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9. STUDENTS' USE OF THEIR LANGUAGES AND REGISTERS

*An Example of the Socio-Cultural Role of Language in
Multilingual Classrooms*

INTRODUCTION

In multilingual classrooms, use of different languages is an important, although often neglected or not appreciated, resource (Clarkson, 2007; Moschkovich, 2002). Multilingual classrooms based in multilingual and multicultural societies present potentially rich instances of language and cultural resources that can inform language sensitive teaching strategies for developing conceptual understanding among students (see, Cummins, 2000; Duval, 2006). Some of the previous studies undertaken in multilingual and multicultural societies like India, Pakistan and South Africa have highlighted how transitions between everyday registers, school registers and mathematical registers happen naturally for students by using different representations and non verbal cues (Bose & Choudhury, 2010; Halai, 2009; Setati, 2005). These studies however, did not look particularly at the cultural resources or cues that emerge during classroom lessons. It has been argued separately that in such societies, the linguistic and social nature of mathematics facilitates its social construction together with language (Barton, 2009), and such classroom phenomena can facilitate effective mathematical learning (Prediger, Clarkson, & Bose, 2015).

Researchers have also shown that the plurality of registers can be used purposefully since students' discourse and thinking are not confined to the teaching language but occurs in all languages in which the stakeholders (students and teachers) are fluent (Clarkson, 1983; Prediger & Wessel, 2011). This chapter, using empirical snapshots from some classrooms in Mumbai, India, will show that teachers are at times also prepared to use the multiplicity of languages and registers that are available in their teaching of mathematics. The chapter will first describe some of these episodes from a socio-cultural standpoint of teaching, and then use Prediger and Wessel's (2011) "Integrated Model" that underlines the representations required by the teacher.

MEANING MAKING AND LANGUAGE NEGOTIATION IN
MULTILINGUAL MATH CLASSROOMS

Researchers in the past have emphasized the need to look at the relationship between language and mathematics learning from a “situated-sociocultural perspective” for better “mathematics reforms” (Moschkovich, 2002, p. 189). Previous studies on multilingualism in mathematics classrooms have highlighted the challenges faced by students while tackling words problems, and when they encounter mathematical as well as technical registers and symbols. In these studies, the focus shifted from students’ learning of vocabulary and comprehension skills to one of students’ meaning making and knowledge construction (Clarkson, 2007; Halai, 2009; Moschkovich, 2002; Setati, 2005).

In particular, Moschkovich’s (2002) notion of situated-sociocultural perspective provides an analytic tool to describe students’ competences in drawing on resources derived from their experiences of out-of-school contexts as well as participation in the mathematical discourse in the classroom. This tool provides a perspective, Moschkovich has argued, that is different from but does not replace just acquiring vocabulary or constructing meaning by students. She suggests it is necessary as well to examine students’ mathematical discussions and their use of resources so that more subtle meanings cued from gestures and objects can be deduced. However Moschkovich did not clearly model the various languages and registers that multilingual students may have access to.

The research literature that looks at the interface of multilingualism and mathematics education often reflects three broad notions of language-negotiations in mathematics classrooms: transition between first (or home) and second (or school) languages, which is often referred to as code switching in relevant studies; transition between informal (everyday) and formal (technical) language; and, transition between different mathematical representations (see, Prediger, Clarkson, & Bose, 2015). There seems to be only a few research studies directly addressing the latter two of these transitions.

It is commonly seen that multilingual students often switch between informal (everyday) and formal (school and/or technical) registers favoring their “language of comfort”, as Bose and Choudhury (2010) have termed it. They have argued that students’ “language of comfort” could be their home (or first) language, or their commonly spoken local language, which may be different to their non-home (or second) language, or a mix of both. Their “language of comfort”, in addition to other languages such as home and formal languages, affords the potential for increased switching between everyday and technical registers. This phenomenon has also been discussed by Clarkson (2009) who has noted that the three registers (everyday/informal register, school register and technical register), may exist in more than one of the student’s languages and that multilingual students often encounter them all.

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He has further suggested there is often a dynamic between all three registers, across all the languages (L_1 , L_2 , and so on; see Figure 1).

