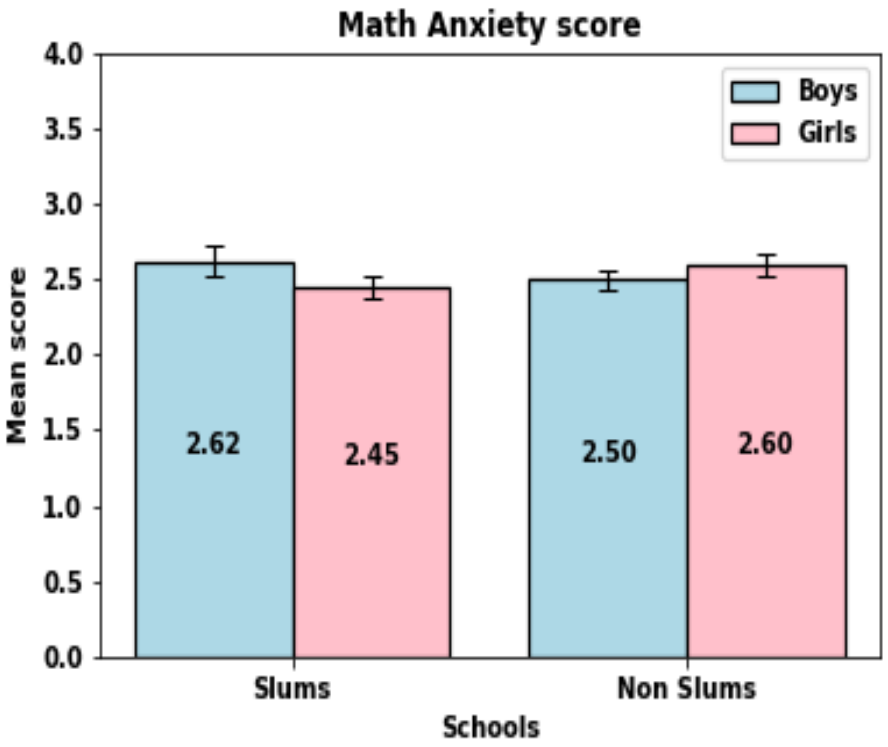
- Between group comparisons (2-way ANOVA)-
  Slum vs. non-slum; Boys vs. girls

- Correlation analyses
  To assess the relationship between variables.

Preliminary findings

Math Anxiety score:

Ratings on a scale of 1-5 (1-Low anxiety; 5-High anxiety)

