Migration, Multilinguality and Mathematics learning

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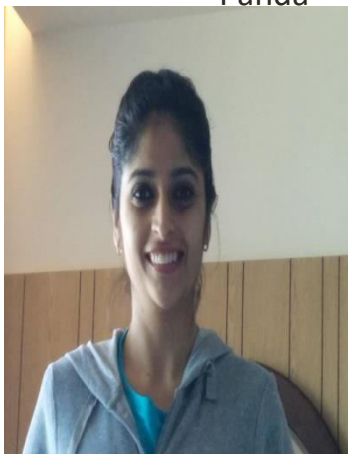

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Linguistic fluidity, Indian Multilingualism and Cognitive Advantages

- India is historically a multilingual country with nearly 1700 and more living languages.
- Indian multilinguality is marked by linguistic fluidity (Pundit, 1954; Srivastava, 1976; Mohanty, 2003; 2010; Agnihotri, 1995, 2006, 2007, 2016; Panda, 2010, 2012, 2015, 2017; Pattnayak, 2002, 2017)
- What is commonplace is heteroglossic ideology. Multilingual communication is a norm and not an exception (Panda, 2016, 2017; Panda & Bhagat, 2017). Mother tongue of many children is this multilinguality and not 'A' language. Best examples are from urban poor settlements in Delhi. Many slum students reported in our present study that their parents speak to them in Bhojpuri or Rajasthani at home and they reply in Hindi. Two of my sociolinguistic studies Rajasthan (Panda, 2016) and Madhya Pradesh (Panda, 2018) reveal numerous such incidences.
- Suppression of linguistic fluidity affects adversely the creativity and learning of poor children from migrant families. Creative use of multilingual-multi-semiotic resources of young marginalised children may create new pedagogic affordances for learning in schools.

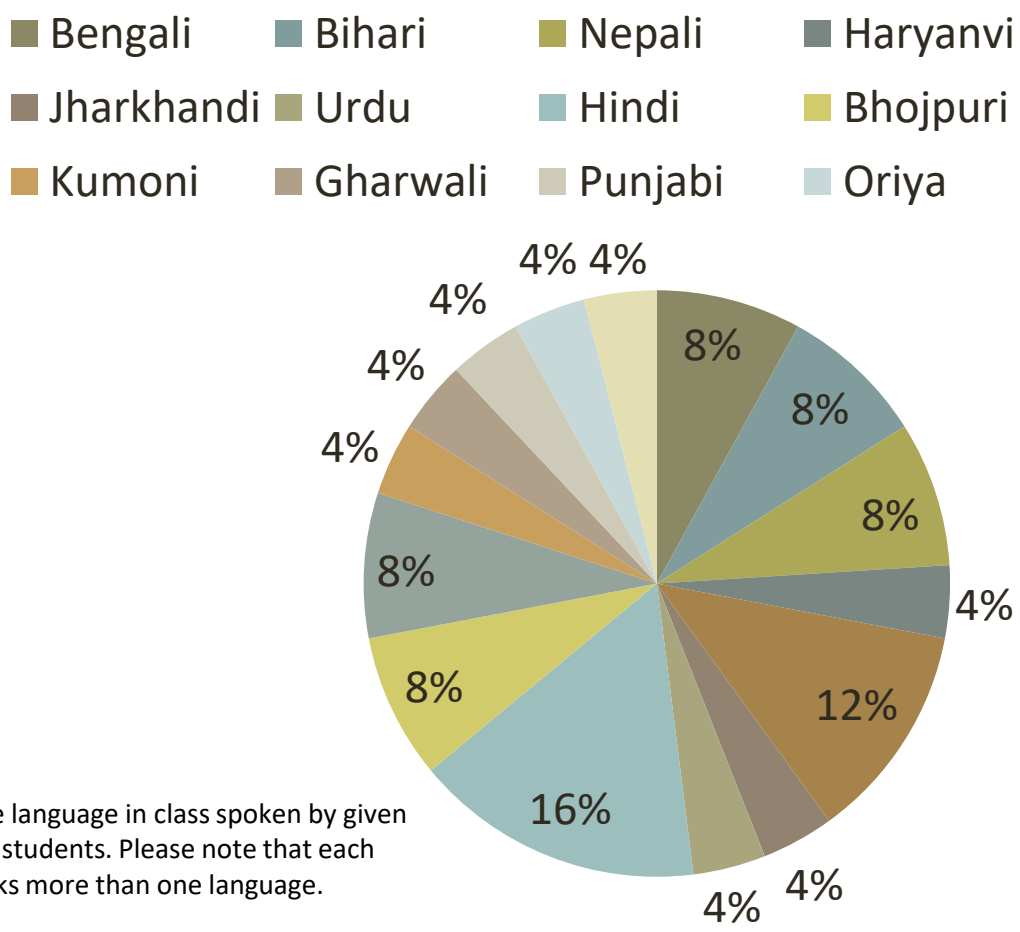
- But, there is a tension between the linguistic fluidity (language practice) of the country and the language planning which is often monolingual (language policy) (Canagarajah, 2003, 2016; Rehman, 2007; Panda, 2017, 2018).

- Language-in-Education policy has never probably attempted to approximate to the actual language practice of the country (language fluidity). Three language formula was a political settlement at the time of independence lacking a psycholinguistic imperative. The language-in-education policy even today lacks a critical psycholinguistic perspective.

- This impacts the education of the marginalised in a multilingual classroom, where children speaking different home languages study. The number of home languages many times exceed 10.

- Aspiration for English education has unfortunately not achieved any settlement with the real issues of learning and creativity in this country.