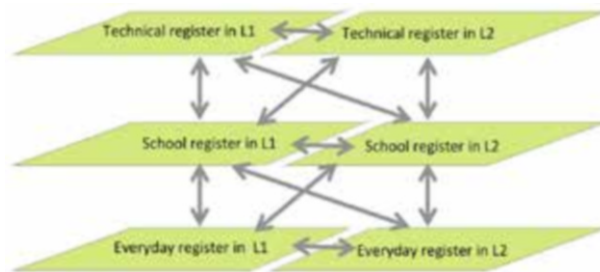


Figure 1. Three-tiered model of language and registers showing possible dynamic movement (adapted from Clarkson, 2009)

Prediger and her students have extended Clarkson's model by incorporating other teaching registers (see Figure 2). Prediger has been exploring how immigrant Turkish students utilize these registers in their learning when enrolled in German secondary schools (e.g., Prediger & Wessel, 2013). Within all of these registers she argues that various socio-cultural cues are used to good effect for the students' learning.

In this chapter we use notions from both Prediger and Wessel's model and Moschkovich's situated-sociocultural perspective to examine the language moves

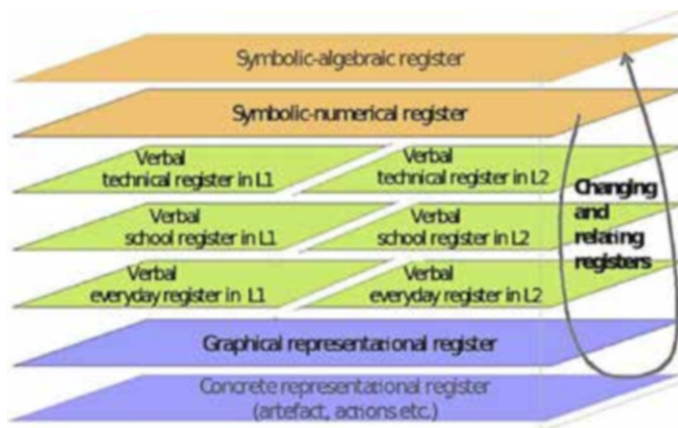


Figure 2. An integrated model that surrounds the language model (both written and verbal) with other teaching registers (adapted from Prediger & Wessel, 2011)

and utilization of cultural cues in various mathematical learning settings by multi lingual students in Mumbai, India.

CONTEXTS AND SNAPSHOTS FROM THE CLASSROOMS

We present below a number of snippets of recorded dialogue from two different types or contexts of classrooms: the first context is dialogue from two standard classrooms, while the second context is from class sessions taught during a vacation camp that was conducted in the school by the first author and his colleagues. But first we sketch in the contexts of the two types of classrooms.

The 'Ordinary' Classroom and the 'Vacation Camp' Classroom Contexts

The snippets of dialogue analyzed later come from two different Grade 6 and a Grade 7 classroom of two government-run schools in a large, densely populated low-income settlement in central Mumbai, India. The first group of students were attending an English-medium school, while the second group participated in a vacation camp run for sixth and seventh graders of the above English-medium school and another Urdu-medium school, both co-housed in the same building.

An economically active neighbourhood surrounds the school building. This neighbourhood is dotted with micro-enterprise businesses in that practically every household (single room, low height dwellings) runs a small-scale manufacturing or factory unit. Being an old and established settlement, it draws migrants from various parts of the country. These migrants come to Mumbai in search of a livelihood. This mostly unskilled workforce often gets work in different workshops. Children living in the neighbourhood participate in the income generating practices from an early age and thus have ample opportunities to gather everyday mathematical knowledge associated with various manufacturing practices.

The five-floor school building has each floor designated as a separate school. Each of these schools uses a different language as a medium of instruction; namely Telugu, Marathi, English, Tamil and Urdu, respectively from the ground floor through to the fourth floor. The local government runs all five schools. Every student, no matter which school they attend, can fluently speak at least two different languages, while many can speak three languages or more.

The English-medium school draws the largest number of students compared to the other schools since the learning of English is seen as a gateway to future welfare, and hence school education in English is in huge demand. The English school finishes at Grade 7. Unlike the Urdu school which has single sections for Grades 8, 9 and 10, students graduating from Grade 7 of the English school need to transfer to other privately run schools to complete the higher grades, or they drop out from school and stop studying altogether.

Students, whose dialogue was analyzed, came from the low-income settlement surrounding the school building and most belonged to migrant families. They all

knew Hindi and Urdu while some spoke a different home language as well, for example, Marathi, Tamil, Bhojpuri, etc.

