

# WHO GETS TO SPEAK MATHEMATICALLY? EXPLORING THE POLITICS OF THE MATHEMATICS REGISTER

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It's "Aooooow" and "Garn" that keep her in her place.  
Not her wretched clothes and dirty face.  
Why can't the English teach their children how to speak?  
This verbal class distinction by now should be antique.  
If you spoke as she does, sir, Instead of the way you do,  
Why, you might be selling flowers, too.  
An Englishman's way of speaking  
absolutely classifies him,  
The moment he talks he makes  
some other Englishman despise him.  
One common language I'm afraid we'll never get.  
Oh, why can't the English learn to set  
A good example to people  
whose English is painful to your ears?  
The Scotch and the Irish leave you close to tears.  
There even are places where  
English completely Disappears.  
In America, they haven't used it for years!  
Why can't the English teach their children how to speak?

*(Why can't the English?, My Fair Lady,  
Alan Jay Lerner / Frederick Loewe, 1956)*

When we first began discussing our contribution to this tribute to David's career, we shared many stories about our conversations with him. We settled on focussing on the impact that ideas in his book *Speaking Mathematically* have had in the work we do. We decided to open this piece with the lyrics from "Why can't the English?", which is one of the songs from the musical theatre production of "My Fair Lady", because it highlights how people use variations of language to discriminate, sort, and marginalise others. In the case of the song, Professor Higgins (a linguist) was denigrating how a woman selling flowers in the street market (and thus from a lower socioeconomic class) spoke as being "painful to his ears". He then further denigrates other groups of people whose ways of speaking "leave you close to tears" or who have not "spoken it [English] in years". We connect this harmful perspective on language with our focus in this essay: how the field has taken a normative stance towards the mathematics register and associated it with standard mathematics language practices. We contend that the field needs to take seriously an important challenge made by Baker-Bell (2020): "If language scholars are truly interested in linguistic justice for linguistically and racially diverse students, we

have to question whose linguistic and cultural norms are privileged by labels like 'academic language'" (p. 9). In mathematics education, there are many proxies for academic language that separate out "math" language from not-math language, including, for example, the mathematics register, mathematics talk/communication, and mathematical argumentation/justification. Although there is something to learn by separating these language practices from everyday language because they give us a sense of canonical ways of communicating about mathematics, we think the field needs to more critically consider challenges voiced by Baker-Bell and other scholars in research related to academic discourse and issues of equity and justice.

We begin with vivid recollections of interactions with David related to ideas in his book, highlighting some of our early considerations of the mathematics register. We then briefly contextualise and historicise the mathematics register to point out that this was not what Michael Halliday or David necessarily intended. We highlight two ways discriminatory ideas about standard and nonstandard forms of language are implicitly reified in mathematics education and offer examples of some mathematics education research that has used it to open up and humanise teachers' and students' experiences.

*Beth:* The timing of David's arrival at Michigan State University came when I was first getting interested in classroom discourse. David's insights and mentorship provided opportunities to have conversations that problematised and opened up my perspective to views from scholars around the world. Probably like many mathematics teachers, I was initially concerned that students did not seem to easily learn or know mathematics vocabulary [1]. I remember considering the range of meanings that students may bring to words that had similar/different meanings in "real life" as the words had in mathematics classrooms, something David describes in Chapter 4 of his book. Yet, when I started observing in middle school mathematics classrooms where teachers were using curriculum materials [2] focussed on problem-solving contexts, multiple representations and discussion, I started to recognise all the different ways youth used language to talk about mathematical ideas and processes. This complicated my narrow focus on mathematics vocabulary and I began to think that it was most important for youth to use language that made sense to them. For example, in one of my dissertation teacher's (Karla's) classroom, the students

came to call exponential functions “swoopy curves”. This recognition and use of “classroom generated language” [3] was intriguing and seemed important to the students’ meaning making and to the development of the classroom community. Yet, the following year, a new teacher (we’ll call her Lynn) said she saw little evidence that the students knew anything about algebra. Karla encouraged Lynn to ask the students about “swoopy curves” and then to come back to let her know what students said. Lynn returned to Karla’s classroom a couple days later. She told Karla that, after asking her students to tell her about swoopy curves, she filled three white boards with information the students shared. She said she now had no idea what to do next because they knew so much more than she had realised! When Karla shared this story with me, I grappled again with the potential repercussions of students exclusively naming ideas through their own language. This realisation (and others) led me to shift to recognising some of the critical and sociopolitical implications of language in mathematics classrooms and mathematics (teacher) education.