Languages Spoken in one of the slum schools included in the Delhi Study

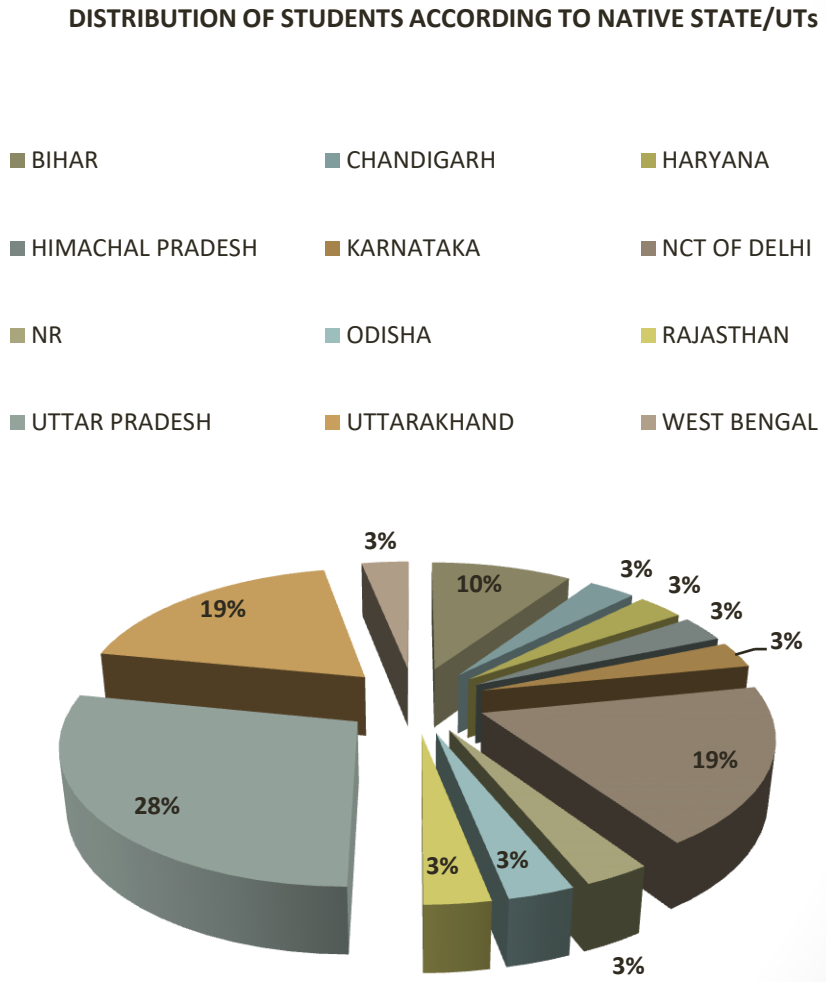


This shows the language in class spoken by given percentage of students. Please note that each students speaks more than one language.

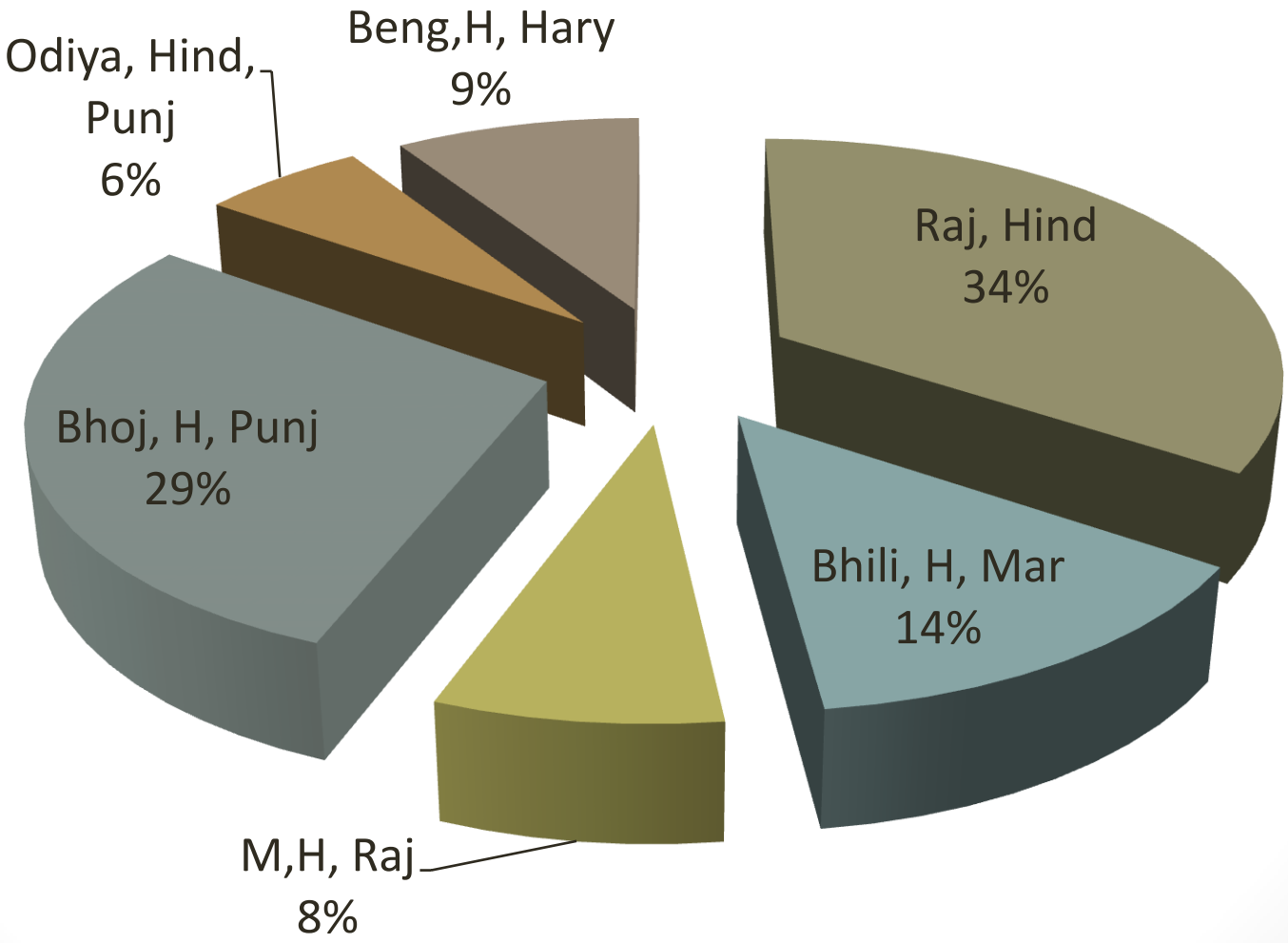
Multilinguality of students in a class VI science classroom in Delhi (Panda & Bhagat, 2017)

I

STATES/UTs	Number of Students	%age of Students
BIHAR	3	9.38
CHANDIGARH	1	3.13
HARYANA	1	3.13
HIMACHAL PRADESH	1	3.13
KARNATAKA	1	3.13
NCT OF DELHI	6	18.75
NR	1	3.13
ODISHA	1	3.13
RAJASTHAN	1	3.13
UTTAR PRADESH	9	28.13
UTTARAKHAND	6	18.75
WEST BENGAL	1	3.13
	32	100.00



What languages do you speak in your community? (See Panda, 2002, Kusumpur Pahadi school)



Facilities of Multilinguality

- Given bellow is an excerpt from a classroom dialogue of a teacher in a KV privately (a English-Hindi Bilingual school) who has knowledge of three languages – Marathi, Hindi and English, believes privately in monolingual policy but dialogues in bilingual code in class (see our Delhi study , Panda & Bhagat, 2017).

