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There has been a good deal of research on interaction in multilingual mathematics classrooms, with an increasing emphasis on the socio-political dimension of language in shaping students' and teachers' language choices. I argue that this approach remains under-theorised and offers a limited perspective on the politics of language in mathematics classroom interaction, largely focused on language choice. To deal with this problem, I draw on ideas from the contemporary sociolinguistics of multilingualism, including the notions of heteroglossia and orders of indexicality. To illustrate these ideas and their utility, I present an analysis of an episode observed in a sheltered elementary school second language mathematics classroom in Canada. My analysis shows how the two students are marginalised by the interaction.

Keywords: Multilingual mathematics classrooms, second language learners, heteroglossia, linguistic stratification.

INTERACTION IN MULTILINGUAL MATHEMATICS CLASSROOMS

Research on interaction in multilingual classrooms has increasingly emphasised the socio-political dimension of language and language use (Setati, 2005; Planas & Civil, 2013). I refer to any classroom in which any of the participants uses more than one language in their daily life as multilingual. This definition includes classrooms commonly referred to as bilingual or second language classrooms, as well as those in which the languages of some students are not used and not recognised. This is consistent with sociolinguistic perspectives that challenge rigid separations between languages or language situations (Makoni & Pennycook, 2007). In such classrooms (indeed, in any classroom), language is not simply a means of communication or a tool for thought; the way language is used means that some participants may be privileged in different ways, while others may be marginalised. Such influences are sometimes systemic and reflect wider social forces, such as those of racism or class. I refer to these influences as the socio-political dimension of language.

While research has identified the significance of the socio-political dimension of language, its effects on mathematics classroom interaction are poorly understood. Research on mathematics classroom interaction in multilingual settings dates back at least to the 1990s. Much of this work has adopted a view of language as a 'resource'. Research on teaching practices includes Adler's (2001) identification of dilemmas that arose for several teachers in different multilingual mathematics classrooms in South Africa; Khisty's (1995) comparison of three teachers in Spanish-English bilingual classrooms in the USA and Moschkovich's (1999) study of a Spanish-English bilingual mathematic class also in the USA. These studies highlight the challenges many teachers face in working with students who draw on multiple languages in the mathematics classroom. In all three studies the dilemma, to use Adler's term, of whether or not to give explicit attention to mathematical language or focus on the mathematical ideas emerged a challenge. Research on students' participation, meanwhile has identified several resources on which students may draw in mathematical discussion. These resources include code-switching (Setati, 2005; Planas & Setati, 2009); genre and narrative (Barwell, 2003, 2005); and gestures, writing and diagrams (Moschkovich, 2009).

While the majority of these studies show some awareness of the socio-political dimension of language, this awareness is not always apparent in the design and conceptualisation of the research. In recent years, research has emerged that gives more explicit attention to this dimension. Setati's (e.g., 2008) work, in particular, has highlighted how learners' and teachers' language choices are influenced by the broader

politics of language in South Africa. By choosing to study mathematics in English, for example, students hope to get access to better opportunities in higher education or employment. The value of these "social goods" outweighs the challenges that such students may face in studying mathematics in a language that they may only use at school. Similarly Planas and Civil (2013), drawing on data from Catalonia and Arizona, show how the choices of the students and teachers in their study about language use in their mathematics classrooms are politically mediated. In particular, and rather like Setati, they argue that the pedagogical value of students' home languages may be overridden by broader political considerations.

It is clear, then, that the socio-political dimension of language influences what happens in mathematics classroom interaction. The research I have discussed, while making a contribution to the field, has, however, generally avoided a theorisation of this aspect of language use. This work has tended to focus on one single aspect of language use: the choice (if it is a choice) of language. Thus, in Setati's (2008) work, the choice is between English and an African language or languages; in Planas and Civil's (2013) study, the choice is between Spanish and English, or Catalan and Spanish. The socio-political dimension of language is, however, likely to influence mathematics classroom interaction in many other ways than participants' choice of language. To investigate these influences, additional theoretical ideas are needed.

I propose to address this problem by drawing on theoretical ideas from the contemporary sociolinguistics of multilingualism. These ideas are illustrated through analysis of data collected in a second language mathematics classroom in Quebec, Canada. My aim is to demonstrate that these theoretical tools make it possible to develop a more nuanced understanding of how language is implicated in the stratification of students' participation in mathematics and hence how it has an impact on their opportunities to learn mathematics.

