ENCODING AUTHORITY: PERVASIVE LEXICAL BUNDLES IN MATHEMATICS CLASSROOMS

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In this paper, we describe, interpret and critically examine characteristics of 148 secondary mathematics classroom transcripts to augment the mostly qualitative research on mathematics classroom discourse, which typically focuses on limited examples. Using corpus linguistics research methods, we examine pervasive "lexical bundles" (frequently occurring sets of words that are identified using a computer program) from eight secondary mathematics classrooms. We show that authority and positioning were pervasive in the classrooms.

Mathematics education researchers have used many tools to examine discourse in various contexts. Almost all of this literature has drawn on qualitative research methods and has focused on a limited number of examples to describe, interpret, and sometimes critically examine phenomena related to teaching and learning in mathematics. We use a quantitative linguistic tool to examine 148 secondary classroom transcripts to illuminate authority structuring in mathematics classroom discourse. These structures have been partially addressed in qualitative scholarship, and we make suggestions for further qualitative work.

Following Pimm (1987) and others, we use the linguistic term *register* to refer to this discourse, defining register as a situationally defined variety of a language. Our analysis of the register draws upon a large database of transcripts of mathematics classroom conversations from a range of mathematics classroom contexts. Linguists use the word *corpus* for such a body of transcripts. Mathematics classroom research has not drawn on such corpora to identify pervasive features of this register. Except for Monaghan's (1999) investigation of the ways the word *diagonal* was used in textbooks, and Wagner and Herbel-Eisenmann's (2007) analysis of the word *just* in mathematics classrooms, corpus analysis has not appeared in mathematic education literature. Our approach differs from these two exceptions because it identifies pervasive patterns in the register instead of pre-selecting significant words for analysis, and differs from Monaghan's because it analyses oral speech.

First we draw on the literature to describe some characteristics of the mathematics classroom register and other related registers, and connect these descriptions to literature on authority and positioning. Second, we describe our research methods. Finally, we share our findings from the analysis of the corpus, and raise issues associated with these findings. From this we will show that authority and positioning were pervasive in the register and we will argue that the ways in which these are encoded in language in mathematics classrooms needs further consideration by mathematics researchers, teacher educators, and classroom teachers.

ACADEMIC DISCOURSE

Linguistic analysis has characterized academic discourse as decontextualised, explicit, and complex. Schleppegrell (2004) and others have argued for more nuanced analysis, noting the context of schooling, in which students are expected to "display knowledge authoritatively in highly structured texts" (p. 74). She and others have used Systemic Functional Linguistics and other tools to note the prevalence of abstract noun phrases, nominalization and high modality (Morgan, 1998), and the importance of metaphor for meaning-making (Pimm, 1987) in the mathematics register. Modality describes the authority or weight a speaker attaches to his or her utterances, and can be recognized in the use of modal auxiliary verbs, such as *must*, *will*, and *could*. Schleppegrell described the interpersonal function of language as being construed through the usually unconscious choice of the declarative mood, of modality and of attitudinal resources to convey stance. The declarative mood has a sense of authority because it positions the speaker as a giver of information and the listener as someone who receives information.

Biber, Conrad, and Cortes (2004) have shown that classroom teaching draws on both conversational and academic registers, and found that the classroom teaching register was even more structured by set-word combinations than either conversations or academic prose. These combinations, called "lexical bundles" are described as groups of three or more words that frequently recur in a particular register. Lexical bundle analysis considers larger chunks of a register than much discourse analysis, which looks at the word level but which helps us analyse lexical bundles. For example, pronouns indicate who is involved in processes, and imperatives indicate the nature of the processes. Analysis of such words helps us understand particular bundles.

Pimm (1987) described how mathematics teachers use the pronoun *we* when addressing students, without clarifying to whom *we* refers: the teacher with the mathematical community; the teacher with students; the teacher as an individual (the royal *we*); the students; or any combination of these. Regardless of who is included, the unconscious use of *we* points to issues of authority. Rowland (2000) showed how the pronoun *you* can be vague in a way similar to *we*. This sense of generality, which refers to no one in particular, suggests that anyone would or must do or understand the same thing. Though these pronouns recognize students' mathematical action, they also take authority away from the students because it is implied that anyone would concede. There is no choice.