*Sandra:* Taking a course with David in graduate school at the University of British Columbia was life changing. Working with David helped me pay attention to language in new ways. I began to notice not only what the students communicated but also to the ways in which their communication was similar and different from how teachers and students communicate in the mathematics classroom. Reading his book *Speaking Mathematically* gave me insights and a lens through which to notice the linguistic moves that teachers and students make in the classroom that open and close mathematical communication. But his teachings were also relevant to life, in general. I have many memorable examples of learning from and with David, but one that connects with this paper is the time when I shared with him that an elderly white woman riding the bus shouted, “Can’t you read English?” at me while she pointed to the sign that suggested to passengers to “cede your seat to elderly passengers”. I was further embarrassed when a fellow passenger (a young white man) confronted this elderly passenger about why she had singled me out when she could have asked some 12 or so other passengers also sitting in the same section (I was the only brown skinned person in that part of the bus). This whole scene made me very upset and I decided to get off the bus rather than continue to listen to the shouting match between these two passengers. I shared this story with David who promptly pointed out that because I had not even spoken a word in this situation there could not have been any way for this elderly passenger to know anything about my English proficiency. He then said that there is a big difference between saying, “Can’t you read?” and saying, “Can’t you read *English*?” and that emphasising the word “English” made all the difference between making a rude comment and making a racist statement. Revisiting David’s work reminds me of how much of my scholarship attends to the covert forms of communication that go on in the mathematics classroom and the many ways in which students and teachers communicate even when they have not spoken a word.

Our stories above share a similar theme: how a focus on dominant language practices (here the mathematics register) might make it difficult to hear what students (and teachers)

are trying to communicate and might be used to discriminate and make inferences about their mathematical knowledge. We argue that in our field, the mathematics register has been used to consider what counts as mathematics communication and what does not. Yet, Halliday’s articulation and Pimm’s *Speaking Mathematically* book offered much in the way of thinking about (although tacitly) issues of power that have not received the same attention (*e.g.*, overt and covert aspects of mathematics classroom interactions). The mathematics register has sometimes been used as a sorting mechanism, even though this is counter to how Pimm wrote about it in his work; for example, he focussed on ways to elevate the status of students’ informal speaking of mathematics and to consider metaphorical aspects of the mathematics register as conceptual bridges.

Given evolving understandings of mathematics education, we read and interpret David’s work through sociopolitical lenses by paying attention to what the book communicates about issues of power, even though these issues typically are not taken up by the many scholars who reference his book. Attending to the political requires one to articulate “how power, privilege, and oppression tacitly and explicitly play a role in all research programs” (Aguirre *et al.*, 2015, p. 126). Many scholars use the mathematics register as a way to index and understand teachers’ and students’ mathematics and mathematical ideas. This, however, is not Pimm’s only point. There are more messages that many mathematics educators have missed. Instead of attending to more conventional reads and uses of ideas from *Speaking Mathematically*, we look for threads of sociopolitical leanings. As mathematics education researchers in the USA, we attribute this take-up as being related to the “math wars” and to the debate about “Where’s the math?” in mathematics education research. This question, as opposed to questions related to “Where’s the context?” offered by Martin, Gholson, and Leonard (2010), point to the fact that a sociopolitical reading of Pimm’s *Speaking Mathematically* is timely. Because the mathematics register has often been used to consider what counts as mathematics communication and what does not, it has been sometimes employed to draw boundaries. We ask, *Why those boundaries? Who might those boundaries privilege? Who might those boundaries marginalise or discriminate against?*

### **Contextualising and historicising the mathematics register**

It is important to remember that at the time when *Speaking Mathematically* was published, the dominant paradigm in mathematics education was cognitive psychology. This book pushed on the dominant cognitivist perspective on mathematics learning and helped move the field towards a sociolinguistic perspective on mathematics education. As the field has since turned towards using sociocultural, situated, and sociopolitical frameworks to understand mathematics education spaces, we can see hints of these potential readings and contributions in *Speaking Mathematically*. We start first by situating the idea of mathematics register in the work of Halliday because there is a trend not to return to original theories in mathematics education articles when they use discourse-related ideas (see Herbel-

Eisenmann *et al.*, 2017). As Stinson and Bullock (2012) point out:

All research is value-laden (Lather, 1991): but too often mathematics—positioned as an asocial, ahistorical, and apolitical discipline (Ernest, 1998)—has manifested mathematics education research that posits itself to be somehow atheoretical (Martin, Gholson & Leonard, 2010). Nevertheless, removing mention of theory from mathematics education research does not absolve the researcher of theoretical responsibilities or the subsequent consequences of her or his research. Mathematics education research is not an innocent science that exists outside of socio-cultural, -historical, and -political discourses (Gutiérrez, 2010). (p. 52)

Thus, this lack of attention to history, theory, and tracing constructs like the mathematics register must be addressed, although we do it briefly here due to word limit constraints.