Teachers in both the English speaking and Urdu speaking schools are normally assigned a grade for the whole academic year and are expected to teach all subjects. In other words, there is no separate subject teacher in any grades in these schools. The English-medium school has a newly appointed batch of young teachers (mostly males) who joined the school in the last five years. None of the teachers live in the neighbourhood. However, through constant interaction with the students, parents and the community, and having participated in conducting the recent governmental census (an official duty assigned to the government-run school teachers), most teachers had an awareness and knowledge about the students' sociocultural and socioeconomic background, the kinds of work the families or the students were involved in, the students' everyday practices and routine, their income, wages, etc. All the teachers of the English-medium school could speak Marathi (first or home language) and Hindi fluently, while most of them could only partially speak English. Not every teacher in the Urdu-medium school was fluent in Marathi and English, but they were natively fluent in Urdu and Hindi.

Lessons in the fortnight-long vacation camp were taught by a senior colleague of the first author (a senior researcher in mathematics education). The attendance of students was voluntary. The vacation camp teacher could speak six languages fluently including Hindi (spoken Hindi is similar to spoken Urdu but the scripts are different), and the local language of Mumbai, Marathi. The camp commenced soon after the term-end examinations, and before the declaration of results. During this fortnight teachers were occupied in the grading and results preparation work. Therefore it was an ideal time for holding teaching camps during regular school hours but without disturbing any classroom teaching. The daily average attendance was around 25 with a majority of girls. The camp had daily classes for one hour and a half with a weekly holiday on Sundays.

Socio-Cultural Background and Language Context

The phenomenon of language switching is a common feature and part of the routine communication in urban India, but not a common practice during formal classroom sessions. In fact, in most English-medium schools, there is active discouragement of using multiple languages. English is expected to be the sole teaching and learning language used. However, in the English-medium school of the low-income settlement from where the following snippets originated, there is a marked departure from this convention. The researcher observed the regular teachers using multiple languages, with frequent use of English as would be expected, but also *Bambaiya Hindi* (a dialect of Hindi popularly used in Mumbai and surrounding areas) from time to time. Hence, switching between these languages by the students was expected in these classes.

In contrast, the medium of instruction in the vacation camp classes was a combination of Hindi and Urdu with occasional use of English. Hence it was

expected to find the vacation camp students following code-switching and using a mixture of languages.

Classroom Situations

The classroom situations in both contexts (school and vacation camp classes) had some differences. Use of both English and Hindi/Urdu during routine teaching processes usually came during explanation of difficult terminologies with an objective to clarify the concepts in an effective way. The main motto of the teachers was to 'clear the concept' and students often opened up in their home language than in English. The English-medium school had classrooms with no desks or benches for the students and they sat on a long mat or rug put on the floor. The students attending the camp, conducted in the Urdu-medium school in the same building, had the privilege of having benches and desks. Boys and girls in both schools sat in separate groups during their regular school schedule, a sociocultural norm, which was also observed in the vacation camp classes.

While the regular classroom scenario reflected a routine teaching/learning process in that teachers commonly started a lesson with introducing the topic for the day followed by individual bookwork, in comparison the vacation camp classroom scenario was more informal and relaxed with much more of an emphasis on student discussion. School classroom teaching did not involve group-work, although students informally discussed among themselves and/or looked at each other's work while doing the given exercises. Emphasis was given on working out every problem given at the end of each lesson in the textbook. Typically, the teacher solved one problem on the blackboard with explanations and occasional discussion with students but building on students' knowledge and experience rarely occurred. Rather emphasis was given on using the formulae appropriately. In contrast, the practice of group-work was encouraged during the vacation camp classes. The vacation camp teacher encouraged students to shift from individual work towards making public (shared) comments and questions using mathematically discursive practices (Bose, 2014). During math lessons in the regular English-medium classes, textbooks were only used with no use of other aids or resources. Much emphasis was given to rote memorization of multiplication tables, facts and formulae and their application. In contrast, the vacation camp saw use of diverse artifacts and emphasis was given to understanding rather than just knowing.

Snapshots from the Classrooms

Snapshot 1. We present below three transcripts (Transcripts 1a, 1b and 2) as snippets from regular math lessons in the English-medium school on the topic "profit and loss" from Section A and Section B classes of Grade 6. The first author observed both classes. In all the excerpts, the left-hand column indicates the segment number of the original transcripts while "T" and "S" indicate the teacher and student

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respectively. The next column reflects the actual utterance, while the right-most column presents the exact translation into English of the utterance. The grey shaded words represent words spoken in English in the original utterance while underlined and shaded words (only in Transcript 3) represent the words spoken in Urdu. The acronym 'BB' in the transcripts stands for the 'blackboard'.