"…par chote bachhon ke saath ye hai ki they are …matlab abhi bahut chote hain …they do not understand English …poora ek do para English mein unko explain kar do, they will give you blank face so I have to explain to them in hindi jab mujhe lagega ..confidence aa jaayega ki inko aa raha hai then I will explain in English …"

- (Panda & Bhagat, 2017)

CONT…

Exa: Use of code switching as a pedagogic tool for alignment of motives in a science class (Panda & Bhagat, 2017)

T: what do you mean by natural and artificial …? (looks at them waits for answer)

S: no response

*T: natural **aur** artificial **mein** **kya** difference **hai** (pause)*

Use of code switching By students : Equivalence, floor holding ,conflict control, reiteration

*T: garbage disposal **se… kya matlab hai…pehle to mujhae iss** term **ka matlab bataiye** …what do you mean by ..garbage.. disposal (moves her hand with each word in air)…**bolo…***

*S: (stands) maam garbage **ko khaad banana hai** …*

Selection of schools for the Present Study in Delhi

- Eight schools catering to poor children in Delhi were identified for this study with four each in slum and non-slum areas. The slum schools are the ones that are locate d within or very close to Delhi slums. In order to get a matched sample, four Government schools located in residential colonies but catering to poor children were selected. We used the Delhi Government's definition of slum for selecting the sample.

- Economic deprivation is a categorical variable. Children who are brought up in slum localities witness more economic and social deprivation compared to other economically weaker sections.

- As many migrant communities live in these slums, schools located in slums witness a mobile students population who simultaneously engage with house hold chores as school education.

Sample

	Location1 (In/Near Slum) Total 4 schools	Location2 (In/Near Residential Colonies) Total 4 Schools	Total 8 Schools
Boys	107	98	205
Girls	96	111	207
Total	203	209	412

Multilingualism in classrooms

- In every school, children came from families which had migrated from far off places such as Bihar, Bengal, Rajasthan, Himachal UP and so on
- On an average, every classroom had children who spoke and understood 2 to 3 languages. Every classroom had a presence of 10 to 12 different languages.
- In the schools, official medium of instruction was either Hindi or English
- In the English medium schools, teachers switched between official medium of instruction and Hindi to facilitate children's understanding of the lessons.

Addressing some Teething Issues in Administering the Research Tools

- Word Problems
  - In English medium schools, children couldn't read or comprehend the problems in English.
  - Hindi translation was found to be too technical and was hindered by poor reading skill of the children
- Action taken: The instructions for all the word problems were recorded in local Hindi and circulated to all teams to maintain parity.
- Math Anxiety
  - Children couldn't understand the meaning of 'anxiety'
  - Use of emojis
- Action taken: RAs associated the meaning of emojis with feelings with words for the child and explained the meaning of anxiety
- Children enjoyed computer based tasks: Flankers and N back.

Tools (contd.)

Child Questionnaire

- When the children were asked to name the home language or the mother tongue, they had difficulty in name the language even if they knew that they speak a different language at home.
- Section C – Children were not comfortable answering questions from this section.

Action taken: It was decided that because the children could not provide sufficient information, alternate ways must be explored to reach the desired information.

Meta mathematics task

Initial plan of recording children's responses to why another person makes such a mistake was changed in favour of giving alternative answers so that the responses can be quantified.

Table 1

Pearson's Correlation among variables

	1	2	3	4	5	6
1.ASER English						
2. ASER Hindi	.762**					
3. Numeracy 1	.615**	.653**				
4. Word Problems	.299**	.290**	.349**			
5. Meta Math	.406**	.378**	.435**	.303**		
6. Ravens	.375**	.35**	.374**	.268**	.205**	
7. Math Anxiety	.119	-.071	-.121	-.056	-.016	-0.69

*Note: *p<.05, ** p<.01*

Table 2

Table Comparing Two Principal Component Analysis

Variables	Principal Component Analysis 1 r	Principal Component Analysis 2 r
ASER Reading English	.845	.714
ASER Reading Hindi	.841	.711
Numeracy 1	.828	.684
Word Problems	.535	.287
Meta Math	.615	.383
Raven's	.567	.322
Math Anxiety	-.160	
Eigenvalues	3.119	3.11
Percentage of Variance Explained	44.55	51.683

Notes: r is the coefficient of correlation of the variables with the extracted component

Table 3

Table showing the ANOVA results showing difference between males and females in locations 1 and 2 with respect to the extracted component

Source	df	Mean Squares	F	P
Sex	1	.511	.520	.471
Location	1	5.90	6.007	.015
Sex*Location	1	3.94	4.01	.046

Analysis of variance showed a statistically significant difference at the $p < .05$ level in the extracted variable for students from location 1 (In/Near Slum) and location 2 (In/ Near Residential colonies): $F(1, 412) = .52, p = .015$. The results also show a significant interaction effect between sex and location $F(1, 412) = 4.01$, $p = .046$.

Table 4

Table showing mean and standard deviation of males and females in locations 1 and 2 on the extracted component.

Sex	Location	Mean	Standard Deviaion	n
Males	1 (In/Near Slum)	-.006	1.00	107
	2 (In/ Near Residential colonies)	-.049	.977	98
	Total	-.027	.98	205
Females	1 (In/Near Slum)	.260	.847	96
	2 (In/ Near Residential colonies)	-.175	1.09	111
	Total	.026	1.01	207
Total	1 (In/Near Slum)	.119	.940	203
	2 (In/ Near Residential colonies)	-.116	1.04	209

Table 5

Table showing the ANOVA results showing difference between males and females in locations 1 and 2 in Math Anxiety