Many of the citations to *Speaking Mathematically* and, in particular, to the mathematics register, include the following definition:

A register is a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings. We can refer to a “mathematics register”, in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is being used for mathematical purposes. (Halliday, 1978, p. 195)

Current use of the mathematics register, however, is not often grounded in the theory from which it was developed: systemic functional linguistics [4]. Michael Halliday, the person who developed this theory, published this definition as part of a collection of essays he wrote between 1972 and 1976 [5]. In the Introduction to his book, he points out that “A child learning language is at the same time learning other things through language—building up a picture of reality that is around him and inside him” (p. 1). He connects to both Bernstein and Labov to emphasise that there are relationships between social structures and linguistic structures—that is, he highlights the fact that variation in language and dialect expresses diversity of social structures or hierarchies of all kinds. This point is revisited in many ways throughout the rest of Halliday’s book as he cites and clarifies points about language and social structure and how language variation is used to discriminate and marginalise. In writing about the mathematics register, however, Halliday does not explicitly attend to power nor does he recognise how systems and institutions are implicated in the continued marginalisation of learners in schools. In fact, this is one of the only chapters in which he does not cite Bernstein or Labov. Rather, he uses the words “experience”, “perspective” and “values” without recognising the social stratification that occurs due to how hierarchies and power play out in the historical development of mathematics and in mathematics education. In fact, Halliday sometimes describes mathematics, unlike language, as being “as closely to [being as value-free and pattern-free] as we ever get” (p. 203).

There are some implicit leanings towards issues of access and power in the chapter, however. For example, Halliday recognised that every language has some mathematical meanings in its semantic structure, that these should “serve as a point of departure for initial learning of mathematical concepts” (p. 195) to make the teaching relevant to the background of the learner. He pointed out that, just because a child may not have a name for something does not mean that they do not discern classifications (*e.g.*, various kinds of angles or triangles) or differentiations. Rather than ranking languages, Halliday argued that different mathematical ideas may be “variously highlighted in the semantics of different languages” (p. 199), an area that he thought deserved investigation, including how those semantic resources might best be used to support learners. He pointed out that being able to say the same thing in different ways, while keeping the meaning as close as possible, was one of the most important ways to support learners. He recognised that children all come from environments where they have many opportunities for learning and suggested that some children are “at an advantage because of the wide range of experience that is available to them” (p. 201). He wrote that it is a “mistake” to think that the language of mathematics is “entirely impersonal, formal, and exact” (p. 202) and identified a range of issues with how mathematics is communicated that might make it difficult, including the great deal of metaphor and poetry and the high degree of nominalisation that may not align well with a number of languages. He ended his chapter with a postscript recognising that experience of reality “is never neutral”, pointing to how experience is interpreted “through the patterns of knowledge and the value systems that are embodied in cultures and in languages” (p. 203). These examples of Halliday’s writing and theorising of language are rarely carried through in the mathematics education literature. This points to one source of misrepresentation in our field: not returning to original ideas and theories, which can lead to misinterpretation.

Pimm (1987), then, wrote of the distinctive features of discourse about mathematics which is the widespread use of technical vocabulary that has been developed by mathematicians for the purposes of communicating with each other; it is language and meanings that have been developed to meet the needs of the expert users. The existence of this “approved” manner of communicating can make teachers feel as if they *should* communicate that way, affecting the spoken environment of mathematics classrooms (p. 59). Pimm, in his analysis of transcripts, pointed out unequal distribution of authority and power over the language to be used in a class setting, with the teacher acting as arbiter of acceptability, reformulating, and correcting without comment. He illustrated some of the tensions teachers may have to contend with in navigating between precise ways of communicating mathematics, which have broader currency in mathematics, and ways of communicating that may have more local currency. Pimm expands on Halliday’s points about ways to expand a register, illustrates and describes some of the difficulties in communicating about mathematics, and explores some of the ways metaphor relates to communicating about mathematics.

My main point is that the processes by which pupils attempt to assign meaning to the phrases and expressions they hear in mathematics classes are completely consonant with those by which they acquired and manipulated meanings as young children “learning how to mean”. The process seems to be as follows. To assign a plausible meaning to an unfamiliar expression or usage, bring to bear as much knowledge of the world as you have as well as knowledge of language itself. Then try it out later and experiment. That is to say, use both the context of the utterance and the syntax and semantics of the words you are familiar with as far as possible, to guide your assigning of possible meaning. (pp. 88–89)

When we read carefully the work of Halliday and Pimm, we see recognition by both authors of the strengths children bring to classrooms, the complicated and nuanced nature of meaning making and language development, and some leanings towards issues of authority, power, and hierarchies. The mathematics education research community, however, has sometimes taken up the idea of the mathematics register as a way to confirm or validate the point of view that there is a “better” way to talk.