Transcript 1a. Grade 6, Section A (English-medium school); Lesson: Profit & Loss; Teacher: T₁

1	T ₁	We all know about profit and loss/ what it is? Kaun batayega mujhe?	We all know about profit and loss/ <u>what</u> <u>it is?</u> Who's going to tell me?
2	S	fayda and nuksan/	profit and loss/
3	T ₁	kab hota hai profit and loss?	when do <u>profit and loss</u> occur?
4	S	jab.	when...
5	S	jab hum kam price mein kharidkar jyada price mein bechte hain/	when we buy for lesser <u>price</u> and sell for more <u>price</u> /
6	S	agar hum bag three fifty ka lenge aur char sau mein bechenge to profit hoga/	if we buy a <u>bag</u> for <u>three fifty</u> and sell for four hundred then there'll be <u>profit</u> /
7	T ₁	kitna profit hoga?	how much <u>profit</u> ?
8	S	fifty/	<u>fifty</u> /
9	T ₁	bagseller ne kitne mein kharida? Three fifty (writes 350 on BB)/ usne Wasim ko four hundred mein bech diya/ (writes 400 on BB)/	how much did the <u>bagseller</u> buy for? <u>Three fifty</u> (writes 350 on BB)/ he sold it to Wasim for <u>four hundred</u> / (writes 400 on BB)/
10	T ₁	to usko kitna rupees jyada mila?	then how much <u>rupees</u> more did he get?
11	S	humlog jitne mein bag kharidte hain, agar kam daam mein bechenge to loss hoga/	whatever price we buy a <u>bag</u> for, if we sell it for less then <u>loss</u> occurs/

*Transcript 1b. Grade 6, Section A (English-medium school);
Lesson: Profit & Loss; Teacher: T₁*

34	T ₁	pehle bag three fifty mein kharida aur four hundred mein becha to kya hua?	<u>first bag</u> was for <u>three fifty</u> and sold for <u>four hundred</u> then what happened?
35	S	profit/	<u>profit</u> /
36	T ₁	kitna?	how much?
37	S	fifty rupees/ (chorus)/	<u>fifty rupees</u> / (chorus)/
38	T ₁	kaise mila fifty rupees?	how did you get <u>fifty rupees</u> ?
39	S	minus kiya/	did <u>minus</u> /

(Continued)

40	T ₁	very good/ kisko kisme se minus kiya?	very good/ what did you minus from what?
41	S	four hundred mein se three fifty/	three fifty from four hundred/
42	T ₁	four hundred kya tha aur three fifty kya tha?	what was four hundred and what was three fifty?
43	S	four hundred SP aur three fifty CP/	four hundred SP and three fifty CP/

Transcript 2. Grade 6, Section B (English-medium school); Lesson: Profit & Loss; Teacher: T₂

2	T ₂	write the heading / (writes "Profit & Loss")	write the heading / (writes "Profit & Loss")
3	T ₂	First we discuss meaning of profit and loss / jaise hum dukan mein jate hain toh mostly hum yeh use karte hain / example, dukan mein jate ho, pen buy kara, uska daam hai ten rupees / yeh uska cost price / kharidne ki kimat ko CP bolte hain / maine same pen bech diya fifteen rupees mein / to mera kya hua?	First we discuss meaning of profit and loss/ So when we go to shops mostly we use this/ example, you visit a shop, buy a pen, its price is ten rupees/ this is its cost price/ buying price is called CP/ I sold the same pen for fifteen rupees/ then what do I get?
4	S	profit/	Profit/
5	T ₂	yaani CP se jyada jo mila toh that is called as a profit / CP se upar jo value mila toh profit hua/	Meaning whatever is obtained more than CP that is called as a profit/ The value that is obtained over CP becomes profit/
6	T ₂	ab loss kya hai?	Now what is loss?
7	S	agar uss pen ko paanch rupaye mein beche to loss hua/	If that pen is sold for five rupees then it's a loss/
8	T ₂	yeh CP hai (writes CP on BB) usse agar mujhe kam kuchh milta hai to woh loss hota hai/	This is CP (writes "CP" on BB) if I get anything less than this then it is a loss/

Both Grade 6 teachers introduced the technical terms *profit*, *loss*, *cost price (CP)*, *selling price (SP)* and the formulae for finding profit or loss. Emphasis was given on solving the textbook problems and correctly arriving at the answers. The transcripts are parts of the discussions that happened while the teachers were explaining the concepts. The students, with their exposure and engagement in the work contexts, and knowledge about the income generating work around them, possessed an understanding of "profit and loss" and used their everyday language to encode the formal meanings of these terms.