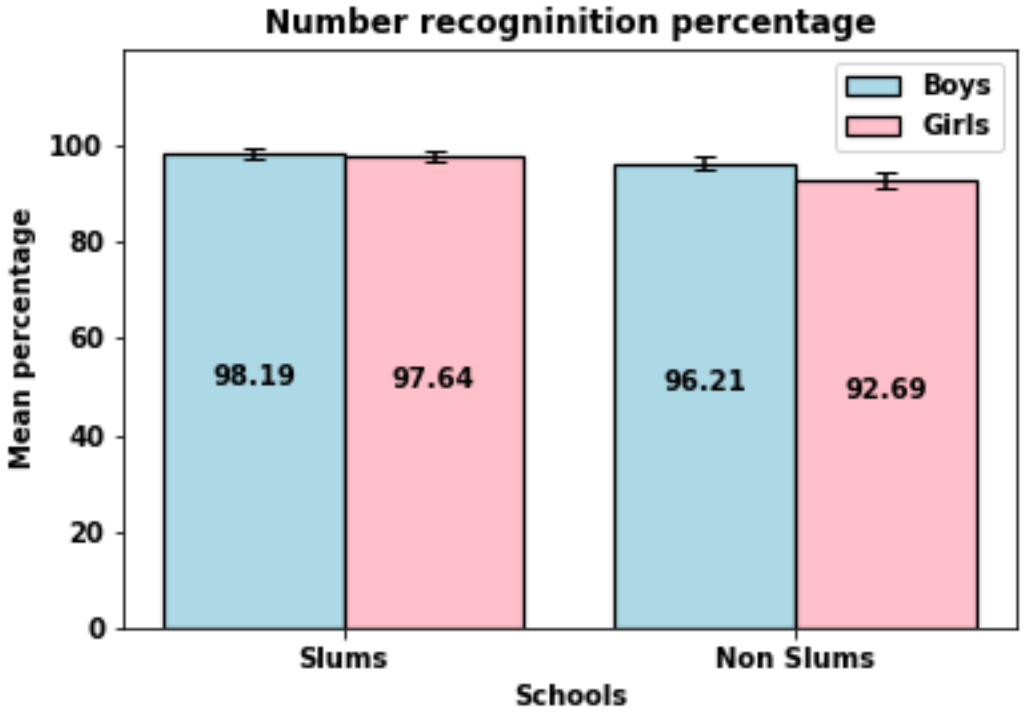


- No main effect of group(school type): F(1,340)=.015, p=0.90
- No main effect of gender: F(1,340)= 0.17, p=0.67
- No interaction of group x gender: F(1,340)=2.87, p=0.09.

Math anxiety scores

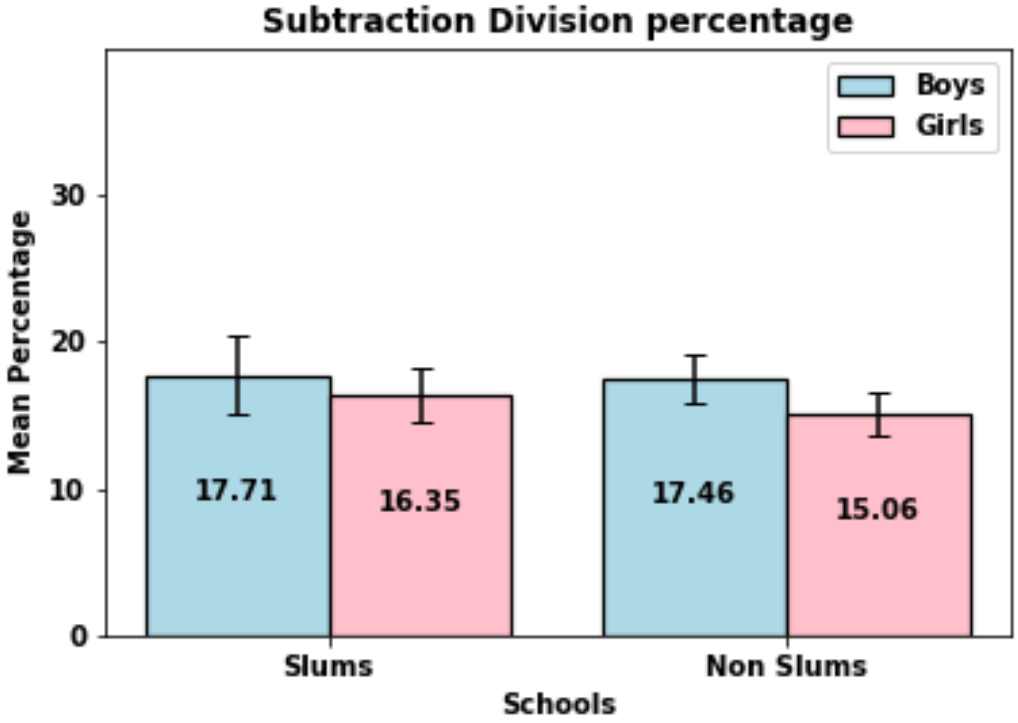
- When children were asked about how they would feel if another student performs better in the class, many replied they would be happy, or everybody should clap etc.
- It seems that children are quite young to feel math anxiety OR that the schools we tested in (low SES) do not foster competition and comparisons.
- Child participants in our study may struggle with comprehension, regular attendance etc.
- Teacher and parent expectations could also be lower for similar reasons.

Number Recognition task



-- This is part of ASER's basic numeracy task: Children are asked to name single and double-digit numbers – 'threshold test'

