

# AN INVESTIGATION OF THE ROLE OF LANGUAGE-NEGOTIATIONS IN A MULTILINGUAL MATHEMATICS CLASSROOM

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*In this ongoing study, based on the assumption that language-use is a socially embedded process, we have attempted to analyse multilingual mathematics classroom discourse to comprehend the different roles of code-switch and mix between the 'language of instruction' and the 'language of comfort' and their different manifestations, during student-teacher interaction for effective and successful mathematics learning. We have (tentatively) claimed that language-negotiation helps teachers to provide scaffoldings to the learners and reduce their cognitive load. And that, language-negotiation enhances students' understanding and participation in the classrooms. We also conclude that a complex mode of code-mixing can result in a language that is hybrid whose grammatical construct does not conform to either of the negotiated language.*

## **Introduction**

Mathematics is an important school subject taught right from the kindergarten level across most of the contemporary cultures. However, as Bishop (1988) claims, it is one of the least understood subjects and not many people feel comfortable with it. Post-Piagetian constructivism has emphasised the fact that a child's mind is not a '*tabula rasa*', which children studying in elementary classes enter their schools with prior knowledge drawn from their environment and everyday experiences. This includes knowledge of home language and/or local language, or more specifically, the 'language of comfort'. The linguistic and social nature of mathematics allows it to develop together with language (Barton, 2009). Both are socially constructed. But, as Halai (2009) asserts, the proficiency of language becomes essential in comprehending the mathematical tasks, more so because mathematical abstractions become contingent upon understanding of the language in which it is put forth. Hence, when students learn mathematics in a language that is different from their language of comfort, they need to learn both mathematics and the language, which can result in learning of a poor quality. At this juncture, language negotiation serves a useful pedagogical resource that offers comfortable and flexible mode of communication between the students and the teachers (Bose & Choudhury, 2010; Setati, 2008, 2005). Therefore, it is of importance to a community of mathematics educators to investigate how the negotiation of languages is carried out in the classroom both by the learners as well as the teachers for successful mathematics education.

Multilingualism in school education, in particular, in mathematics classrooms has been gaining grounds internationally both in the arenas of political as well as academic deliberations. This has happened in the backdrop of the recent trend of globalisation and in the aftermath of colonial era in many countries, that has made the migration of people from one place to another a common precedent. Language no longer remains a barrier for people who move and settle down at alien places. Hence even the traditional monolingual cultures, viz. that of Europe, Australia and North America, are now facing the challenges of incorporating a classroom set up that caters to the multilingual community which is continuously increasing in size and also influences the socio-cultural order (See Barwell, 2009).

### **Sociolinguistic Scenario in India: Multilingual Aspect**

Indian society has always been multilingual, with a variety of languages and their numerous dialects changing form and flavour every few miles. During the British colonial regime the phenomenon of 'plural monolingualism' was the officially sanctioned policy wherein English was the formal as well as legal language while the local languages were used in the day-to-day life, outside the purview of the official parlance. In elite schools where the primary language of instruction was English, usage of other languages, especially during science and mathematics lessons, was barred.

The condition in most elite schools still remain the same, despite the post colonial emphasis on the national and regional pride which caused, among other things, a surge to preserve the diversity of the traditional cultural and linguistic assets which led to the replacement of English as the medium of instruction in many states by their regional (read: official) languages. However, with the advent of globalization and the liberalisation of the economy, the importance of English as an international language was reaffirmed. The knowledge of English was seen as a gateway to success and achievement in life. Majority of the population saw English as a symbol of power and honour, and private English medium schools started mushrooming all over. The socio-cultural set-up was now being dominated by multilingualism that was distinct from the plural monolingualism of the past. The technological revolution that made the mobile telephone and internet based communication available to all tiers of the society helped the emergence of a communication that consisted of a hybrid language, involving code mixing and code switching. This phenomenon is more prevalent in cosmopolitan metros like Mumbai (Bombay).

However, there is no national language policy in place for school education till date. Different Indian states opt for different languages as mediums of instruction that include their respective official languages, English, Hindi, Urdu, etc. People in most Indian states barring few northern states (whose official language is Hindi) can speak or understand at least three languages, viz., English, Hindi and the state's official language. Therefore, multilingual

classrooms are a common feature of typical non-elite Indian schools and so are the interactions between multiple language resources.

