Appraising lexical bundles in mathematics classroom discourse: obligation and choice

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Abstract Working from a large corpus of transcripts from secondary mathematics classrooms, we identify patterns of speech that encode interpersonal positioning. We extend our analysis from a previous article (Herbel-Eisenmann, Wagner & Cortes, Educ Stud Math, 2010, in press), in which we introduced a concept from corpus linguistics—a "lexical bundle," which has been defined as a group of three or more words that frequently recur together, in a single group, in a particular register. In that article we noted the prevalence of pervasive stance bundles unique to the mathematics classroom register. Because stance bundles communicate personal feelings, attitudes and values, we noted the importance of positioning in mathematics classrooms. In this article, we interpret the stance bundles as they relate to authority in mathematics classrooms by organizing them into groups that relate to the ways in which students are assumed to have choice in the discourse and to have obligations. Gradations of obligation and choice are important because they can help mathematics educators think about the ways in which they might open up or close down discourse in the classroom. We argue that it is important for university researchers, classroom teachers, and even mathematics students to engage in conversations about issues of authority, as they relate to developing mathematical understanding in their classroom discourse.

This article shows how secondary mathematics teachers' recurring multi-word language choices, which structure mathematics classroom discourse, encode teacher and disciplinary authority in ways that could encourage limited student agency. We extend our analysis from

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an earlier article (Herbel-Eisenmann et al., in press) in which we introduced a concept from corpus linguistics—the *lexical bundle*, which is a frequently occurring set of words used across a register. Lexical bundles are identified within a large corpus (body) of text by a computer program. Thus, the choice of what patterns to study is not a person's choice. Rather, the researcher's role is to try to understand what the computer-identified pervasive patterns of speech index about the discourse in which they are used.

Analyzing a corpus of transcripts from secondary mathematics classrooms, we found that *stance bundles*, which Biber, Conrad and Cortes (2004) defined as lexical bundles that communicate "personal feelings, attitudes, value judgments, or assessments" (p. 966), comprised about half of the pervasive lexical bundles (Herbel-Eisenmann et al., in press). We compared the stance bundles from our corpus to those found in the analysis of other corpora (i.e., university teaching and conversations), and found that most of the stance bundles were particular to our corpus, i.e., the register of secondary mathematics classrooms. The analysis highlighted the importance of stance in the mathematics classroom register, because pervasive lexical bundles are indicators of what is important in the register, especially significant to learners of the register.

In this article, we examine the stance bundles found in the previous article in more depth to illustrate how the stance bundles relate to teacher authority and how they "position" teachers, students, and the discipline of mathematics in different ways. The patterns identified are likely to seem normal, but according to Apple (1990) and others, such apparent normality (established in this analysis by the frequency of the word patterns in mathematics classrooms) indexes hegemonic practices. Denormalizing pervasive discourse patterns by interrogating them makes possible critical reflection about alternative possibilities for structuring mathematics classroom practices. Such interrogation allows educators to become aware of and reflect on the kind of authority structures that would be the most appropriate for the development of students' mathematical and social agency. Our analysis focuses on identifying discourse practices to develop awareness and thus support reflection. Our analysis does not identify preferred discourse practices as alternatives to present practice. Instead, our concluding comments on this analysis draw attention to the kind of research and professional reflection that could take this next step.

1 Positioning and authority

In this section we outline the key literature that relates to the ideas of positioning and authority, which are central to our interpretation of the stance bundles. In some of the sections that follow it, we will draw on further literature that relates to specific categories of bundles. As we argue in Section 2, stance can be understood through aspects of language that construe the interpersonal function of language. Thus, stance also relates to how people are positioned in interactions. Harré and van Langenhove (1999) describe positioning as the ways in which people use action and speech to arrange social structures. *Positioning* can refer to physical positioning, as it does in the study of Goodwin (2007) of how parents and children physically position themselves while the children do mathematics homework, but more often *positioning* is used metaphorically to represent relationships. Harré and van Langenhove's description of positioning carefully addresses the role of positioning in interaction through a focus on "storylines."