Rotman (1988) considered imperatives in mathematics communication. *Inclusive* imperatives (e.g., *consider*, *define*, *prove*) demand "that the speaker and hearer institute and inhabit a common world" (p. 9) and position the reader/hearer as a "thinker." *Exclusive* imperatives position the reader/listener as a "scribbler" who performs actions relatively independent of interaction (e.g., *write*, *simplify*). Both scribbling and thinking are important in mathematics.

For analyzing lexical bundles, as for any form of discourse analysis, it is important to be clear about the register under consideration. We are focusing on the mathematics classroom register, which we distinguish from the "mathematics register" (a term too-often used for vastly different contexts). Furthermore, lexical bundles do not define a discourse. Rather, the pervasive lexical bundles allow us to focus on mundane combinations of words that often go unnoticed but that also have important structuring effects in the discourse (Biber et al, 2004). In particular, many of the bundles we examine here have been classified as "stance" bundles, identified by linguistic aspects including pronouns, modality and verb choice.

The ideas of authority and positioning are central to our interpretation of the lexical bundles because their forms are closely related to stance and interpersonal functions of language. Authority has been defined by Pace and Hemmings (2007) as "a social relationship in which some people are granted the legitimacy to lead and others agree to follow" (p. 6). This relationship is highly negotiable, as students rely on a web of authority relations with their friends and family members as well as the teacher (Amit and Fried, 2005). Following Harré and van Langenhove's (1999) theorization of positioning, in which they show how any instance of language enacts known storylines and assigns positioning within the storylines, we claim that the recognition of the negotiable nature of storyline enactment has emancipatory power.

RESEARCH METHODS

The Secondary Mathematics Classroom Corpus (SMC Corpus), which we analyse here, comprises 679,987 words. It represents 148 classroom transcripts from a 5 year NSF funded project[1] focusing on working with middle grades mathematics teachers to examine how doing action research on classroom discourse might impact teacher's beliefs and practices over time. The SMC Corpus comprises mathematics classroom discourse from early in the project, before the teachers' action research. The classrooms are varied in terms of levels of poverty, kinds of schools (e.g., gifted vs. low achieving), level (grades 6-12), kinds of curriculum materials used, and the gender, experience and education of teachers.

Classroom conversation were recorded and transcribed, then analysed using the Lexical Bundles program (designed by Cortes) to identify 4-word bundles that appeared at least 40 times and in at least 5 out of the 8 classrooms. This is relatively conservative for such analysis. We then used concordancing software to locate the bundles in their contexts (See Wagner and Herbel-Eisenmann, 2007, for elaboration on how such software is used).

Here we focus on the bundles we call "authority bundles" because they have implications for participant positioning and because they encompassed most of the bundle instances. They include those that had the pronouns *you*, *I*, or *we* because pronoun-use is an indicator of positioning. In the findings we refer to and interpret all of the authority bundles identified by the software (The bundles are underlined). In the presentation, we will list all of the pervasive bundles, not only the authority bundles, and we will give examples of the authority bundles in their contexts.

FINDINGS AND DISCUSSION

One of the most important findings of this research is the quantitative evidence that interpersonal positioning is pervasive in mathematics classroom discourse. The authority bundles that we found in the corpus bundle analysis included 31 of 71 total bundles. This kind of bundle was also the most prevalent, representing 46.9% of all instances of the bundles. This is significant because lexical bundles are markers of what is important for people learning a register. The bundles represent ways of thinking and speaking within the register. Even if these authority bundles were common outside the mathematics classroom register, they would be significant to mathematics learning because of their prevalence. We found, however, that they were especially prevalent in the mathematics classroom. Comparing the authority bundles to findings from other corpus analyses, we found that 20 of the 31 bundles were unique to the SMC Corpus (The unique bundles will be identified in the presentation). Thus we asked in our analysis how the authority bundles connect to significant characteristics of mathematics learning. The most striking features of these authority bundles are: 1) the interpersonal relationships referenced by the bundles, and 2) the degree with which people are assumed to be complicit to a particular storyline. We organize our findings around these two features.

We first address more general findings about interpersonal relationships highlighted in the bundles and then address specificities of the register illuminated by these bundles that encode classroom participants' agency. As we use the lens of authority and positioning to describe the nature of the middle school mathematics classrooms in which these bundles appeared, we emphasize that these are pervasive practices. Authority and positioning are significant features of all mathematics teaching. Almost all of the instances of the bundles in this research were spoken by teachers.