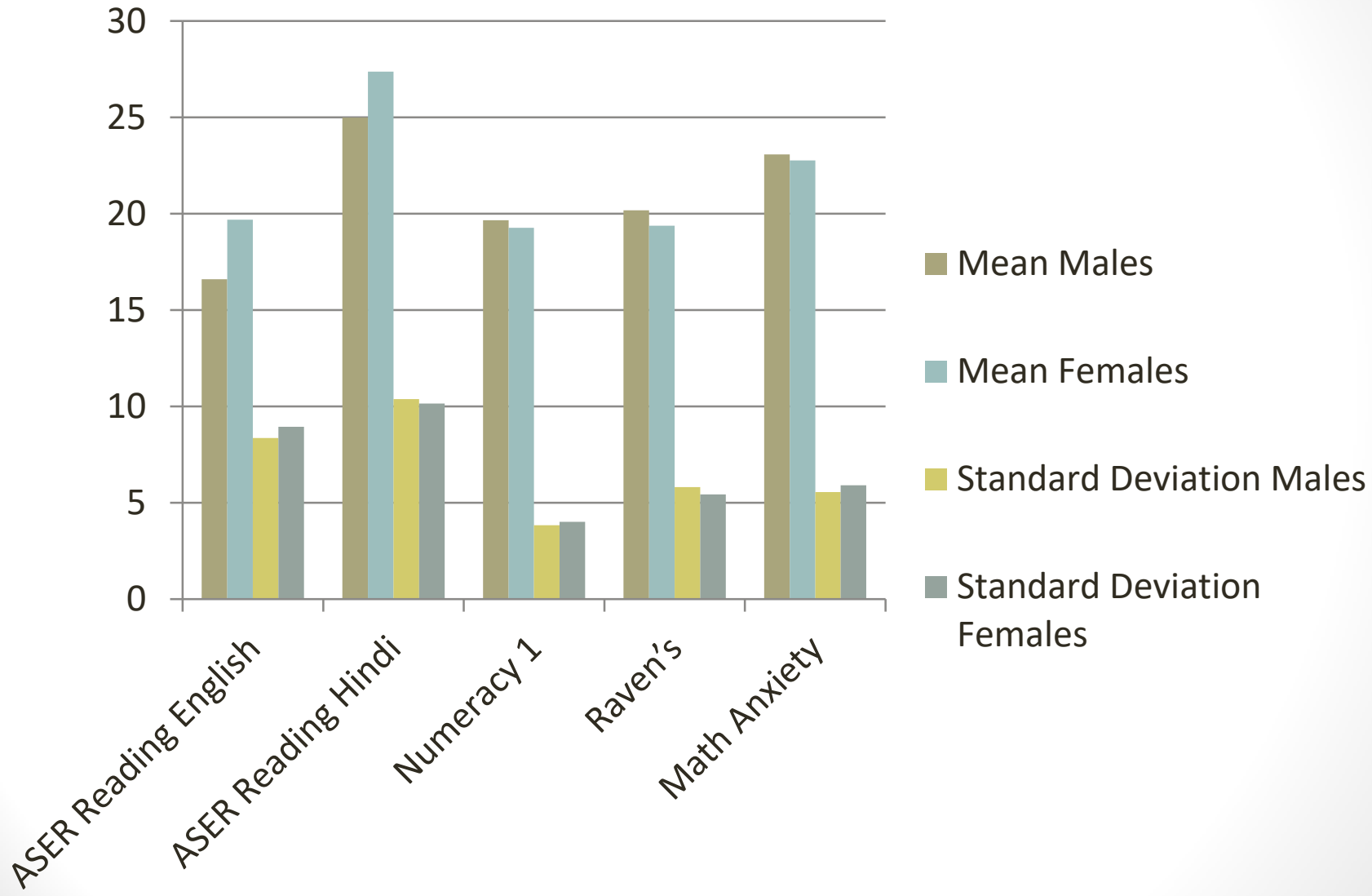
Source	df	Mean Squares	F	P
Sex	1	11.409	.347	.556
Location	1	6.71	.204	.651
Sex*Location	1	91.35	2.778	.096

Table 6

Table showing mean and standard deviation of males and females in locations 1 and 2 on math anxiety.

Sex	Location	Mean	Standard Deviaion	N
Males	1 (In/Near Slum)	23.401	5.298	107
	2 (In/ Near Residential colonies)	22.714	5.843	98
	Total	23.073	5.562	205
Females	1 (In/Near Slum)	22.125	5.148	96
	2 (In/ Near Residential colonies)	23.324	6.473	111
	Total	22.768	5.913	207
Total	1 (In/Near Slum)	22.798	5.254	203
	2 (In/ Near Residential colonies)	23.038	6.179	209
	Total	22.919	5.736	412