As outlined by van Langenhove and Harré (1999), in any utterance, clues in the word choice or associated actions evoke images of known storylines and positions within that story. For example, a teacher may say something that positions herself as a coach and the student as

a motivated athlete. The student may continue the interaction complicit with this positioning or resistant to it. Alternatively, the teacher and student might be operating under different assumptions about what storylines may be at play, for example, the teacher may see herself as a coach, while the student sees her as a drill sergeant. This multiplicity of possible storylines relates to the reality that language can have a multiplicity of meanings. No one can enforce a particular storyline or positioning in a conversation. Any participant is free to make moves (with speech or action) to establish, modify or resist a particular positioning, but the skill and willingness with which people do this vary and some ways of being positioned are harder to resist than others. The interplay between free will and structuring influences has been subject to much debate in literature related to language use and agency (Ahearn, 2001; Carter & Sealey, 2000; Emirbayer & Mische, 1998). In our findings, we interpret some of the language forms and storylines in terms of students' obligations to structuring influences (i.e., the teacher and the 'discipline') they seem to encode.

The notion of positioning is important because it recognizes that interpersonal relationships, especially relationships between teachers and students, necessarily involve issues of control, authority, and power. Authority is one of many resources teachers employ for control (Metz, 1978) and has been defined in an educational context as "a social relationship in which some people are granted the legitimacy to lead and others agree to follow" (Pace & Hemmings, 2007, p. 6). Oyler (1996) problematizes possession metaphors for power, showing that authority and power are always present in discourse, and that there are various ways of negotiating them, including relatively unoppressive ways. Amit and Fried (2005) noted that students rely on a web of authority relations with friends, family members, and teachers. In this article, we work from the perspective that authority relationships are highly negotiable, and we focus primarily on the relationships among the teacher, students, and the 'discipline' of mathematics.

In mathematics classrooms, there is the potential for authority and power to be amplified in comparison to other subject areas, partially because of the importance of justification and truth in the teaching and learning of mathematics. Thus, authority and positioning are significant features of all mathematics teaching. A focus on lexical bundles allows us to interrogate what might be thought of as common sense or mundane practices in mathematics classrooms, and thus, expose hegemonic practices such as unintended authoritarianism and control. Students commonly believe that knowledge of mathematics comes from somewhere else (Schoenfeld, 1985); the authority is with the teacher and the discipline of mathematics. When people "have" authority, it means that there is an expectation that they exercise their agency; they are licensed to be agents of change. However, one can exercise agency even when others do not authorize their agency. For example, in the account of student agency by Powell (2004), he recognized the agency of students when they expressed themselves in ways authorized by their teacher, but in the account of Houssart (2001) of a different classroom, students were exercising agency without teacher authorization. In our interpretation of stance bundles, we consider the implied structuring of authority. Who is invited to have agency? And, by contrast, who is obliged to follow whom (or what)? Our focus is on how pervasive stance bundles, which we found to be spoken almost exclusively by teachers, encode authority (we use the word 'encode' to describe how the lexical bundles relate to classroom positioning, following the use of Michael Stubbs (1996) of this word).

Like the focus of Davies and Harré (1999) on local participants in discourse, we claim that while the 'discipline' of mathematics itself, or school mathematics, is taken to be an entity or force of some sort in the classroom, it is represented by participants in the classroom. A teacher may be the face or medium of this force, but the students *only* experience the teacher, not the apparent discipline represented by the teacher. Discourse

practices, however, may suggest the reality of some outside force as having authority. It is unclear to what extent students see themselves in relation to mathematics as a discipline or to the teachers as people. Furthermore, Moschkovich (2007) argued that, if students see themselves relating to the discipline, this sense of the discipline can be imagined in *many* different ways. We have elaborated further on the implications of positioning theory in Wagner and Herbel-Eisenmann (2009).

We draw on a distinction made in appraisal linguistics. In this tradition, White (2003) suggested that linguistic resources can be "broadly divided into those which entertain or open up the space for dialogic alternatives and, alternatively, those which suppress or close down the space for such alternation" (p. 259). This distinction aligns with our consideration of the degree with which the pervasive stance bundles assume obligation to someone or something (closing down diverse perspectives in dialogue) or recognize choice (opening up to alternate perspectives).

