UNIVERSITY OF CAMBRIDGE

Multilingualism and Multiliteracy: Raising Learning Outcomes in Challenging Contexts in Primary Schools across India

MultiLiLa

Research report of a study on multilingualism, literacy, numeracy and cognition in Delhi, Hyderabad and Patna (2016–20)

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Multilingualism and Multiliteracy: **Raising Learning Outcomes in Challenging Contexts in Primary Schools across India**

MultiLila project team

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Table of contents

1	Outline of the MultiLiLa project	7
2	Findings and recommendations for different stakeholders	12
	2.1 Policy makers	12
	2.2 Parents	15
	2.3 Teachers and teacher educators	16
3	The MultiLiLa participants: Schoolchildren in government schools in Patna, Delhi and Hyderabad	19
	3.1 Patna	19
	3.2 Delhi	21
	3.3 Hyderabad	23
4	What does our research show about how children in government schools in Patna, Delhi and Hyderabad learn to read and understand written and oral language?	25
	4.1 Patna	26
	4.2 Delhi	27
	4.3 Hyderabad	28
5	What does our research show about how children in government schools in Patna, Delhi and Hyderabad learn to count and reason in mathematics?	30
	5.1 Patna	32
	5.2 Delhi	33
	5.3 Hyderabad	34
6	What does our research show about the cognitive skills of children in government schools in Patna, Delhi and Hyderabad?	35
	6.1 Patna	37
	6.2 Delhi	38
	6.3 Hyderabad	38
7	What does our research show about language use in the classrooms of English-medium, Telugu-medium and Hindi-medium schools in Delhi and Hyderabad government schools?	39

8 What does our research show about gender differences and geographic location in our participants' school and cognitive skills? 42
8.1 Patna 43
8.1.1 Gender differences 43
8.1.2 Town vs non-remote rural school sites 46
8.1.3 Statistical comparisons: Age, gender and school site 50
8.2 Delhi 51
8.2.1 Gender differences 51
8.2.2 Differences by school site 56
8.2.3 Statistical comparisons: Age, gender and school site 60
8.3 Hyderabad 61
8.3.1 Gender differences 61
8.3.2 Differences by school site 65
8.3.3 Statistical comparisons: Age, gender and school site 70
9 Limitations, challenges and opportunities for the future 71

References 74

1

Outline of the MultiLiLa project

The Multilingualism and Multiliteracy (MultiLila) project was a four-year research study (2016–20) funded by the Economic and Social Research Council and the Department for International Development (ESRC-DfID), UK. Its aim was to identify whether or not children who learn through the medium of a language which is not the same as their home languages have different levels of learning outcomes than those children whose home and school languages are the same.

In a linguistically highly diverse country, like India, it is obvious that millions of children are at a disadvantage in this respect: there are only 22 'scheduled' languages which receive financial support from the government to be used as mediums of instruction and a total of 462 languages spoken in the country (Simons & Fennig, 2018). Education in a minority language needs to rely on funding from trusts, foundations or individuals. One study from 2011 calculated that there are only 31 mediums of instruction in use across the country, reduced from over 67 in the 1970s (Meganathan, 2011).

According to the National Education Policy (NEP) document released for public comment in May 2019, mother-tongue education is a priority for all children, while English is expected to be offered in schools as a subject taught in a high-quality manner to reduce social inequalities and provide access to English for all. In reality, NEP recognizes the shortfall in resources to implement this approach, which includes the lower quality of 'vernacular'-medium textbooks, the low provision for linguistic minorities across schools and the difficulties teachers face to undertake a 'bilingual approach' in the classroom (p. 80). In reality, several state governments (Andhra Pradesh, Telangana, Karnataka, Punjab and West Bengal) have already implemented English-medium instruction (EMI) in government schools, most often without the necessary resources and investment in teacher potential (Rao, 2019; The Telegraph, 2019; D'Souza, 2019; Aman, 2018; Hindustan Times, 2018).

Children speaking minority languages are often familiar with the regional language, either because the regional language is used along with other languages spoken in the home or because of its predominant use in the community. The MultiLiLa project sought to capture inequalities created for children in government schools because of a monolingual imposition of a medium of instruction, which may be English or a regional language. Alongside language inequalities, the project considered gender differences and socioeconomic disadvantages created by further distinctions between children in slum

Field visit to school in Delhi

and non-slum urban sites, namely Delhi and Hyderabad, as well as town compared to non-remote rural areas in Patna. The age of the children in Standard (Std) IV and Std V was also taken into account because a proportion of overage children in each school year was attested in all three sites.

The school skills assessed in MultiLiLa include ***basic literacy and numeracy tasks***, developed by ASER (www.asercentre.org/; Pratham 2014, 2017). Literacy was assessed in English and regional languages, while numeracy skills included subtraction and division from the mathematical operations included in the relevant ASER tool. Reading comprehension was also assessed with comprehension questions on the short ASER tool story the children were asked to read. In terms of oral language, we tested children's ability to comprehend and retell a narrative based on pictures presented on the computer screen while listening to the story in the school language. Children had to retell the story they had listened to in their preferred language (home or school) and had to answer a number of comprehension questions that monitored how well they understood the story. The stories were from the Multilingual Assessment Instrument for Narratives (MAIN; www.leibniz-zas.de/de/publications/schriftenreihe/zaspil/zaspil-56/main-start/?&L=1; Gagarina et al., 2012, 2019). They were slightly culturally adapted to make them accessible to children in India. The narratives were adapted to Hindi and Telugu, and children were presented with the narrative in the school language (Hindi, Telugu or English) in all sites.

Mathematical reasoning skills were tested with word problems and a meta-mathematics test. Word problems were appropriate for Std IV children and were adapted from examples provided by the Trends in International Mathematics and Science Study (TIMSS; https://www.iea.nl/studies/iea/timss). Children's ability to critically analyse mathematical problems solved by another student incorrectly was assessed with the meta-mathematics task originally developed by Panda et al. (2011) in a longitudinal project in Odisha and Andhra Pradesh. The children were required to identify and explain errors made in computing addition, subtraction and multiplication, which asks children not only to follow an algorithm to reach the solution but

to reflect on mathematical logic involved in solving mathematical problems.

The project also sought to understand whether children who use more than one language in the home or children who live in linguistically highly diverse environments have better ***cognitive skills*** than children in monolingual or less diverse contexts. To this end, MultiLiLa included tasks measuring non-verbal intelligence, complex working memory, inhibition and semantic fluency. With the exception of semantic fluency, which was tested in English and the regional language, the other three tasks were non-verbal, so level of proficiency in any language was not a prerequisite to perform the tasks. Raven's Coloured Progressive Matrices (CPM) (Raven, Raven & Court, 1998) was the test used for non-verbal intelligence, the N-back (2-back) task for working memory and updating, the Flanker task to test inhibition, and finally a semantic fluency task to test a combination of lexical ability and cognitive control.

Examples of the Raven's and of the N-back tasks respectively are presented in Figures 1a and 1b.

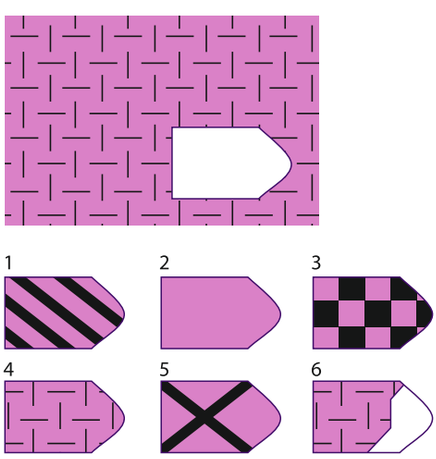


Figure 1a: Example Raven's task

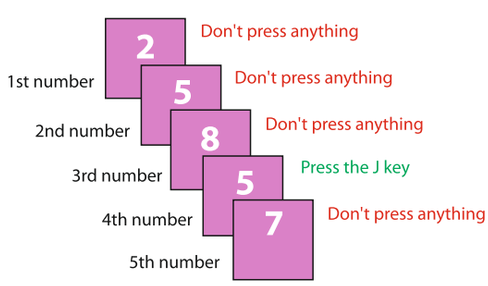


Figure 1b: Example N-back task

An example of the Flanker task is presented in Figure 2. The child has to press a key on the computer keyboard to indicate the direction the middle fish is looking. In some trials, all fish look towards the same direction and this is why this is called the 'no conflict' condition. In other trials, the fish surrounding the middle fish look towards a different direction from the middle fish and this is why this is called the 'conflict' condition. The 'conflict' condition is more challenging than the 'no conflict' condition because children have to inhibit the direction the surrounding fish are looking when they press the button for the direction the middle fish is looking.

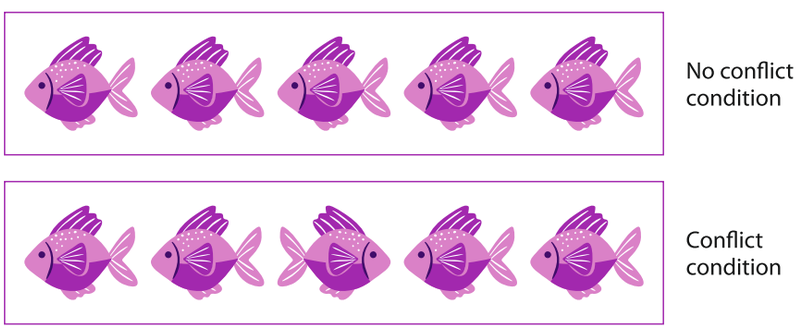


Figure 2: Example Flanker task

We also administered two semantic fluency tasks which asked children to name as many entities belonging to each of the following two semantic categories as they could within one minute:

(i) living entities (e.g. animals for the home language and vegetables for the school language)

(ii) non-living entities (e.g. household items for the home language and school objects for the school language).

Many children could find words in the school language, but naming the living and non-living entities in their home language was more difficult, which may be because each language is being used for a different domain (e.g. home language for household items, school language for school objects). Sometimes loanwords from English were used in the children's answers, which were counted as correct because English loanwords are very frequently used in India.

Finally, MutliLiLa used a number of ***questionnaires and surveys*** with the aim to elicit background information that could then be used to evaluate the findings from the direct assessments of literacy, numeracy and cognitive tasks outlined above. Specifically, we used a demographics, language, socioeconomic status and sociolinguistic diversity child questionnaire that involved an adaptation of a child questionnaire used in previous studies (Rothou & Tsimpli, 2017; Kaltsa et al., 2019) and was included in a published study on some of the MultiLiLa children (Tsimpli et al., 2020). Furthermore, we adapted questionnaires for teachers and head teachers from the Young Lives project in India (https://www.younglives.org.uk/content/india-school-survey). The adaptation involved adding questions on teaching practices and languages used in the classroom as well as attitudes to language mixing and multilingualism. Finally, we used a classroom observation tool which was adapted from a British Council tool. The adaptation involved adding a time-locked record of languages used in a five-minute period within a 30-minute class observation.

The project ran in Delhi, Patna and Hyderabad, collecting data from children in Stds IV and V. The design of the study included comparing urban areas (Delhi and Hyderabad) with town and non-remote rural areas in Patna, while urban children are further divided into those attending schools in slum and non-slum areas. We recruited children from government schools only because our aim was to better understand the interaction of lower socioeconomic status, location, medium of instruction and school or teaching resources with children's school, language and cognitive development. Focusing on government schools also allows us to present our findings in the light of policy recommendations that state governments and education authorities in different sites may wish to consider in the near future.

A variety of quantitative and qualitative data was collected over a period of four years. The data includes children's performance in the 14 different tasks of literacy, numeracy, oral language, verbal reasoning and cognitive tasks mentioned above. In addition, we collected data from the surveys and questionnaires used for teacher and head teacher interviews. In total, 741 children from Delhi and 780 children from Hyderabad were tested at two points in the same calendar year, namely when the children were attending Std IV and Std V respectively, in order to capture a short longitudinal perspective of the children's development. In Patna, 907 children – of whom half were attending Std IV and half Std V – were recruited and tested with the same battery of tasks. Although testing in Patna was carried out in parallel for Std IV and Std V, and

as a result the data from Std V is not from the same children as in Std IV, a developmental picture based on the findings from the two consecutive school years can still be drawn for the Patna learners. The participating schools from Delhi and Hyderabad differed in the official/stated medium of instruction. Specifically, we collected data from children attending EMI and Hindi-medium schools in Delhi as well as EMI and Telugu-medium schools in Hyderabad. Patna schools had only Hindi as the official medium of instruction. English was taught as a curriculum subject in all schools in Patna and in the schools in Delhi and Hyderabad that did not have English as the medium of instruction. We therefore assessed English literacy across all schools regardless of medium of instruction.

In this report, we present our main findings on almost all the tasks we administered by site (Patna, Delhi and Hyderabad) and further divided by gender and by school site. We do not present the findings from one of the cognitive tasks, namely Flankers, due to lack of time for data analysis by the time of publication of this report. Finally, we do not present our teacher and head teacher questionnaire data for similar reasons. The project team has already published academic journal articles and is preparing more for publication in the near future. A short list of published papers can be found here:

Tsimpli I.M., Mukhopadhyay, L., Treffers-Daller, J., Alladi, S., Marinis, T., Panda, M., Balasubramanian, A. & Sinha, P. (2019). 'Multilingualism and Multiliteracy in Primary Education in India: A discussion of some methodological challenges of an interdisciplinary research project.' *Research in Comparative and International Education*, Vol.14 (1): 54–76.

Tsimpli, I., Vogelzang, M., Balasubramanian, A., Alladi, S., Reddy, A., Panda, M. & Marinis, T. (2020). 'Linguistic diversity, multilingualism and cognitive skills: A study of disadvantaged children in India.' *Languages*, 5: 10.

Mukhopadhyay, L. (in press). 'Translanguaging in primary level ESL classroom in India: An exploratory study.' *International Journal of English Language Teaching*.

Before we present a full list of the findings and some statistical comparisons on those, the next section outlines major findings and recommendations with relevance to different groups of stakeholders, namely policy makers, parents and teachers/teacher educators.

2

Findings and recommendations for different stakeholders

2.1 Policy makers

A. Medium of instruction

The project confirms previous studies showing an advantage for learners who are being educated in primary school years in a language known from home or from the immediate community. When it comes to English as a medium of instruction, our findings robustly show that **this is an obstacle to learning** for young children from a low socioeconomic background because they often have limited or no literacy support in the home in any language. English is not used as one of the home languages in any of the learners' households; therefore, oral familiarity with English was also non-existent in any of the schoolchildren in the project. It is therefore unsurprising that English literacy scores are overall lower than literacy scores in Hindi or Telugu. Importantly, the most evident difference between regional languages and English is the children's performance in reading comprehension: reading comprehension in English ranges from minimal to very poor, in contrast to reading comprehension in the regional languages, which is good.

B. English is an obstacle to teaching because teachers cannot adequately support and maintain English in the classroom.

The project ran classroom observations in all participating schools. These observations show that *language mixing* between English and Hindi, English and Telugu or English, Hindi and Telugu is a common feature of all classrooms observed in Delhi and Hyderabad. Therefore, there is a strong **discrepancy between the official, single medium of instruction and the inevitable reality of the multilingual classroom** in each of the English-medium, Hindi-medium or Telugu-medium schools. *In EMI schools, language mixing was significantly more frequent than in regional language schools.* Patna schools were all Hindi-medium and showed the least amount of language mixing between Hindi and English.

C. There are clear differences between schools in different cities.

There are significant differences between states and cities in the implementation of English as a medium of instruction. In Delhi, English language classes and

mathematics classes in EMI schools were mostly delivered through code-switching (language mixing) between Hindi and English, with **English never used as the sole medium of instruction.** Hyderabad classrooms in EMI schools show some use of English alone, both by the teachers and by the learners. *Education authorities need to carefully reconsider imposing EMI* in primary schools because literacy, numeracy and academic language skills can be best developed in a language that both teachers and learners are familiar with.

D. Teachers' familiarity with English needs to be secured before teachers are asked to teach in English.

Teachers' level of familiarity with English and confidence in teaching in English as the medium of instruction differ widely across states and individual teachers. Most teachers in Delhi schools were not themselves educated in EMI schools, while around half of the teachers in Hyderabad schools were themselves educated in EMI schools. Teacher allocation to EMI schools needs to *take into account* the teachers' qualifications in English.

E. Multilingual practices in teaching and learning are natural and need to be supported because teachers and learners are multilingual.

Language mixing in classrooms should be accepted, developed and adopted across early primary school years to ensure children can build on multiple language resources in order to develop good reading comprehension as an essential skill for learning across school subjects and for concept understanding. *It is essential to provide teachers with training on how to successfully integrate multilingual methods when preparing, organizing and structuring lessons so that languages are switched at particular points of lesson delivery and classroom activities. This can lead to better monitoring of the amount of language input in less familiar languages and improving comprehension levels.*

F. Poverty, lack of rich print exposure in the home and migration do not necessarily create disadvantages in learning IF schools support children effectively.

Children living in slum areas in Delhi either did not differ from or in some cases outperformed children living in non-slum areas. The slum/non-slum distinction did not seem to lead to significant differences in most data from the Hyderabad children. In Patna, there were no differences in Hindi literacy skills between children in non-remote rural areas and children in the town areas. Education authorities should invest further in disadvantaged children who lack parental support in literacy and numeracy. *Educating disadvantaged groups in a language they do not understand may lead to a proliferation of illiterate and innumerate citizens.*

G. Development from Std IV to Std V

Our findings show that, overall, girls and boys in slum and non-slum areas and regardless of medium of instruction improve in literacy, numeracy and cognitive tasks from Std IV to Std V. Development and learning are attested across children, although the starting point is low in many cases and the learning outcomes in Std V are not always at a

grade-appropriate level. This finding indicates that despite several disadvantages these children face at home and at school, they are capable of learning. *It is therefore essential that education policy invests in the potential of these children by supporting multilingual practices in lesson delivery, including in their home languages too, for improved concept understanding and text comprehension skills.*

H. State governments need to urgently acknowledge the shortcomings of blindly imposing English as medium of instruction on learners

who will as a consequence be deprived of developing sufficient levels of literacy, numeracy and academic language in preparation for secondary school education. MutliLiLa findings have important implications for curricular and pedagogic reforms and for teacher education curricula. Our assessments of school skills (literacy, reading comprehension) and language abilities (narratives and semantic fluency) in English revealed lower performance than the assessments in Hindi or Telugu, even when these regional languages were not the first language or one of the home languages for some of the children. As an example, we note that only 90 out of 1,520 children attending Std IV or Std V in EMI schools in Delhi and Hyderabad attempted to use English to retell a picture-based story after listening to that same story in English.

I. English should be taught and supported from Std I as a subject

and only in late primary/early secondary school should it become an option as a medium of instruction. Pupils need to develop basic literacy and numeracy skills, but crucially, above all, they need to learn how to learn. *When good learning skills are established in a language children know, they can transfer these skills to develop academic English in secondary school, after having already acquired a good level of proficiency in English in primary school.*

J. Teacher training is urgently required.

Teachers need training to develop the necessary skills to a) deliver lessons in a structured and interactive way using their already available multilingual methods and resources, and b) teach children strategies of improving listening and reading comprehension skills. Both sets of skills will improve levels of teaching and raise learning outcomes across subjects.

K. Multilingualism is good for the learners.

Children coming from households *where more than one language is spoken* show cognitive benefits in complex working memory and intelligence. This finding holds across schools and is true for both Delhi and Hyderabad children.

L. Sociolinguistic diversity is good for the learners.

Children *speaking one language* in the home but growing up in sociolinguistically diverse communities, homes and schools have better intelligence scores. Social diversity and linguistic diversity are beneficial for children who grow up in households where one language is mainly used.