Graph showing mean and standard deviation for males and females



Graph showing mean and standard deviation for males and females

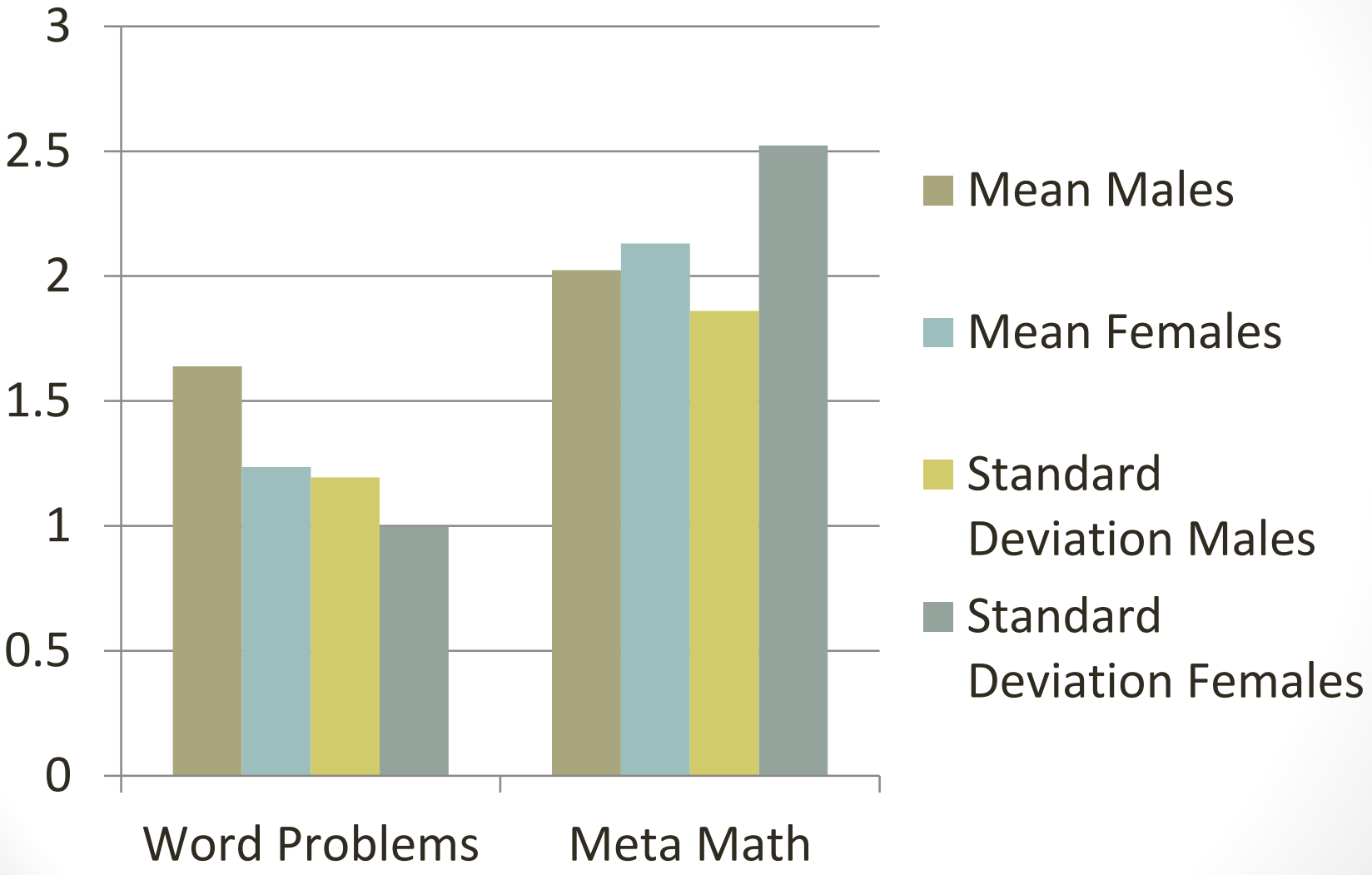


Table 7

T test results for various parameters by sex

Parameters	df	t	Mean Difference	Standard Error of Mean Difference
ASERReadingEnglish	410	3.621*	-3.090	.853
ASER Reading Hindi	410	2.353*	2.381	1.011
Numeracy 1	410	.990	.383	.387
Word Problems	410	3.710*	.402	.108
Meta Math	410	.485	-.106	.218
Raven's	410	1.448	.803	.554
Math Anxiety	410	.539	.305	.565

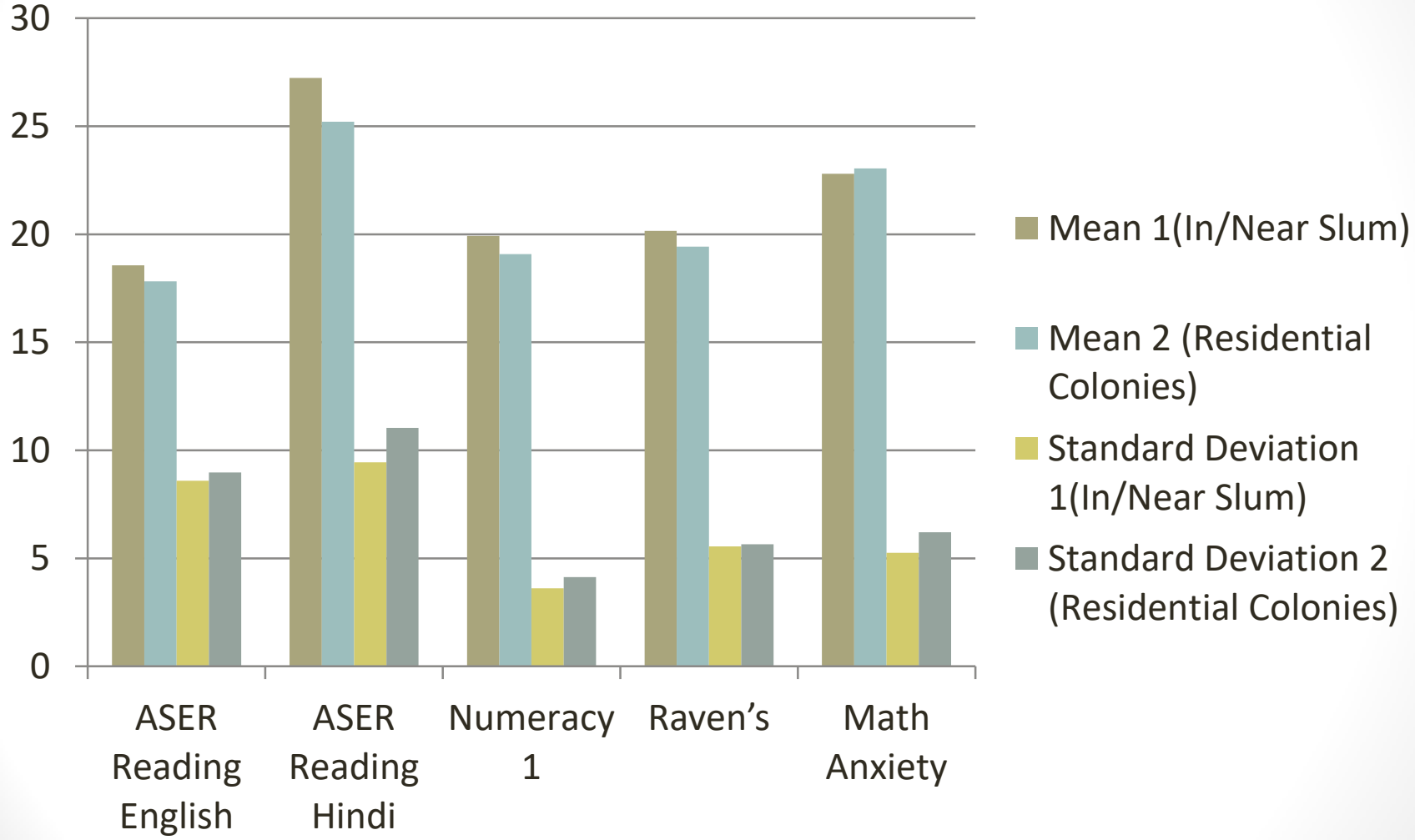
Note $*p \leq .05$

Table 8

Table showing mean and standard deviation for males and females on all parameters

Parameters	Mean		Standard Deviation	
	Males	Females	Males	Females
ASER Reading English	16.604	19.695	8.368	8.944
ASER Reading Hindi	24.995	27.376	10.383	10.157
Numeracy 1	19.658	19.275	3.842	4.011
Word Problems	1.639	1.236	1.194	.998
Meta Math	2.024	2.130	1.861	2.523
Raven's	20.185	19.381	5.817	5.441
Math Anxiety	23.073	22.768	5.562	5.913
Total Males	205			
Total Females	207			