In our earlier analysis of the mathematics classroom register (Herbel-Eisenmann et al., in press), we drew upon further sub-categories of stance bundles developed by Biber et al. (2004), in which they distinguished between epistemic and attitudinal stance. All the stance bundles were oriented around personal relationship and thus, coded as attitudinal stance. Within attitudinal stance there was further categorization of stance bundles to distinguish between ones that encode desire, obligation/directive, and intention/ prediction. We found that these distinctions did not reflect well the nuances of the bundles in context. Thus, for this article we developed our own categorization for stance bundles in relation to positioning and authority structures, and how these structures seem to open and close dialogue.

When students were assumed to be obligated in the interactions, authority seemed to lie with the teacher (which we denote "Personal Authority") or with the discipline of mathematics (which we denote "Demands of the Discipline as Authority"). Another form of obligation seemed more subtle and appeared to draw on some presence external to students, suggesting inevitability to an upcoming action (which we call "More Subtle Discursive Authority"). When choice was encoded in the stance bundles, we indicate how "Personal Latitude" was expressed in the language choices and hence suggest an opening up of viewpoints. Before sharing our interpretations of the bundles in these categories, we briefly describe the data set and analysis and then outline some of the theoretical tools that enabled us to identify the kind of positioning encoded by each bundle and interpret its connection to the structuring of mathematics teaching.

2 Methods

2.1 Description of corpus

The data set from which we draw includes 148 classroom transcripts from classroom observations from seven different schools in eight different teachers' classrooms. These observations were part of a larger project, which focused on collaborating with secondary mathematics teacher-researchers to examine how doing action research on classroom discourse might impact teacher-researchers' beliefs and practices over time. In the first year of the project (September 2005–May 2006), we collected baseline classroom observation data of the teacher-researchers' classroom discourse. The teacher-researchers selected a focus class that they felt was representative of the students they typically taught. The transcripts from these baseline data comprise the Secondary Mathematics Classroom (SMC) corpus.

The transcripts come from a range of contexts, as the teacher-researchers taught in different kinds of communities (rural ($n=2$), urban ($n=4$), and suburban ($n=2$)), with students from varying levels of poverty (free and reduced lunch percentages varied from 12% to over 65%) and in different kinds of schools (e.g., a school where over 65% of the students are achieving well below grade level, a school where all the students are labelled as talented and gifted). Six of the teacher-researchers taught in middle-school settings (grades 6–8), one in a high school (grades 9–12), and the one who taught in the talented and gifted school taught students from grades 5 through 12. Three of the teacher-researchers were working in schools in which curriculum materials funded by the National Science Foundation have been used for more than 10 years. The other five teacher-researchers taught in schools where more conventional curriculum materials were used.

The teacher-researchers in these classrooms were purposefully selected to vary gender, context of teaching situation, certification level, years of teaching experience, extent of involvement in professional development, reasons for entering the teaching profession, and so on. Five of the teacher-researchers were female and three were male. Five of the teacher-researchers were certified to teach secondary mathematics and the remainder were elementary certified. The number of years they had been teaching mathematics ranged from 2 to 18 years. Some of the teacher-researchers had master's degrees in mathematics, mathematics education, or science.

Each set of classroom observations took place for 1 week at a time in September, November, January, and March. Typically one university-based researcher observed, took field notes, and videotaped observations. The camera was mainly focused on the teacher-researcher, who wore a microphone. An additional microphone was attached to the camera and picked up much of the classroom talk. Because the classrooms were of varying shapes and sizes and students talked at different volumes, the amount of student talk captured varied from observation to observation. All classroom observations were transcribed by paid transcribers using Transana (Fassnacht & Woods, 2005). These transcripts, which make up the SMC Corpus, were the primary data source for this study. We detail this corpus further in Herbel-Eisenmann et al. (in press).