2.2 Parents

A. School language (medium of instruction)

Children learn better and faster if they know the school language well, either when it is used in their home or when it is used in the community. Even if the language of the home is not the same as the regional language, children are more familiar with the regional language than with English. In our project, the children who were educated in EMI schools had many problems using or understanding the school language (English) compared to children who were educated in regional language schools. Having English as the language of instruction at primary school prevents children from learning how to read and understand in all school subjects. *Children need to learn to read and write, count and solve problems in a language they understand well.*

B. Only when good knowledge of English has developed should children attend EMI schools.

English should be taught from Std I and throughout primary school years as a language subject. English should *not* be used as the school language in primary school because many parents find it difficult to help children with their homework and learning and teachers do not speak good English themselves. English can be the school language in secondary school when children already have good knowledge of the language and good learning skills and can continue their studies without support outside the school.

C. The purpose of learning to read is to be able to learn from your reading.

It is therefore essential for children to understand what they are reading. Children in Delhi, Hyderabad and Patna were good at reading aloud words or sentences in Hindi or Telugu and in English, but they ***were not as good at understanding what they were reading***. This was most difficult for English and easier for Hindi for children in Patna and Delhi. Children need to learn *how to read for understanding and parents can help children by asking them about what children learned at school every day.*

D. In India, the most natural and effective way of learning in class involves being able to use more than one language.

We found that teachers mix languages because they want to help children learn English; teachers also feel more comfortable speaking Hindi or Telugu in the classroom. Mathematics and English language classes always include Hindi or Telugu mixed with English, even in EMI schools. It is unnatural and problematic for teachers and children to use only English in the classroom. This is why very often they use a limited amount of English mixed with the regional language. *Using home languages in the classroom helps children understand what the lesson is about and what they do not understand from the content of the lesson.*

2.3 Teachers and teacher educators

A. English as medium of instruction is an obstacle to learning for young children coming from a low socioeconomic background, with limited or no literacy support in the home in any language.

As English is not used as one of the home languages in any of the learners' households in the project, oral familiarity with English was also non-existent in any of the schoolchildren. Our findings show that *English literacy scores were lower than Hindi and Telugu literacy scores.*

B. Reading comprehension is essential for learning across school subjects.

The purpose of learning to read is to learn across subjects of the curriculum, and for that it is essential for children to understand what they are reading.

Children in Delhi, Hyderabad and Patna were good at reading aloud words or sentences in Hindi or Telugu and in English, but *were poor in understanding what they were reading*. This was most difficult for English texts, where comprehension was two percent in Patna (where English is taught as a subject only) and below 15 percent even for children in EMI schools in Delhi and Hyderabad. Reading comprehension in Hindi and Telugu was strikingly better. Hyderabad children performed better in English than Delhi children, which is consistent with another finding of our project showing that the use of English in Delhi classrooms is minimal compared to in Hyderabad. Reading comprehension was challenging for all children, and particularly for children whose home languages were different from the language used as a medium of instruction.

Teachers have to be trained to teach strategies of reading comprehension. Reading comprehension is a skill that needs to be taught. Even if learners are learning to read in their home language, reading comprehension needs to develop as a set of strategies. When developed sufficiently, learners will be able to transfer these strategies to reading in other languages and to reading for comprehension across school subjects.

C. School language – home language – learning to read

Hindi literacy scores in Patna and Delhi were found to be better than Telugu literacy scores in Hyderabad. This is partly because very few children in Delhi and Patna schools do not speak Hindi in the home, while quite a few children in Hyderabad schools do not speak Telugu in the home. *Teachers need to be aware of children speaking minority languages in the classroom and encourage them to use them for developing concept understanding in the regional language.*

D. Teachers' level of familiarity with English and confidence in teaching in English as a medium of instruction differ widely across Delhi, Hyderabad and Patna.

This finding also explains the overarching result from classroom observations

showing that language mixing was higher in EMI than in regional language schools and that Delhi teachers mixed languages more than Hyderabad teachers.

E. Multilingual practices in teaching and learning are natural and effective because teachers and learners are multilingual.

Our findings show that teachers mix languages during the teaching of mathematics or English language classes. Language mixing is higher in EMI schools compared to regional language schools and motivated by the teachers' wish to explain concepts better to learners. Many teachers do not feel confident using only English in lessons. *We recommend that language mixing in classrooms should be accepted, developed and adopted across early primary school years to ensure that multiple language resources support children to develop comprehension and critical skills during learning and concept understanding. However, teachers need to be trained to integrate multilingual methods of teaching by preparing, organizing and structuring teaching materials so that languages will be switched at particular points of lesson delivery and classroom activities.*

F. Multilingualism is good for the learners.

Children coming from households where more than one language is used show cognitive benefits in complex working memory and intelligence. This finding is across schools and is true for both Delhi and Hyderabad children. Therefore, children from minority language backgrounds who do not speak the regional language are equipped with good cognitive skills to catch up with their peers if *teachers give them time, support and special attention in the first few months of schooling.*

G. Numeracy and mathematical reasoning

Basic numeracy was better for subtraction than for division. Ability in division was very low across pupils in Stds IV and V. Solving word problems in mathematics was also challenging across children. However, word problems that included visual information that children needed to process (tables, figures, scales) were considerably more difficult than those based exclusively on language and numbers. This finding was across Patna, Hyderabad and Delhi schools and shows that children are not trained in visually presented mathematical reasoning tasks. *Teachers should focus on word problems and balance their presentation across visual and language-based cues.*

H. Poverty, lack of rich print exposure in the home and migration do not necessarily create disadvantages in learning IF teachers and schools support children effectively.

Children living in slum areas in Delhi either did not differ from or in some cases outperformed children living in non-slum areas. The slum/non-slum distinction did not seem to lead to significant differences in most data from the Hyderabad children. In Patna, there were no differences in Hindi literacy skills between children in non-remote rural areas and children in the town areas. These findings show that children from challenging home contexts with limited or no support from parents *can and will* benefit from good and dedicated teacher support and appropriate school

resources. Teaching these children requires a higher commitment from teachers because disadvantaged children's learning and development depend mostly, if not exclusively, on schooling. With this in mind, teachers should be aware that *educating disadvantaged groups in a language they do not understand will lead to a proliferation of illiterate and innumerate citizens.*

I. Teacher training

Two major findings from the project are relevant as recommendations for areas in which teachers would benefit considerably from training. The first has to do with the finding that teachers mix languages in class spontaneously and naturally and do so more when they are expected to teach in English (EMI schools). Although using more than one language is natural for multilingual teachers and learners, *multilingual lesson delivery requires organization, lesson planning and scaffolding so that language use will be associated with specific activities and teacher–learner or peer interaction.* The second finding has to do with pupils' low reading comprehension scores, which are related to limited critical thinking or questioning of textbook content for better understanding. Training teachers on how to focus on *strategies for reading comprehension* will improve learners' performance across subjects and encourage more teacher–pupil interaction. Teachers will then be better able to monitor learners' understanding and development.

In the following sections, the MultiLiLa findings are presented by location (Patna, Delhi, Hyderabad), gender, school site (town/non-remote rural, slum/non-slum), school year (Std IV and Std V) and age. We begin with a presentation of participant numbers in each of the three sites, their age, gender, languages and the area in which the school is located (school site) (Section 3). We then present the results for each site on reading (decoding) skills, reading and oral language comprehension (Section 4), numeracy and mathematical reasoning tasks (Section 5) and cognitive tasks (Section 6). Section 7 presents our findings from classroom observations with respect to languages used during mathematics and English language classes in Delhi and Hyderabad and EMI and regional language schools. Section 8 presents all the school and cognitive skills data by gender and school site across the two years of schooling: Std IV and Std V. Finally, Section 9 discusses some limitations and challenges identified in the project that could inform future research, interventions and teacher training needs.

3

The MultiLiLa participants: Schoolchildren in government schools in Patna, Delhi and Hyderabad

Given the vast scope of the MultiLiLa project in terms of breadth (the range of issues explored), depth (the search for basic school skills as well as problem-solving, critical-thinking and cognitive skills) and length (four years of research), we will begin by presenting the demographics of our participants. The reader will therefore be able to appreciate the balance across the geographical factors (urban, rural), socioeconomic (slum, non-slum), gender and age factors that were taken into account in the research. Information on the linguistic diversity in the participants' environment in each of the three project sites as well the participants' language skills will also be presented.

To ensure a randomized control trial design we tested all children in Std IV and Std V classrooms across the three sites in the schools that agreed to participate. This meant that the number of boys and girls who participated in our study was not always balanced.

3.1 Patna

Our participants from Patna were from schools in the town area and in non-remote rural areas of Patna in order to capture possible differences in school performance between the two groups. We expected the children from non-remote rural areas to be disadvantaged compared to the children from the town area and that this disadvantage may show up in the findings from school and cognitive skills. In Patna, we followed a cross-sectional design and tested children from Std IV and Std V in parallel. Our participants are presented in Table 1 and the languages they speak at home in Table 2:

Table 1. Distribution of Patna participants by age, year, site, gender and bilingualism in the home

n= 907	Age range	Mean age (SD)	Site		Gender		Bilingualism in the home[1]	
			Town	Non-remote rural	Boys	Girls	Monolingual	Bilingual
Std IV (n=423)	7–15	9.36(1.17)	265 (63%)	158 (37%)	169 (40%)	254 (60%)	296 (70%)	126 (30%)
Std V (n=484)	7–16	10.42(1.25)	364 (75%)	120 (25%)	200 (41%)	284 (59%)	290 (60%)	194 (40%)
Total	-	-	629 (69%)	278 (31%)	369 (41%)	538 (59%)	586 (65%)	320 (35%)

[1] Data unavailable for one participant

Although children in Std IV and Std V are expected to range between 8–9 and 9–10 years respectively, the age range in the classrooms was very large, showing overage children in both school years. Whether age differences among children in the same classroom have an effect on children's school skills is a question we will come back to when presenting the results. Older children are expected to have better cognitive skills. Whether differences in cognitive skills, if found, affect performance in school skills is a question we will come back to in the relevant sections.

Table 2. Language/s used in the home by children in Patna

Home languages	**Std IV** (n=423)	**Std V** (n=484)	**Total** (n=907)
Hindi	286	288	574 (63.29%)
Hindi, Maghi	36	86	122 (13.45%)
Hindi, Bhojpuri	39	44	83 (9.15%)
Hindi, Urdu	26	40	66 (7.28%)
Hindi, Bhojpuri, Maghi	10	10	20 (2.21%)
Maghi	9	0	9 (0.99%)
Hindi, Maithali	3	4	7 (0.77%)
Hindi, Urdu, Bhojpuri	3	4	7 (0.77%)
Hindi, Bengali	3	1	4 (0.44%)
Bhojpuri	1	2	3 (0.33%)
Hindi, Bhojpuri, Rajasthani	1	1	2 (0.22%)
Hindi, Urdu, Bhojpuri, Bengali	2	0	2 (0.22%)
Hindi, Bengali, Urdu	0	1	1 (0.11%)
Hindi, Bhojpuri, Punjabi, Bengali	0	1	1 (0.11%)
Hindi, Nepali	1	0	1 (0.11%)
Hindi, Dehati	1	0	1 (0.11%)
Hindi, Odiya	0	1	1 (0.11%)
Hindi, Punjabi	0	1	1 (0.11%)
Bhojpuri, Maghi	1	0	1 (0.11%)
No information available	1	0	1 (0.11%)

Almost all of the children in Patna speak Hindi in the home, although a variety of other languages are also used by almost 37 percent of the children. Maghi, Bhojpuri, Maithali and Urdu are not so distant languages from Hindi, whereas Odiya, Punjabi, Nepali and Dehati belong to different language families. All of the schools in Patna were Hindi-medium, which means that textbooks, assessments and teaching were carried out in a language that the majority of children were familiar with from home.

3.2 Delhi

In Delhi, we followed a longitudinal design, testing the same children twice as they progressed from Std IV to Std V. There was some attrition (46 students) from Std IV to Std V, which was due to children moving to other schools or migrating to other areas and a smaller percentage of dropouts. Our participants in Delhi attended either Hindi-medium or EMI schools (see Table 3), which meant that Hindi or English respectively would be the language of instruction, assessment and textbooks. Although assessment and textbook language was consistent with the official medium of instruction, the language of instruction was neither one only (Hindi or English) nor predominantly the official one. We will present these findings in Section 7 below.

Table 3. Distribution of children by school year, age, site, gender and medium of instruction in Delhi

Phases	Age range	Mean age (SD)	Site		Gender		Medium of instruction	
			Slum	Non-slum	Boys	Girls	English	Hindi
Std IV (n=387)	8–12	8.78(0.63)	189 (49%)	198 (51%)	194 (50%)	193 (50%)	308 (80%)	79 (20%)
Std V (n=341)	9–13	9.77(0.64)	178 (52%)	163 (48%)	171 (50%)	170 (50%)	275 (81%)	66 (19%)

Although the age range was smaller than that in Patna schools, schools in Delhi also had overage children. Children attending Hindi-medium schools were a minority of around 20 percent. This is mostly due to the fact that Delhi education authorities shifted government schools to EMI in 2014–15, leaving only a few schools (Municipal Corporation of Delhi (MCD) schools mostly) to maintain Hindi-medium of instruction.

In Table 4 we present how many of the children spoke more than one language in the home, how many had Hindi in the home and for how many the official medium of instruction was the same as the home language. Table 4 presents how many of the children attending EMI schools spoke English as one of the home languages and how many of the children attending Hindi-medium schools spoke Hindi as one of their home languages.

Table 4. Bilingualism in the home, medium of instruction (MoI) overlap with home languages and use of languages in the home by children in Delhi

School year	Bilingualism in the home		MoI overlap		Home language	
	Monolinguals	Bilinguals	No MoI overlap	MoI overlap	Hindi	Others
Std IV (n=387)	257(66%)	130(34%)	318 (82%)	69 (18%)	251(65%)	136(35%)
Std V (n=341)	223(65%)	118(35%)	283(83%)	58(17%)	217(64%)	124(36%)

As most schools in Delhi are English-medium, it is of no surprise that most of our participants from Delhi had zero overlap with the official medium of instruction. A good number of children (around 34 percent) spoke more than one language in the home (see Table 5).

Table 5. Languages used in the home by children in Delhi

Home languages	**Std IV** (n=387)	**Std V** (n=341)
Hindi	251(64.86%)	217(63.64%)
Hindi, Bhojpuri	42(10.85%)	38(11.14%)
Hindi, Bihari	14(3.62%)	13(3.81%)
Hindi, Haryanvi	13 (3.36%)	12(3.52%)
Hindi, other	13(3.36%)	13(3.81%)
Hindi, Rajasthani	12(3.10%)	12(3.52%)
Hindi, Garhwali	6(1.55%)	5(1.47%)
Hindi, Nepali	6(1.55%)	6(1.76%)
Hindi, Pahari	5(1.29%)	5(1.46%)
Hindi, Kumaoni	3(0.78%)	2(0.59%)
Hindi, Urdu	3(0.78%)	2(0.59%)
Hindi, Maithili	2(0.52%)	1(0.29%)
Punjabi	2(0.52%)	2(0.59%)
Hindi, Bengali, Bihari	2(0.52%)	1(0.29%)
Hindi, Jharkhandi, Nepali	1(0.26%)	1(0.29%)
Rajasthani	1(0.26%)	1(0.29%)
Hindi, Kathedi Hapur language	1(0.26%)	1(0.29%)
Hindi, Tamil	1(0.26%)	1(0.29%)
Hindi, Punjabi	1(0.26%)	1(0.29%)
Hindi, Jharkhandi	1(0.26%)	1(0.29%)
Maghi	1(0.26%)	1(0.29%)
Hindi, Chattisgarhi, Punjabi	1(0.26%)	-
Hindi, Bhojpuri, Bihari	1(0.26%)	1(0.29%)
Kannada	1(0.26%)	1(0.29%)
Hindi, Raigarh and Bundela	1(0.26%)	1(0.29%)
Hindi, Mewati	1(0.26%)	1(0.29%)
Other	1(0.26%)	1(0.29%)

Most of the children who speak other languages in the home (apart from Hindi) have languages related to Hindi (Bhojpuri, Bihari, Haryanvi, Urdu), while only a very small minority of children speak languages that are not related to Hindi.

3.3 Hyderabad

In Hyderabad, as in Delhi, we followed a longitudinal design and tracked the progress of the children as they moved from Std IV to Std V. There was considerably more attrition (142 students) than in Delhi from Std IV to Std V, which was due to children moving to other schools or migrating to other areas and a small number of dropouts. Our participants in Hyderabad attended either Telugu-medium or EMI schools, which meant that Telugu or English respectively would be the language of instruction, assessment and textbooks. Although assessment and textbook language was consistent with the official medium of instruction, the language of instruction was neither one only (Telugu or English) nor predominantly the official one. We will present these findings in Section 7 below.

It should be mentioned, however, that in Hyderabad parents have the option of choosing a government school with Telugu or English as the medium of instruction, as there has been no blanket imposition of EMI across schools. Table 6 presents the participants in each phase of the data collection, that is, for children in Std IV and Std V, with 319 children being the same in the two phases as they progressed from one school year to the next.

Table 6. Distribution of participants by phase, age, site, gender and medium of instruction in Hyderabad

School Year	Age range	Mean age (SD)	Site		Gender		Medium of instruction	
			Slum	Non-slum	Boys	Girls	English	Hindi
Std IV (n=461)	7–15	9.57(1.19)	243 (53%)	218 (47%)	206 (45%)	255 (55%)	175 (38%)	286 (62%)
Std V (n=319	9–16	10.53(1.18)	173 (54%)	146 (46%)	142 (55%)	177 (45%)	115 (36%)	204 (64%)

There were overage children in Hyderabad classrooms too, and the age ranges are similar to those found in Patna, and higher than in Delhi schools. As in Delhi and Patna, in Hyderabad too we selected all children from each class so that our sample would be sufficiently randomized (see Tables 7 and 8).

Table 7. Bilingualism in the home, medium of instruction (MoI) overlap and use of languages in the home in Hyderabad

School year	Bilingualism in the home		MoI overlap		Home language	
	Monolinguals	Bilinguals	No MoI overlap	MoI overlap	Hindi	Others
Std IV (n=461)	252(55%)	209(45%)	232(50%)	229(50%)	286(62%)	175(38%)
Std V (n=319)	178(56%)	141(44%)	154(48%)	165(52%)	202(63%)	117(37%)

Table 8. Languages used in the home by children in Hyderabad

Home languages	**Std IV** (n=460)	**Std V** (n=318)
Telugu	286(62.04%)	202(63.32%)
Telugu, Hindi	40(8.68%)	29(9.09%)
Hindi	29(6.29%)	19(5.96%)
Telugu, Lambadi	21(4.56%)	10(3.13%)
Telugu, Kannada	15(3.25%)	13(4.08%)
Lambadi	14(3.04%)	9(2.82%)
Urdu, Hindi	9(1.95%)	2(0.63%)
Marathi, Hindi	8(1.74%)	6(1.88%)
Pahari	5(1.08)	5(1.57)
Nepali, Hindi	4(0.87%)	4(1.25%)
Telugu, Marathi	3(0.65%)	3(0.94%)
Telugu, Urdu	3(0.65%)	1(0.31%)
Telugu, Marathi, Hindi	2(0.65%)	2(0.63%)
Marathi	1(0.22%)	-
Telugu, Rajputi, Gujarathi, Hindi	1(0.22%)	1(0.31%)
Telugu, Urdu, Hindi	2(0.43%)	-
Telugu, Hindi, Kannada	2(0.43%)	2(0.63%)
Telugu, Lambadi, Hindi	2(0.43%)	2(0.63%)
Bihari, Bhojpuri, Hindi	1(0.22%)	1(0.31%)
Telugu, other	1(0.22%)	1(0.31%)
Telugu, Kannada, Lambadi	1(0.22%)	1(0.31%)
Bihari	1(0.22%)	-
Tamil	1(0.22%)	1(0.31%)
Other	1(0.22%)	-
Lambadi, Hindi	1(0.22%)	1(0.31%)
Kannada	1(0.22%)	1(0.31%)
Telugu, Voddera	1(0.22%)	-
Telugu, Bihari	1(0.22%)	1(0.31%)
Telugu, Pahari, Hindi	1(0.22%)	1(0.31%)
Kannada, Hindi	1(0.22%)	-
Telugu, Lambadi, Bhojpuri, Marathi, Hindi	1(0.22%)	-

A large number of our participants speak Hindi or Lambadi (both Indo-Aryan languages) in the home, both being languages that are typologically different from Telugu, a Dravidian language.