Graph showing mean and standard deviation for locations 1 and 2 on various parameters



Graph showing mean and standard deviation for locations 1 and 2 on word problems and meta math

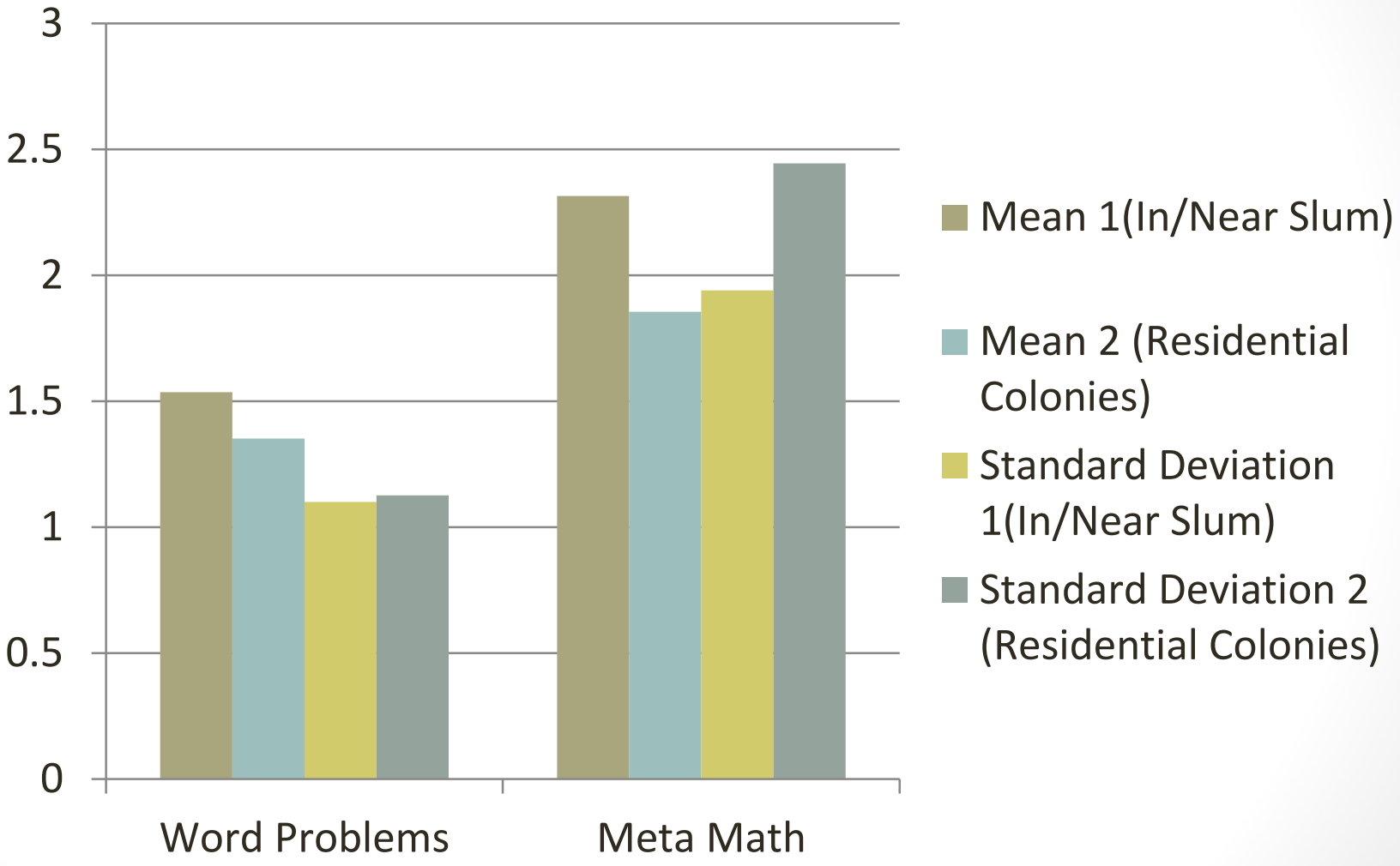


Table 9

T test results for various parameters by location

Parameters	df	T	Mean Difference	Standard Error of Mean Difference
ASER ReadingEnglish	408	.847	.735	.867
ASER Reading Hindi	408	1.998*	2.028	1.015
Numeracy 1	408	2.199*	.843	.383
Word Problems	408	1.676	.184	.109
Meta Math	408	2.108*	.46	.218
Raven's	408	1.305	.722	.553
Math Anxiety	408	-.449	-.255	.568

