Language Negotiation In a Multilingual Mathematics Classroom: An Analysis

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We have analysed multilingual mathematics classroom discourse to understand how languages are negotiated in student-teacher conversations under the assumption that language-use is a socially embedded process. We attempt to comprehend in what different ways languages (of instruction and local) are mixed and switched to arrive at better clarity and understanding of the mathematical contexts. We conclude that when teachers cultivate negotiation between languages by reinforcing the practice of code mixing and switching, students' understanding and participation is enhanced.

It is widely accepted that language plays an important role in thinking and learning. Central to learning and teaching school mathematics lies the "ability to communicate mathematically" (Setati, 2008, 2005). One of the main current policy documents for school education in India, *The National Curriculum Framework* acknowledges, "the kind of thinking one learns in mathematics is an ability to handle abstractions, and an approach to problem solving" (NCF, 2005). Language patterns and discursive practices in classrooms help students in abstracting mathematical concepts and relationships (Sfard *et al*., 1998). It is also the use of language that leads to a conflict between students' negotiations with the mathematical meanings of the word problems, and the required mathematical operations therein. This happens due to inconsistency in their expectations arising from the everyday experience and the structure of the instruction language. Therefore, language proficiency becomes essential in comprehending the mathematical tasks, more so because mathematical abstractions become contingent upon the understanding of the language in which it is put forth (Halai, 2009). Hence, when students learn mathematics in a language other than their language of comfort, they need to learn both mathematics and the language, which can result in learning of a poor quality. The *Position Paper on Teaching of Mathematics* of the NCF asserts that "for a vast majority of Indian children, the language of mathematics learnt in school is far removed from their everyday speech, and especially forbidding" and that this becomes "a major force of alienation in its own right" (Position Paper, 2005, p.5). Evolving a sound language policy for effective teaching and learning of mathematics is hence of current relevance in Indian school education.

In this paper, we try to observe how more than one language is negotiated in such classrooms, starting with current literature and analysis of the excerpts from a set of mathematics lessons to explore the nature of language-use in a mathematics classroom.

Research on the Use of Languages In Mathematics Classrooms

India is linguistically diverse with many languages and even more dialects spoken by its people. Although Hindi is the national and the official language, English, the associate official language, enjoys a special status that is associated with the international recognition as well as the colonial history. However, during informal conversations it is commonly the local language that is used more often. Use of a mixture of vernacular and English is very common in urban settings. This situation is closer to Halai's descriptions of

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classrooms in Pakistan (Halai, 2009) while Setati's reports from South Africa indicate even more diverse use of languages in mathematics classrooms (Setati, 2008, 2005). Interestingly, the world scenario is not very different according to Morgan's claim that in most of us are multilingual today and switch over to different languages in different ways while speaking using different vocabularies and syntactical constructions (Morgan, 2007).

The issue of multilingualism in mathematics classrooms raises a few questions. Halai (2009) for example, maintains that for understanding the mathematical ideas and concepts one has to be able to understand the instruction-language, which means, if the instruction-language is foreign to the learner then it becomes a "double" task of learning both the "foreign" language as well as the mathematics that is being taught – all at the same time. She suggests that this problem can be addressed only by allowing the movement between the languages used in the class, known as "code-switching". This has remained the focus of many studies of late. Setati (2008, 2005) as well advocates code switching in the backdrop of the new language policy currently under way in South Africa's post-apartheid regime.

Clarkson (2007) discusses Kern's empirical study to ascertain how learners comprehend foreign language texts using their first learnt language L1. He argues that L1 facilitates semantic processing, while if a learner were to process the input exclusively in L2 (second language/formal language of instruction), then she might run into trouble handling syntactically complex or harder sentences. He adds that translation is not always beneficial or reliable as it might not reflect the exact meaning. However, the exact meaning can be retained by replacing few words in L2 with words from L1. Hence the use of code mixing and switching helps in such situations for better understanding and comprehension.

However, there is little research that might help us understand the role of language and specific curriculum content in the light of learners' interactions (Barwell, 2005). Therefore, by looking at code-mixes, code-switches and hybrid languages, one may expect to make better sense of the ways learners socialise into discursive practices and their ways of using and interpreting given arithmetical tasks.