4

What does our research show about how children in government schools in Patna, Delhi and Hyderabad learn to read and understand written and oral language?

Teaching children how to read for comprehension forms the basis of learning in school and everyday life. Reading comprehension is a complex cognitive process that builds on a child's listening skills and their ability to recognize written words. In multilingual children, reading comprehension can usually transfer from one language to the other subject to the distance between languages and writing systems. Another key prerequisite for reading comprehension is language proficiency, i.e. having a good level of ability in the language children are expected to read and learn from. In MultiLiLa, we tested children's ability to recognize letters and words and to read sentences and stories in their school language and in English (if English was not the official medium of instruction). We included English because English is taught as a subject in all schools, even those that are Hindi-medium or Telugu-medium, in the three sites we collected data from (Patna, Delhi and Hyderabad). To assess their reading skills we used the ASER reading tool in Telugu, Hindi and English, which is available online and has been used with hundreds of thousands of children in India and other countries (http://www.asercentre.org/p/141.html). It is important to emphasize that the ASER tool is meant to assess Std II reading skills, whereas the children in our study were attending Stds IV and V. Because the ASER tool assesses only reading skills ('decoding'), not reading comprehension, we added two comprehension questions to the story included in the ASER tool per language.

We also assessed children's oral (listening) comprehension skills by asking children to listen to a story from the Multilingual Assessment Instrument for Narratives (Gagarina et al., 2012, 2019), retell the story and respond to a number of comprehension questions. The questions were about the main components of the story (the 'goals' of the story characters in the episodes of the story) as well as some questions about the emotions of the story characters in different parts of the story. All questions were therefore asking the child to consider the story as it unfolded and

respond to 'why' and 'how' questions. The total number of questions was nine, with an additional question about the setting of the story. Evaluating narrative comprehension allows us to assess, in a child-friendly way, the oral language abilities of the children in the regional language (Hindi or Telugu), including their critical-thinking skills which help the child evaluate the cause of events in the story and the characters' reactions to them.

We present our findings per project site, beginning with Patna, followed by Delhi and Hyderabad.

4.1 Patna – Reading and oral/written language comprehension

Table 9 presents our findings from English literacy (letters, words, sentences and story reading), English reading comprehension, Hindi literacy (letters, words, sentences and story reading) and Hindi reading comprehension of the Patna children in Std IV and Std V.

Table 9. Reading and reading comprehension in Hindi and English and narrative comprehension in Hindi by Patna children in Std IV and Std V

Tasks	**Std IV** (n=423)				**Std V** (n=484)			
	min	max	mean	SD	min	max	mean	SD
English literacy (raw score)	0	32	17.62	10.19	0	32	20.7	89.83
English literacy (% correct)	0	100	**55.08**	31.8	50	100	**64.95**	30.71
English reading comprehension (raw score)	0	2	0.03	0.23	0	2	0.09	0.37
English reading comprehension (% correct)	0	100	**1.77**	11.53	0	100	**4.85**	18.54
Hindi literacy (raw score)	0	33	26.46	10.51	0	33	28.51	8.38
Hindi literacy (% correct)	0	100	**80.18**	31.86	0	100	**86.40**	25.39
Hindi reading comprehension (raw score)	0	2	1.32	0.88	0	2	1.52	0.79
Hindi reading comprehension (% correct)	0	100	**66.07**	44.09	0	100	**76.34**	39.96
Narrative comprehension (raw score – Hindi)	0	9	7.90	1.2	2	9	8.13	1.12
Narrative comprehension (% correct – Hindi)	0	100	**87.81**	14.01	22.22	100	**90.34**	12.49

Children in Patna can read relatively well in Hindi (80 percent and 86 percent in the two school years) but not as well in English (55 percent and 65 percent in the two school years). Although English is only taught as a subject, Patna children seem to have good decoding skills in the language. However, when we turn to reading comprehension, there is a striking contrast between Hindi and English. Children in Std IV achieve 66 percent

in Hindi reading comprehension and less than two percent in English. Children in Std V improve by ten percent in Hindi and less than three percent in English. These findings show that teaching English focuses only on decoding (being able to read aloud) rather than comprehension of what is read. The lack of oral language skills in English contributes to these very problematic results in reading comprehension. There is improvement in Hindi reading comprehension, but it is not as good as the improvement in reading skills, presumably because teaching of reading skills does not include reading comprehension strategies in Hindi either. Therefore, the most likely reason why children perform better in Hindi compared to English is because of their good familiarity with Hindi from its use in the home and in the community. Even children who also speak other languages in the home have good knowledge of Hindi, as shown in Table 2 above. Finally, comparing reading with listening comprehension, it is clear that children's ability to understand oral language (narrative comprehension) is better than their reading comprehension skills.

4.2 Delhi – Reading and oral/written language comprehension

Table 10 presents our findings from English literacy (letters, words, sentences and story reading), English reading comprehension, Hindi literacy (letters, words, sentences and story reading) and Hindi reading comprehension of the Delhi children in Std IV and Std V. Recall that 341 children are the same in Std IV and Std V, so the findings show development in largely the same group of learners.

Table 10. Reading and reading comprehension in Hindi and English and narrative comprehension in Hindi by Delhi children in Std IV and Std V

Tasks	**Phase I/Std IV** (n=387)				**Phase II/Std V** (n=341)			
	min	max	mean	SD	min	max	mean	SD
English literacy (raw score)	0	32	18.06	8.61	0	32	20.73	8.75
English literacy (% correct)	0	100	**56.44**	26.91	0	100	**64.78**	27.34
English reading comprehension (raw score)	0	2	0.25	0.50	0	2.00	0.44	0.65
English reading comprehension (% correct)	0	100	**12.66**	24.83	0	100	**22.14**	32.55
Hindi literacy (raw score)	0	33	25.03	9.55	0	33	28.60	7.41
Hindi literacy (% correct)	0	100	**75.85**	28.93	0	100	**86.65**	22.46
Hindi reading comprehension (raw score)	0	2	1.38	0.85	0	2	1.67	0.69
Hindi reading comprehension (% correct)	0	100	**68.86**	42.50	0	100	**83.28**	34.50
Narrative comprehension (raw score)	0	8	6.18	1.25	3	10	8.65	1.18
Narrative comprehension[1] (% correct)	0	88.88	**68.75**	13.92	30	100	**86.53**	11.88

[1] Narrative comprehension was assessed in 320 children in each school year

The findings from Delhi show similar performance to the Patna children in English reading skills (decoding) and a similar level of improvement from Std IV to Std V. Delhi children are also similar to Patna children in Hindi literacy (decoding). When we turn to reading comprehension in Hindi, Delhi children show improvement of around 15 percent, reaching 83 percent in Std V. These results seem to be better than Patna children's literacy in Hindi at Std V. English reading comprehension is at 13 percent in Std IV and 22 percent in Std V, which is a very low score for children who, in their majority, are educated in officially EMI schools. The fact that Delhi children score higher in English reading comprehension than Patna children is expected, as most of the Delhi children are supposed to be taught content across subjects in English. Clearly, there's something going seriously wrong with English teaching both as a subject and, more alarmingly, as a medium of instruction in Delhi schools.

Finally, reading and listening comprehension in Hindi are similarly good in Delhi children, and both abilities seem to improve to the same level from Std IV to Std V.

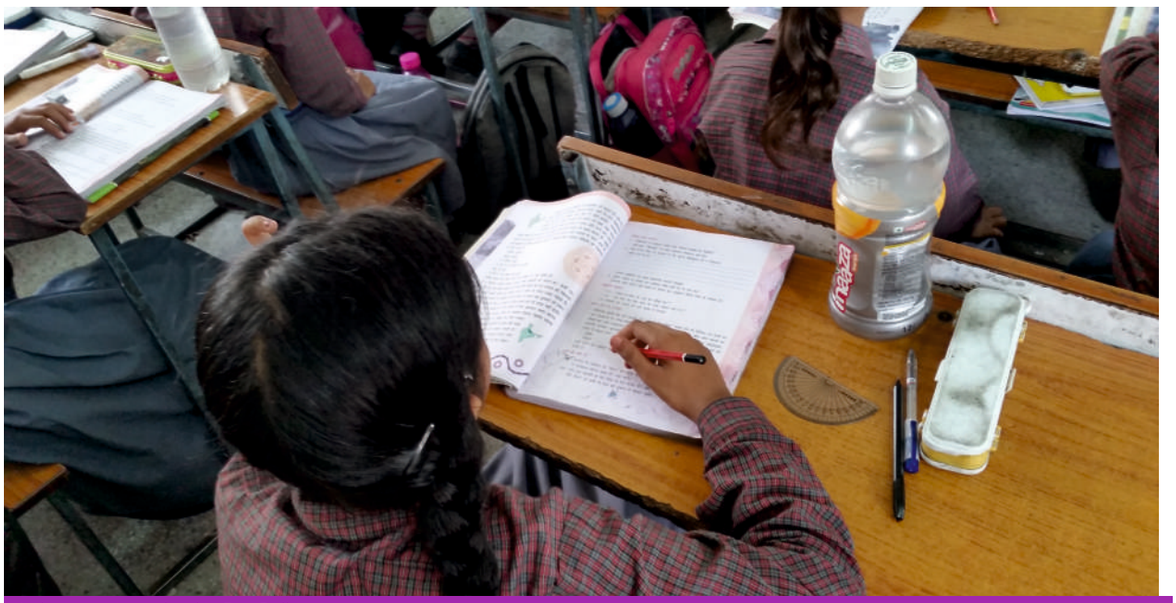
4.3 Hyderabad – Reading and oral/written language comprehension

Table 11 presents our findings from English literacy (letters, words, sentences and story reading), English reading comprehension, Telugu literacy (letters, words, sentences and story reading) and Telugu reading comprehension of the Hyderabad children in Std IV and Std V. Recall that 319 children are the same in Std IV and Std V, so the findings show development in largely the same group of learners.

Table 11. Reading and reading comprehension in Telugu and English and narrative comprehension in Telugu by Hyderabad children in Std IV and Std V

Tasks	**Phase I** (n=461)				**Phase II** (n=319)			
	min	max	mean	SD	min	max	mean	SD
English literacy (raw score)	0	32	19.39	8.68	0	32	22.16	8.87
English literacy (% correct)	0	100	**60.60**	27.14	0	100	**69.25**	27.73
English reading comprehension (raw score)	0	2	0.35	0.72	0	2	0.37	0.71
English reading comprehension (% correct)	0	100	**17.46**	36.17	0	100	**18.96**	35.80
Telugu literacy (raw score)	0	32	22.14	10.74	0	32	22.8	9.54
Telugu literacy (% correct)	0	100	**69.19**	33.59	0	100	**71.27**	29.84
Narrative comprehension (raw score)	0	10	9.62	1.01	1	10	9.61	0.96
Narrative comprehension[1] (% correct)	0	100	96.23	10.12	10	100	96.10	9.66

[1] Narrative comprehension was assessed in 300 children in each year



A classroom in a school in East Delhi

Children from Hyderabad government schools perform well in English literacy and show some level of improvement (nine percent) from Std IV to Std V. Their reading comprehension is low compared to their English decoding skills and does not improve as much as the Delhi children's comprehension in English story reading. Surprisingly, Telugu literacy is lower than English literacy in terms of decoding skills. As we will show in Section 7 of the report, where we present the findings from language use in the classroom, we will see that English in Hyderabad is used considerably more than it is in Delhi EMI or regional language schools. Nevertheless, reading comprehension in English is slightly poorer in Hyderabad compared to Delhi. Note that there are no results from reading comprehension in Telugu, as most of the children were unable to respond to the comprehension questions from the beginning of the data collection and thus no data could be gathered from this part of the literacy task. The lower reading comprehension scores in English and the paucity of Telugu reading comprehension data indicate that children in Hyderabad government schools may not be taught reading comprehension strategies either in the regional language or in English. An additional factor is that Telugu, unlike Hindi, is a language that is not spoken in the home by many children in Hyderabad (see Table 8 above). On the other hand, Hindi is spoken by the vast majority of children in Delhi, as shown in Table 5 above. Turning to narrative comprehension in Telugu, it appears that children in Hyderabad perform at ceiling in this task from Std IV already. It is therefore clear that the reading comprehension skills that are poor in these children stem from the lack of reading strategies for comprehension, which usually need to be taught as part of the school curriculum. Following a story, however, and drawing inferences that have to do with story characters' goals, intentions and emotions seems well developed, indicating that verbal reasoning in the oral modality is developed. Notice that the written story and the oral narrative are of a similar text type, namely that of imaginary narrative, so it cannot be argued that content differences are responsible for the strikingly better performance in oral narratives compared to written text comprehension.

5

What does our research show about how children in government schools in Patna, Delhi and Hyderabad learn to count and reason in mathematics?

We used a variety of tasks to assess children's numerical understanding and their problem-solving skills. As with basic literacy assessment, to measure their *numerical skills* we used the ASER numeracy tool which has been widely used in the Indian context with hundreds of thousands of children. The test includes a number recognition task. Learners were directed to read aloud the numbers correctly in the language they were comfortable with, typically the school language. In addition, we selected from the ASER tool four subtraction problems (two digits) and two division problems (three digits by one digit). Because all subtraction and division problems aim to assess the child's understanding of place value and borrowing, the number of subtraction problems was reduced to four and division problems to two. These tasks were at the complexity level of Std II (Pratham, 2017) and suitable for measuring mathematical ability among Indian learners from disadvantaged backgrounds. A complicating factor in the administration of this task was that there are differences in the mathematics curriculum across states (e.g. in relation to the use of fractions and division), which need to be taken into account when evaluating the findings.

We were also interested to find out about the children's *mathematical reasoning skills*, and therefore we also used mathematical word problems. Verschaffel, Greer and de Corte (2000: p. ix) define word problems as 'verbal descriptions of problem situations wherein one or more questions are raised the answer to which can be obtained by the application of mathematical operations to numerical data available in the problem statement'. Word problems in the MultiLiLa test were adapted from the 2011 version of the Trends in International Mathematics and Science Study (TIMSS) for Grade 4, administered in 63 different countries worldwide. Children in India were unlikely to have seen these, as India does not take part in tests aimed at establishing global educational rankings. Some cultural adaptations were made to facilitate comprehension (e.g. children can be asked to

buy kerosene for the household but are not normally helping to paint a house, so the original formulation was changed to correspond to children's experiences in India). One of the word problems could not be included in the final version because the weighing scale in the problem did not look like traditional weighing machines used in India (*Tarazoo*, a weighing balance with a fulcrum and weight estimated in iron bars as scales). English names were changed to Indian names and included both Muslims and Hindus, girls and boys.

A third task was included to measure children's *meta-mathematical ability*, that is, their skills in critically analysing mathematical problems solved incorrectly by another student. The children were required to identify and explain errors made in computing addition, subtraction and multiplication, which, as well as following an algorithm to arrive at the solution, requires children to reflect on mathematical logic involved in solving mathematical problems. The task was developed by Minati Panda and had been used previously in a longitudinal study conducted in Odisha and Andhra Pradesh (Panda & Mohanty, 2011; Panda et al., 2011). As during the pilot-testing phase the children were found to struggle with verbalizing why the mistake had occurred, we presented them with a multiple-choice type answer with four options, three of which reflected three degrees of meta-mathematic ability and the fourth being a 'don't know' option.

All the numeracy and mathematical reasoning tasks were administered on a one-to-one basis and outside class time. ASER arithmetic tasks were already available in Hindi, Telugu and English. All the mathematical reasoning tasks (word problems and meta-maths) were translated into Hindi and Telugu. The version which matched the learners' medium of instruction was used. However, if children were unable to understand – a situation which was typically found with children in EMI schools but also with the written form of Hindi or Telugu – the items were read out aloud and presented in colloquial Hindi or Telugu to achieve understanding of the instructions and the problems.

As with the literacy data, we present our findings per project site, beginning with Patna, followed by Delhi and Hyderabad.

5.1 Patna: Numeracy and mathematical reasoning

Beginning with the Patna data in the two school years, we observe from Table 12 that number recognition is unproblematic for all children across the two school years. Subtraction is much better performed than division, even by children in Std V, but development of around 20 percent is attested in both of these mathematical operations, indicating some consolidation of division and subtraction from Std IV to Std V.

Table 12. Numeracy, word problems and meta-mathematical ability in Patna children in Std IV and Std V

Tasks	**Phase I** (n=461)				**Phase II** (n=319)			
	min	max	mean	SD	min	max	mean	SD
Number recognition single digit (raw score)	0	8	7.94	0.58	0	8	7.93	0.73
Number recognition double digit (raw score)	0	10	8.45	3.16	0	10	9.17	2.34
Number recognition (total raw score)	0	18	16.39	3.37	0	18	17.10	2.69
Number recognition (% correct)	0	100	**91.04**	18.73	0	100	**95.02**	14.97
Subtraction (raw score)	0	4	2.28	1.77	0	4	2.98	1.53
Subtraction (% correct)	0	100	**56.97**	44.23	0	100	**74.38**	38.30
Division (raw score)	0	2	0.52	0.80	0	2	0.91	0.90
Division (% correct)	0	100	**26.24**	40.10	0	100	**45.35**	44.98
Math word problems (raw score)	0	6	2.48	1.53	0	6	2.75	1.50
Math word problems (% correct)	0	100	**41.33**	25.50	0	100	**45.83**	24.93
Meta-maths (raw score)	0	5	0.75	1.32	0	5	0.93	1.42
Meta-maths (% correct)	0	100	**15.04**	26.43	0	100	**18.55**	28.47

Turning to mathematical reasoning skills, children perform rather poorly on word problems, although we need to emphasize that these word problems are meant for Grade 4 children internationally and therefore they are more demanding than the ASER basic numeracy tool which is meant to target Std II levels of numeracy in India. Taking this into account, children seem to perform rather well in word problems, although improvement is not very evident in Std V in this cross-sectional data. The poorest performance is found in meta-mathematical reasoning, which shows some improvement in Std V but the level is very low, indicating that children may not be presented with such critical evaluation problems in class.

5.2 Delhi: Numeracy and mathematical reasoning

Table 13 presents our findings from number recognition (single and double digits), subtraction and division from the ASER tool in children from Std IV and Std V. The table also includes the scores for word problems and meta-mathematical skills from these children. Recall that 341 children are the same in Std IV and Std V, so the findings show development in largely the same group of learners.