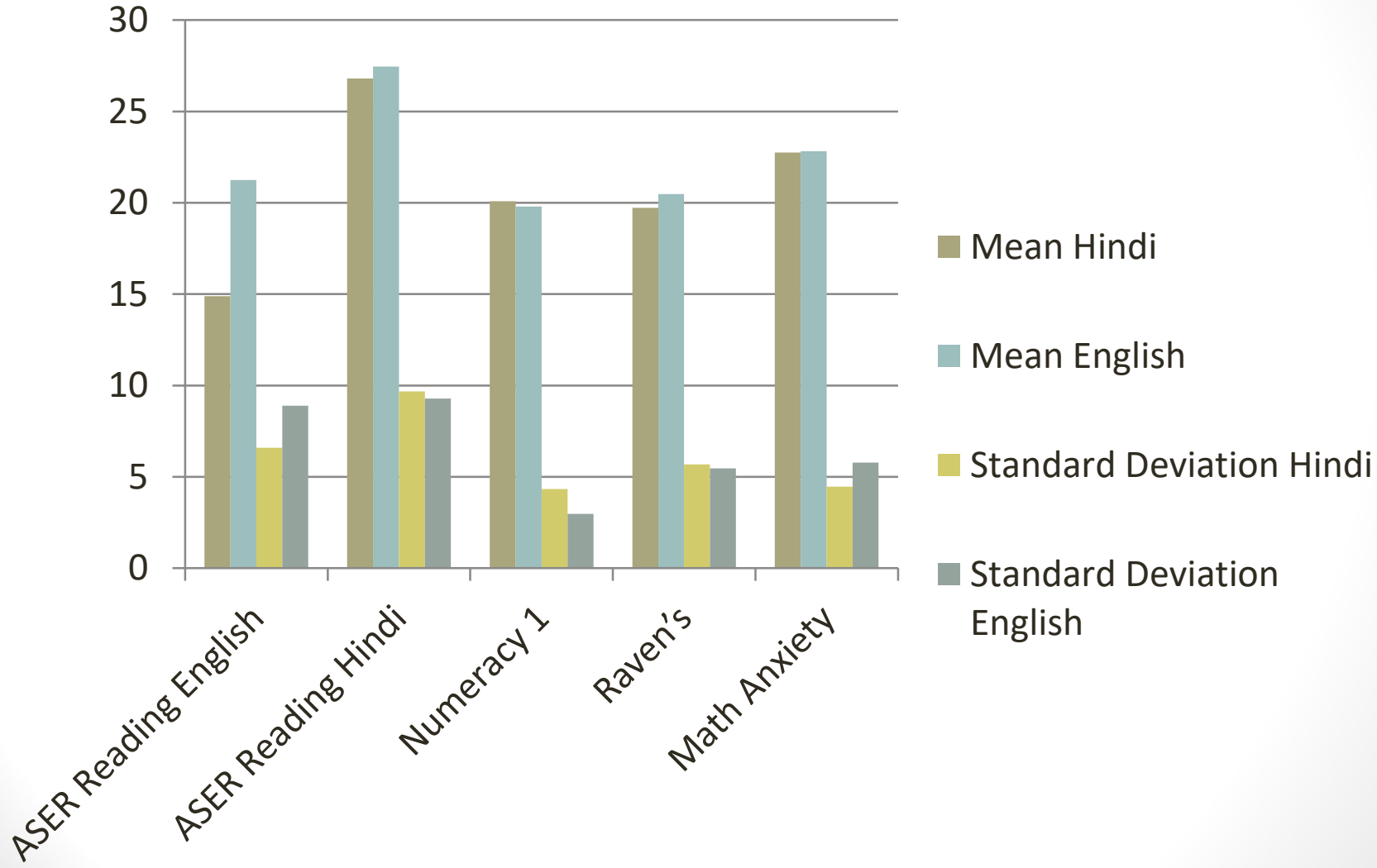
*Note *p ≤ .05*

Table 10

Table showing mean and standard deviation for the locations 1 and 2 on all parameters

Parameters	Mean		Standard Deviation	
	1(In/Near Slum)	2 (Residential Colonies)	1(In/Near Slum)	2 (In/ Near Residential Colonies)
ASER Reading English	18.561	17.826	8.586	8.976
ASER Reading Hindi	27.241	25.212	9.439	11.041
Numeracy 1	19.921	19.077	3.612	4.134
Word Problems	1.536	1.352	1.1	1.126
Meta Math	2.315	1.855	1.94	2.445
Raven's	20.152	19.43	5.558	5.656
Math Anxiety	22.798	23.053	5.254	6.205
Total Location 1	203			
Total Location 2	207			

Graph showing mean and standard deviation for Hindi and English Medium students from location1



Graph showing mean and standard deviation for Hindi and English Medium students from location1

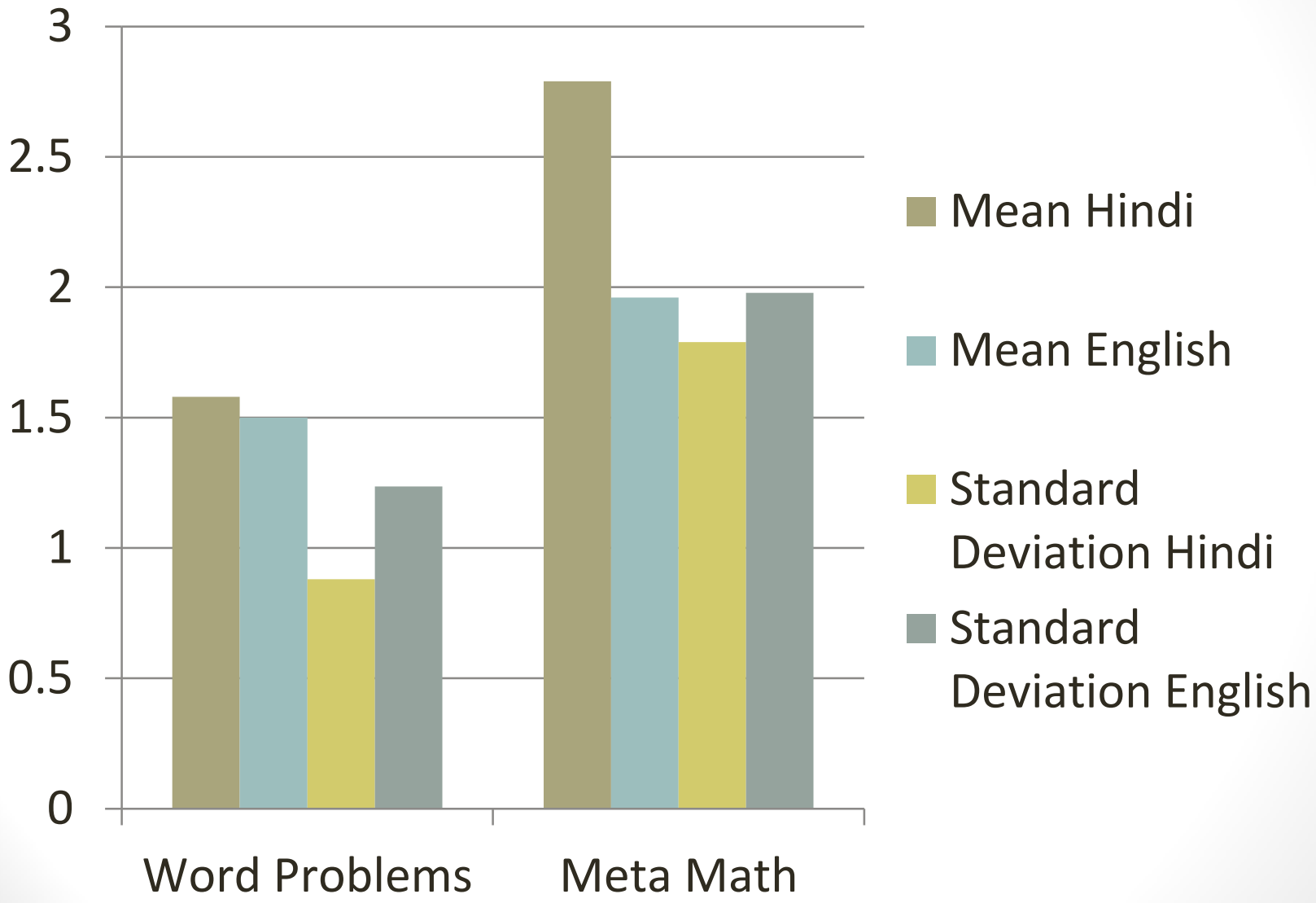


Table11

T test results for various parameters by medium of instruction for students from Location 1