Interpersonal relationships: *I*, *you*, and *me*

As noted by various linguists, personal pronouns are strong markers of personal positioning, so bundles with two personal pronouns are especially significant. These include <u>I want you to</u>, <u>what I want you</u>, <u>I would like you</u>, and <u>you want me to</u>. The pervasiveness of these bundles shows that there is an expectation in mathematics classrooms for people to comply with the desires of another - the teacher's role is to tell students what to do. Of these bundles, only <u>you want me to</u> included student utterances, always with the students asking what the teachers wanted them to do (e.g., "Do you want me to copy the steps?"). These interpersonal bundles also are not unique to mathematics classrooms. Nevertheless, as teachers use these bundles and similar phrases, they remind their students again and again of this particular storyline: students need to follow their teachers' wishes about both their mathematical processes and their social behaviour. When we tried to distinguish between mathematical and social expectations for each instance of the bundles, we found, as has Morgan (2006), that they overlap considerably. These interpersonal bundles directed us to ask of each instance of the authority bundles: 1) Why might the student do what the teacher wants? 2) How necessary is this complicity?

Shades of Complicity - Personal Authority

The first shade of complicity we describe relates to the above set of bundles. When a teacher said "I want you to …," students were expected to follow the instructions though no reason was given. The teacher's desire seemed to be sufficient reason. In the contexts, we found students following step-by-step instructions from the teacher, who did not give justification for processes. The storyline often evoked seemed to be an expert guide giving step-by-step instructions to inexperienced followers: "don't think, just do what I say" - the kind of guidance we would look for when in imminent danger. Another storyline evoked with these bundles was a coach readying players for a game: "Visualize the situation, plan your action."

In both cases, students were positioned as people who trusted their teacher to make good decisions about what should be done. Though this complicity did not allow for students to question their teacher's guidance, the role of the student varied. In the first case, the verbs were scribbler verbs (using Rotman's distinction for imperatives), structuring students working independently, exclusive from human interaction. The student "types," "goes back," and "takes." In the second case, the verbs were thinker verbs, which positioned students to interact. The student "looks," "thinks," and "says." We saw both kinds of positioning in all of the classrooms.

Shades of Complicity - Demands of the Discourse as Authority

Other storylines were evoked in instances of the other bundles. With <u>we have to do</u>, <u>we need to do</u>, <u>do we have to</u>, <u>you don't have to</u>, <u>you have to do</u>, <u>you need to do</u>, and <u>do you have to</u> there is still an authority external to the student, but this authority also demands complicity of the teacher. With these the personal pronouns *we* and *you* are prominent, drawing our attention to the generalizing sense of these pronouns, which assumes complicity. In any instance it is debatable to what extent these pronouns have a generalizing sense and to what extent they refer directly to the students. However, the reality for students is that the usage is ambiguous - the demand is directed at the individual and at the same time seems to be necessary for anyone in the same situation, and thus general. The auxiliary verbs that suggest complicity, namely *have to* and *need to*, in these bundles gives the sense of the generalizing *you*. This verb form also appeared in the bundle <u>going to have to</u>.

Generalization is characteristic of mathematical thinking, but also has implications for authority and positioning. The pervasive speech patterns contribute to the development of a sense of inevitability to mathematics. There is something, perhaps "out there," that compels humans to act in certain ways. This gives students the sense that mathematics is a thing outside of human agency, and establishes or reinforces the idea that there is a mathematics discipline to which people need to be subject. We recognize that this storyline serves people and cultures well in various ways, but we reiterate that there are alternatives to this storyline. Nevertheless, the discourse (perhaps mediated through a teacher or a textbook) can prompt students to think deeply, even when the storyline is one of complicity.

Shades of Complicity - More Subtle Discursive Authority

A more subtle sense of complicity appeared with the bundles you are going to, we're going to do, we are going to, so we're going to, so I'm going to, and and I'm going to. These did not feature auxiliary verbs that encoded complicity but there was still a sense of inevitability. One might say these bundles represented thinking ahead, but this was a special kind of forward thinking. It gave the sense that the speaker knows what will happen. The certainty of expression in these cases can be located in the auxiliary verbs *are* and *am*, which express higher certainty than, for example, if the teacher said "we might do" or "I think I'm going to…" Thus it is different from hypothetical thinking or thinking about various possibilities. The teacher, when using these bundles, invoked a storyline in which s/he was in control, and thus knew what would happen. With the instances of these bundles, it was easier to distinguish social from mathematical expectations. When the storyline indicated mathematical control, the teacher and students appeared subject to an established, inevitable mathematical procedure external from the particular humans in the classroom.