### How (mis)reading the math register has led to hierarchies and sorting practices

It’s “swoopy” and “slanty” that keep them in their places.

Not that researchers and teachers know  
little about their previous classroom spaces.  
Why can’t math teachers teach their students  
how to properly math-speak?

This verbal tracking distinction by now should be antique.

If you spoke as they do, sir, instead of the way you do,  
Why, you might be failing Algebra, too.

A math student’s way of speaking  
absolutely classifies them,  
The moment they speak,

researchers and teachers start to categorise them.  
One common language I’m afraid we’ll never get.

Oh, why can’t teachers and researchers learn to set

A good example to the students  
whose math-speak is painful to their ears?  
Some claim low-track kids and  
ELLs leave you close to tears.

Others even think there are places  
where Math completely disappears.

Many university mathematicians  
think schools haven’t been using it for years!

Why can’t math teachers teach  
their students how to properly math-speak?

We open this section by revising the lyrics to “Why can’t the English” to “Why can’t math teachers” to represent our concern that an important point that is often missed by those that nominally draw on Pimm’s work is that he locates the difficulties of learning in the ways mathematics itself is communicated, not in the teachers and learners who are doing the communicating. In highlighting some of the difficulties that arise in how people communicate about mathematics, Pimm provides an entrée into making the

mathematics teacher aware—part of the critical language awareness suggested by Morgan (1998) and Wagner (2007). Mathematics education researchers can hybridise theories with critical perspectives to engage with a praxis of uncertainty for reconceptualising and doing mathematics education research (Stinson & Bullock, 2012). Adding sociopolitical perspectives to the idea of the mathematics register must be the next step. We now turn to naming and unpacking the problem we see with the field continuing to take a narrow reading of the mathematics register.

One uptake of the mathematics register has led down the path of normalising and promoting the mathematics register as the standard mathematics language to be used in the classroom and that teachers should promote. When they do not, we see negative and deficit framings of both students and teachers. Here we highlight two examples of the kinds of deficit narratives that the field of mathematics education has produced about elementary students and prospective teachers. We consciously chose a well-established program of research and a fairly well-embraced curriculum movement because: a) in the world of academia these authors are relatively ‘safe’ in the sense that they are tenured professors; b) we do not see these framings as characteristic of particular *authors*, rather they are part of the *discourse* the field participates in and helps to propagate; and c) looking back at some of the earlier work in these programs of mathematics education research helps us understand our histories [6].

Scholars that study mathematical knowledge for teaching, such as Hill *et al.* (2008) recognise the bridge that needs to be made towards the specialised language of elementary mathematics. In describing the “general” and “everyday” language of children, however, the article uses words like “vague” and “contradictory” and suggests that students arrive at school “not knowing the mathematical ‘register’ (Pimm, 1987), often rendering their utterances incomplete, imprecise, and at the extreme, incomprehensible” (p. 455). These authors connect the fact that the teacher “heard” mathematical ideas in children’s “very garbled statements” to her mathematical knowledge for teaching. Systemic functional linguistics, however, would suggest otherwise. As Halliday (1978) stated:

We are readily aware that there is no need to name a concept at the outset. This does not mean that we keep silent while manipulating objects or doing whatever else is being done to facilitate learning. On the contrary, the more *informal* talk goes on between teacher and learner *around* the concept, relating to it obliquely through all the modes of learning that are available in the context, the more the learner is getting in mastering it. (p. 202)

Suggesting children’s language is “imprecise” or “incomprehensible” dilutes and misrepresents what Halliday suggests: instead, he sees it as a necessary part of the learning process and the complicated relationship between language and learning to make meaning with language. We emphasise here, too, that the mathematics register is something that describes the discourse practices of mathematicians—and, probably only exists in written form, although written practices can also vary (Solomon & O’Neill, 1998)—and that

some of these ways of expressing oneself are based in particular epistemologies and practices developed mostly by White Western European men. It overlaps with, but is different from the mathematics classroom register (Herbel-Eisenmann & Wagner, 2010). As some mathematics education researchers have shown, for example, mathematical discourses are not monolithic and can vary by context (*e.g.*, Moschkovich, 2002, 2008; Setati, 2005) and there are no real boundaries between everyday and mathematical discourse, even when mathematicians are engaged in conversations about mathematics (*e.g.*, Barwell, 2013).