Research Framework

The main question on which we focus in our analysis is: how do participants in a mathematics classroom negotiate the use of two languages through code mixing as well as code-switching? We enumerate the various outcomes that follow this negotiation. We are interested in observing how knowledge of more than one language is used in communication and how diversity of knowledge and its comprehension is integrated as a result of which a new set of knowledge (of language and content) is constructed. We have made an attempt to address these issues in the present work.

Code Mixing and Code Switching

Code switching is a practice of switching between two or more languages in a conversation or an utterance, while code-mixing happens when switch between the languages is only for "one or few words" (Farrugia, 2009). In Indian classrooms, code mixing is inherent and quite predominant in the student-student interaction and to a lesser degree in the teacher-student interaction. Code switching, when it occurs, is also accompanied by code mixing. To keep things in proper perspective, we will first describe code mixing and then differentiate it from the code switching.

Code-mixing: each sentence is spoken in one language, let us call it the primary language, with words (subject, predicate, object, adjectives, verbs/auxiliary verbs)

substituted by words from a second language, say, secondary language; ***without disturbing the original sentence structure, which is in the primary language.***

> Example: "first problem mein kya karna hai?" / (*What is to be done in the first problem?).* The underlying sentence-structure indicates that the primary language is Hindi and it is "mixed" with two words from English, the secondary language.
>
> Example: "... sun lo phir wapas you discuss, ok" / (*"... listen, then again you discuss, ok").* Underlying sentence-structure indicates that the primary language is English and "code-mixing" occurs with the incorporation of four words of Hindi.

Code switching: when the primary language is switched to the secondary language (i.e. from Hindi to English or vice-versa), as a consequence of which, the sentences may remain as a combination of English and Hindi, but the structure of the sentences changes and their roles interchange (primary language becomes secondary and vice-versa).

> Example: "each book ka cost tha seventeen rupees/ each book's cost is rupees seventeen/ tho how much money I spent?" / (this whole utterance was spoken by the teacher, an example of "repetition with translation" and code-switching).

There can be different communicative contexts where code mixing and switching can be used, for example, the linguistic form of English-Urdu mix as reported in Halai's (2009) work. In the Indian context utterances and conversations involving language swapping (interchangeably using primary and secondary languages) are very common; examples of which are discussed below in the "observations" section.

Sample and Methodology

The classroom sessions observed and recorded using a video camera, were multilingual in nature. These sessions were part of a camp that was held at HBCSE, Mumbai (Bombay) for 21 (12 boys + 9 girls) grade 6 students of age 10-11 years from a neighbourhood English medium school. Camp-classes were held over a period of two months every Thursday for one and a half hours. Students were selected by their respective class teachers on the basis of their performance in the school mathematics test, and had secured less than 40% marks. All the students knew Hindi and English, although some spoke a home language different from these (for example, Marathi, Tamil). Teaching was conducted by an HBCSE member-researcher fluent in English, Hindi and Marathi.

The medium of instruction in the camp was English. However, the teacher as well as the students used Hindi, which we consider here as the first learnt language. In urban India, the phenomenon of code mixing is very common and is a regular feature in daily-life conversations though not so much in the formal classrooms. Especially in most English-medium schools (including the one these students came from) the practice is to use only English in the classrooms. Use of any other language is generally discouraged. In this camp, however students and the teacher overtly used English and Hindi in the classroom.

For the analysis, clips of different episodes of the lessons were made which depict some interesting student-teacher exchanges involving significant amount of code mixing and switching occurring in tandem. These clips were then transcribed for the analysis. In these sessions the teacher discusses six word problems with the students, who were expected to solve them in groups of two. Whole class interaction between students and the teacher happens when they first discuss the problems and later when they discuss their respective solutions. There are five different sessions of which the transcript is recorded and labelled 'a)' through 'e)'. English translations are given in the parentheses, wherever

needed; the numerals before the teacher-utterances indicate the line numbers in the respective transcripts. "T" and "C" stands for "teacher" and "student" respectively.