Shades of Complicity - Personal Latitude

Positioning theory reminds us that there are other storylines possible in mathematics classrooms, with other kinds of positioning for students. Students do not have to be followers. While some of the bundles considered so far give glimpses of such possible storylines that position students with some authority, other bundles and their contexts much more explicitly recognized that humans make choices in mathematics.

Teachers' choices were often recognized with am I going to, do I need to, I'm not going to, and I was going to. Some of these accompany interrogative moods: when there is a question about what to do, choice is necessary. The others (I am going to and I was going to) suggest that there is no obvious procedure in the given situation. Other bundles showed that even novices in the discourse could make choices when doing mathematics. Students' decisions were recognized with if you want to, do you want to, you want to do, are you going to and are we going to. The first three in this set explicitly referred to students' desires (to what they "want"). Such recognition that human desire has a role in mathematics draws attention to the students' potential to exercise agency. Though these phrases could be taken as being used rhetorically, and thus not promoting authority, it is important to recognize that students can take them either way—as invitations to agency or as rhetorical suppression of agency.

The possibility for multiple interpretations was most evident in the last two bundles in the list. We noted earlier that *you* and *we*, when taken in a generalizing sense, encoded discursive authority. However, in the instances in which *you* and *we* seemed to refer directly to the participants in the classroom, as in many of the instances of the bundles listed in this section, the effect could be significantly different; these instances asked participants to articulate their choices. This kind of decision making was also clear in the bundles do we need to, do we have to, do you have to, and what do we do. In the instances of these bundles, even when *we* and *you* were used in the generalizing sense, there was recognition that the classroom participants answered questions and made choices about apparent mathematical necessities.

Because students were positioned with some authority in these bundles, it is important to consider in which areas they were permitted personal latitude. We found differences between particular teachers. It is not clear to us what this idiosyncratic character of the bundles represents. Just as any conversation presents multiple possibilities for storylines, this idiosyncratic data allows various interpretations. One available interpretation is that the idiosyncratic use of the bundles represented the reality that experts in the mathematics classroom register (teachers, and proficient students) learn to use a common phraseology (learning the lexical bundles) and that they could use it for their own various purposes. This phenomenon exemplifies positioning theory's assertion that participants in a discourse use the discursive resources available to them to serve their purposes in terms of positioning. It also highlights the fact that teachers and students are participants in other discourses (e.g., home, community), which also shape their language practice in the classroom.

CONCLUSION

The most important conclusion we draw is that the pervasiveness of authority bundles in the mathematics classroom register substantiates the claims in qualitative research that social positioning is very significant to teachers' and children's experience in mathematics classrooms. This supports the value of completed and upcoming research that investigates socio-cultural and linguistic phenomena that are associated with authority and related issues, such as positioning. Our study, with its large data set, needs to be complemented with more in-depth investigations of authority structuring in particular classroom situations.

Our intention with this report is to raise awareness about authority structures in mathematics classrooms and to promote reflection about alternative structures of authority and possible ways of establishing them. We are not saying that teachers should release their authority in their classrooms. Teachers need to use their authority to exercise their responsibilities for both social and mathematical outcomes (e.g., Chazan & Ball, 1999). Yet, there is a paucity of research related to productive ways to work with authority in mathematics classrooms. We suggest that the kind of in-depth studies of particular classroom episodes that our research compels should be done *with* teachers and not *on* them because teachers can offer interpretations and identify complexities that we, as researchers and teacher educators (who no longer teach in public schools), may not see. We note that the most powerful examples of changing classroom discourse to better empower students can be found in literature on teachers' action research.

As mathematics educators recognize how they encode the authority structures that are implicit in their classroom practice, it becomes possible to envision alternative authority structures. How are truth and value established in mathematics? Who should decide what mathematical questions are worth pursuing, and on what basis?

Participants in the development of mathematical understanding, namely students and teachers, are well-positioned to address these questions, and they alone have the authority to apply the answers to these questions in their mathematics classrooms.

Endnote

This research was supported by the National Science Foundation (Grant No. 0347906). Opinions, findings, and conclusions or recommendations expressed here are the authors' and do not necessarily reflect the views of the foundation.

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