Through these kinds of framings, the mathematics register becomes a sorting tool that helps to create a hierarchy of proficiency—from more to less—and that serves to exclude those who do not conform or adopt the “proper” ways of speaking mathematically. Such hierarchies, however, are not aligned with Pimm’s perspective. For example, Pimm analysed the transition to formal language on a continuum and did not take any of the points on the continuum as better or worse. Instead, he laid out the advantages and disadvantages of each—a more nuanced perspective than many articles that merely use the mathematics register to say something is or is not mathematical. Pimm claimed that teachers rush to symbolism, as if symbolism is the hallmark of mathematics. He suggested instead slowing down to adjust the type of style to the type of problem, rather than symbolism at all cost (p. 115).

Pimm’s approach is also different from the message of narrowing and normalising in the *Common Core State Standards for Mathematics* [7] from the USA, for example, where mathematical precision is described as an important mathematical practice:

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. [8]

Such a description of who is “mathematically proficient” automatically construes one who is *not* mathematically proficient: any student who does not “try to” communicate precisely, use clear definitions, or state the meaning of their symbols. In addition to perpetuating rules that order, classify and divide the “mathematically proficient” from the “not mathematically proficient”, the choice of the *Common Core* to ground the examples in items such as specifying units and labelling axes also perpetuates the valuing of things that are “arbitrary” (Hewitt, 1989) about mathematics.

Although these instances of research related to mathematical knowledge for teaching and policy documents focus on trying to describe what mathematics discourse *should* be or what it is *not* (when teachers and students communicate), there is a range of work in mathematics education research that distinguishes “mathematical” discourses from “non-mathematical” ones. In contrast, for example, Barwell (2013) and Meaney (2006) argue that it is necessary to consider mathematical *and* everyday discourses in our

examinations of mathematics education contexts. Mathematics education researchers’ separation of these kinds of discourses results in falling prone to ranking, sorting, vitiating, and missing points made by Halliday and Pimm. In the next section, we explain how this narrow path does not help the field challenge and address discriminatory and dehumanising educational experiences in the mathematics classroom.

### **How (mis)using the mathematics register leads to discriminatory language practices**

Our essay now turns to considering the concerns that much of what has been taken up about the mathematics register has not challenged discriminatory educational discourses nor language policies and practices in mathematics education. In the USA the primary language of instruction and the official curriculum privileges students from White, English monolingual, and middle-class backgrounds (see, for example, De Costa, 2020; Nieto, 2000; Orelus, 2014). In order to be recognised as capable and competent, students with different cultural backgrounds are expected to unquestioningly accept and adopt the dominant culture’s language practices instituted in their mathematics classrooms. This includes insistence on conforming to the dominant forms of speaking mathematically without considering diverse language practices as resources for learning mathematics. As Alim and Smitherman (2012) point out, academic language is a proxy for White mainstream English and reveals hidden racist practices that preserve a racial and linguistic hierarchy in schools.

As we discussed above, the sociopolitical context of mathematics education at the time period when the mathematics register entered the scene, the “math wars” [9] had begun to separate mathematics educators into opposing camps. The ongoing debate between those advocating for access to and those advocating for rigour of mathematics gave rise to the need for mathematics educators to find common ground, and the mathematics register provided just that. In some ways, the focus on the mathematics register served to reassure the dominant group of mathematics educators committed to rigour that the substance of the mathematics curriculum and the mathematical preparation of teachers would not lose its status and centre stage in mathematics education. Hence the mathematics register provides a bridge idea that could speak to mathematics educators with commitments to broadening what counts as mathematical and at the same time it could speak to mathematics educators taking on the role of policing the purity of mathematics.

A parallel and similar debate has also been going on in the world of language education with the distinction that this field makes between academic language and informal language and the relationship between the two. Researchers and educators, in fact, introduced the idea of academic language in the 1970s so they could distinguish between language used in school and language used outside of school (Gottlieb & Slavitt-Ernest, 2014). Although some language educators see the goal of language learning as teaching students the standard form of academic English, others propose the need to recognise and appreciate the multiple forms and richness in the diversity of the English language around the world and in diverse communities. The teaching of English to