Problem-Tasks Given to Students

The following word-problems ('i' through 'vi') were given to the students. The teacher presented them in a story-telling manner contextualising the word-problems.

i. Jay is older than Rahim, Rahim is older than Sheela. Sheela is younger than Jay and Sangeeta is older than Jay. List the people from oldest to youngest.

ii. One morning an ant fell down a hole 2 metres deep. She would climb 1/4 of a metre every day. At this rate, how many days ant will take to come out?

iii. Mini interchanged two digits of the number 3840 and the number increased by 990. Which digits did Mini interchange? Explain your answer.

iv. If one story-book costs Rs 8, how much will seventeen books cost?

v. Raghav goes to college by bus whose one-way fare if Rs 4. Then, how much money does Raghav spend in 26 days a month in his travel to college and coming back?

vi. Divide a square into four equal parts that cover the whole of the square. Find as many such divisions as possible.

Observation and Analysis

In all the 5 transcripts that we analysed, there were altogether 155 monolingual sentences (either completely in Hindi or completely in English) and 150 sentences where code mixing occurred. This shows that the use of code mixing was a characteristic feature of this particular mathematics classroom. The number of instances of code switching from Hindi to English was 30 and from English to Hindi was 29.

Code-mixing

From the transcripts, we find that code mixing results in:

1. free exchange of conversation establishing classroom practices,
2. the students building a rapport with the teacher by mixing informal modes of addressing the teacher (for example, using the term "Didi"), which is reaffirmed by the teacher when she uses the term "beta" *(son)* to address the students. This normally happens when the student or the teacher is too engrossed in the classroom process, for example: a) 25 C: bahut didi hard hai/*(didi it's too hard/)*
3. "Didi" is the Hindi word for elder sister. The student who was engrossed in the task, suddenly exclaimed "didi"! The same student addresses the teacher as "teacher" on other occasions.
4. Additionally, code-mixing in mathematics classrooms also enhances the knowledge of vocabulary of a "foreign" language of instruction, as evident from the following utterance: a) 30 T: bade se chhota/ oldest matlab bada/ old insaan ko chhota bolenge kya? (*old to young/ oldest means older/ will we call an old person young?*)

Code mixing also ensures continuity in conversations, particularly, when a person is unable to think of a proper word or a phrase in the middle of a conversation. Use of equivalent words or phrases borrowed from other language(s) not only helps to attain better comprehension but also helps to maintain a continuous flow of the conversation. So, lack of language proficiency does not distract students from the mathematical problems.

The students were not accustomed to mathematical discourse, which allowed code switching and code mixing since this is discouraged in the school (they are not allowed to speak in languages other than English). Students in the camp-session, however, quickly grasped this practice of code mixing and got involved in the classroom discussions freely with their peers and the teacher. Exposure to this practice allows each student to assert her individuality. Hence, in their zeal to share their newly found status as answer-providers to the problems posed by the teacher, all the students became enthusiastic to share their answers with the whole class irrespective of their proper understanding of the problems.

Code switching

From transcripts of the HBCSE camp mathematics classroom, we note a few points: first, students engage in code-switching (moving from one language to another) especially moving from the language of instruction to a local language. Code switching occurs on account of a need felt by learners to make sense of the given instructions and also of the involved mathematics. Generally there is a shift to local language as soon as there is some conceptual difficulty. Such difficulties include comprehension of complicated problems, clarification of embedded concepts, making sense of the instructions and difficult vocabulary (Barwell, 2005). Examples of more such occurrences are discussed below:

Repetitions in terms of translations. The instances of code switching commonly occurs when a direct translation of a statement is made, repeating the original statement. For example:

a) 32 T: see, I am older than you matlab main badi hoon/(*... I am older than you means I am older)*. Here, the teacher directly translates an English statement into Hindi to elaborate problem (i). Neither the English nor the Hindi utterance was part of the problem. Whereas, in the following two utterances, the teacher gives a direct translation of the English statement as an elaboration of problem (v) into Hindi:

d) 17 T: Raghav is a college student/hmm/He goes to college, he travels to college by bus everyday/

d) 18 T: matlab bus se jata hai, bus se aata hai from his house/ok/(*means goes by bus, comes by bus from his house/ok/)*.