Table 13. Numeracy, word problems and meta-mathematical ability in Delhi children in Std IV and Std V

Tasks	**Phase I** (n=387)				**Phase II** (n=341)			
	min	max	mean	SD	min	max	mean	SD
Number recognition single digit (raw score)	4	8	7.98	0.22	7	10	8.00	0.12
Number recognition double digit (raw score)	0	10	9.14	2.45	0	10	9.55	1.78
Number recognition (total raw score)	4	18	17.12	2.52	8	20	17.55	1.80
Number recognition (% correct)	22.22	100	**95.10**	13.99	44.44	100	**97.52**	9.98
Subtraction (raw score)	0	41.88	1.78	0	4	2.52	1.67	
Subtraction (% correct)	0	100	**47.09**	44.40	0	100	**62.90**	41.77
Division (raw score)	0	2	0.45	0.75	0	2	0.90	0.90
Division (% correct)	0	100	**22.35**	37.55	0	100	**44.87**	45.16
Math word problems (raw score)	0	5	1.44	1.13	0	6	2.29	1.56
Math word problems (% correct)	0	100	**28.84**	22.61	0	100	**38.17**	25.92
Meta-maths (raw score)	0	5	2.18	1.79	0	5	3.32	1.96
Meta-maths (% correct)	0	100	**43.51**	35.70	0	100	**66.45**	39.24

Turning to mathematical reasoning skills, children perform rather poorly on word problems, although we need to emphasize that these word problems are meant for Grade 4 children internationally and therefore they are more demanding than the ASER basic numeracy tool which is meant to target Std II levels of numeracy in India. Taking this into account, children seem to perform rather well in word problems, although improvement is not very evident in Std V in this cross-sectional data. The poorest performance is found in meta-mathematical reasoning, which shows some improvement in Std V but the level is very low, indicating that children may not be presented with such critical evaluation problems in class.

5.3 Hyderabad: Numeracy and mathematical reasoning

Table 14 presents our findings from number recognition (single and double digits), subtraction and division from the ASER tool in children from Std IV and Std V. The table also includes the scores for word problems and meta-mathematical skills from these children. Recall that 319 children are the same in Std IV and Std V, so the findings show development in an overlapping group of learners.

Table 14. Numeracy, word problems and meta-mathematical ability in Hyderabad children in Std IV and Std V

Tasks	**Phase I** (n=461)				**Phase II** (n=319)			
	min	max	mean	SD	min	max	mean	SD
Number recognition single digit (raw score)	0	8	7.49	1.86	2	8	7.98	0.34
Number recognition double digit (raw score)	0	10	9.01	2.84	0	10	9.80	1.21
Number recognition (total raw score)	0	18	16.50	4.54	7	18	17.72	1.39
Number recognition (% correct)	0	100	**91.67**	25.23	38.89	100	**98.47**	7.73
Subtraction (raw score)	0	8	2.37	1.94	0	4	2.39	1.74
Subtraction (% correct)	0	100	**54.72**	42.84	0	100	**59.72**	43.39
Division (raw score)	0	4	0.28	0.69	0	2	0.50	0.82
Division (% correct)	0	100	**12.69**	30.69	0	100	**25.39**	41.18
Math word problems (raw score)	0	6	2.17	1.19	0	6	2.43	1.45
Math word problems (% correct)	0	100	**36.15**	19.76	0	100	**40.49**	24.12
Meta-maths (raw score)	0	5	1.98	2.02	0	5	2.36	2.08
Meta-maths (% correct)	0	100	**39.56**	40.32	0	100	**47.27**	41.66

As with the Patna and Delhi data, number recognition is unproblematic for the Hyderabad group of children. Subtraction is considerably better than division results, while division seems to be lower than the Delhi scores. This is probably due to the fact that division is taught from Std V in Hyderabad in contrast to Delhi and Patna where it is part of the mathematics curriculum earlier. Performance in word problems is lower than performance in meta-maths, which is similar to the pattern found in Delhi and different from the Patna findings. However, the data from Hyderabad shows lower performance in the meta-maths scores and a smaller improvement in subtraction or word problems than those found in Delhi, where the data is also longitudinal. It is possible that some of the 142 children who were not tested in the second round because they were no longer in the same schools may have been higher achieving.

6

What does our research show about the cognitive skills of children in government schools in Patna, Delhi and Hyderabad?

Cognitive abilities, such as memory and attention skills, are known to underpin learning outcomes in monolingual and multilingual learners. They serve as predictors of academic success and may be related to multilingualism in a number of ways. For instance, proficiency in two languages and frequency of use have been shown to correlate with measures of cognitive control (Costa et al., 2009). Although most of the relevant studies focus on adult bilinguals, Tsimpli et al. (2020) show positive effects of bilingualism in the children from the MultiLiLa project on non-verbal intelligence and complex working memory. In this report, we present three cognitive tasks, namely those that measured general intelligence, complex working memory/updating and verbal ability with executive control: (i) Raven's Coloured Progressive Matrices (CPM) (Raven, Raven & Court, 1998), (ii) an N-back task, (iii) a semantic fluency task.

Raven's is a non-verbal task that asks the child to complete a pattern by choosing from different options. An example is presented in Figure 3.

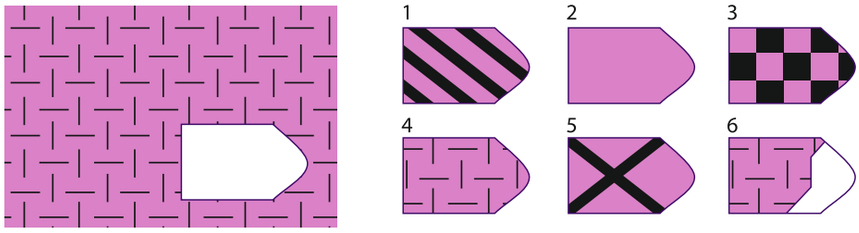


Figure 3: Example of Raven's task

The N-back task (Kirchner, 1958) is a working memory task that involves a number of executive processes, namely working memory updating, monitoring of ongoing performance and inhibition of irrelevant items (Morris & Jones, 1990; Miyake et al., 2000). Previous studies have proposed a link between working memory and verbal reasoning as well as arithmetic skills (but not general mathematical ability) (Gathercole, Lamont & Alloway, 2006). The child is presented with digits, one by one, on the computer screen and needs to press a pre-specified key on the keyboard when the number presented is the same as the one shown two digits back. An example can be found in Figure 4.

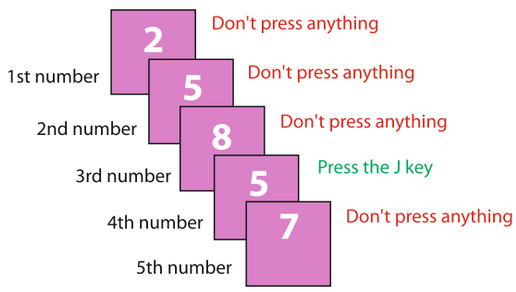


Figure 4: Example of N-back task

Finally, the semantic fluency task asked children to name as many entities as they could belonging to a specific semantic category, namely living (animals or vegetables) and non-living (school objects or household objects) within one minute. The home language and the school language were tested on different days to avoid interference. This task aims to test verbal ability and cognitive control at the same time.

Children carried out the tasks on a one-to-one basis with a research assistant. Instructions for all the three cognitive measures were initially presented on a computer screen in English; however, during the piloting phase of the tests in Delhi in July 2017 it became apparent that children were having difficulties comprehending instructions as displayed on the screen. To facilitate the children's comprehension, the research assistants gave oral instructions to the children in Hindi or Telugu. For the main data collection phase, all instructions on the computer screen were presented either in Hindi or Telugu and the oral instructions were also prepared in these languages. All research assistants used the same set of instructions to maintain reliability in task instructions. Children approached all the computerized tasks with great enthusiasm because they associated laptops with games and assumed that they would play games on the laptop.

Below, we present our findings per project site, beginning with Patna, followed by Delhi and Hyderabad.

6.1 Patna

As shown by the mean scores in Table 15, non-verbal intelligence scores improve in Std V, while working memory only shows a slight difference. The same is true for semantic fluency tasks. It is worth noting that semantic fluency in the home language usually involved the regional language (Hindi), although this was the school language too for the Patna children. The categories on which children were tested, though, were different for school and home language, although both included one category of living and one of non-living things. As all of the children reported having Hindi in the home as the first and only or as a second or third language, it is not surprising that performance in the school language is overall better than scores in the home language. This implies that although Hindi was both the school and the home language, the difference in performance may indicate an effect of the semantic categories responded to for each (animals for the home language and vegetables for the school language for living things vs. household items for home language and school objects for school language).

Table 15. Raven's, working memory, N-back and semantic fluency results from children in Patna

Tasks	**Phase I** (n=423)				**Phase II** (n=484)			
	min	max	mean	SD	min	max	mean	SD
Raven's progressive matrices (raw score)	5	32	15.45	5.28	4	34	17.75	6.05
Raven's progressive matrices (% correct)	13.89	88.89	**42.93**	14.65	11.11	94.44	**49.29**	16.82
N-back (A prime)[1]	0.10	0.90	**0.65**	0.14	0.07	0.93	**0.66**	0.16
Semantic fluency (school language)	0	33	**16.38**	4.6	00	30	**17.00**	4.45
Semantic fluency (home language)	0	32	**14.32**	4.69	0	36	**14.72**	4.81

[1] A total of 900 children did the N-back task. Thirteen children with a negative A prime score were excluded because a negative score may be an indication that they have not understood the task. The results reported are from 415 children in Year 4 and 472 children from Year 5.

6.2 Delhi

Children in Delhi seem to improve considerably on the Raven's between Stds IV and V; development between the two school years is also shown in their working memory scores. Interestingly, semantic fluency in the school language and in the home language develops as well, but school language starts from a lower mean score, making improvement more evident in Std V. Recall that most of the government schools in Delhi were officially English-medium, meaning that semantic fluency scores in the school language for the majority of children was tested in English. It is therefore not surprising that fluency in the school language lags behind fluency in the home language, even in Std V. These results indirectly point to the contribution of language proficiency in this verbal, cognitive task.

Table 16. Raven's, working memory, N-back and semantic fluency results from children in Delhi

Tasks	**Phase I** (n=387)				**Phase II** (n=341)			
	min	max	mean	SD	min	max	mean	SD
Raven's progressive matrices (raw score)	735	19.93	5.64	10.00	35	22.18	5.39	
Raven's progressive matrices (% correct)	19.44	97.22	55.35	15.67	27.78	97	61.62	14.96
N-back (A prime)[1]	0.10	0.91	0.68	0.14	0.24	0.91	0.71	0.12
Semantic fluency (school language)	0	32	12.25	6.29	1	31	15.05	5.15
Semantic fluency (home language)	0	33	15.10	5.56	6	31	16.09	4.58

[1] On the N-back task, we had to exclude a few children because they had a negative A prime score, which may be an indication that they have not understood the task. The results reported are from 384 children from Phase I and 339 children from Phase II.

6.3 Hyderabad

Children's development in non-verbal intelligence (Raven's) is strong from Std IV to Std V, whereas the improvement in the working memory task is small. Semantic fluency in the school language is higher than in the home language in both school years, although the differences are small.

Table 17. Raven's, working memory, N-back, and semantic fluency results from children in Hyderabad

Tasks	**Phase I** (n=461)				**Phase II** (n=319)			
	min	max	mean	SD	min	max	mean	SD
Raven's progressive matrices (raw score)	2	35	16.50	5.68	1	36	20.45	6.76
Raven's progressive matrices (% correct)	5.56	97.22	45.83	15.78	2.78	100	56.81	18.79
N-back (A prime)[1]	0.07	0.91	0.66	0.16	0.07	0.95	0.68	0.15
Semantic fluency (school language)	4	27	14.74	4.38	5	32	16.26	4.69
Semantic fluency (home language)	4	32	13.42	4.40	0	32	15.25	4.96

[1] Data on the N-back is available only for 449 children in Phase I and 319 children in Phase II, of which five children had a negative A prime score in Phase I and six children in Phase II. The children with a negative A prime score were excluded from the analyses because a negative score may be an indication that they have not understood the task.

7

What does our research show about language use in the classrooms of English-medium, Telugu-medium and Hindi-medium schools in Delhi and Hyderabad government schools?

Although the new National Education Policy (NEP) released for public comment in May 2019 acknowledges the benefit of mother-tongue-based instruction and promotes the use of multiple languages in the classroom, this is at odds with current practices at the state level, where decision making around education is largely made. Andhra Pradesh, Telangana, Karnataka, Punjab and West Bengal have all recently committed to increasing EMI instruction in their government schools (Rao, 2019; The Telegraph, 2019; D'Souza, 2019; Aman, 2018; Hindustan Times, 2018). In addition, the dichotomous imposition of a monolingual medium of instruction (MoI) policy in primary schools, where education practices are either in English or a regional language, such as Hindi (in Delhi) or Telugu (in Hyderabad), is strongly questioned by the MultiLiLa findings presented in this report, as shown by the literacy findings above.

A major question that the MutliLiLa project addresses is whether the official naming of a government (or any other) school as EMI or any other single language medium maps onto the linguistic reality of the classroom: is the official medium of instruction the only language used in the classroom? Do learners and teachers use the same linguistic resources when interacting in the classroom and to what extent is there a meaningful interaction in one or the other language during oral or written activities?

A few studies have sought to systematically record language use in the classroom, and the MultiLiLa project has explored this question. We included classroom observations of mathematics and English language lessons in the schools these children attend. The observations explore what languages are being used by the teacher and the learners, at

what stages during the lesson and accompanying what types of activities. In the following graphs, we report the frequency of language use in the different contexts observed. Specifically, we aimed to look at whether or not teachers and learners use more or less language mixing and how this related to the official medium of instruction of the school. Given that we were only able to recruit EMI and regional language medium schools from Delhi and Hyderabad, as Patna's schools were all Hindi-medium, we only report the findings on language use in the classroom from the two urban sites. In both Delhi and Hyderabad, the language classes observed were targeting learning of English as a subject – this was true for all schools, regardless of their official medium of instruction.

Our findings report the recordings of the language (or languages in combination) used during every five-minute interval of each 30-minute part of lesson (Lightfoot et al., in press). Each of the languages used was named and indicated on the observation tool within each five-minute period. We recorded whether the language was used for a single word, a complete turn, alone or in combination with others. This meant that in some five-minute intervals, only one language would be recorded – if the teacher used that language alone with no words spoken or written on the board in any other language – while in others two or more would be recorded as s/he mixed languages while instructing the students or modelling target language. The occurrence of these languages was coded according to whether they were using English, the regional language or language mixing. In Delhi, language mixing involved the use of English and Hindi or Hindi and Urdu, while language mixing in Hyderabad schools involved the concurrent use of English and Telugu, Hindi and Telugu as well as English, Hindi and Telugu.

The occurrence of each language use or language mixing was added for all time intervals, which gives us the total occurrence of a particular language over a 30-minute lesson. We also computed the percentage of such occurrences in the 30-minute lessons according to the total number of language-use recordings across the lessons. This procedure was followed to analyse both English and mathematics classes across the two sites.

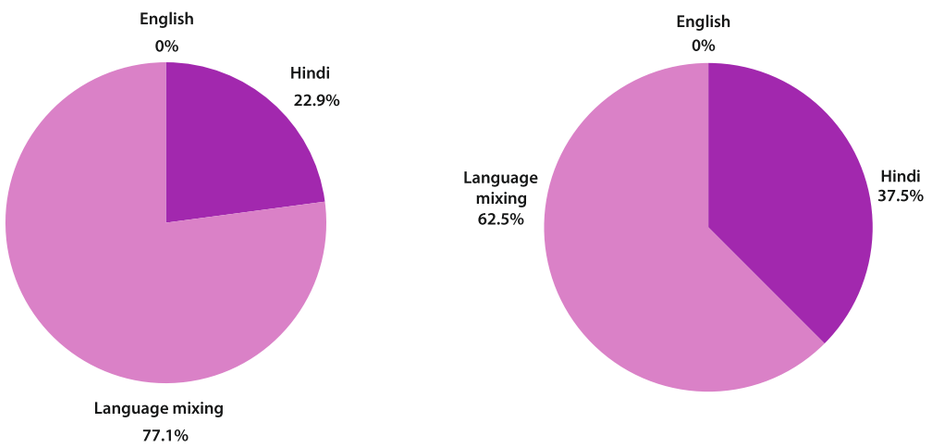


Figure 5. Languages used by teachers in Delhi schools, EMI (left panel) and Hindi-medium (right panel)

Figure 5 shows that, strikingly, English is not used on its own at all in Delhi schools, regardless of whether they are EMI or Hindi-medium. In contrast, language mixing is the most frequent language practice in classrooms in Delhi schools, with 15 percent more language mixing in EMI than Hindi-medium schools. As expected, the use of Hindi on its own is higher in Hindi-medium schools.

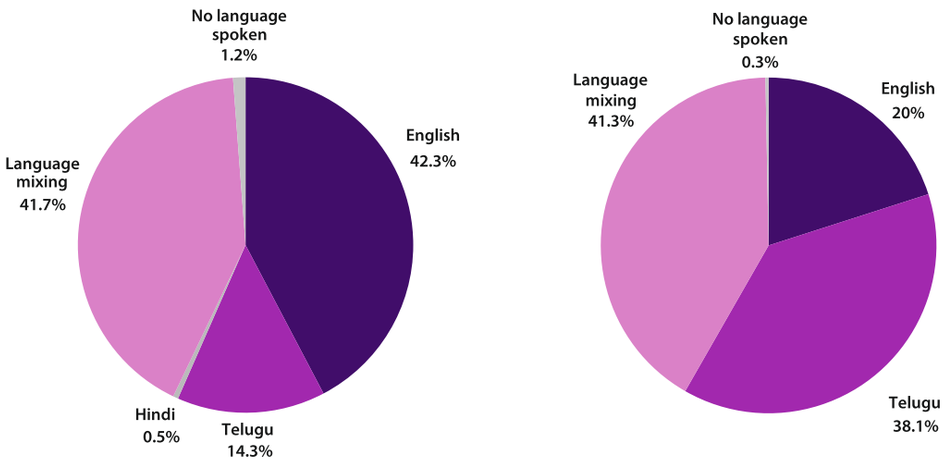


Figure 6. Languages used by teachers in Hyderabad schools, EMI (left panel) and Telugu-medium (right panel)

Figure 6 shows that in Hyderabad schools, in contrast to Delhi schools, English is used on its own; this is considerably more in EMI schools than Telugu-medium schools. Language mixing is also quite frequent, and Telugu is used on its own in both medium of instruction schools, but, as expected, considerably more in Telugu-medium schools.

When comparing languages used in the classrooms in the two sites, we observe that English alone is used much more in Hyderabad than in Delhi by teachers. Furthermore, the use of language mixing is much lower in Hyderabad schools and is comparable across English- and Telugu-medium schools, whereas in Delhi, EMI schools include more language mixing than Hindi-medium schools, presumably due to the absence of English used alone in the classrooms. These findings are very informative when it comes to understanding English literacy scores in Hyderabad schoolchildren, which are higher than Delhi schoolchildren, although English reading comprehension scores in Std V are higher in Delhi than in Hyderabad. We would have expected that higher English literacy scores would signal higher reading comprehension scores too, as more English input (observed in Figure 2) would ensure more exposure and better performance. However, more English input seems to lead only to better literacy scores (decoding). It seems that better comprehension scores would require more teaching of comprehension strategies in English or in the regional language, from where transfer of these skills would be possible to English too. Given that Telugu literacy is lower than Hindi literacy anyway and similar to English literacy in Hyderabad schools, the problem seems to be with overall lower literacy and reading skills in Hyderabad compared to Delhi.

8

What does our research show about gender differences and geographic location in our participants' school and cognitive skills?