### **Research on the Language-use in Mathematics Classrooms**

As discussed above, India is linguistically diverse with many languages and even more dialects. During informal conversations which is commonly in local language, switching and mixing of vernacular and English is very common in urban settings (Bose & Choudhury, 2010). This situation is similar to that of Pakistan as described by Halai (2009). South Africa's situation as reported by Setati (2008, 2005) indicates even more diverse use of languages in mathematics classrooms. Interestingly, Morgan (2007) asserts that the world scenario is not very different with most of us being multilingual in our modern societies and while speaking we switch over to different languages in different ways using different vocabularies and syntactical constructions.

The issue of multilingualism in mathematics classrooms raises a few questions. Halai (2009) for example, maintains that for understanding the mathematical ideas and concepts the learner has to tackle a "double" task of learning both the "foreign" language (language of instruction, if that is different from home language) as well as the mathematics that is being taught – all at the same time. She suggests movement between the languages used in the class, i.e. "code-switching" to address this problem. 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 asserts that translation is not always beneficial or reliable as it might not reflect the exact meaning which can be retained by replacing few words in L2 with words from L1. Hence the use of code mixing and switching helps for better understanding and comprehension.

The proper illustration of the logical structure and reasoning of the mathematical concepts are often achieved by constructing scaffoldings (Woods et al., 1976; Pea, 2004; Lester, Jr., 2005; Anghileri, 2006) along with, or otherwise independently, by using non-mathematical objects, mathematical objects from other domains or by presenting mathematical objects in non-symbolic language. To accomplish this, the teacher needs to have an effective oral communication with the students who are well versed with the multilingual mode of communication prevailing in the society, outside the classroom. 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). In addition, there has not been much work to analyse the scaffolding that teachers provide to make way for the reduction of the learner's cognitive load with the help of language negotiation. Therefore, by looking at the different forms of language negotiations one may expect to understand the ways learners socialise into discursive practices and their ways of using and interpreting given arithmetical tasks.

### **Research Framework**

This is an ongoing work in which we are investigating the issue of teaching mathematics in the context of diverse language conditions. Our investigation so far has resulted in establishing a framework for defining and classifying the concepts of code-mixing and code-switching according to their occurrences in the context of a multilingual classroom in Mumbai (Bose & Choudhury, 2010). Currently our focus is to address the following question: how is language-negotiation used by the teachers for providing scaffoldings to students for reducing their cognitive load during the mathematical discourse? More generally, we are trying to understand the resources and strategies employed by the teacher in a multilingual mathematics classroom that enable the students to grasp the concepts and “move to more formal mathematical talking and learning” which according to Clarkson (2009) involves language-switch. Our study continues the analysis of the negotiations of the participants in a mathematics classroom with the use of two languages through code-mixing as well as code-switching. The current status of analysis suggests (and we expect that the final conclusion will not differ much) that one of the outcomes of this negotiation in the classroom can lead to the emergence of a hybrid language. In addition, we are 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 & content) is constructed.

#### *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). A detailed definition and explanation of the practice of code-switching combined with code-mixing in the Indian classroom is reported by Bose and Choudhury (2010). For the sake of completeness, an abridged explanation of these is given below.

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.

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 their structure changes and their roles interchange (primary language becomes secondary and vice-versa).

### **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 for 21 (12 boys + 9 girls) grade 6 students of age 10-11 years from a neighbourhood English medium school. The camp-classes were held over a period of two months every Thursday for one and a half hours. All the students knew Hindi and English, and the teaching was conducted by an HBCSE member-researcher who speaks English, Hindi and Marathi fluently. 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 language of comfort (Bose & Choudhury, 2010).

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. Whole class interaction between students and the teacher happens when they first discuss the arithmetical problems and later when they discuss their respective solutions. There are seven different sessions of which the transcript is recorded and labelled 'a)' through 'g)'. 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 'vii') were given to the students. The teacher in the classroom 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  $\frac{1}{4}$  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.

vii. A cat take (sic) a jump of 4 and a rat take (sic) a jump of 2. Now the cat is at number 8 and rat is at number 20. Will the cat catch the rat?

(As provided to the authors by the teacher-researcher).