minoritised language students has created an even more polarised and politicised debate with groups of educators falling into various camps (Flores & Rosa, 2015). The two most extreme views include those who value linguistic diversity in schools and consider variations of Englishes and multilingualism as a *resource* for learning, and those who see it as a *barrier or challenge* to students' learning to use academic language in order to have access to the official curriculum and to the school promise of social mobility. Flores and Rosa (2015) call this latter approach an "appropriateness-based" approach because it conceptualises standardised linguistic practices as an objective set of linguistic forms that are appropriate for an academic setting. In contrast, Flores and Rosa, along with others in their field, highlight the raciolinguistic ideologies through which racialised bodies come to be constructed as engaging appropriately (or not) in academic linguistic practices. They discuss many kinds of discrimination students designated as long-term English learners, heritage language learners, and Standard English learners are subjected to as they navigate schools, classrooms, teachers, and peers. These students are profiled as inhabiting a shared racial positioning that frames their linguistic practices as deficient regardless of how closely they follow the supposed rules of appropriateness. These authors illustrate how appropriateness-based approaches to language education are implicated in the reproduction of racial normativity by expecting language-minoritised students to model their linguistic practices after the White speaking subject.

Ironically, mathematics teachers do not see themselves as language teachers, yet much of their attention is spent on how to teach students proper ways of speaking mathematically. In his book, Pimm helps us understand why this happens in mathematics classrooms by drawing attention to the fact that one distinctive feature of discourse about mathematics is that there is a lot of technical vocabulary. As Pimm points out, the technical discourse in mathematics meets the needs of expert users and is not really meant to be, but is often taken as, the approved manner of communicating in mathematics classrooms: "Certainly one of the widely perceived tasks of teachers is to shape their pupils' mathematical usage towards the approved 'dialect'" (p. 59). This often results in mathematics teachers policing the mathematical discourse of students and feeling the need to correct their speech at every utterance if it does not conform to the accepted form of mathematical talk. For Pimm this concern with correcting students' mathematical talk results in many missed opportunities for teachers to build on the unconventional and sometimes strikingly evocative language of their students. The focus on precision and appropriateness of mathematical language is amplified when teachers hear students speaking non-standard forms of English and other world languages in their classroom.

The song we opened with from "My Fair Lady" (and the entire play) illustrates the overt and covert linguistic discrimination of people whose version of English do not conform to the mainstream dominant culture's version of what "proper" English is supposed to sound like. As members of the dominant culture teachers are not immune to enacting these kinds of cultural and linguistic preferences and values. Beth's story about the "swoopy curves" illus-

trates what happens when educators only listen for proper mathematics talk from students. To further illustrate how linguistic discrimination also plays out in elementary mathematics education we offer an example from Sandra's dissertation work, which examined prospective teachers' emerging teaching practices during an 8-week letter writing exchange with fourth graders. Upon reading the students' first letter the prospective teachers expressed their first impressions about their students as learners of mathematics. Many of the prospective teachers' initial impressions hinged on unexamined assumptions about language proficiency and mathematical ability. For example, one prospective teacher said, "If I wanted to generalize, I could make the assumption that, based on his writing and spelling abilities (which are dreadful), he's not good at math." (Crespo, 2000).

Teachers' assumptions and expectations based on deficit perspectives about minoritised students' language practices are continually perpetuated and enacted in the mathematics classroom, not only by the teacher but also by peers. Many such examples exist in the research literature focused on students learning mathematics in a language other than the official language of instruction. An example is offered in Sandra's recent co-edited book (Crespo, Celedón-Pattichis & Civil, 2018) in a chapter by Chval and colleagues (2018). In their chapter these authors discuss some of the covert and overt messages minoritised language students are constantly hearing from teachers and their peers, such as teachers asking monolingual students to "slow down" and "go at the speed" of the minoritised language student they were asked to help. In mathematics classrooms when monolingual and emerging bilingual students are paired up, the dominant speakers constantly interrupt, talk over/for their peer, and call their partner "copy cat". Without a teacher's explicit attention and pedagogical tools to disrupt these forms of discrimination in their mathematics classrooms, academic and school language learners continue to experience and are left to themselves to negotiate these verbal aggressions from peers.

These classroom scenes are widespread across the USA and in many parts of the world where immigrant and First Nation children who are minoritised linguistically and racially experience what has been referred to as "subtractive schooling", or assimilationist forms of school policies and practices that undermine the cultural wealth and identity of these students' communities. What this research tells us is that exclusionary and marginalising classroom discourses serve to exclude and shape minoritised students' academic identities. It highlights the urgency for educators to address prevalent discriminatory discourse practices in all classrooms but especially in the mathematics classroom.