In another instance, the teacher translates a Hindi statement into English to reinforce the understanding the of problem:

d) 7 T: each book ka cost tha seventeen rupees/each book's cost is rupees seventeen/

We note here that the original Hindi statement is an instance where code mixing has been used very effectively to elucidate the English statement uttered subsequently. The fact that in the first statement the teacher says "seventeen rupees" indicates that here the primary language is Hindi, whereas the second statement is completely in English, i.e. the primary language is English and the cost is stated in terms of “rupees seventeen” spoken in the way it is written. That is, while writing the currency and its unit, the general norm is to write the unit of the currency first followed by the amount (say, Rs 100/-), whereas in the spoken language the amount is stated first followed by the unit of the currency. Another example of such an instance is:

d) 21 T: bus se jata hai, bus se aata hai/ his one-way ticket of bus is rupees four/ (*goes by bus, comes by bus/ his one-way ticket of bus is rupees four/)*

Mathematical terms and operations. English was always used for mathematical terms and operations while the rest of the sentences were in Hindi; verbs and predicates were commonly in English. There are numerous instances of such utterances, one of them is produced below (problem vi):

e) 21 T: "yeh square ka char equal part karke chahiye mujhe"/ (*I need four equal parts of this square/*). Here the technical terms "square", "equal part" are used in English while explaining this problem. The teacher illustrates technical terms using English words in the following example (problem ii):

a) 8 T: second question kya hai ki ek subah ek ant ek hole mein gir gayee/ two metre ka hole hai/ ab woh ant chalna shuru kiya/(*second question is that one morning an ant fell in a hole/ hole is of two metre/ now that ant started climbing/*).

a) 9 T: everyday woh kitna karti hai?/ one by four metre cover karti hai/ haan/ to poora do metre karne ko usko kitne din lagenge?/ How many days?/(*everyday how much does it do?/ it covers one by four metre/ yes/ then how many days will it take to complete two metre?/ how many days?/*).

Explanations. Explanations given by the teacher were mostly in Hindi. For example, in problem (i):

a) 4 T: Jay is older than Rahim/Rahim is older than Sheela/Sheela is younger than Jay and Sangeeta is older than Jay/

a) 5 T: to aapko likhna hai sabse bada kaun hai/aur usse chhota, usse chhota, usse chhota, sabse chhota kaun hai/aise sabke naam likhne hain/line mein (*so you need to write who is eldest, and younger, and younger, and younger, and youngest is who/ like this you write all the names/ in a line*).

a) 6 C: ascending/

a) 7 T: nahin, sabse bada se chhota, descending/ oldest to youngest/sabse bade se chhota/ (*No, oldest to the young, descending/ .../ oldest to the young/*).

The purpose of code switching in lines a) 4 and a) 5 is evidently to bring out a clear understanding of problem (i). In addition, the teacher attempts to teach the meanings of technical terms like, "ascending", "descending", "older", and "younger" using code mixing and code-switching.

Enforcement of authority, discipline in the classroom. While enforcing authority and discipline, the teacher switches from primarily a Hindi utterance to English as reflected in the following: e) 20 T: beech ka poora square baaki hai/main bol rahee hoon, hanso mat/this is difficult problem/I want solution/ *(whole square in the middle is remaining/I am speaking, don't laugh/this is difficult problem/I want solution/).*

Achievements in problem-tasks. In camp sessions, while having an informal discussion with the teacher in Hindi, the children switched over to English when they felt confident of their answers and were eager to declare their achievement to the class as the following:

e) 25 C: Teacher, Teacher/

e) 26 C: Teacher, Teacher, I got/Teacher, one, two, three, four/

This instance also illustrates the high degree of class involvement in the exercise.

Code switch from formal to informal language. In addition to the code switch involving the two languages, English and Hindi, the teacher also switches from a formal version of Hindi to a very colloquial form of the same language. This sets up the environment of shared learning and ownership in the classroom. For example:

b) 14 T: Ok/ who is going to explain how five days? Lavesh chalo batao, kaise aaya panch days? *(...?/ Lavesh com'on tell, how did you get five days?/).*

Here the code switch takes place as a language-swap from English to Hindi, as well as from the formal form to an informal form. Here the utterance in English is also an example of the hybrid sentence (discussed below).