Gender inequalities in education have been documented for many countries and for India in particular among underprivileged children. It has been shown that a larger number of the nearly 12 million Indian children not in school are female. Between 2006 and 2010, only 26 percent of girls completed secondary education, compared to 50 percent of boys. According to the 2011 census, 82 percent of boys are literate, while only 65 percent of girls can read and write. According to UNICEF's (2015) report on out-of-school children, gender gaps are largest for the poorest families and for lower secondary school-age children. In rural India, older girls are more likely to be excluded than older boys. Girls in rural areas, particularly those from Scheduled Castes and Scheduled Tribes in India, also have higher rates of exclusion. UNICEF's report also suggests that urban out-of-school children are concentrated among households with low incomes, with around 73 percent of out-of-school children being from the lowest wealth quintile. In terms of location, poor urban children tend to live in slums. Apart from socioeconomic reasons, girls are more likely to be affected by sociocultural barriers (e.g. marriage, reduced mobility for older girls to attend secondary school) as well as hygienic barriers which prevent adolescent girls from continuing with education (UNICEF, 2015). Looking after younger siblings, doing household chores and the demotion of the importance of school for girls are social attitudes or reasons for girls not to participate in education for more than a few years.

In the MultiLiLa project, gender and socioeconomic status depicted as location/school site were two of the factors we wanted to examine in relation to school and cognitive performance, as well as in relation to developmental trajectories for girls and boys assessed in Std IV and in Std V. Regarding socioeconomic status, we considered slum and non-slum differences in school sites in Delhi and Hyderabad, which were the urban sites of the project, while in Patna we considered non-remote rural vs town differences in school sites. We therefore present and analyse our data first according to gender in each of the project's locations and then according to school site within each location. We focus on literacy, numeracy and mathematical reasoning, oral language comprehension (narrative) and cognitive skills, and compare boys' and girls' performance in the two years. We then focus on the same

outcomes in school and cognitive skills, dividing the children into school sites this time. Recall that in Patna, the children in each year are different, as they were tested during the same period of time, while in Hyderabad and Delhi the data is developmental and only a small proportion of children from Std IV are not included in the Std V group.

8.1 Patna

8.1.1 Gender differences

In Figure 7, we present the performance in literacy in English and Hindi by boys and girls in Stds IV and V. The score is a composite one, i.e. it includes letter, word, sentence and text reading. As reported above, literacy in Hindi is better than literacy in English, although improvement is attested for both. Figure 7 shows that girls improve less than boys in both English and Hindi literacy from Std IV to Std V.

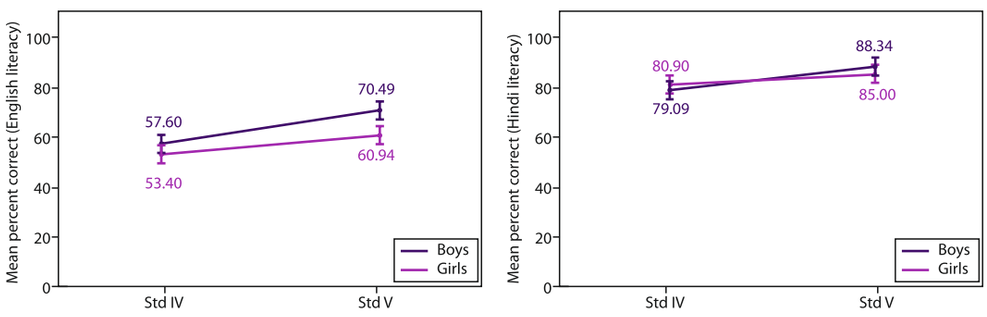


Figure 7. Mean percent scores of children's performance (Std IV and Std V by gender) in literacy in English (left panel) and Hindi (right panel)

Figure 8 presents the performance in reading comprehension in the two languages by boys and girls in Stds IV and V respectively. The mean improvement of girls is lower than that of boys in Hindi, and the same is true for accuracy in reading comprehension. English reading comprehension is very poor, despite the slight improvement found in Std V for both boys and girls.

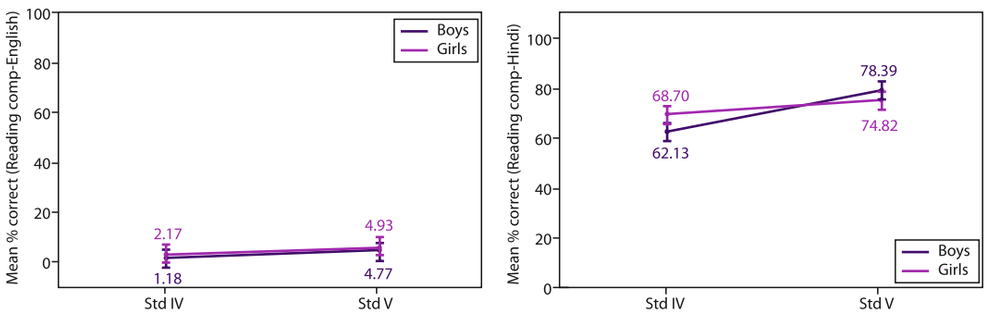


Figure 8. Mean percent scores of children's performance (Std IV and Std V by gender) in reading comprehension in English (left panel) and Hindi (right panel)

Figure 9 presents scores of narrative comprehension, i.e. oral language comprehension of a story that the child had listened to and retold to the research assistant. The narrative comprehension and the story itself were only in Hindi, as this was the medium of instruction in Patna schools. The comprehension questions were mostly asking the child to infer emotions and outcomes of characters and their actions. For some of the questions the answer was in the story itself, and for others the child had to think about it on his/her own to respond. Boys and girls are doing very well in narrative comprehension, showing their good oral language skills.

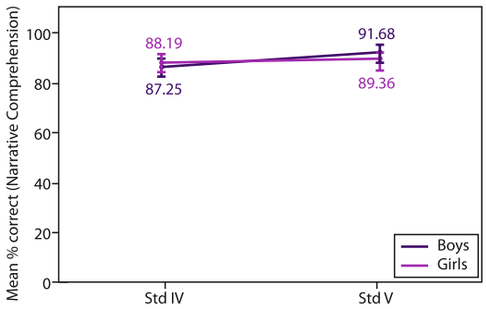


Figure 9. Mean percent scores of children's performance (Std IV and Std V by gender) in narrative comprehension

Figure 10 presents accuracy scores in subtraction and division respectively, split by gender and Year. As we can see, subtraction scores are similar between boys and girls, while there is a small trend for improvement of girls in Std V. Division is better performed by boys in both years, although a good level of improvement is found in both boys and girls alike.

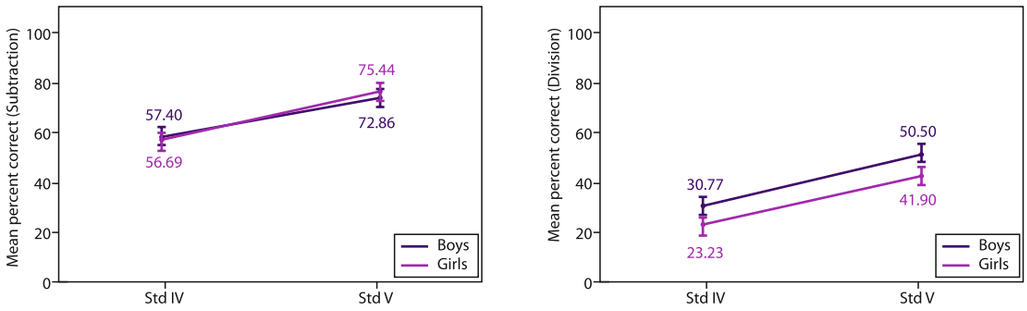


Figure 10. Mean percent scores of children's performance (Std IV and Std V by gender) in subtraction (left panel) and division (right panel)

Figure 11 presents the accuracy scores for mathematical reasoning, as assessed by the meta-maths task and the word problems task. We can observe very low performance in the meta-maths by boys and girls, although boys perform better than girls in Std V. For word problems, the advantage for boys is manifest in both school years, although the difference is not large, and performance overall is also rather low.

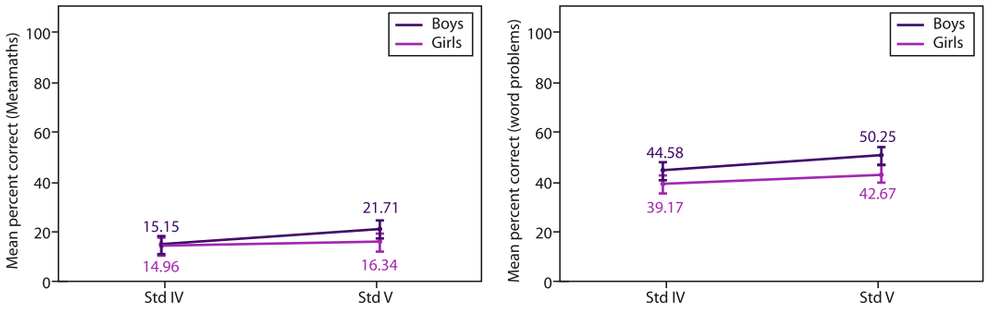


Figure 11. Mean percent scores of children's performance (Std IV and Std V by gender) in meta-maths (left panel) and mathematical word problems (right panel)

Finally, performance in the cognitive tasks is presented in Figures 12, 13 and 14 for Raven's, N-back and semantic fluency tasks respectively. Improvement is similar in boys and girls, although boys' scores are slightly higher than girls' in both years.

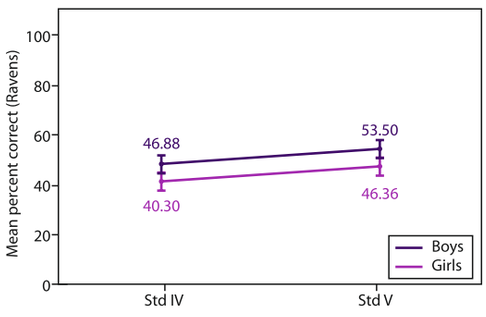


Figure 12. Mean percent scores of children's performance (Std IV and Std V by gender) in Raven's progressive matrices

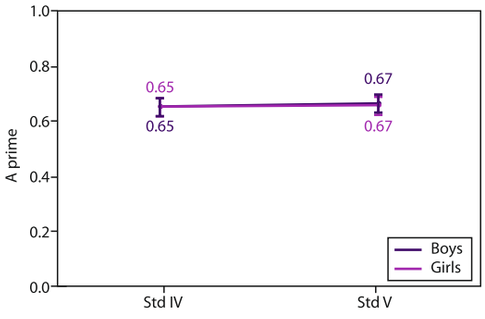


Figure 13. Children's performance (Std IV and Std V by gender) in the N-back

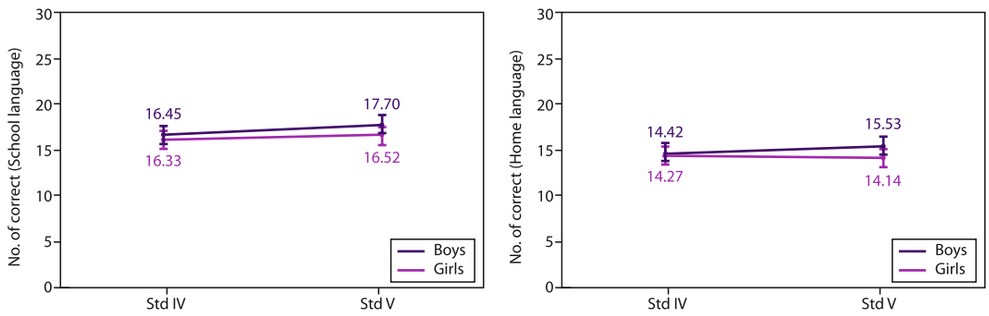


Figure 14. Number of correct responses in children's performance (Std IV and Std V by gender) in the semantic fluency task in the school language and the home language

Although no differences are found in the working memory task (N-back) a small improvement in the boys' performance is found in the semantic fluency tasks when looking at the two school years. However, the difference between boys and girls in either year is negligible. We should note that performance in the school language (left panel) is better than in the home language for both sites and both school years.

8.1.2 Town vs non-remote rural school sites

We recruited 629 children from town schools and 278 children from non-remote rural area schools across Std IV and Std V. In Figure 15, children's literacy scores are presented by Year and school site. The left panel presents reading (decoding) skills in letters, words, sentences and texts in English and the right panel the same task in Hindi.

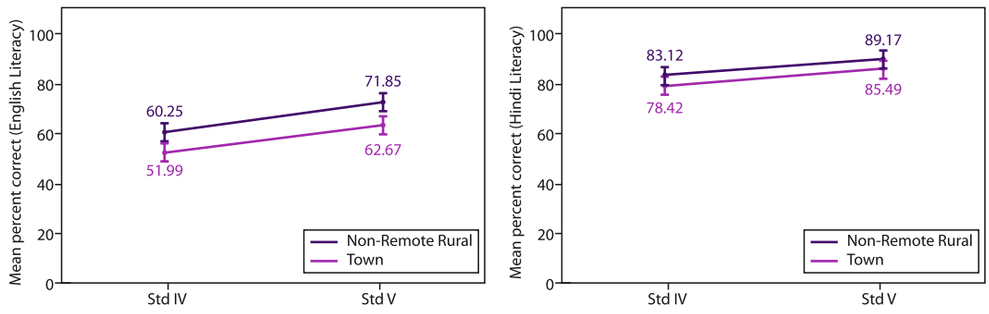


Figure 15. Mean percent scores of children's performance (Std IV and Std V by site) in literacy in English (left panel) and Hindi (right panel)

As expected, literacy in the medium of instruction, i.e. Hindi, is much higher than in English. Recall that English in Patna schools is only taught as a school subject. The average scores in both literacy tasks are higher for children in non-remote rural schools, which is surprising given that the town site was expected to include fewer socioeconomically disadvantaged children, which should have an effect on school skill performance. A possible reason for the difference is that children in non-remote rural schools receive more out-of-school support through private tuition compared to town schoolchildren. Improvement is attested, however, in both English and Hindi from Std IV to Std V in both school sites.

Figure 16 presents scores for reading comprehension in English (left) and Hindi (right) for the same groups of children.

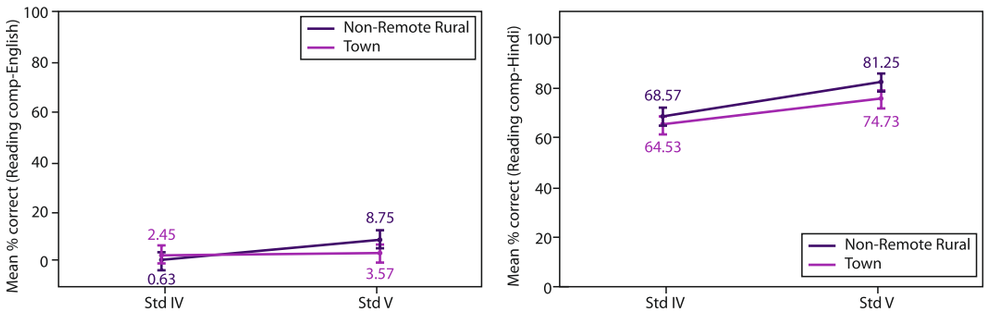


Figure 16. Mean percent scores of children's performance (Std IV and Std V by site) in reading comprehension in English (left panel) and Hindi (right panel)

Despite their good decoding skills in English, the children's comprehension is very poor, indicating that the emphasis on English focuses more on decoding skills (recognizing words and sentences and reading them aloud) than on understanding the content of what is read.

Oral language comprehension, tested through narrative picture-based stories, was only carried out in the school language, namely Hindi (Figure 17). Performance is very good and in fact better than reading comprehension in Hindi, shown in the right panel of Figure 16 above. No differences are shown between the two school sites, indicating a strength in oral language skills unaffected by whatever socioeconomic differences may be associated with the two school sites.

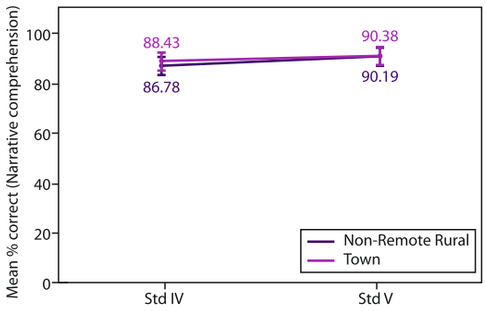


Figure 17. Mean percent scores of children's performance (Std IV and Std V by site) in narrative comprehension

Turning to numeracy and mathematical reasoning, Figure 18 presents accuracy scores in subtraction (left) and division (right) for the two school sites in Stds IV and V. As shown for literacy scores above, non-remote rural schoolchildren perform higher than town schoolchildren in both arithmetical operations, with better performance overall in subtraction than division. Improvement from Std IV to Std V is evident and greater (between 15 and 20 percent change from Std IV to Std V) than the improvement we saw in literacy scores (ranging between 6 and 11 percent).

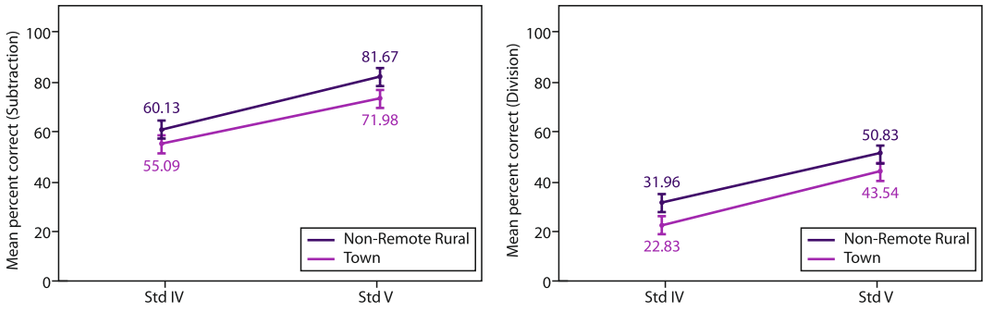


Figure 18. Mean percent scores of children's performance (Std IV and Std V by site) in subtraction (left panel) and division (right panel)

Continuing with mathematical reasoning, we present the results from meta-maths and word problems in the two panels of Figure 19. Progress from Std IV to Std V is rather small, although, as explained above, the data from Patna is cross-sectional and not longitudinal. However, it is worth remembering that the word problems selected for the task were adapted from international tests on mathematics (TIMMS), which are appropriate for Std IV students.

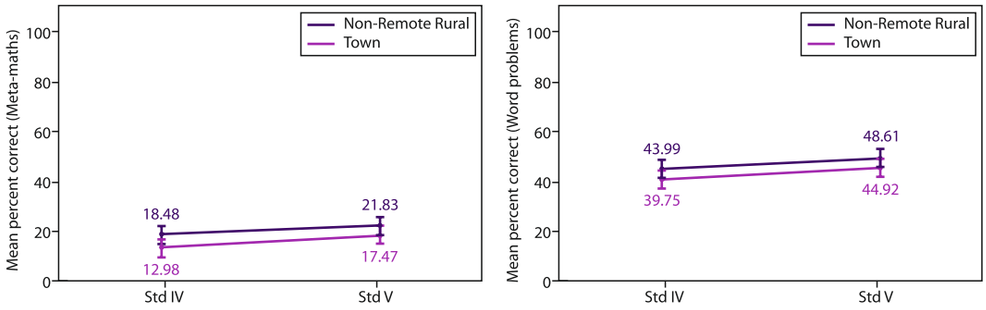


Figure 19. Mean percent scores of children's performance (Std IV and Std V by site) in meta-maths (left panel) and mathematical word problems (right panel)

Finally, we consider children's performance in the Raven's task, presented in Figure 20, where the improvement in children from non-remote rural schools is higher than that found in the children attending schools in town.