## **Observation and Analysis**

In all the transcripts that we analysed, there were altogether 260 monolingual sentences (either completely in Hindi or completely in English) and 203 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 42 and from English to Hindi was 37. *(This data will change when we provide the final report)*

### *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, 3) code-mixing in the mathematics classrooms also enhances the knowledge of vocabulary of the "foreign" language of instruction. 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 in maintaining the continuous flow of the conversation. With this, lack of proficiency in a language does not distract the students from the mathematical problems.

### *Code-switching*

The salient points that we notice is that students engage in code-switching (moving from one language to another) especially moving from the language of instruction to the language of comfort. The various cases of code-switching may be classified as: 1) repetitions in terms of translations, 2) mathematical terms and operations were always told in English, 3) explanations, 4) enforcement of authority, discipline in the classroom, 5) achievements in problem-tasks. In addition, there are instances of the teacher switching from a formal version of Hindi, the language of comfort, to a colloquial (informal) form of the same language.

## **Preliminary Analysis**

### *Scaffolding*

The analysis shows that indeed code-switching occurs when the teacher

introduces non-mathematical objects or presents the mathematical objects with non-symbolic language. She then uses code-switch to construct scaffoldings to develop the logical reasoning of the students who are already grappling with the task of understanding the language in addition to grasping the mathematical concepts. (*A detailed analysis with the requisite data will be provided in our final report*). 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 but scaffolding was constructed using mathematical objects in non-symbolic language. In the following case the teacher uses code-switch to elaborate a word-problem with a visual aid on the blackboard to help the learner to contextualize the problem. This acts a scaffolding to understand the logical construct of the mathematical reasoning:

g) 45 T: tho samjho aisa yeh ek number line hai/ haan, aisa ek tree hai number wala/ (*then assume that there is a number line/ yes, like a tree of numbers*)

The visual aid is to imagine the number-line where a number comes as a 'tree' (labelled with numbers) on which the cat and the rat are jumping (question 'vii'). This is a construct of scaffolding that uses code-switch and a non-mathematical object.

#### *Reduction in cognitive load*

The analysis shows that code mixing generally happens when the teacher is attempting to reduce the cognitive load of the student. (*A detailed analysis with the requisite data will be provided in our final report*). For example 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*).

The objective of reducing cognitive load is accomplished here by presenting mathematical objects in non-symbolic language using a complex amalgam of code-mixing and switching.

#### *Use of hybrid language*

On few occasions the act of complex code-mixing resulted in the formation of hybrid sentences. These are the instances when the primary language is not very explicitly distinguishable 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. (*A detailed analysis with the requisite data will be provided in our final report*). For example, while explaining problems (iv) and (v) the following conversation took place:

d) 4 T: bought eight story books/ how many books I bought?/

b) 14 T: ok/who is going to explain how five days?/

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). From the above instances, we observe that hybrid sentences occur when the speaker bends or takes liberties by mixing the grammar of one with the other. We speculate that the switch from one language to another is not discrete rather it occurs as a continuum.

### **Conclusions and Implications**

Historically in India, the tradition of knowledge-transfer was oral. The culture of imparting knowledge by verbal means is thus ingrained in the society. Indian society has always been multilingual (with varying extent), but in formal settings of education the phenomenon of 'plural monolingualism' has always prevailed. In the ancient traditions, the formal language was Sanskrit, Pali, etc. whereas in the recent past, during the era of British colonisation the formal language of knowledge-transfer was predominantly English and only non-elite schools used vernacular languages as mediums of instruction. It is a recent phenomenon, that under the current socio-economic set-up and influence of the popular entertainment mass media and modern communication technologies, that situation in formal classrooms are changing where a hybrid language (result of multilingualism) is emerging. The advantages of this mode of verbal communication can be used for the effective mathematical understanding. We expect that the construction of scaffoldings and the reduction of cognitive load enable the students to grasp the logical concepts as well as the foreign language. This becomes particularly visible when the teacher introduces a word-problem with its illustrations in the 'language of comfort' and tutors the learner with a 'gentle push' through relevant hints to make her arrive at the correct solution.

Our observations, though tentative, indicate that language-switch can become a pedagogic resource – by often providing the learners with a learning resource allowing her to reduce cognitive load by making use of the language of comfort and the teachers with teaching resource by allowing her to make use of the metalinguistic usages of the words, terminologies and manipulation of the structural features of the language. The policies related to teaching multilingual classrooms needs reflections and rethinking to reshape the current assumptions about the use of more than one language particularly in mathematics classrooms. Such policies may have a universal bearing subject to local adaptation.

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