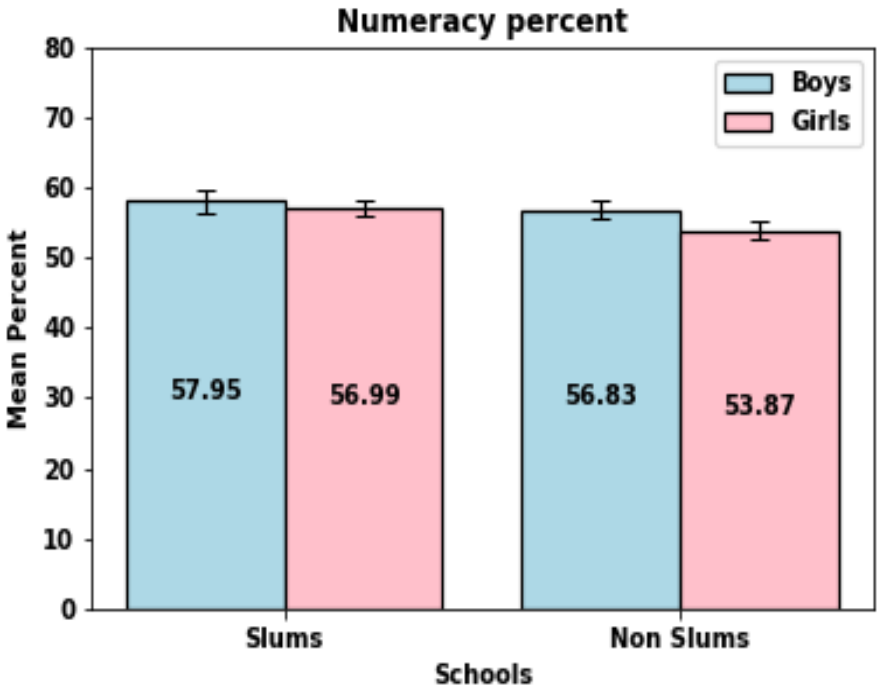
ASER Numeracy:
Subtraction and Division task



-- Scores are rather low for Std IV children. However, division vs. subtraction are not of the same level of difficulty

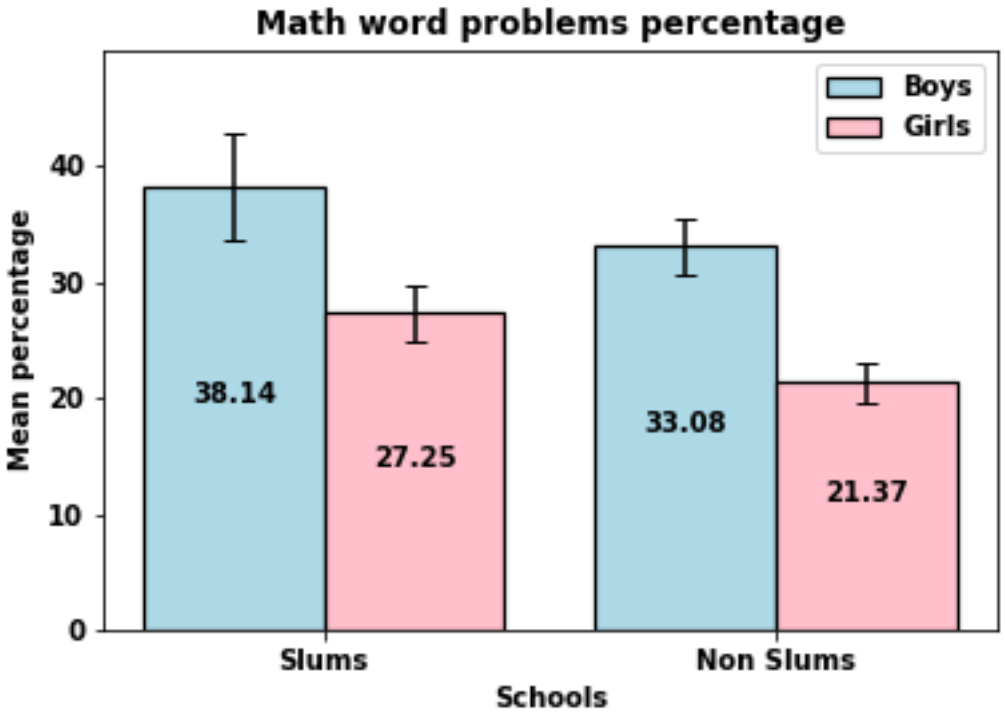
Numeracy

- For the numeracy skills, the scores of number recognition and subtraction & division were averaged and combined.



- No main effect of group(school type): F(1,340)= 2.19, p=0.14
- No Main effect of gender: F(1,340)= 1.87, p=0.17
- No interaction of group x gender: F(1,340)=0.48, p=0.48.