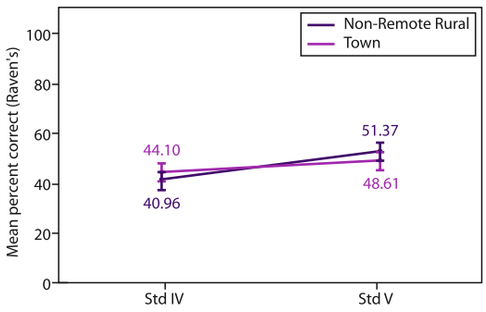


Figure 20. Mean percent scores of children's performance (Std IV and Std V by site) in Raven's progressive matrices

Performance in complex working memory (N-back) is presented in Figure 21. No difference is found in Std IV scores between the two sites, whereas a slight improvement by the non-remote rural schoolchildren is found in Std V. A similar picture arises for the results of the semantic fluency tasks (Figure 22). We should note that semantic fluency scores in the school language are better than those for the home language for schoolchildren from both sites.

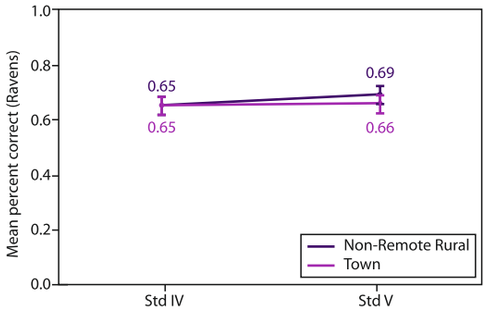


Figure 21. Children's performance (Std IV and Std V by site) in the N-back

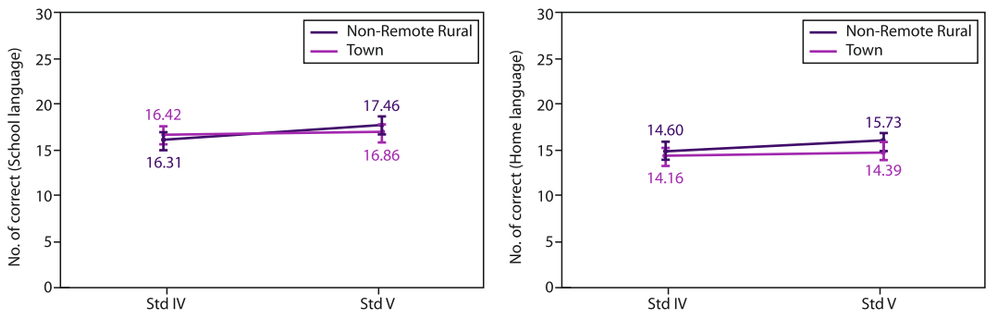


Figure 22. Number of correct responses in children's performance (Std IV and Std V by site) in the semantic fluency task in the school language and home language

8.1.3 Statistical comparisons: Age, gender and school site

Having presented the Patna results by gender and by school site, we turn to some statistical comparisons of these two factors. Age is also included in the variables because we have seen that despite children attending these two school years, the age range of the children is wide, including a certain number of overage children in each Year. Table 18 below presents the findings from a Generalized Linear Model, with the results of each of the tasks presented above as the dependent variable and gender and school site as the independent variables, comparing boys and girls and school sites in each school year separately.

We can see that English literacy gives rise to significant differences between school sites in both school years, with non-remote rural schoolchildren performing better than town schoolchildren. Boys outperform girls in Std V in English literacy and in oral language comprehension (narratives). In mathematical reasoning, boys have an advantage over girls in both school years in word problems, and in meta-maths in Std V only. The gender difference in favour of boys is also found in the non-verbal intelligence task in both school years, and in semantic fluency and complex working memory in Std V only.

The advantage of non-remote rural schoolchildren is found also in numeracy in Std V, and in meta-maths only in Std IV; this is the only task where town schoolchildren outperform non-remote rural schoolchildren, indicating that this task measures something distinct from school skills, in which the non-remote rural children showed significantly better performance in some of the tasks. In the complex working memory task (N-back) and the semantic fluency task, in Std V, a significant difference is found in favour of children in non-remote rural schools. The advantage that town schoolchildren had on the Raven's in Std IV disappears in Std V, although recall that these are not the same schoolchildren tested in the two school years. All other comparisons were non-significant.

Table 18. Statistical comparisons on tasks of literacy, narrative comprehension, numeracy and cognition in Patna (with effect sizes)

Tasks	Std IV			Std V		
Literacy	Age	Gender	Site	Age	Gender	Site
English literacy	ns	ns	p=0.009 (town<non-remote rural); d=0.26	ns	p=0.001 (boys>girls); d=0.31	p=0.005 (town <non-remote rural); d=0.30
English reading comprehension	ns	ns	ns	ns	ns	ns
Hindi	ns	ns	ns	ns	ns	ns
Hindi reading comprehension	ns	ns	ns	ns	ns	ns
Narrative comprehension	ns	ns	ns	ns	p=0.04 (boys>girls); d=0.19	ns
Numeracy						
Subtraction	ns	ns	ns	ns	ns	p=0.014; d=0.25 (town<non-remote rural)
Division	ns	ns	ns	ns	ns	p=0.02; d=0.16 (town<non-remote rural)
Meta-maths	ns	ns	p=0.03; d=0.21 (town<non-remote rural)	ns	p=0.04; d=0.19 (boys>girls)	ns
Mathematical word problems	ns	p=0.02; d=0.21 (boys>girls)	ns	ns	p=0.001, d=0.31 (boys>girls)	ns
Cognition						
Raven's	ns	p<0.05; d=0.46 (boys>girls)	p=0.016; d=0.21 (town>non-remote rural)	ns	p<0.05, d=0.43 (boys>girls)	ns
N-back	p=0.02	ns	ns	ns	ns	p=0.055, d=0.20 (trend, non-remote rural>town)
Semantic fluency (school language)	ns	ns	ns	ns	p=0.004, d=0.26 (boys>girls)	ns
Semantic fluency (home language)	ns	ns	ns	p=0.004	p=0.002, d=0.30 (boys>girls)	p=0.008, d=0.27 (non-remote rural>town)

[1] ns=non-significant; d=Cohen's d [small (d = 0.2), medium (d = 0.5) and large (d = 0.8)]

8.2 Delhi

8.2.1 Gender differences

We tested 194 boys in Std IV and 171 boys in Std V and 193 girls in Std IV and 170 in Std V, giving us 50 percent of the total number of children in each gender. As data collection in Delhi followed a longitudinal design, there were only 23 boys in Std IV who were not included in Std V and only 23 girls in Std IV missing from Std V. Thus, development from one school year to the next is reliable enough, as the vast majority of children are the same in Std IV and StD V.

Figure 23 presents performance in English and Hindi literacy in Delhi schoolchildren divided

by gender. Recall that the task was the ASER literacy tool, which assesses letter, word, sentence and text reading, but no reading comprehension.

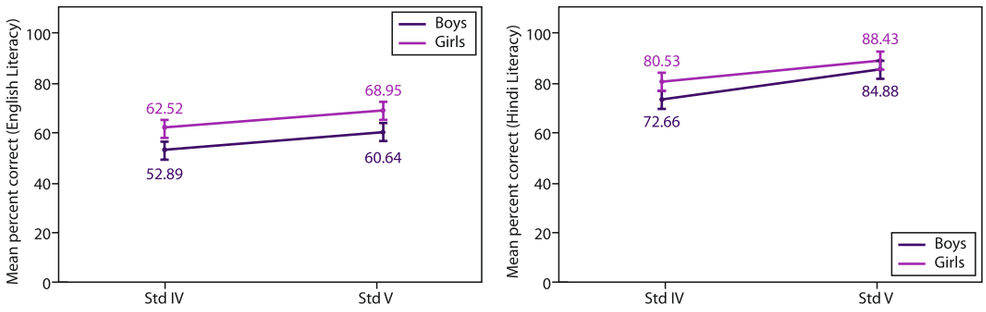


Figure 23. Mean percent scores of children's performance (Std IV and Std V by gender) in literacy in English (left panel) and Hindi (right panel)

There is a larger increase in the English literacy scores between the two school years than in the Hindi literacy scores, although Hindi is stronger across school years and groups. There is a trend for girls to perform better in literacy in both languages, while their development from StD IV to Std V is also slightly greater than for boys.

Figure 24 presents boys' and girls' performance in reading comprehension in English and Hindi. Recall that reading comprehension was assessed with two comprehension questions that were added to the short story reading of the ASER tool.

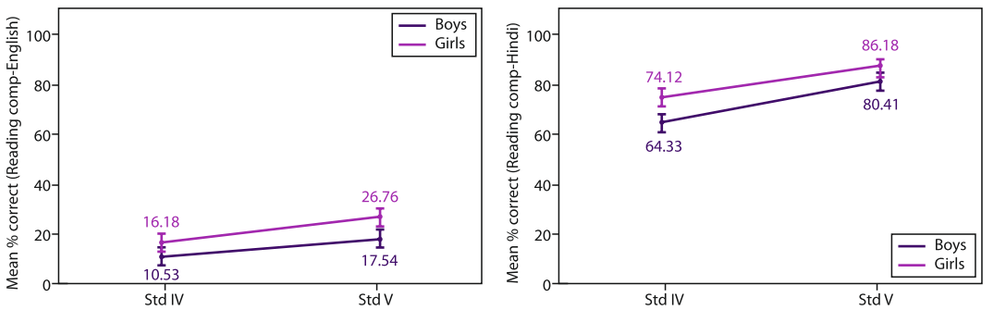


Figure 24. Mean percent scores of children's performance (Std IV and Std V by gender) in reading comprehension in English (left panel) and Hindi (right panel)

Reading comprehension in English (left panel) lags well behind reading ability presented in Figure 23 (left panel), indicating that children's reading skills in English focus more on decoding than understanding texts. Note that most of the Delhi schools were EMI officially, implying that textbooks and assessments are carried out in English. The low reading comprehension scores presented in Figure 24 for English raise concerns about how effective EMI provision is across subjects. In contrast to English, reading comprehension in Hindi is strikingly better, and development from Std IV to Std V is between 12 percent and 16 percent for girls and boys respectively, with girls still showing higher comprehension as they have a higher starting point in Std IV.

Turning to narrative comprehension, no differences are found between boys and girls in either school year, and both groups improve similarly from Std IV to Std V in these skills (Figure 25).

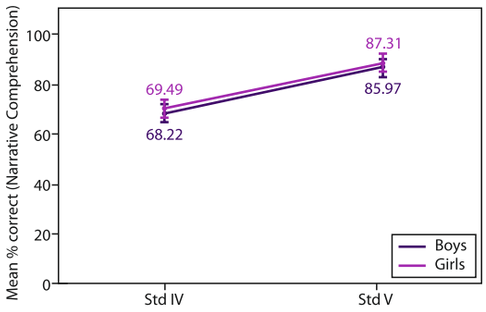


Figure 25. Mean percent scores of children's performance (Std IV and Std V by gender) in narrative comprehension

Moving on to numeracy and mathematical reasoning skills in boys and girls attending Delhi schools, Figure 26 presents accuracy in subtraction and division in Std IV and Std V.

Recall that numeracy was tested using the subtraction and division test of the ASER numeracy tool.

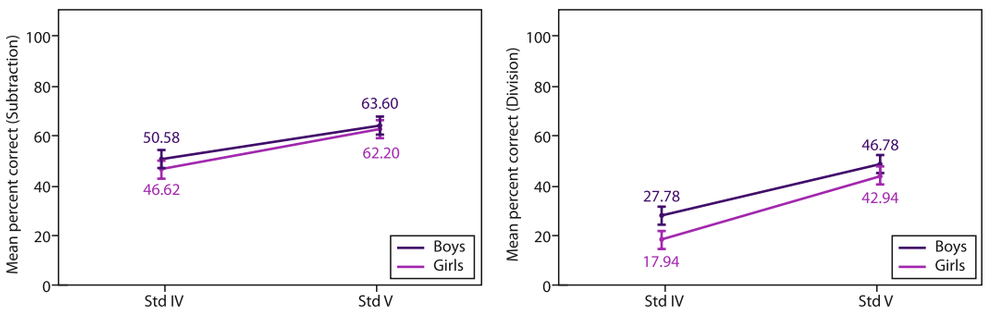


Figure 26. Mean percent scores of children's performance (Std IV and Std V by gender) in subtraction (left panel) and division (right panel)

Subtraction scores are higher than division, which is expected given the increased complexity of the latter. However, Std IV scores for division are really low, compared to Std V scores for subtraction. Improvement leads to around 62 percent accuracy for subtraction in Std V and below 50 percent for division. Girls have only slightly lower scores for subtraction and division than boys, but improve similarly, if not more than boys, from Std IV to Std V.

Figure 27 presents accuracy scores for meta-mathematics and word problems in each year divided by gender. Word problems were grade-appropriate (Std IV, TIMMS) while the meta-mathematics task also required non-basic numeracy skills.

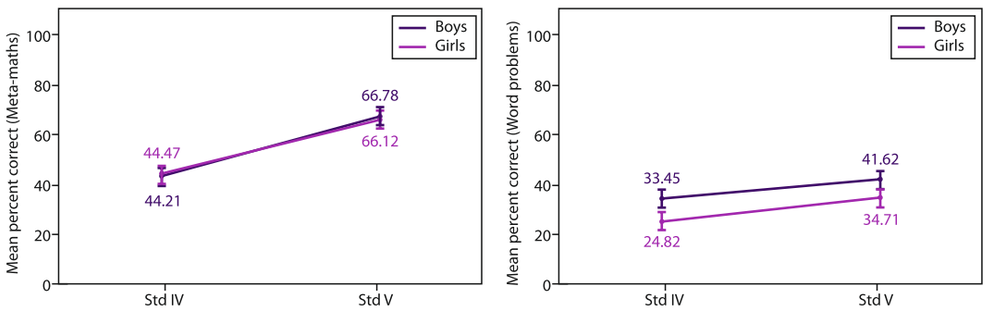


Figure 27. Mean percent scores of children's performance (Std IV and Std V by gender) in meta-maths (left panel) and mathematical word problems (right panel)

No gender differences are found in either Year in meta-maths, while boys perform better than girls in word problems in both years. Development is attested for both groups in both tasks and is more striking in meta-maths performance, where improvement of 22 percent is attested in both groups.

Figure 28 presents the non-verbal IQ scores for girls and boys in Std IV and Std V. Boys tend to perform better in this task than girls, although improvement of the same magnitude is found in both groups.

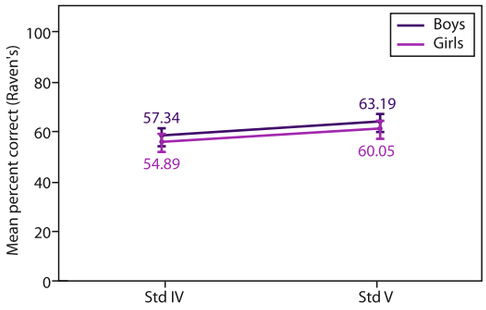


Figure 28. Mean percent scores of children's performance (Std IV and Std V by gender) in the Raven's progressive matrices

Turning to complex working memory and updating skills, in Figure 29 we present the results of this non-verbal task and development for boys and girls.

Only girls seem to slightly improve in this task between Stds IV and V, and differences between boys and girls are not found.

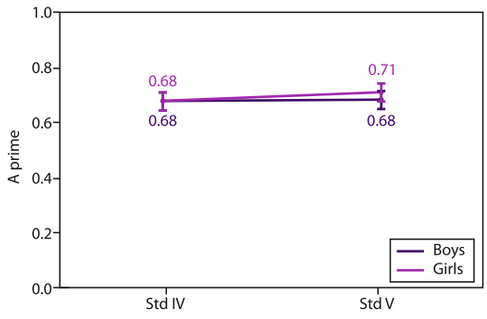


Figure 29. Children's performance (Std IV and Std V by gender) in the N-back task

Figure 30 presents the semantic fluency scores in the school and the home language, with some noticeable improvement in the school language and only a slight improvement in the home language for both boys and girls.

Notice that fluency in the home language is better for boys and girls in Std IV and remains in Std V, although the gap between home and school language is smaller at this point.

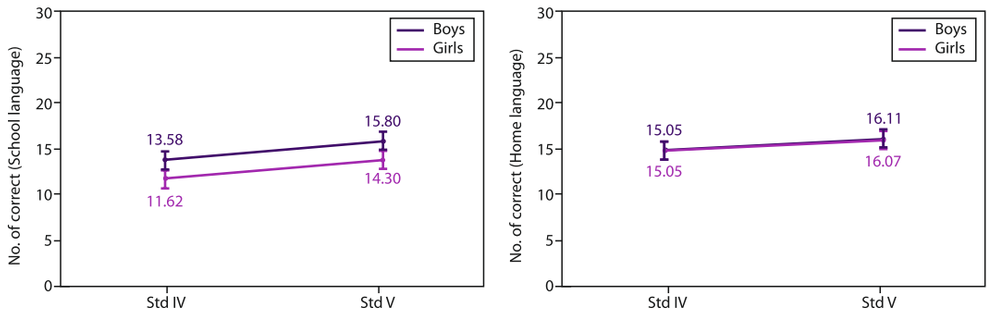


Figure 30. Children's performance (Std IV and Std V by gender) in the semantic fluency task in the school language and home language

8.2.2 Differences by school site

We recruited 189 children from schools in slum areas in Std IV, of whom 178 were assessed again in Std V. We also recruited 198 children from schools in non-slum areas, 163 of whom remained in Std V. We therefore have an almost equal division between the two school sites.

As in the previous section, we present literacy scores first per year and school site.

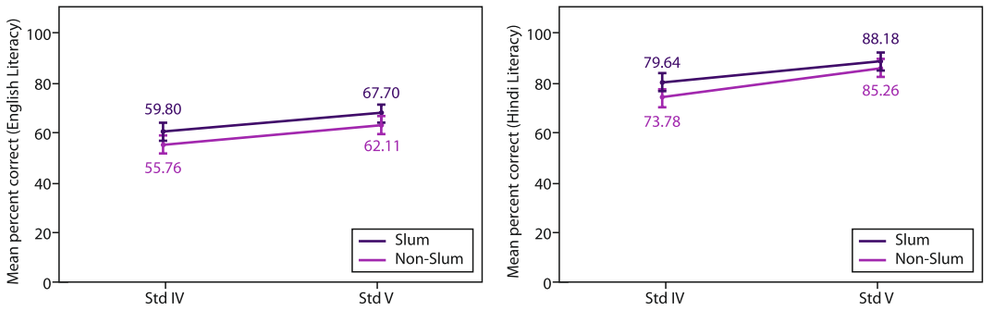


Figure 31. Mean percent scores of children's performance (Std IV and Std V by site) in literacy in English (left panel) and Hindi (right panel)

As shown in Figure 31, there are no major differences between school sites, and those that are shown are in favour of schools in slum areas. Development between the two years is similar across schools in slum and non-slum areas, but overall, as expected, performance in Hindi literacy is higher by around 20 percent compared to English literacy. However, turning to reading comprehension, Figure 32 shows very poor performance in English compared to Hindi, with a difference of around 55 percent.