The classroom conversations drew on such experiences. For example in Transcript 1a, line 5, 6 and in Transcript 2, line 7, students' use of the instances of profit and loss came from their routine economic transactions and shopping. Students from the settlement have a rich exposure to handling and exchanging currency notes and coins and in doing the calculations mentally (Bose & Subramaniam, 2011). Such exposure created natural everyday settings for the students to co-relate such mathematics content as was being discussed in the classroom with their out-of-school contexts. This prompted them to use their "everyday" registers; for instance in line 11, Transcript 1a, *agar kam daam mein bechenge to loss hoga (if we sell it for less than loss occurs)*. Interestingly here the sentence construction used by the student also reflects an informal and everyday usage of their colloquial registers, which are different from the sentence construction when used in a formal usage.

Snapshot 2. During the vacation camp classes the teacher adopted a teaching design experiment approach to try and explicitly build connections between middle graders' everyday mathematical knowledge, work-context knowledge and identities to inform their school mathematics learning. In contrast, during these students' regular classroom lesson in the Urdu-medium school, use of their everyday mathematical knowledge was spontaneous even though their teachers only used the textbook. In the vacation camp however, the teacher planned the lessons to build on students' funds of knowledge from everyday practices with a focus on measurement knowledge and use of fractions. Transcript 3 depicts the classroom scenario when the teacher gives a task of taking different possible measures of various kinds of garments viz., shirts, t-shirts, and *kurta* (long full sleeve shirts) first using a standard measuring tape (popularly known as *inch tape*) followed by a non-standard paper-strip of fixed length. In Transcript 3, the highlighted and underlined words are the Urdu words used during conversation.

Transcript 3. Vacation camp, Grades 6 & 7 (mixed), Lesson: Length measurement

765	T ₃	achha, to yeh jo size, kisime likha hai thirty eight, kisime likha hai thirty nine, kisime likha forty, kisime likha thirty eight, aur kuchh likha hai / yeh number kahan se aaya?	ok, so these sizes, some have written on them thirty eight, some have thirty nine, some have forty, some have thirty eight, and some more is written / where have these numbers come from?
766	C	kahan se aaya? Sir, yeh number collar ka hai/	where have they come from? Sir, these numbers are collar's/
767	T ₃	collar se?	from collar?
768	C	yes sir/	yes sir/
769	T ₃	collar ka to seventeen hai, yeh to thirty eight hai/	collar's is seventeen, this is thirty eight/
770	T ₃	haan?	yes?

(Continued)

771		(not clear)	(not clear)
772	C	sir, uski size hai/	sir, it's the size/
773	T ₃	uski size hai? Size kahan se aata hai? Size kahin na kahin to rahna chahiye / Size ka bhi koi naap hona chahiye na? Kahan se aaya?	It's its size? Where does size come from? Size must be somewhere or the other / there must be some measure for size, no? Where has it come from?
774	T ₃	yeh jo thirty eight likha hai, yeh kiska naap hai? Kahan se aaya hai?	this one thirty eight written here, whose measure is this? From where has it come?
775	C	Sir, sir bolu main/	Sir, sir may I say?
776	T ₃	haan/	yes/
777	C	sir, lambai aur chaurai ko zarab karke jo aaya woh hai/	sir, it is one which comes by multiplying (zarab) length and breadth/
778	T ₃	lambai aur chaurai ko zarab karke dekhna kya aata hai, woh bahut bada sankhya aayega na bahut bada lambai yeh hai, chaurai yeh hai, isko zarab karenge to kya aayega? (indicates length and breadth on the blackboard)	see what come by multiplying (zarab) length and breadth, that'll be a large number, no, very large/ this is length, this is breadth, by multiplying (zarab) them what will come? (indicates length and breadth on the blackboard)
779	C	one hundred ... (not clear)	one hundred ... (not clear)
780	T ₃	haan? To yeh kahan se aaya?	yes? So where has it come from?
781	C	tailor likh deta hai/	tailor puts it/
782	T ₃	tailor aise hi likha rahega?	has tailor put it just like that?
783	T ₃	soch ke batao na/	think and tell/
784	C	sir tailor ko pata rahta hai/	sir tailor knows it/

TRANSFER BETWEEN REGISTERS

The above transcripts show that students did move between their languages of comfort and evoked their 'out-of-school' knowledge, often encoded in their everyday language, during lessons. We observed that the context of the lessons impacted on such phenomena. Moving between languages and the 'knowledges' they encoded is now examined.