Math word problems task



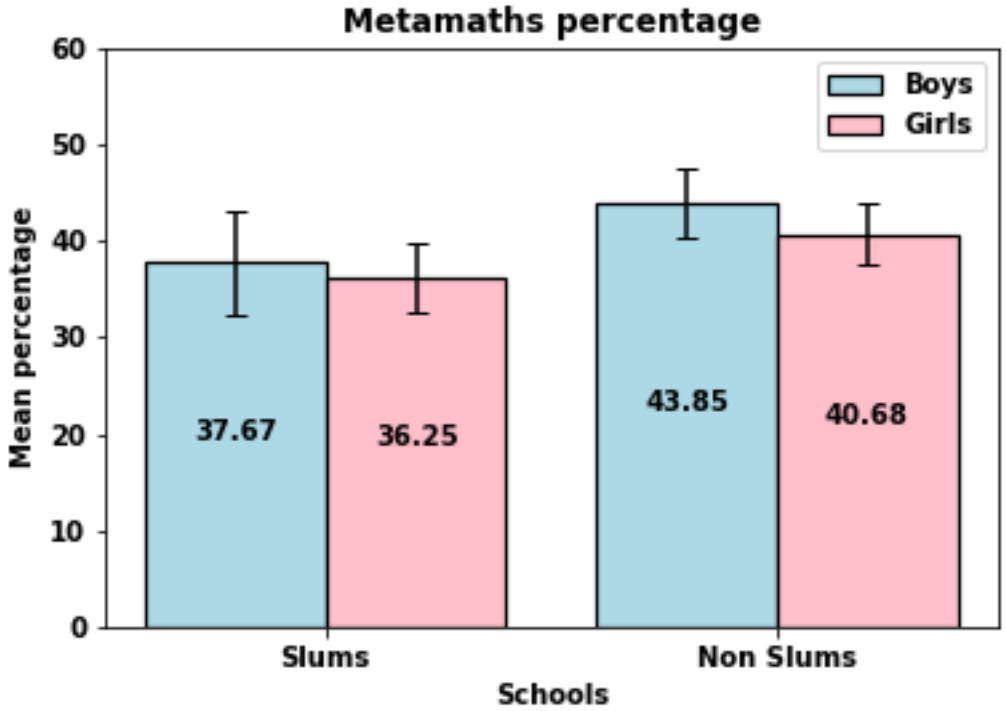
Teachers usually have to read out the word problems 2/3 times before asking children to solve them.

Word problems were orally presented to the children in our study

Gender difference

Tendency for an advantage of the slum group?

Metamaths task

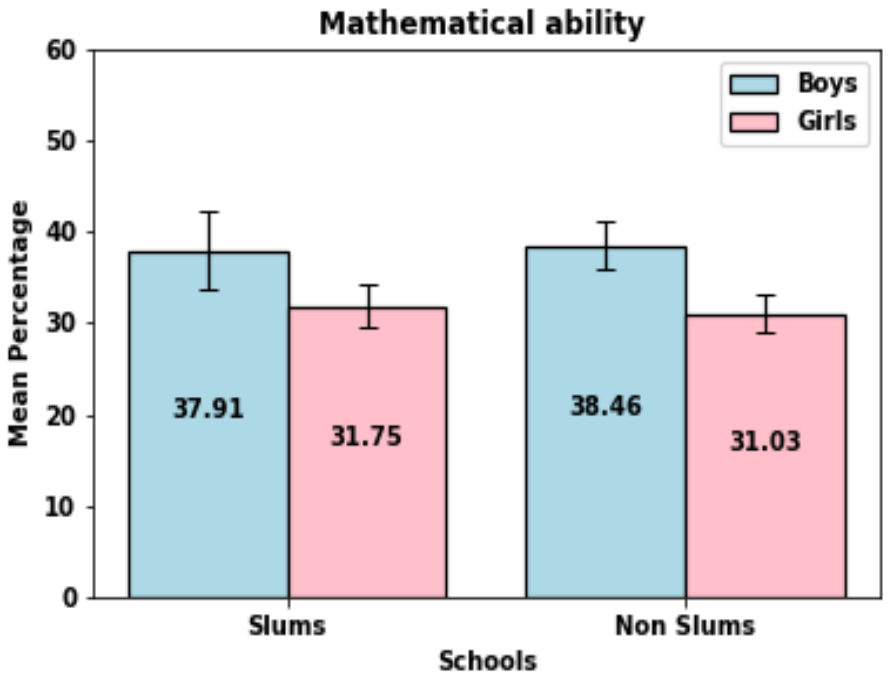


Although these children seem to struggle with subtraction and division, the development of mathematical meta-cognition and oral heuristics appears to be better.

Life experience?