HETEROGLOSSIA AND ORDERS OF INDEXICALITY

There have been some significant shifts in how multilingualism (and language itself) is conceptualised and understood in recent years. Many of these shifts can be traced, in part, to the work of Bakhtin (1981) who developed a view of language as situated, dialogic and tension-filled. Bakhtin's ideas have led to a view of multilingualism that, rather than focusing on discrete, clearly defined languages and associated clearly defined groups of speakers, looks at language as social practice situated in social and political contexts (Blackledge & Creese, 2010, p. 25). More specifically, Bakhtin defines the key concept of heteroglossia as "the social diversity of speech types" (Bakhtin, 1981, p. 263). He describes this diversity as follows:

> At any given moment of its evolution, language is stratified not only into linguistic dialects in the strict sense of the word [...] but also [...] into languages that are socio-ideological: languages of social groups, "professional" and "generic" languages, languages of generations and so forth. (pp. 271–272)

Heteroglossia, then, refers to the many patterns that arise within language and which can be associated with some group of people, situation, activity or other social formation. There are two important points to note about this account. First, the many different patterns within the diversity of language overlap and intersect. The language of teachers, the language of mathematics and the language of a region may all be present in the same utterance. Moreover, the distinctions between the speech types to which Bakhtin refers are produced by these practices; they are not pre-given. Thus, what counts as an accent, as 'teacher talk' or even as a language, is locally produced (Bailey, 2007). The way that language practices can 'point to' such associations, allowing as to recognise particular activities, group memberships or situations, is called indexicality. This aspect of language is important in framing particular utterances, so making them interpretable. In previous work, I have examined the role of heteroglossia in the language tensions that have been reported in multilingual mathematics classrooms around the world (Barwell, 2012, 2014).

Second, these ideas make a link between moments of language use and broader social patterns and forces:

> Linguists have increasingly turned to the works of Bakhtin and his collaborator Volosinov because their theories of language enable connections to be made between the voices of social actors in their everyday, here-and-now lives and the political, historical, and ideological contexts they

> inhabit. In familiar terms, Bakhtin's philosophy of language contributes to the means by which we may understand the structural in the agentic and the agentic in the structural; the ideological in the interactional and the interactional in the ideological; the "micro" in the "macro" and the "macro" in the "micro." (Blackledge & Creese, 2009, pp. 237–238)

Ways of talking both reflect the socio-historical dimension of language and create this dimension for the future.

Third, these different ways of talking are stratified; some ways of talking are considered more valuable than others. To explain how this stratification arises in the context of multilingualism, Blommaert (2010) focuses on indexicality:

> Ordered indexicalities operate within large stratified complexes in which some forms of semiosis are systemically perceived as valuable, others as less valuable and some are not taken into account at all, while all are subject to rules of access and regulations as to circulation. That means that such systemic patterns of indexicality are also systemic patterns of authority, of control and evaluation, and hence of inclusion and exclusion by real or perceived others. (p. 38)

This kind of stratification typically maps onto scalar differences in practices, so that local, idiosyncratic practices are perceived as less valuable than more widely used, standardised practices (Blommaert, 2010, p. 35).

Blommaert discusses several examples to illustrate these ideas. For one, he refers to a price list for cold drinks found in London's Chinatown (p. 31). The price list is written in Chinese characters and in English. The English includes "quite spectacular typos" (p. 31), such as "Lced" for "Iced" and "Coffce" for "Coffee". Blommaert points out that for many customers in London, the Chinese characters are "a meaningless design", but which index "Chineseness" and a link with wider Chinatown. He also imagines the sign being printed somewhere in China, where the English would be equally meaningless, simply symbols to be reproduced in printed form. To customers in London, the spelling mistakes might be a source of amusement, but might also index less favoured or less valuable forms of English literacy. Hence, indexicality is itself situated, dependent on who is producing or interpreting language or text, as well as where they are and what they are doing. Blommaert (2010) illustrates this point as follows: "the English spoken by a middle-class person in Nairobi may not be (and is unlikely to be) perceived as a middle-class attribute in London or New York" (p. 38).

RESEARCH SETTING: A SECOND LANGUAGE MATHEMATICS CLASS

From 2008–2012, I conducted an ethnographic study of mathematics learning in different second language settings in Canada, a country with two official languages, English and French. In this paper, I refer to data from one of these settings, located in an Anglophone school in the French-majority province of Quebec. The data come from interactions with a Grade 5–6 sheltered class for students identified by the school as falling behind in both English and mathematics. The students therefore studied these two subjects in a separate class from their regular classmates. I visited the class regularly throughout the 2009–2010 academic year. During that time, enrolment in the class varied quite a bit but never went over 9 students.

For most of the year, all of the students in the class were Cree, one of the original peoples of Canada. The children's families originated in communities in northern Quebec. The students spoke Cree as a first language. They also spoke English, though with a range of proficiency levels. In the move from James Bay to the city, the students went from being part of the majority in small Cree-speaking communities, to part of a minority in a city dominated by French and English.