### **(Re)reading the mathematics register with a (re)humanising lens**

As a field we are now more aware about how appropriateness-based language plays out in mathematics classroom interactions that basically replicate the societal marginalisations we discussed earlier and are illustrated in "My Fair Lady". We argue that Pimm's work has much more to offer that can move the field beyond awareness and provide starting points towards rehumanising goals (Gutiérrez, 2017, 2018). In fact, there are clues as early as the Preface of

*Speaking Mathematically* that indicate Pimm's concern with what we see as the dehumanising potential of mathematics. His attention to communication in mathematics re-centred the idea that mathematics is after all a social and very human activity. When discussing the Cockroft report, Pimm writes:

Mathematics is, among other things, a social activity, deeply concerned with communication. In this way, "We find an echo of K.C. Hummer's aphorism that the most neglected existence theorem in mathematics is the existence of people" (Brookes, 1970, p. vii). (p. xvii)

Pimm also drew attention to the cultural and political aspects of the mathematics register when he discussed what happened in Tanzania when English became the language of instruction instead of Swahili. He discussed the example of educators using the Swahili language as a resource for creating new terms for mathematical ideas: "ulalo", which in Swahili means "the longest of all" in reference to a rope that goes from one corner to the opposing one within a rectangular frame used in the construction of string beds (see p. 94), was used to refer to diagonal. Bringing together the two languages through metaphoric extension allowed the usage of the word "ulalo" to also include the mathematics concept of diagonal. The word "ulalo" offers a particular definition of diagonal with specific characteristics and leaves some others out—as all other definitions of diagonal do (see, for example, Lakatos, 1976). Using the Swahili word "ulalo" extends, complements, and offers a meaning of diagonal that is grounded in the funds of knowledge and linguistic preferences of that community. Pimm used this example to show how much of the English mathematics register, which is rooted in Latin, has gone through similar metaphoric extensions and that because this was done so long ago, we do not realise the ways in which languages have hybridised through this kind of process in order to allow us to communicate mathematically.

Some contemporary work on the mathematics register picks up on the threads in Pimm's book about diversity in the mathematics register. In similar ways that the teacher in Beth's dissertation was able to listen differently to students' ways of speaking mathematically, there is potential for expanding the ways the field has been using the mathematics register. In fact, there are already examples of scholars whose work have begun to open up a different reading and use of the mathematics register that is more consistent with Pimm's goal to humanise the mathematical experiences of students and teachers in the classroom. Flores (2020) questions claims made about "whether one is successfully engaging in academic language because they are primarily determined by a white listening/reading subject whose perceptions have been shaped by histories of colonialism that continue to frame racialised speakers as coming from communities with linguistic deficiencies that need to be policed and corrected" (p. 24). Rosa and Flores (2015, 2017; Flores, 2020) contend that there needs to be a shift from focussing on the speaker/writer to focussing on and interrogating the interpretations and practices of the listener/reader. The examples we have chosen illustrate such a shift in mathematics education work and draw on decolonising methodologies (e.g., Battiste, 1998, 2000; Smith, 1999, 2005). We only share a few examples here, so we have

chosen ones from different geographical contexts that highlight the promise of a (re)humanising approach (see Paris, 2011; Paris & Winn, 2013) when considering ideas like the mathematics register. We also recognise that such brief treatments of this complicated, long-term work very much oversimplifies it and hope that scholars who are unfamiliar with it will seek it out and read it.

Some of the most relevant work related to humanising aspects of mathematics discourse and the mathematics register can be seen in long-term collaborations with Indigenous communities. Lisa Lunney Borden (2011), for example, describes her learning to "verbify" mathematics as she worked with and taught Mi'kmaq students. Their work together shows careful listening on Borden's part as she learned to explore language, culture and mathematics, to understand how language was structured to be able to better understand how students might think about a concept, and to recognise problems with the use of nominalisation in mathematics. Borden argues that it is not merely a goal to move students from everyday language to formal language; rather the goal should be to "go further and build on the grammatical structures of students' language" (p. 11). She suggests one way to do this is the process of "verbification" or drawing on "the extensive use of verbs" in the Mi'kmaq language and illustrates the kind of learning that took place when she built on the grammatical processes students used to talk about geometric solids. In another article, Borden (2013) argues that a lot can be learned by asking elders "Is there a word for...?" or "What's the word for...?"

A second example can be found in *Collaborating to Meet Language Challenges in Indigenous Mathematics Classrooms* (Meaney, Trinick & Fairhall, 2011), which provides a detailed account of a collaboration of Māori and non-Māori educators to document the process by which the group met and worked together in humanising and participatory ways to use *te reo Māori* for teaching and learning mathematics. This work began in the 1980s and 90s with a collaboration among Uenuku Fairhall, Tony Trinick and Bill Barton (Barton, Fairhall, & Trinick, 1998), who worked to develop a mathematics register using *te reo Māori*. Additional work that takes similar approaches can be found, for example, in Hunter *et al.* (2018).