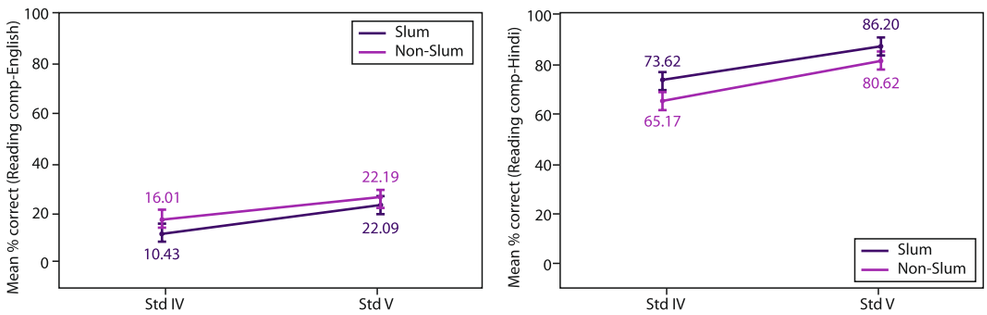


Figure 32. Mean percent scores of children's performance (Std IV and Std V by site) in reading comprehension in English (left panel) and Hindi (right panel)

Development is also rather low in English compared to Hindi when comparing Std IV and Std V scores. No difference between slum and non-slum sites was found for English in Std V, and a difference in favour of schools in slum areas for Hindi reading comprehension skills was found in both years. This is reminiscent of the advantage that non-remote rural schools had in Patna compared to town schools. Even if school sites (slum vs non-slum, town vs non-remote rural) are expected to show differences in the level of disadvantage or socioeconomic deprivation that schoolchildren and their households have, these do not seem to be reflected in literacy or reading comprehension scores in Delhi. Other factors, such as more government support or more emphasis on schooling provision or additional tuition, are likely to contribute to the unexpected differences found between site groups.

Turning to narrative comprehension scores, children's improvement from Std IV to Std V is clear and similar to their reading comprehension in Hindi (Figure 33).

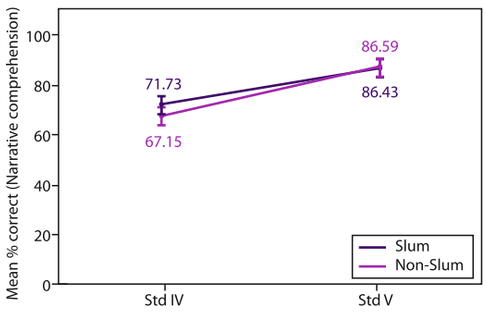


Figure 33. Mean percent scores of children's performance (Std IV and Std V by site) in narrative comprehension (Hindi)

Turning to numeracy skills, Figure 34 presents subtraction and division scores per school site and school year for Delhi children.

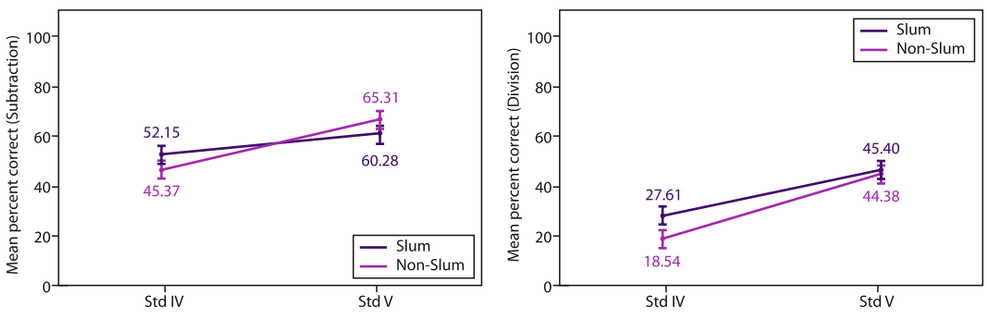


Figure 34. Mean percent scores of children's performance (Std IV and Std V by site) in subtraction (left panel) and division (right panel)

In both numeracy measures, children from schools in non-slum areas start from a lower performance score than children from schools in slum areas but seem to catch up, and in subtraction they outperform their peers. As expected, division scores are lower than subtraction scores in both Std IV and Std V, which is consistent with the Patna data.

Mathematical reasoning skills measured through the meta-maths task and word problems are presented in Figure 35.

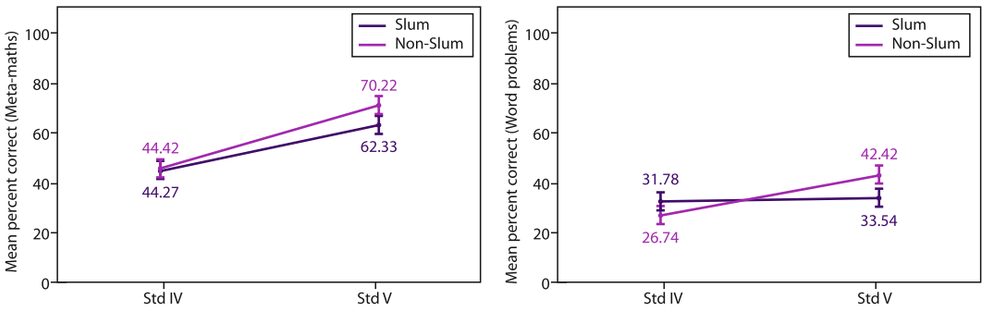


Figure 35. Mean percent scores of children's performance (Std IV and Std V by site) in meta-maths (left panel) and word problems (right panel)

School site differences are non-existent for meta-maths in Std IV, whereas children in slum school sites have a slightly better performance than children in non-slum sites. In Std V, an eight to nine percent advantage for children in non-slum school sites is found for both meta-maths and word problems. Word problems show no real development in children attending schools in slum areas.

Turning to cognitive tasks, Figure 36 shows performance in the two school sites between Stds IV and V. Development is attested in the two years, but no real differences between school sites are shown.

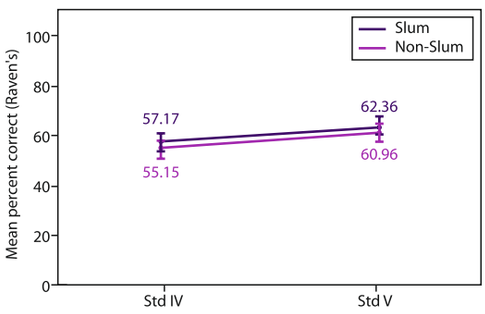


Figure 36. Mean percent scores of children's performance (Std IV and Std V by site) in Raven's progressive matrices

Figure 37 presents the working memory (N-back) results from the same children in Stds IV and V. As with the results of the Raven's above, no differences are found between school sites.

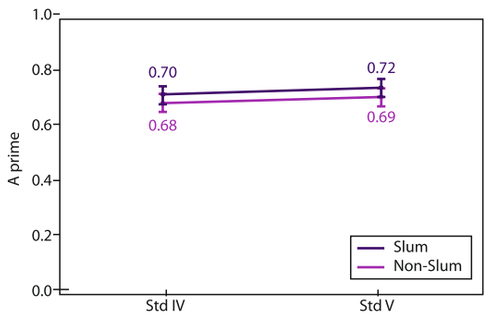


Figure 37. Mean percent scores of children's performance (Std IV and Std V by site) in the N-back

Figure 38 presents the children's performance in the semantic fluency task in Stds IV and V in the school and home language.

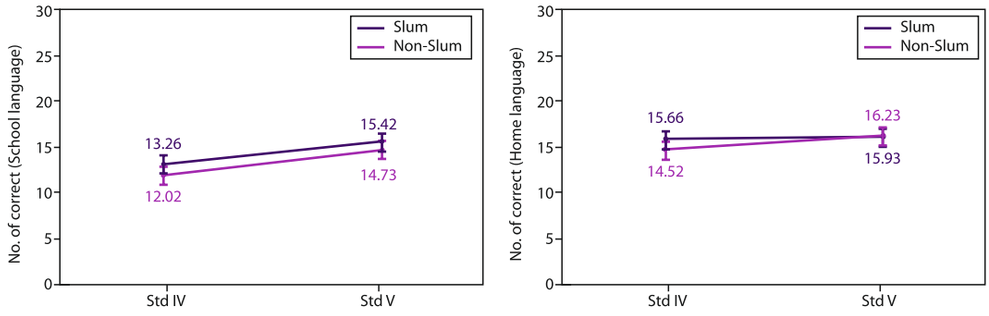


Figure 38. Children's performance (Std IV and Std V by site) in the semantic fluency task in the school language and home language

There is slightly better performance by children from schools in slum sites in both home language and school language fluency compared to children from schools in non-slum sites, although both groups improve similarly in the school language between Stds IV and V (i.e. the two school years). Home language is slightly better for children from schools in non-slum sites in Std V than children from schools in slum sites.

8.2.3 Statistical comparisons: Age, gender and school site

Having presented the Delhi results by gender and by school site, we turn to some statistical comparisons of these two factors. Age is also included in the variables because we have seen that despite children attending these two school years, the age range of the children is wide, including a certain number of overage children in each year. Table 19 below presents the findings from a Generalized Linear Model on all the tasks individually presented above, as well as comparisons between boys and girls and school sites in each school year.

We can see that English literacy gives rise to significant differences between girls and boys, with girls performing significantly better than boys in both years. A similar advantage for girls is also found in Std IV only for Hindi literacy scores. A marginally significant advantage of slum school sites is also found in Std V for English literacy. Children from schools in slum areas show significantly better performance in narrative comprehension skills compared to children in non-slum school areas in Std IV only. Older children also show an advantage in this oral skill in Std IV.

Turning to numeracy, division scores in Std IV reveal an advantage for boys, an advantage for older children and an advantage for children in slum school sites. In mathematical reasoning, boys have an advantage over girls in Std V in word problems. In the same task, children in schools in non-slum sites perform better than those in slum sites.

No gender, age or school site differences have been found in the non-verbal intelligence or the working memory tasks. However, semantic fluency in the school language shows a significant difference in favour of girls in both years. There is also a trend for an advantage for children attending schools in slums sites performing better than those in non-slum areas in semantic fluency in the school language.

Table 19. Statistical results from Generalized Linear Model analyses on tasks of literacy, narrative comprehension, numeracy and cognition in Delhi (with effect sizes)

Tasks	**Std IV**			**Std V**		
Literacy	Age	Gender	Site	Age	Gender	Site
English literacy	ns	p=0.001, d=0.34 (girls>boys)	ns	ns	p=0.006, d=0.28 (girls>boys)	p=0.05, d=0.23 (slum>non-slum)
English reading comprehension	ns	ns	ns	ns	ns	ns
Hindi literacy	ns	p=0.009, d=0.26 (girls>boys)	ns	ns	ns	ns
Hindi reading comprehension	ns	ns	ns	ns	ns	ns
Narrative comprehension	p=0.02	ns	p=0.003, d=0.33 (slum>non-slum)	ns	ns	ns
Numeracy						
Subtraction	ns	ns	ns	ns	ns	ns
Division	p=0.01	p=0.03, d=0.27 (boys>girls)	p=0.05, d=0.24 (slum>non-slum)	ns	ns	ns
Meta-maths	ns	ns	ns	ns	ns	ns
Mathematical word problems	ns	ns	ns	ns	p=0.01, d=0.03 (boys>girls)	p=0.001, d=0.17 (non-slum>slum)

Tasks	Std IV			Std V		
Cognition	Age	Gender	Site	Age	Gender	Site
Raven's	ns	ns	ns	ns	ns	ns
N-back	ns	ns	ns	ns	ns	ns
Semantic fluency (school language)	ns	p=0.006, d=0.32 (girls>boys)	p=0.058, d=0.20 (trend; slum>non-slum)	ns	p=0.012, d=0.29 (girls>boys)	ns
Semantic fluency (home language)	ns	ns	ns	ns	ns	ns

ns=non-significant; d=Cohen's d [small (d = 0.2), medium (d = 0.5), and large (d = 0.8)]

8.3 Hyderabad

8.3.1 Gender differences

In Hyderabad schools, we tested children in Stds IV and V as in Delhi. In Std IV, 206 boys were tested, of whom 142 were retested in Std V; 255 girls were tested in Std IV and 177 were retested in Std V. Although the attrition rate was high in the Hyderabad data, the gender balance was retained across the two years of the data collection.

Figure 39 presents performance in English and Telugu literacy in Hyderabad schoolchildren divided by gender. Recall that the task was the ASER literacy tool, which assesses letter, word, sentence and text reading, but no reading comprehension.

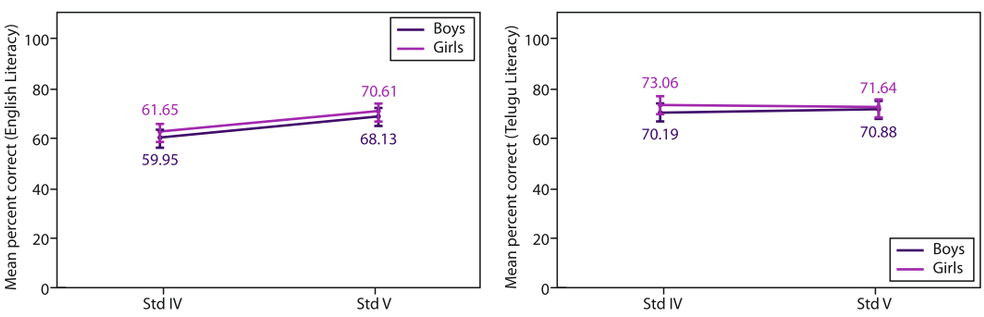


Figure 39. Mean percent scores of children's performance (Std IV and Std V by gender) in literacy in English (left panel) and Telugu (right panel)

As shown in Figure 39, girls and boys perform very similarly in the two languages when it comes to decoding skills in reading. It is somewhat worrying that there is no development in Telugu literacy skills from Std IV to Std V in boys or girls, whereas development is attested in English literacy, which, in Std V, reaches the levels of Telugu literacy skills. However, the lack of development in Telugu reading skills and the fact that performance is not at ceiling is a cause for concern as the reading levels tested are for Std II, according to the ASER literacy too. Thus, there is definitely room for

improvement in regional language literacy skills of children attending government schools in Hyderabad.

Turning to reading comprehension, we should point out that children were unable to answer comprehension questions after reading the story of the ASER tool in Telugu. Therefore, we do not report any results on reading comprehension. The problems with reading comprehension could be considered in relation to the lack of any development in Telugu decoding skills shown in Figure 39 and the rather low performance (around 70 percent accuracy) in Telugu reading skills. A possible factor to take into consideration is that in Hyderabad schools, 30 percent of children did not speak Telugu in the home but were minority language speakers. These children face more challenges in learning to read in an unfamiliar language, and their literacy skills may therefore lag behind those of children whose home languages included Telugu.

English reading comprehension scores are presented in Figure 40. Girls outperform boys in this task in both years. However, development between Stds IV and V is minimal for both boys and girls. Overall, scores for comprehension do not reach 25 percent, which again indicates a strong asymmetry between decoding and reading comprehension scores.

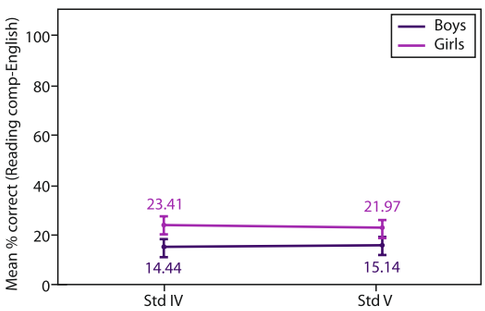


Figure 40. Mean percent scores of children's performance (Std IV and Std V by gender) in reading comprehension in English

Turning to narrative comprehension in Telugu, the results from both boys and girls are almost at ceiling, as shown in Figure 41.

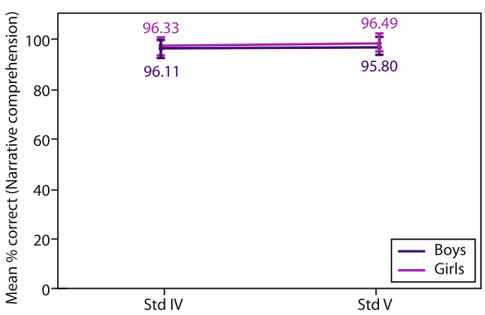


Figure 41. Mean percent scores of children's performance (Std IV and Std V by gender) in narrative comprehension

Turning to numeracy and mathematical reasoning, Figures 42 and 43 present the results by gender. As we saw above in the Patna and the Delhi numeracy data, division is a more demanding operation that children in Hyderabad were apparently taught in Std V and not before. The very low scores attested in Std IV for division are, thus, probably due to the curriculum, and this also explains the improvement in Std V. Nevertheless, performance in division is still under 30 percent, and girls underperform compared to boys in division. Subtraction presents a different picture, where performance is around 59 percent in Std V, with no differences between boys and girls, and a small improvement from Std IV to Std V only found in girls.

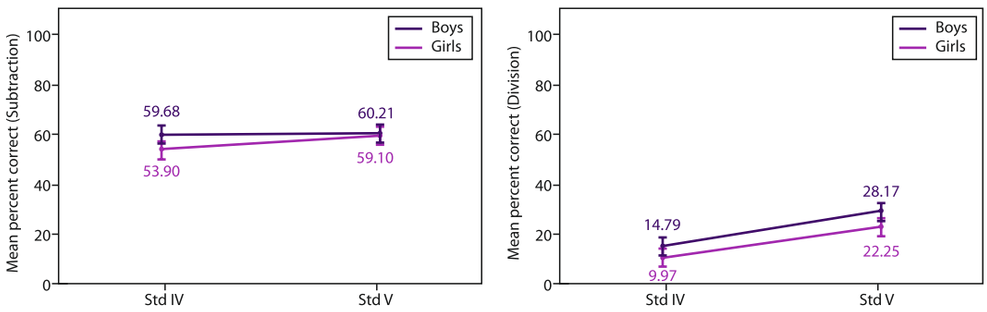


Figure 42. Mean percent scores of children's performance (Std IV and Std V by gender) in subtraction (left panel) and division (right panel)

Moving to meta-maths and word problems, Figure 43 presents the relevant data. Gender differences are not striking, although boys improve slightly more than girls in word problems in Std V. The opposite pattern is found in meta-maths, where girls show a ten percent improvement in their performance in Std V. Overall, performance is not high and does not reach 50 percent accuracy in either task.

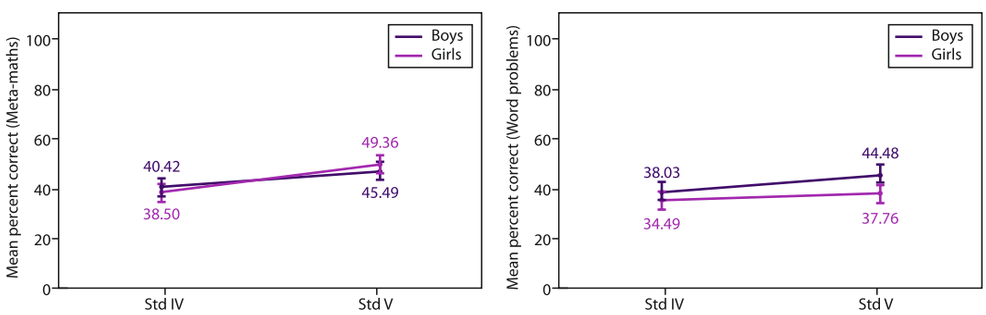


Figure 43. Mean percent scores of children's performance (Std IV and Std V by gender) in meta-maths (left panel) and mathematical word problems (right panel)

Results from cognitive tasks, namely from non-verbal IQ and from complex working memory (N-back) tasks, are reported in Figures 44 and 45 by gender. In Std IV boys and girls do not differ in the Raven's, and there is a difference of about five percent in favour of boys in Std V.

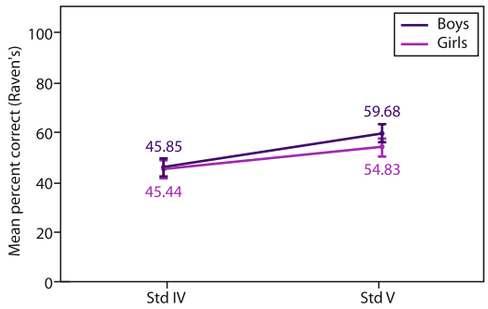


Figure 44. Mean percent scores of children's performance (Std IV and Std V by gender) in the Raven's progressive matrices

No differences are found in the working memory scores of boys and girls in either year, as shown by Figure 45.