Use of Code-Switching

Transcripts 1a, 1b and 2 showed that teacher-students talk involved frequent transitions between the home language and the second language, the language of teaching (English here). There are instances when the code-switch occurred in the

form of translation (Transcript 1a; lines 1 and 2), and explanation (Transcripts 1b; lines 38–43, where the action of subtraction is termed as “minus” and used as a verb reflecting an apparent use of a code-switch from their home language). Code-switches also occurred at the instances of exclamations or while complimenting a student’s work (e.g., Transcript 1b; line 40). Code switching was further noted while calling out numbers like *three fifty*, *four hundred*, etc. Incidentally *three fifty* (Transcript 1a) was also used to indicate three *fifty* (or ‘three fifties’ as an acronym for three times fifty, referring to one hundred and fifty) in many cultures in their everyday register, but when spoken in English it assumes a different connotation that students (also some non-English speaking communities) are aware of. In the excerpts above, *three fifty* stood for *three hundred and fifty* and not for *three times fifty*. Use of language in examples such as these derives from socio-cultural roles of the languages. That is, language-use carries with it varying nuances and connotations and a shared understanding, which was not clearly visible at times in these contexts to an observer.

Transition from Everyday to Technical Register

Two key issues in the teaching/learning of mathematics are presenting explanations by the teacher and encouraging student to do the same, related scaffolding, and the need for reducing the cognitive load. These two issues are addressed below.

Explanations/scaffolding. Language switching during the vacation camp classes often occurred between everyday (informal) and technical (formal) registers (see Figure 2). Code switches also occurred laterally between home and other languages while transiting to technical registers (see Figure 2). Such instances occurred naturally while giving explanations and also reflected the use of technical registers embedded in the everyday parlance. In Transcript 3, the vacation camp teacher asked students to explore the meaning of the numbers printed on the collars of the garments they were measuring. These numbers are generally referred to as the “size” of the garment. Students deliberated upon questions like, which measure did those numbers signify, and how were the numbers arrived at? They had already taken measures of different attributes of the garments, such as length (L), breath or width (W), *kamar* (waist) (K), *gala* (neck) (G), *asteen* (sleeve-width) (A), and shoulder (S). Transcript 3 showed students’ familiarity with the tailoring work, which is one of the popular livelihoods in the settlement. Drawing on their available knowledge resource, or the ‘concrete representational register’ of Figure 2 (or as some cultural anthropologists call it ‘funds of knowledge’, (see Gonzalez, Moll, & Amanti, 2005), students were making sense of the different measures. For example, it was easy for the students to figure out that for measuring the waist one needed to double the width’s measure at that location. Though the measurements were taken initially with the standard measuring tapes and then with the help of non-standard “paper strip” of fixed length, use of “palm-length” (called *bitta* locally) was also common. Students’

descriptions first were articulated in their everyday register, but they then made a transition to the technical register. Language negotiation seemed to offer scaffolding to meaning making while engaged in doing the activity.

Exposure of children to various work practices in the economically active settlement in which they lived came in the form of language as well as their immersion and active participation in these work practices. That the language played an important role seemed to emerge from the fact that transition from a novice to an apprentice and further to an expert happened not only by learning to do the tasks efficiently but also by learning the technical registers appropriately. For example, in the tailoring work, a novice is first trained to learn different kinds of sewing and knowing their names. Sohrab (pseudonym), a 14 year-old boy from Grade 6 of the Urdu-medium school, explained the different stages of learning that a novice goes through to become an apprentice, and eventually an expert. Transcripts 4a and 4b present a glimpse of how Sohrab used the technical registers. To further explain these terminologies to the interviewer (the first author) in colloquial Hindi, Sohrab switched to the everyday register [Transcript 4a; line 31 and Transcript 4b; lines 70, 74–76].