During my visits to the class, I acted as a participant observer, making field notes during teacher-led activities, and interacting with the students during small-group work. The teacher often asked me to work with small groups of students. I made numerous audio recordings of whole-class interaction and some small-group work, including my own work with groups of students. I collected samples of students' work and photographs of other artefacts, such as posters, work written on the blackboard and anything else that seemed relevant. After each visit, I wrote a brief report summarising my observations.

In the next part of the paper, I present and analyse an episode that I observed during the study. I have described aspects of this episode elsewhere (see Barwell, 2014) but have not previously examined the stratification that arose in the students' interaction.

THE TULIP FESTIVAL PROBLEM

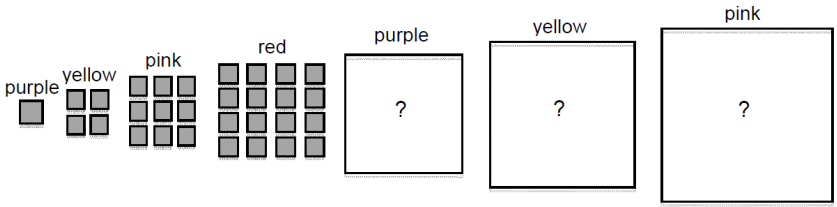
The episode occurred in February 2010, during a part of a class in which the students were working at activity stations. I worked with two students, Curtis and Ben, at a station in which they had to solve the problem reproduced in Figure 1.

> Every year Ottawa holds a world-renowned tulip festival in the month of May. There are different gardens in various locations, one of which is on Parliament Hill. The Canadian Tulip Festival was established to honour Queen Juliana of the Netherlands, in 1953. [...] You are a gardener hired to plant tulip bulbs for the Canadian Tulip Festival in May. You decided to arrange the flowers in a V for Victory format. You decide to use a pattern to make your design. Here is the design you started.

The problem text has a number of indexical features relevant to the students' subsequent work. First, the text is in English. The first part indexes factual registers typical of textbooks or informational texts, such as tourist brochures. Second, the text is an elaborate form of word problem, with a scenario, some information and a mathematical calculation to be carried out. The presentation and structure of the text thus indexes the genre of mathematical word problems. This genre is widespread in Canadian mathematics classrooms and this particular form, known in Quebec as a situational problem, is a common form of assessment item in the province. Third, the text indexes a particular place, Ottawa, and a particular event, the Tulip Festival, with which people in the region might be expected to have some familiarity. More specifically, and crucially for this episode, the text assumes a familiarity with tulips, a flower that is very common in the spring in this region. These associations, combined with the register used in the first part of the problem (e.g. Ottawa as the national capital, "world-renowned"), perhaps also index a form of 'Canadian-ness'. Fourth, the text indexes certain mathematical forms, particularly geometric patterns indicated by the diagram. Thus the text indexes a nation, a region, an event, speakers of a language, a register, a genre and finally, some mathematics.

I began by asking Curtis and Ben to read the problem to themselves and then initiated a discussion about the content [2]:

RB:	okay (.) so what's it about?
Curtis:	its about (.) world's biggest flower=I don't know
RB:	ottawa's biggest
Curtis:	tu (.) lip festival
RB:	tulip festival (.) do you know any of those? (.) do you know what a tulip is? [hm
Curtis:	[flower
RB:	flower right (.) have you ever seen a tulip?
	[...]
Ben:	(...) it's white
RB:	they are lots of different colours white ones red ones
Curtis:	like a rose?
RB:	yellow ones say again
Curtis:	rose
RB:	no it's a bit different from a rose (.) roses yeah (.) tulips just come up in the spring and have a nice flower for about two weeks (.) then they are fin-



How many purple, yellow, and pink tulips do you need to complete the design? Show all your work.

Figure 1: The Tulip Problem [1]

ished (.) there we go (.) let me see your picture
Ben, Curtis: [*laughter*]
RB: have you seen flowers like that
Ben: ^no^
Curtis: yeah (.) in a store

It is apparent from this exchange that the two students have some trouble interpreting the text in the way it was presumably intended. For them, "tulip" initially indexes something rather vague: a kind of flower – they mention roses and, at another point, poppies. And while the text might be designed to index a place and an event, and by extension, some aspects of Canadian-ness, the two students do not make this connection. In this way, the text serves to alienate the students.

Our discussion, which continues in similar vein to clarify what 'bulbs' are and what 'a gardener' does, can be read as an encounter between different "speech types": those of the text, the students and me. Over the next few minutes, the students work at the problem, interacting with the diagram, as I recorded in my notes:

> Ben moved first, drawing in rows of tulip bulbs in the boxes shown in the diagram. He did 5x5 in the first empty box and then moved on to the next box. Curtis looked at what he was doing and then did something similar. At some point, Curtis came up with a solution, fairly quickly. He just wrote three numbers at the bottom of the answer box. I didn't understand his solution but explained that he needed to explain how he worked it out. He wrote a sentence along the lines of 'I added the tulips' – something quite general. So I said he needed to be more precise, to explain what calculation he did. At this point he explained to me verbally and I invited him to write it down. What struck me was that he had little trouble solving the problem, and that most of the time was spent on writing it down in an 'acceptable' way.