Now, consider the following excerpt:

c) 31 T: six days kiska aaya? Sayali? Nahin aaya six days? Aapka aya tha?/ nahi aya? *(T: who got six days? Sayali? You did not get six days? You got it?/ did not get?)*
c) 32 T: iske alawa kisika alag answer aaya? Sudhir/ kisika correct answer hai pata nahin/ bindaas bolo jo aaya hai woh! *(T: who else has got a different answer? Sudhir/ don't know if anyone has correct answer/ freely say whatever you've got/)*.

There is a clear transition from formal to informal language as is visible from c) 31 and 32. The use of the highly informal "slang" like "bindas" meaning "carefree" makes the classroom setting informal thereby encouraging the students to open up and take part in the discussion. Here, the teacher is also trying to break students' hesitation by declaring that she does not yet have the correct answer, so, anyone can take the call.

In the following instance, in addition to a code switch in language, there is a switch from formal to informal language as well that builds a social connection of the problem situation (problem iii) with the students:
a) 11 T: third question/ Mini tumlogon jaise camp ki ladki hai woh/ usne kya kiya three eight four zero, three thousand eight hundred forty – yeh number liya/ *(third question/ Mini is a camp-girl like you all/ what she did, three eight four zero, three thousand eight hundred forty – she took this number/).*

Hybrid Sentences

There are instances when the primary language is not very explicitly distinguished from the secondary language, with the whole sentence being code-mixed in a complicated manner, and the resultant structure of the grammar represents a sort of hybrid structure. For example, while explaining problems (iv) and (v) the following conversation took place:
d) 4 T: bought eight story books/ <u>how many books I bought?</u>/
b) 14 T: ok/who is going to <u>explain how five days?</u>/

In b) 14, an apparent error in the grammatical structure is arising because of a code-switch from English to Hindi, but the Hindi sentence is constructed by substituting all the words from English (i.e. a complete code-mixing has occurred). Thus, hybrid sentences occur when the speaker bends or takes liberties by mixing the grammar of one with the other.

Conclusion and Implications

Code mixing and switching facilitates in connecting verbal language and visual supplements from everyday experience as was seen in the ant-problem (problem ii). They become particularly visible when the teacher is introducing a word-problem with its illustrations in the local language. Arguably, code mixing and switching allows simultaneous language learning in addition to mathematical learning. This usually happens when semantic differences of the technical terms are brought forth with the use of language-switches. Code switch from formal to informal language is used as a mark of solidarity that empowers the students in the classroom. This helps the teachers in intervening in student-interactions resolving their confusions or dilemmas in case there is any. This also helps in breaking the authoritative approach of mathematics teaching, which is normally followed in formal classroom set-ups. In addition, this results in students socialising into discursive practices in the classrooms. Yet when required the teacher uses code-switching to establish some authority in the class. Sometimes non-availability or unfamiliarity of particular terms in a language while speaking gives rise to code mixing

and switching. For teachers and students this offers comfortable and flexible mode of communication and therefore serves as a useful pedagogical resource.

As per our observations the language of learning may be different from the language of teaching, therefore for effective mathematical understanding code mixing and switching to student's first learnt language becomes helpful. In order to facilitate and improve learning and achievement in mathematics classrooms where the language of instruction is different from learners' local (or first learnt) language, giving recognition to code mixing and switching allows the learners to make use of the local language as a learning resource. This helps the students to understand the problem better and makes way for a better group work. We argue that code mixing and switching result in 1) development of the socio-mathematical practices in the classroom, and 2) enhanced understanding of the language of instruction making way for better comprehension. However, we feel there is need of more investigation about the role of code mixing in mathematics classrooms and their different manifestations, including the creation of hybrid sentences. There is also less material available on metalinguistic awareness, i.e. the ability to reflect and manipulate structural features of language, in the light of the development of mathematics learning. It is important in our view to note the metalinguistic usages of the "words" in mathematics classrooms that necessitates code mixing and switching.

The process of establishing effective and productive policies related to teaching multilingual students needs revision and reflection to alter current beliefs and assumptions regarding the use of language(s). We speculate that the issue of multilingualism in mathematics classrooms has a universal bearing, subject to local adaptation.

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