Parameters	df	t	Mean Difference	Standard Error of Mean Difference
ASER English	201	5.593**	6.361	1.137
ASER Hindi	201	.567	.761	1.343
Numeracy 1	201	.541	.277	.514
Word Problems	201	.493	.077	.156
Meta Math	201	3.051**	.824	.270
Raven's	201	.949	.749	.789
Math Anxiety	201	.098	.073	.748

*Note **p ≤ .01*

Table 12

Table showing mean and standard deviation for Hindi and English Medium students from location 1 on all parameters

Parameters	Mean		Standard Deviation	
	Hindi	English	Hindi	English
ASER Reading English	14.893	21.25	6.59	8.899
ASER Reading Hindi	26.802	27.46	9.67	9.291
Numeracy 1	20.08	19.80	4.34	2.974
Word Problems	1.58	1.50	.88	1.236
Meta Math	2.79	1.96	1.79	1.978
Raven's	19.720	20.47	5.68	5.46
Math Anxiety	22.755	22.82	4.466	5.78
Total Hindi	117			
Total English	86			

Key Findings

- Interetsingly, all the variables such as ASER Reading (English), ASER Reading (Hindi), ASER Numeracy Task, Math Word Problems, Meta Mathematics and RPM loaded on one factor explaining a total of 44.55% of variance.
- ANOVA shows significant mean difference between slum and non-slum students on the single extracted component. Slum children outperformed the non-slum children on this more reliable extracted domain obtained through factor analysis.
- Interaction effect of sex and location on extracted component.
  - Girls from slum area schools scored highest
- Significant difference between boys and girls
  - Girls scored higher on ASER English and ASER Hindi
  - Boys did better on Word Problems
- Significant difference between locations
  - Students from slum schools did better than those from non-slum schools on ASER Hindi, Numeracy 1 and Meta-mathematics.
- Significant difference between medium of instruction
  - English medium students performed better on ASER English
  - Hindi medium students performed better on meta-math

Trends

- Girls score higher in
  - ASER English
  - ASER Hindi
  - Meta-math
- Boys score higher in
  - Numeracy 1
  - Word problems
  - Ravens
  - Math anxiety
- Students from slum schools scored higher in all parameters.
- Hindi medium scored higher on
  - Numeracy 1
  - Word problems
  - Meta math
- English medium scored higher on
  - ASER English
  - ASER Hindi

Major Findings

- One of the major finding I see here is the significant mean difference between the two locations on the extracted single component (Literacy+Numeracy+inteligence) explaining a variance of 44.5%. The students from the schools located in slum areas performed better than those studying in schools located in residential colonies. Girls from slum schools and boys from non-slum schools performed better.

- The mean difference tests on individual numeracy tasks show the children from the schools located in and around slums performed significantly better than their counterparts studying in schools in and around residential areas.

- A comparison of Hindi and English medium schools located in and around slum areas shows that the Hindi medium students outperformed the English medium students in ASER numeracy tasks, word problems and the meta maths. The performance was significantly high in meta maths.

Possible Reasons

- One possible reason for advantage in numeracy tasks could be that the teachers in the schools located in and around slums are probably more permissive so far children's natural language use and use of their everyday experiences are concerned. The burden of monolinguality in school language and dismissal of everyday knowledge could be more in the schools located in and around the residential areas. (Needs to be explored in detail in the second phase of the study)

- The other reason could be that the children from slums may be involved more in house hold chores including marketing and handling money independently. As revealed from the textbook analysis (Panda, 2006), the school mathematics is filled with shopping applications and therefore benefits those who have handled money in many different ways independently in childhood. The slum children also deal with mathematical ideas and concepts like size and space relations, quantity, space and value relations etc in their everyday life more closely than the non-slum children who may be experiencing a more pedagogically driven parent-child talk than experiencing objects, concepts and ideas themselves. The meaning of these mathematical terms are shaped by the social relations constituting the everyday practice in which these words find their life.

CONT....

- The conceptual capacity of these children for mathematization develops by acquiring pre-conceptual structures resulting from everyday market experiences that work as linguistic and intellectual input. The human capacity for gestalt helps these children develop these pre-conceptual structures by making connections themselves. They acquire numerous semiotic and pre-mathematical structures that help them mathematize any abstract context. A pedagogically mediated space that allows children to use all their early semiotic (multiple signifiers related to mathematical ideas and concepts) and (pre-)structural resources will certainly create the motive, and the conceptual capacity for doing mathematics among children.

- Imposition of school language and school ways of solving problems suppresses the multiple signifiers: lexical, emotional and metaphorical. Allowance of children's linguistic resources are key to retain these, and in turn, enhance the imagination for creation of new pre-conceptual structures.

CONT...

- It is therefore not enough that the children are multilingual or have enough everyday experiences for attaining school success. It is important that the textbooks and classroom dialogues create new affordances for learning by using children's languages, experiences and imagination for further development of their conceptual capacity.

- In fact, formal mathematics in linguistically and culturally hegemonic monolingual classrooms is built on a bounded discourse in which it operates by means of suppression of all aspects of multiple significations.

- The support for this argument also comes from the findings that the students studying in Hindi medium schools and slums performing significantly better in meta-mathematics than the students studying in English medium schools.

CONT....

- The same arguments can be offered to explain the gender differences with girls doing better than boys in ASER literacy tasks (Hindi and English) and boys doing better in word problems (Math).

- Another reason for non-slum children under performing could be the private tuitions themselves. Compared to slum schools, more number of students from non-slum schools were attending low cost over crowded private tuition classes after school hours. The mindless mathematical drills in tuition classes could be foreclosing any possibility for students taking advantage of their old pre-conceptual structures. The students' conceptual capacity, instead of growing may further decline. The higher math anxiety among English medium school students could partly be because of this reason. We however need more data to establish this argument.

- The third reason could be teachers' expectations. The teachers expectation in non-slum schools could be higher than the slum schools. The burden of these expectations is not eased out either by a good classroom interaction or in one-to-one tuition classes.