My account suggests that the students do relate to the mathematical pattern indexed by the diagram and are able to interact with it and, in particular, to extend it. At some level, then, there is some alignment at this point in the forms of language (including graphic elements) used in this part of the text, and the students' own linguistic repertoires. Their expression of their work, however, remains 'local'; that is, it makes sense to them but does not index more widespread forms of mathematical language (for which, in the interaction, I am positioned as the arbiter):

RB: you have to explain now that you've got these totals okay otherwise if somebody comes along and reads it they will wonder where the number comes from in these kinds of situational problems its quite important that you explain some how how you worked it out

My remarks make it explicit that the goal is to write in a way that is interpretable to some kind of generalised 'somebody' and a generalised situation "these kinds of situational problems" (which are typically used as assessment items). This is an example of what Blommaert (2010) calls 'scale jumping'. The students' linguistic productions index their own locally developed forms; my intervention indexes language forms and communicational requirements associated with people (e.g., teachers) and situations (e.g. assessment) that are more widespread and more valued.

The two students spend a relatively long time working on showing "all their work". Their interactions with me, including the following extract, indicate that this part of their work was quite challenging:

RB: so (.) that's a good beginning (.) but you need to explain like the calculations that you did (.) you need to say what kind of calculations you did
Curtis: times
RB: yup but precisely what did you times what did you add
Curtis: I timesed seven (.) times seven (.) six times (.)
RB: right right
Curtis: seven plus that's it
RB: so like when you worked out for purple
Curtis: I did five times five
RB: uhum
Curtis: plus one
RB: right so I would write purple and then exactly what you just said

The interaction between different speech types is particularly clear in this extract. My use of the word

'need', twice, again indexes expected mathematical ways of talking or writing and, indeed, implies they are a requirement. Through the interaction between Curtis and I, an account of his calculations is pieced together and to some extent endorsed by me. Nevertheless, Curtis's account makes use of relatively local forms of mathematical expression, particularly 'times', rendered as a participle 'timesed'. Throughout this extract, including in my own reflections shown in my notes, my utterances index acceptable ways of talking and writing about mathematics. Through the episode, there is some convergence in the students' utterances towards more conventional mathematical language. Needless to say, these conventions, indexed by the problem text and by me, do not make any reciprocal convergence towards the students' forms of mathematical expression.

DISCUSSION AND CONCLUSIONS

For the students and I, this episode involves an encounter with otherness, with difference, with what Bakhtin calls the alien word (see Barwell, 2014). The point I want to highlight in this paper, however, is that the speech types involved in this encounter reflect prevailing orders of indexicality. The students bring speech types from the periphery: those of Cree-speakers from James Bay for whom English is a second language. Their speech types also include local forms of mathematical language that make sense to the students, either individually or among themselves. The word problem text and I both deploy more authoritative speech types, where this authority comes from an indexing of assessment, of the requirements of the genre and of communicating one's work to a generalised other ("someone"). The encounter between the students, the word problem and me is filled with indexical complexity, but this complexity is ordered; the language of the encounter is stratified, with a hierarchy apparent in which local and peripheral speech types are less valued than more widely standardised forms of mathematical language.

The theoretical sociolinguistic ideas I have drawn on in this paper make it possible to see how the interaction in this second language mathematics classroom episode marginalises the two students. The concept of heteroglossia highlights the way specific utterances in the class are linked to broader, stratified, social patterns and the notion of indexicality facilitates a detailed analysis of this stratification as it plays out in the classroom. This is not to say that the students should not learn 'standard' forms of mathematical language in English; the indexicality of language is part of what makes communication possible. Blommaert, however, distinguishes between the indexical order, which refers to the patterns of language that allow us to recognise references to groups, activities or situations, and orders of indexicality, which refers to the stratification of language and which is implicated in processes of marginalisation. It is through the indexical order that the students recognise the geometric pattern and are able to work on it and find a solution. It is the ordering of indexicalities, however, that marginalises much of the students' repertoire of language practices. Unfortunately, there is no neat way to decouple these processes. This analysis sheds some light on how the socio-political dimension of language influences these students' participation in a mathematics classroom activity.

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ENDNOTES

1. To save space, I have not preserved the layout and abbreviated the problem, omitting additional information about the festival. The diagram is my reproduction of the slightly more elaborate version given to the students.

2. Transcript conventions: short pauses are shown by (.), overlaps are shown by [, rising intonation is shown by ?, emphasis is shown by bold type, whispered speech is enclosed by ^ ^.