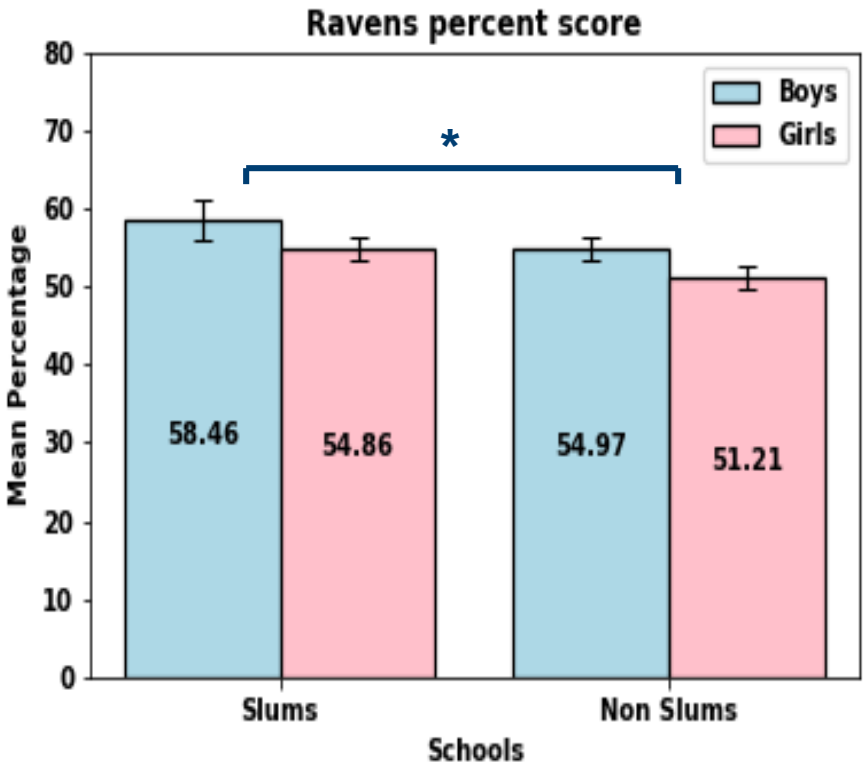
Mathematical ability

- Scores from math word problems and metamaths task were averaged and combined.



- No main effect of group(school type): F(1,340)=0.001, p=0.97
- **Main effect of gender**: F(1,340)= 8.17, p=0.013*
- No interaction of group x gender: F(1,340)=0.05, p=0.81.

Raven's progressive matrices



- **Main effect of group** (school type): F(1,296)= 5.04, p=0.025*

Main effect of gender: F(1,296)= 3.98, p=0.047*

No Group x Gender interaction: F(1,296)=0.32, p=0.56.

Correlation Analyses

- No correlation between numeracy skills and math anxiety (r=-.055, N=344, p=.309)

- No correlation between mathematical ability and math anxiety(r=0.27, N=344, p=0.617).

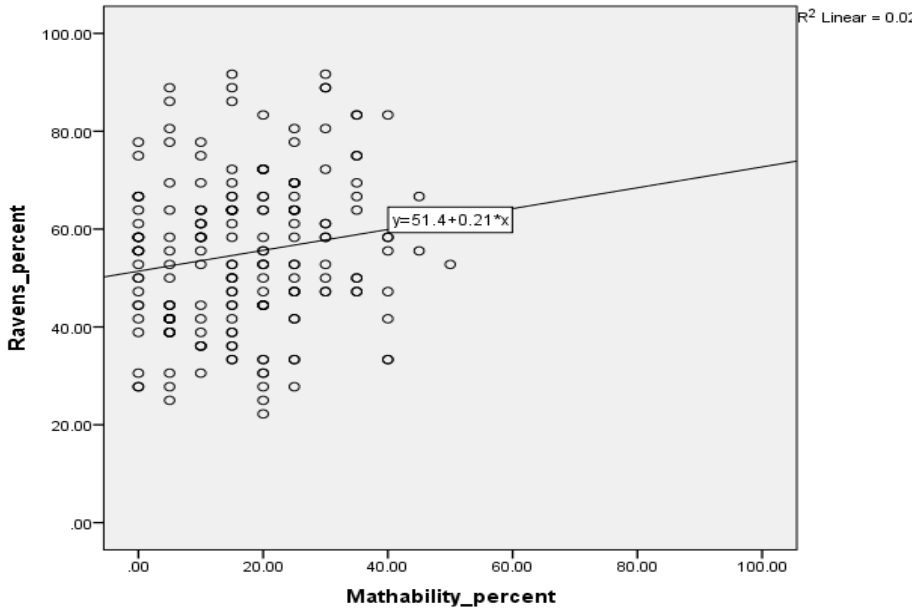
- This probably suggests that the children are too young or not schooled in a context where competition or high expectations would foster math anxiety.