*Transcript 4a. Students' knowledge about their work-contexts;
Sohrab, Grade 6, tailoring work*

31	S	haan, mere ko lace waigrah lagana padhta tha / aur jo peechhe bandhte hain, naari hota hai na naari, jo gol dhaga bandhte hain peeche, woh banata tha / aur suit hua sada suit, churidaar, pyjama, woh sab banata tha sir/	So, I had to put lace and so on / and which is tied at the back, it's <i>naari</i> , which is a round thread tied at the back (of a pyjama), I made that / and suit, simple suit, <i>churidaar</i> (fitting pyjama), <i>pyjama</i> , made all of these.
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*Transcript 4b. Students' knowledge about their work-contexts;
Sohrab, Grade 6, tailoring work*

70	S	pehle straight line sikhna padta hai, dhaga jaise seete hain apun woh line seedha hona mangta hai/	Firstly [stitching on] straight line is learnt. When we sew using a thread that line ought to be straight/
74	S	... pehle to sir turuprei karna sikhayega/	... first hemming [turuprei is a kind of hemming] is taught/
75	T	kya?	Kya?
76	S	turuprei/	<i>Turuprei</i> (hemming)/
79	S	yaani ki dhaaga katna, aur ghadi karna, ghadi kaise hota hai, istiri maarna/	Means cutting thr thread, and pressing it, how do you press, ironing/
80	T	ghadi matlab?	<i>Ghadi</i> means?

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81	S	seedha humlog ghadi karte hain na shirt pant (gestures cloth-folding)	We iron shirt pant by making them straight (gestures cloth-folding)
82	T	achha, fold karte hain?	Okay, folding?
83	S	haan, haan/	Yes, yes/

Similarly every task has its own set of vocabulary and the requirement of learning it. Work-contexts present such different socio-cultural aspects of language. For example, Rizwi, a 12 year old boy from Grade 6 of the Urdu-medium school, while explaining his textile printing work (referred to as dyeing work) frequently referred to various sizes as *char-by-paanch* (four-by-five) for design size, or *satrah-paanch* (seventeen-five) for *stoppers*' size ("stoppers" are wooden blocks used for imprinting designs in block printing). He knew that these were measures in inches and referred to certain dimensions (see Transcript 5).

Transcript 5. Student' knowledge about their work-contexts; Rizwi, Grade 6, Textile printing

178	S	haan, char-by-paanch ka tees rupaya lega woh/	Yes, he takes thirty rupees for four-by-five/
179	T	Char-by-paanch kya?	Four-by-five what?
180	S	design/	Design/
181	T	Char-by-paanch kya matlab naap hai? Char kya hai?	Four-by-five means what measurement? What is four?
182	S	char inch aur lambai paanch inch/	Four inch and length five inch/

Many other work practices entailed similar elements of the mathematical register that over time had become elements of the everyday register or work-context register for the students. Different uses of the mathematical registers emerged while interacting with the students about their varied work-contexts. Another example was of recycling work in which Arshad (12 year old boy from Grade 6, English-medium school) used natural numbers as ordinal numbers for grading waste plastic sheets. Use of ordinal numbers and alphabetical symbols for garment sizes were other occasions when their mathematical registers had become a part of the everyday parlance, even though the underlying conceptual construction might have remained unclear and fuzzy for the students.

Reduction in cognitive load. Mathematics lessons typically invite students to engage in meaning making and subsequently arrive at the solution of a problem task, a practice that amounts to an increase in students' cognitive load. Transition between different mathematical representations as well as between technical and everyday registers (Figure 2) can be seen as a way to reduce such cognitive load in mathematics

classrooms. For these students, often during the classroom discussion and routine conversation the use of acronyms in English resulted in a transition to the technical registers from everyday registers. Such a practice is not unusual and has become ubiquitous in everyday parlance in urban India and reflects the contemporary socio-cultural scenario. In Transcript 6, still in the context of the size of garments, students could make a guess of what “M” signified based on their understanding of what “S”, “L” and “XL” stood for. Use of such acronym-laden technical registers helped, after the initial learning of their meaning, in reducing the cognitive load. It appeared that such synchronous use of acronyms were easier to handle for the students, and had become part of their registers in their various languages.