### Where do we go from here ...

In this essay, we have enjoyed revisiting Pimm's work and reflecting on the influence his work has had on our own scholarship and in the field of mathematics education. We have especially found joyful the opportunity to talk together and collaborate on this piece, something we know David would definitely appreciate. We question and critique some of the uptake of the mathematics register that narrows what is included/excluded as mathematical and who gets (dis)counted as speaking mathematically. Such uses limit how one is allowed to speak mathematically to those who can reproduce ways of communicating and knowing developed and valued by White Western European male mathematicians, creating hierarchies that are oppressive and dehumanising. We propose that a sociopolitical lens can help guide the next generation of mathematics educators to take up Pimm's work on the mathematics register in ways that

attend to issues of power and privilege in mathematics education research. Taking up Rosa and Flores' challenge to interrogate the practices of the listener/reader and learning about and using humanising, participatory, and decolonising methodologies and practices are necessary next steps. We can also seriously engage researcher positionality (e.g., Milner, 2007) throughout our research processes and spend more time historicising constructs, practices of the communities we are working in, and the language policies, media, or curriculum documents shaping the experiences (see Joseph, Frank & Elliott, 2021). Finally, we can interrogate the hierarchies that are perpetuated in our work and be more explicit about the limitations of the various theoretical framings we use in our research on mathematics discourse. These suggestions are just a place to begin, but they centre the question of who gets to speak mathematically and can help the field begin to address the challenge posed by Baker-Bell to work towards linguistic justice for linguistically and racially diverse students.

To close we revise once again the lyrics to "Why the English" to represent a more inclusive perspective on the mathematics register which in our view more closely align with Pimm's original intent to open up the conversational possibilities in the mathematics classroom. Our re-writing of this infamous song is both a tribute to David's love for language, poetry, and singing, but also his encouragement to us and all of his students to push intellectual boundaries and who gets to decide who is/is not speaking mathematically.

It's their own language and culture  
that bring students to math places  
And that researchers and teachers learn about their  
families, communities, and previous classroom spaces.  
Why keep doing harm by insisting students  
must "properly" math-speak?  
This linguistic apartheid by now should be antique.  
If you spoke as they do, instead of the way you do,  
Why, you might be helping more students  
to learn Algebra and Calculus, too.  
A student's way of speaking  
does not absolutely classify them,  
The moment they speak, researchers and teachers  
should stop categorising them.  
One common language should not be the goal  
and thankfully we'll never get.  
Oh, why can't teachers and researchers learn to set  
A good example and humanise students whose linguistic  
repertoire land differently to their ears  
The so-called low-track kids and ELLs  
should not be shedding tears.  
There even are places where everyone's  
math-speak is welcome and no one fears.  
Why should we care if teachers have not been  
speaking 'proper' math for years!  
Why can't math teachers teach their students there's no  
such a thing as 'properly' math-speak?

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### Notes

- [1] In a study group with secondary mathematics teachers that focused, in part, on the mathematics register, we found this to be the case (Herbel-Eisenmann *et al.*, 2015).
- [2] In this case it was the *Connected Mathematics Project* (CMP) (Lappan *et al.*, 1998)
- [3] The framework developed from these observations can be found in Herbel-Eisenmann (2002).
- [4] Some exceptions to this claim include, for example, Meaney (2005), Morgan (1998) and Schleppegrell (2007).
- [5] Originally, however, Halliday introduced this idea as part of a symposium sponsored by United Nations Educational, Scientific and Cultural Organization (UNESCO; in cooperation with the International Commission on Mathematics Instruction and the Centre for Educational Development Overseas) called Interactions Between Linguistics and Mathematical Education (see Jacobsen, 1975).
- [6] We understand that we could trace some of the problematic discourses back much further, too. For example, the separating of "knowledge" from other things like emotion can be traced back much, much further, to Descartes.
- [7] See <http://www.corestandards.org/>
- [8] See <http://www.corestandards.org/Math/Practice/>
- [9] Jo Boaler has been a target of personal and professional attacks by two mathematicians who object to her research findings on how a dual focus on equity and mathematics produces better learning outcomes and academic futures for minoritised students. An article in *Inside Higher Education* in 2012 documented this.

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I want to allude to how mathematical language can be and is used to “sing” mathematical objects into existence, and how the “songs” change over time and the objects with them. Certain old songs are no longer sung: they become forgotten, and the awarenesses they engender diminish and die back—or return into the Dreamtime if you prefer. What are ways in which language can be used to generate rather than merely describe the objects under discussion.

—David Pimm, from p. 36 of ‘The silence of the body’ in *FLM* issue **13**(1).

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