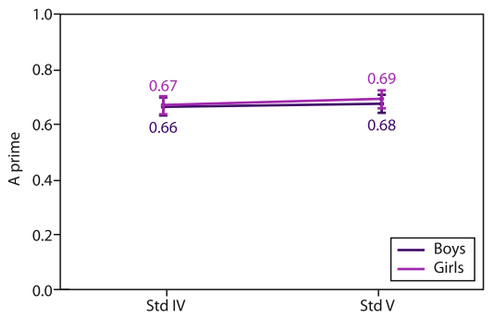


Figure 45. Children's performance (Std IV and Std V by gender) in the N-back

Finally, scores in semantic fluency are similar in boys and girls, both in the school language and in the home language (Figure 46). There is also a slightly better performance in the school language than in the home language in semantic fluency. Slight improvement in the task is also shown in both boys and girls when comparing between Stds IV and V.

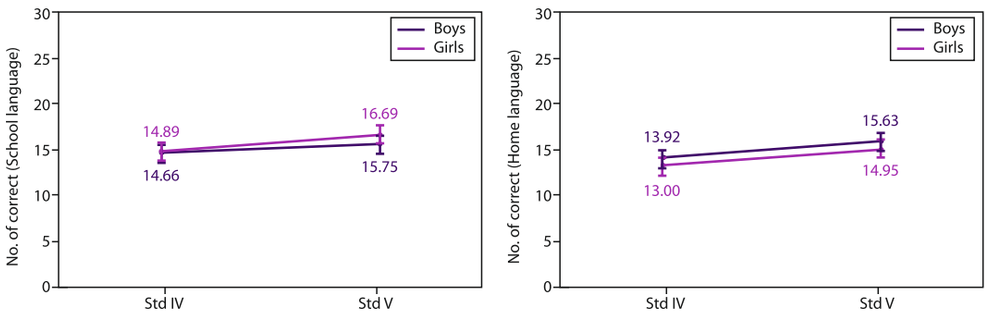


Figure 46. Children's performance (Std IV and Std V by gender) in the semantic fluency task in the school language and home language

8.3.2 Differences by school site

In Std IV we recruited 243 children from schools in slum areas, of whom 173 were assessed again in Std V. We also recruited 218 children from schools in non-slum areas in Std IV, 163 of whom remained in Std V. We therefore have an almost equal division between the two school sites.

As in the previous section, we present all task results in the same order, but in this section by year and school site, beginning with literacy in English and Telugu (Figure 47).

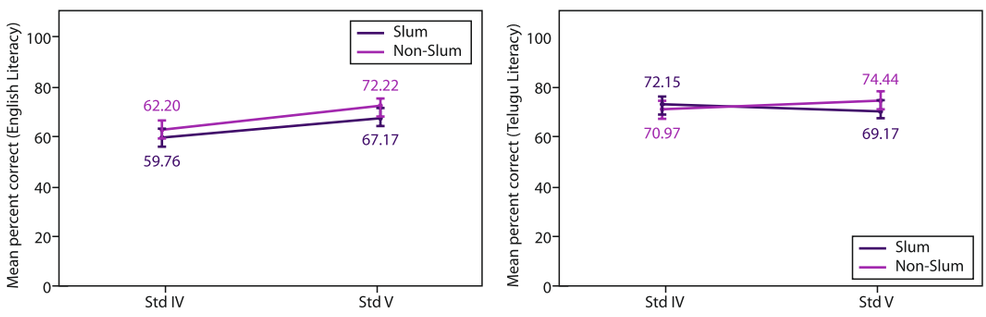


Figure 47. Mean percent scores of children's performance (Std IV and Std V by site) in literacy in English (left panel) and Telugu (right panel)

As shown by the two panels in Figure 47, English and Telugu literacy (decoding skills) are very similar in accuracy rates, although children in non-slum school sites improve slightly more in English than children in slum school sites. For children in slum school sites, Telugu literacy shows a slight decrease in accuracy, which may be due to attrition from Std IV to Std V that may have led to more high-achieving children in Std IV moving to other schools in Std V and the lower-achieving children not showing obvious development, thus dropping the average score below the average score in Std IV.

Reading comprehension in English is very poor, with children in slum school sites showing no change between Std IV and Std V and performing worse than children in non-slum school sites (Figure 48).

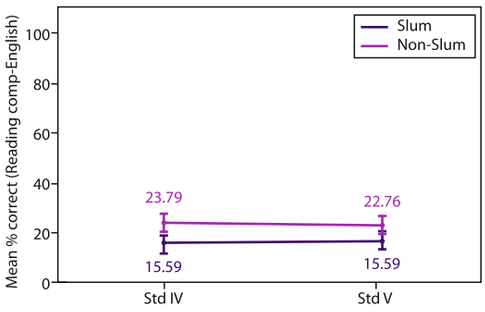


Figure 48. Mean percent scores of children's performance (Std IV and Std V by site) in reading comprehension in English

Oral skills assessed through narrative comprehension in Telugu, however, seem almost at ceiling for all children, regardless of school site, as shown in Figure 49.

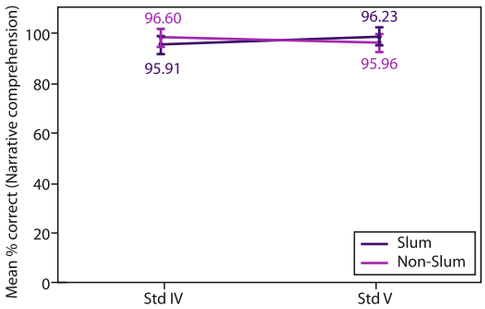


Figure 49. Mean percent scores of children's performance (Std IV and Std V by site) in narrative comprehension in Telugu

Turning to numeracy results, subtraction shows higher averages than division and development in division is found in both school sites, although it is more evident in non-slum school sites. Subtraction does not show much development between the two years, and the differences between school sites is not obvious (Figure 50).

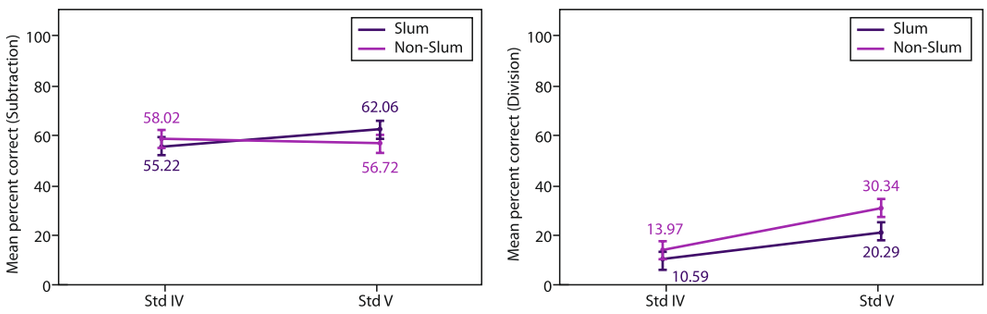


Figure 50. Mean percent scores of children's performance (Std IV and Std V by site) in subtraction (left panel) and division (right panel)

Figure 51 presents accuracy averages for meta-maths and word problems. Although in Std IV children in slum school sites perform very similarly to children in non-slum school sites in word problems, development in Std V is more pronounced in schools in non-slum sites. The same is true for meta-maths results, where children from non-slum school sites show development of around 13 percent between Std IV and Std V, while children in slum school sites show development of only four percent.

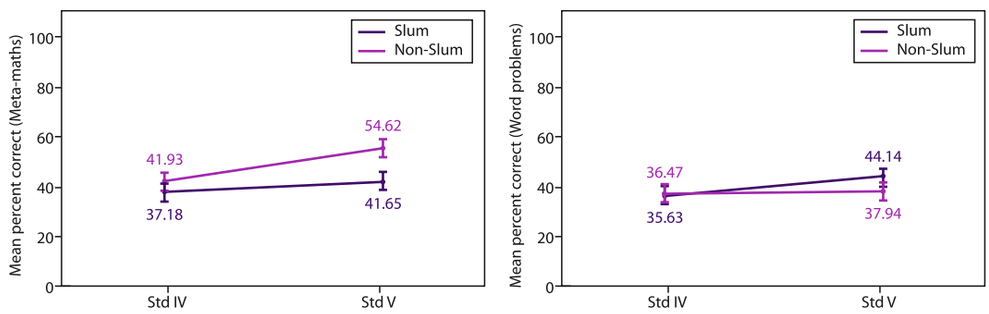


Figure 51. Mean percent scores of children's performance (Std IV and Std V by site) on meta-maths (left panel) and mathematical word problems (right panel).

Finally, turning to cognitive tasks, and in particular non-verbal IQ and working memory tasks, Figures 52 and 53 present children's average scores per school site and year. For the Raven's, no differences are found between the groups in Std IV, and a very small trend in favour of non-slum school sites is found in Std V.

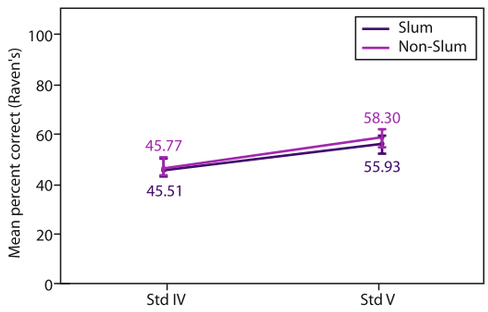


Figure 52. Mean percent scores of children's performance (Std IV and Std V by site) in the Raven's progressive matrices

For working memory, there are no differences between groups at all, either in Std IV or Std V.

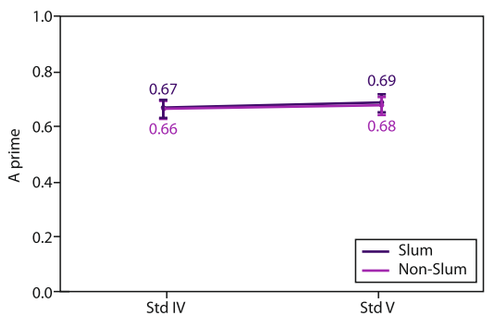


Figure 53. Children's performance (Std IV and Std V by site) in the N-back task

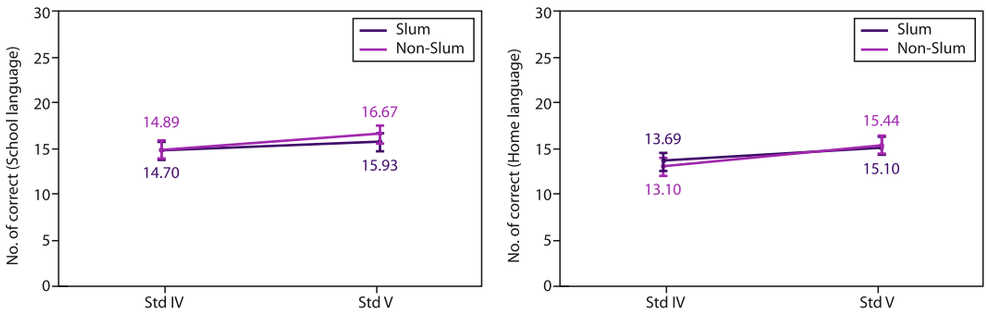


Figure 54. Children's performance (Std IV and Std V by site) in the semantic fluency task in the school language and home language

Semantic fluency in the school language is slightly better than in the home language, and there is similar improvement between Std IV and Std V (Figure 54).

Preliminary field visit to a school in Jaipur, Rajasthan

8.3.3 Statistical comparisons: Age, gender and school site

Having presented the Hyderabad results by gender and by school site, we turn to some statistical comparisons of these two factors. Age is also included in the variables because we have seen that despite children attending Std IV or Std V, the age range of the children is wide, including a certain number of overage children in each class. Table 20 presents the findings from a Generalized Linear Model on all the tasks individually presented above, as well as comparisons between boys and girls and school sites in each school year.

No significant differences have been found for any of the three variables (age, school site and gender) when it comes to literacy in English or Hindi, reading comprehension in English and oral narrative skills (comprehension) in Telugu. Numeracy and mathematical reasoning tasks show differences in favour of non-slum school sites in Std IV only, indicating a disadvantage for children in slum school sites in their progress from Std IV to Std V. Gender differences are found in favour of boys for word problems in Std V and also for Raven's scores in Std V. Semantic fluency in the school language shows a significant age effect, indicating that older children in the same school year perform better than their peers in the same class.

Table 20. Statistical results from Generalized Linear Model analyses on tasks of literacy, narrative comprehension, numeracy and cognition in Hyderabad (with effect sizes)

Tasks	**Std IV**			**Std V**		
Literacy	Age	Gender	Site	Age	Gender	Site
English literacy	ns	ns	ns	ns	ns	ns
English reading comprehension	ns	ns	ns	ns	ns	ns
Telugu literacy[1]	ns	ns	ns	ns	ns	ns
Narrative comprehension	ns	ns	ns	ns	ns	ns
Numeracy						
Subtraction	ns	ns	ns	ns	ns	ns
Division	ns	ns	ns	ns	ns	p=0.02, d=0.27 (non-slum>slum)
Meta-maths	ns	ns	ns	ns	ns	p=0.005, d=0.27 (non-slum>slum)
Mathematical word problems	ns	ns	ns	ns	p=0.004, d=0.25 (boys>girls)	p=0.007, d=0.24 (non-slum>slum)
Cognition						
Raven's	ns	ns	ns	ns	p=0.02, d=0.27 (boys>girls)	ns
N-back	ns	ns	ns	ns	ns	ns
Semantic fluency (school language)	ns	ns	ns	p=0.04	ns	ns
Semantic fluency (home language)	p=0.02	ns	ns	ns	ns	ns

ns=non-significant; d=Cohen's d [small (d = 0.2), medium (d = 0.5), and large (d = 0.8)].
[1] Telugu literacy was administered only to children in Telugu-medium schools in Hyderabad. Children in Telugu-medium schools were unable to respond to the comprehension questions in Telugu.

9

Limitations, challenges and opportunities for the future

The MultiLiLa project was multifaceted. It aimed to examine whether a match or mismatch between the child's home language(s) and the school language affects learning outcomes, while at the same time taking into account other factors that can affect a child's performance in basic school skills and more advanced problem-solving and reasoning skills. Specifically, socioeconomic status, school site, urban vs rural location and differences between two urban sites (Delhi and Hyderabad) were considered when evaluating learning outcomes in the project's tasks. At the same time, factors such as age, gender, bilingualism in the home, language distance between the regional language and the home language of the child as well as the child's cognitive abilities were considered as factors characterising the individual child learner, which could, in addition, interact with the child's learning outcomes. The strongest case of mismatch between school and home language is in the case of English, which was a language that none of the participants used at home. The development of English literacy and reading comprehension was therefore an indication of the challenges faced by children in government schools. Somewhat unsurprisingly, reading (decoding) English words and sentences was not a serious challenge for any of the child groups, even those in Patna, where English was only taught as a subject in the school. The greatest challenge was in reading comprehension across the three sites. In order to evaluate the contribution of English as an unfamiliar/foreign language to this poor performance in comprehension we need to take into account how children perform in reading comprehension in the regional language. The comparison between Hindi and English in reading comprehension is striking: reading comprehension in Hindi is similar to decoding skills which are very good in both Patna and Delhi, with better overall performance in Delhi children. On the other hand, English decoding skills are far better than reading comprehension skills in both sites, with improved scores in Std V reaching less than 20 percent accuracy in Delhi and around five percent in Patna. These results clearly show an important disadvantage created by English and its repercussions for learning through English as a medium of instruction. Oral (listening) comprehension in Hindi was also very good, and in fact better than reading comprehension in the same language.

When comparing reading comprehension in English vs Telugu, however, the situation is different. Children in Hyderabad were unable to respond to reading comprehension questions in Telugu, indicating that their problem with this higher-level literacy skill was more generally a problem with reading comprehension and lack of the relevant strategies. It should be pointed out that in Hyderabad schools, many of the children did not have Telugu as their home language and as such they were different from Delhi children

who all had good knowledge of Hindi from home. Overall lower reading skills were thus expected in Hyderabad because of the larger number of minority language children who had limited exposure to Telugu at home. In English, children in Hyderabad showed low reading comprehension skills, as in the other sites too, but compared to Delhi scores, Hyderabad children also performed lower in Std V (under 20 percent). The lower English skills of Hyderabad children in reading comprehension compared to Delhi children are surprising given that English input in Hyderabad classrooms is greater than in Delhi, as shown by the classroom observations presented in Section 7. It is therefore more likely that the emphasis on reading development in the two cities differs, with decoding skills being prioritized in both cities but comprehension strategies lacking from Hyderabad more than from Delhi schools. Further research into teaching methodologies, teacher training and interventions focusing on reading comprehension skills are essential for this picture to improve in the near future.

In this report we did not present school or cognitive performance based on the medium of instruction that children had. This decision was based on the classroom data shown in Section 7, where the medium of instruction differences did not necessarily translate into differences in languages used in the classroom in Delhi or Hyderabad. In fact, English alone was used more in Telugu-medium schools than Hindi-medium schools, as well as in English-medium schools in Hyderabad compared to English-medium schools in Delhi. Language mixing was found in school classrooms in both cities, and so was the use of the regional language. It is therefore unclear whether the small differences found in language input were relevant to school performance (or cognitive skills). The reader is advised to look for the project's published articles on specific school and cognitive skills, where medium of instruction is taken into account within a particular city or in the comparison between project sites (e.g. Tsimpli et al., 2020).

This report presented the major findings in terms of learning outcomes and cognitive skills in all three sites as well as the major statistical comparisons between genders and school sites. It was not an aim of this report to present direct, statistical comparisons between the three project sites for a number of reasons. First, because there were many differences among the children and the schools they attended, not only in terms of the linguistic diversity of the groups in Patna vs Delhi and in Delhi vs Hyderabad but also in terms of the language practices found in classrooms (reported in Section 7 of the report). Furthermore, the curriculum seems not to be identical across the three sites (see, for example, the sections on numeracy and comments on the teaching of division in Hyderabad vs Delhi). Therefore, direct comparisons would be confounded by these externally driven differences.

Further research into successful interventions exploiting multilingual practices, already attested in Delhi and Hyderabad classroom observations, in a scaffolded and structured way during lesson delivery is essential to ensure better use of teachers' and learners' language resources. The notion of a monolingual medium of instruction seems to be flawed in multilingual India. Further research on the development of multilingual materials for teaching and assessment is essential for improving learners' comprehension skills, for reducing inequalities in assessment and for working towards the abolition of the *double divide* that Mohanty has so eloquently presented in his work and particularly his 2020 monograph. Finally, teacher training to improve the teaching of reading comprehension strategies building on home and school languages is crucial for raising learning outcomes. Pre-service and in-service teachers would benefit hugely from a

compulsory training programme run by state governments with the support of NGOs and foundations endorsing multilingualism for better learning trajectories and outcomes in primary schoolchildren. Such an investment could increase the student potential in secondary and tertiary education too and level socioeconomic and gender inequalities across the country.

A classroom in a government school in Hyderabad

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Not pictured: Suvarna Alladi, Pallawi Sinha, Nainy Rao, Kankan Das, Anu Nagalakshmi, Joshua Reddy, B. Dedeepya, B.R. Deepa, M. Madhuri, Debanjan Chakrabarti, Dhir Jhingran, Rama Mathew, Ganesh Devy

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