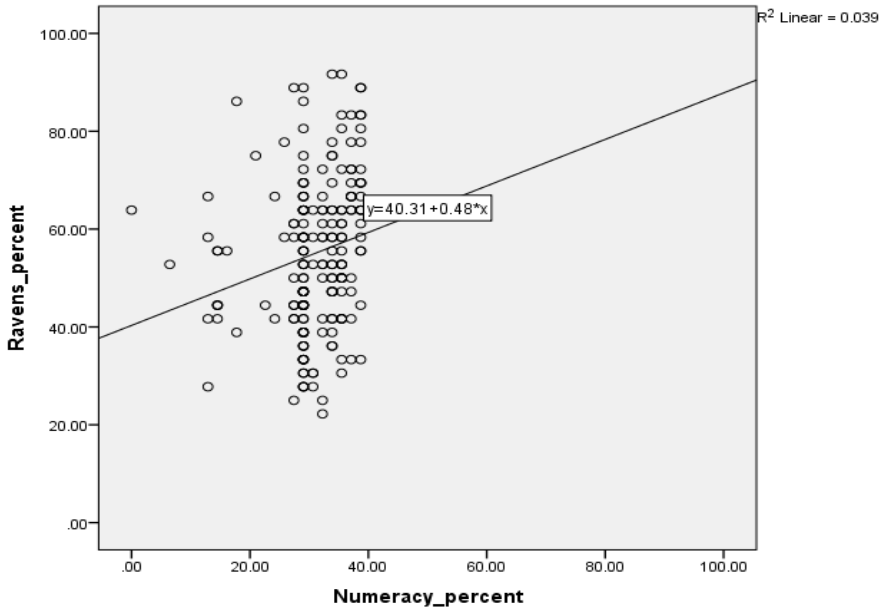
- **Moderate positive correlation between mathematical ability and numeracy skills (r=0.57, N=344, p<0.01)**

Correlation analyses (cntd.)

- Are numeracy and mathematical ability related to cognitive ability (Raven's scores)?

→ a weak positive correlation between mathematical ability and Raven's scores (r=0.16, N=195, p=0.019) and between numeracy skills and Raven's scores (r=0.27, N=195, p<0.01).





Regression

- A multiple regression analysis was carried out to test if the mathematical ability and numeracy skills **significantly predict** the cognitive performance on Raven's matrices.

- A significant regression equation was found [F (2,192)=4.407, p=0.013] with an R^2 of 0.044.

→ Mathematical ability and numeracy skills are **not** significant predictors of cognitive performance.

Discussion

- Oral mathematical skills (word problems and meta-maths) appear to be less problematic for these children than pen and paper tasks (division and subtraction)

- The numeracy data need to be analysed in relation to children's background data and literacy levels, narrative skills and teacher/pedagogy data

→ What is the role of life experience in children living in challenging contexts? The opportunity to engage with quantity assessments and relating these quantities to money or to other quantities is higher among children from poor families as parents often require children's support for handling everyday activities including buying and selling in markets

(cf. Stillman & Galbraith, 1998; Schoenfeld, 1996)

Open questions

- The urban poor may have an added advantage of dealing with quantity phenomena, the relationships and patterns in multilingual and multi-communicative contexts because of frequent migration of people from different parts of the country to slum areas.
- Would this predict better problem-solving skills for children in slum areas?
- All questions are still open.
- A more general question about the data from challenging educational contexts: Could life experience in the urban poor of the Global South compensate for gaps in the schooling system?

The Delhi team - JNU

Prof. Minati Panda

Nainy Rao

Shitika Chowdhary

Shalini Yadav

Yashika Chandna

The Patna and Hyderabad teams:

Patna team:

Dr Lina Mukhopadhyay (EFL-U)

Shravasti Chakrabarti

Kankan Das

Vasim Tamboli

Hyderabad team:

Prof. Suvarna Alladi (NIMHANS)

Abhigna Reddy

Anu Nagalakshmi K

Deepa BR,

Dedeepya B,

Joshua Reddy,

Jyothi M.

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and

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