Transcript 6. Vacation camp, Grades 6 & 7 (mixed), Lesson: Length measurement

724	T	XL ka matlab kya hai?	what does XL mean?
725	C	zyada/	more/
726	T	extra large/	extra large/
731	T	thik hai / aur S ka matlab? S ka matlab kya hai?	alright / and S means what? What does S mean?
732	C	size / size / size/	size/ size/ size/
733	T	aur yeh kya hai?	and what's this?
734	C	M/	M/
735	T	M ka matlab? M ka matlab kya hai? XL ka matlab extra large, M ka matlab?	M means? What's the meaning of M? XL means extra large, M means?
736	C	metre, metre/	metre, metre/
737	T	kya ho sakta hai?	what could it be?
738	T	S ka matlab small, S likha rahta hai na size mein, uska matlab small / L ka matlab large/	S means small, S is written no as size, it means small/ L means large/
739	C	M matlab medium/	M means medium/
740	T	M ka matlab medium/	M means medium/
741		(boy who answered is elated)	(boy who answered is elated)

Use of Non-Verbal Cues Facilitating Transition to Mathematical Representations

Gestures and representations are useful in communication and significant cues are used not only in work practices but they are also helpful during classroom discussions (see Figure 2). During the shirt measurement activity, for example, the students used a variety of gestures for communicating their explanations as was evident from their answers. For example body language and role-playing emerged

when some students behaved like tailors in the way clothing was measured and they put the meter-tape across their neck as tailors do. The prototype of a shirt (representation) that the teacher drew on the blackboard further worked as a visual cue (see Figure 3). This representational cue seemed to facilitate transitions between different mathematical representations, namely, different measures (L, B, W, A, S, K, G), and also in deriving the relation between the “size” of the shirt and these measures. Transition between such representations helped in making sense of the measures, and eventually to complete the task.

Use of Everyday and Mathematical (Technical) Registers

An analysis of the students' verbal interchanges showed there were frequent use of the English mathematical register, although the use of the Urdu mathematical register was also prominent. Switches between these and the students' everyday register were also noted (see Figure 2). One example was the use of different binary fractions, which have become part of the students' daily parlance; e.g., *aadha* (half), *paav* (quarter), *pauna* (three-quarter), *sawa* (five-quarter) and *aadha-paav* (half-quarter). Students often transitioned between *pauna*, *teen paav* (three quarter) and even seventy-five percent, even though knowledge of percent may not have been well grounded. However, moving between such different mathematical representations seemingly helped students in providing explanations and justifying their claims. Use of such binary units and their further divisions came from the interface between sociocultural setting and language.



Figure 3. Teacher's drawing (representation) of a shirt

SUMMARY

The switching between languages is nothing new in one sense. It has always been a normal way of communicating for multi lingual speakers, a practice in which mono lingual speakers clearly cannot participate. However in many Indian school classroom contexts, where colonial influences still have a huge influence with the belief that knowing English is essential in today's world, the notions of learning in one language (English) and only using that language for communicating and thinking prevails. Nevertheless, as emerged from the above data, students from both the English-medium and vacation camp classes switched between languages and used various registers (see [Figure 2](#)), as they engaged in their learning, even though there was very little emphasis on this strategy in the English-medium school.

While early studies on bilingual student's mathematical learning focused on vocabulary acquisition and comprehension of word problems, more recent studies underscore students' knowledge construction, meaning making and participation in mathematical communication (Moschkovich, 2002). Shift towards public expressions in the classroom from individual, private and silent activities leads to greater use of verbal and social cues (Cobb et al., 1993). It is no surprise then that "communicating mathematically" and "participating in mathematical practices" are increasingly being emphasized in the contemporary mathematics classrooms (Moschkovich, 2002, p. 190). Using *situated-sociocultural* perspective, Moschkovich argued that communicating mathematically involves participation in communities of practice, engaging in negotiations through conversation and making use of multiple and diverse resources such as words and objects from language of comfort, gestures, everyday experiences, code-switching and mathematical representations. In line with these notions, we noted that the teacher of the urban vacation class also believed that students utilized all cognitive avenues available to them when engaged in mathematical learning, including moving between their languages, when it appeared that such moves would help their understanding. These notions were not clearly evident in the regular classrooms, and hence there seemed to be a clear distinction in our data between the different teaching contexts, 'regular' and 'vacation camp' classrooms. Further, this distinction seemed to be most visible when word-problems with appropriate illustrations in the students' 'language of comfort' were introduced in the vacation camp classroom.

The above examples also show that students indeed switch between their languages but also utilized the peculiar cultural cues that are drawn from their lives outside of the classroom. In developing such contexts the vacation camp teacher allowed the students to explore their languages and their lived environment to see mathematics around them and hence potentially helped embed the mathematics into their everyday thinking without compromising the formal understanding of this mathematics.

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