2.2 Data analysis

In order to prepare the transcripts for the corpus analysis, a research assistant exported them from Transana and completely cleaned the transcripts (removing non-spoken text such as names of the people speaking). The data set consists of 679,987 words, which is in line with specialized oral corpora used by linguists, and, as detailed above, there is sufficient diversity of contexts in the corpus, which is a necessary characteristic of a representative corpus. Because analysis of the register rests on a very large sampling of diverse representative contexts, it becomes possible to identify characteristics of the register, more broadly, than with analysis of a few selected situations.

2.2.1 First phase of computer analysis

We used two computer programs for analysis. First, the Lexical Bundles program (LBP), designed by Cortes (using Borland Delphi Professional, 1998), was used to find the lexical bundles that were frequently spoken in this corpus. Lexical bundles are defined by frequency, so a word combination must repeat very frequently in order to be considered a bundle. Drawing on corpus linguistics, we adopted a conservative cut-point of 40 instances of four-word combinations appearing in five or more classroom settings. All of the bundles identified

by the LBP were stored in a database, which also recorded the frequency with which each word combination occurred and the number of classrooms in which it was used. This latter count, called "spread" (pervasiveness across settings), is important because we need to be sure that the bundles we report are characteristic of many classrooms. The majority of the bundles we found were "stance bundles" and have implications for participant positioning. We include the full set of stance bundles, in order of frequency, in Table 1.

2.2.2 Focusing in on stance bundles by examining language choice

Because stance bundles relate to attitudes, judgments, and so on, we use systemic functional linguistics and critical discourse analysis (which is concerned with issues like language and power) as theories of language to classify and interpret the bundles. Stance

Table 1 Stance bundles organized by frequency

Stance bundle	Number of instances	Spread
I want you to	333	8
You don't have to	134	8
If you want to	97	8
Want you to do	92	7
You are going to	90	8
You have to do	82	8
Do you want to	80	8
Are we going to	78	8
We're going to do	76	8
Going to have to	75	8
Are you going to	73	8
What I want you	70	7
Am I going to	64	7
You to do is	64	7
Do we have to	63	8
We are going to	62	8
You want to do	62	8
You need to do	59	7
Do we need to	58	8
We have to do	50	8
We need to do	49	8
Do you have to	48	8
Do I need to	45	6
I'm not going to	45	8
So we're going to	45	7
I was going to	44	6
I would like you	44	7
So I'm going to	44	7
What do we do	43	7
You want me to	41	7
And I'm going to	40	6

bundles are closely related to language that construes interpersonal meaning as used by Halliday (1978), Schleppegrell (2004), and Morgan (1998; 2006). Halliday (1978) described the *interpersonal* function of text as "the component through which the speaker intrudes himself into the context of the situation, both expressing his own attitudes and judgements and seeking to influence the attitudes and behavior of others" (p. 112). In particular, modal verbs and first person pronouns are seen as some of the strongest indicators of stance (Biber, Johansson, Leech, Conrad & Finegan, 1999). Three aspects of language, in particular, were important to our categorization and interpretation: mood and modality, verbs/processes, and personal pronouns.

Schleppegrell (2004) showed the interpersonal function of the language of schooling as being construed through the usually unconscious choice of declarative mood, of modality, and of attitudinal resources to convey stance. When people use declarative forms, it is different from when they command (in imperative form) or question (in interrogative form). Declaration has a sense of authority to it because it positions the speaker as a giver of information, and the listener as someone who receives information. Imperative forms indicate that the speaker can tell someone else what they are to do. The interrogative form can be used to elicit information, but has a more participatory effect to it by inviting response. These different moods are important because they indicate asymmetries between participants (Fairclough, 2001).

As Martin and Rose (2005) suggested, language allows us to express attitudes with varying intensity. Modality is one way that people amplify something. Modality includes "indications of the degree of likelihood, probability, weight, or authority the speaker attaches to the utterance" (Hodge & Kress, 1993, p. 9). Modality of the text can be found in the "use of modal auxiliary verbs (*must*, *will*, *could*, etc.), adverbs (*certainly*, *possibly*), or adjectives (e.g., *I am sure that...*)" (Morgan, 1998, p. 87).

In addition to modal auxiliary verbs, further consideration can be given to the verbs or processes in which involvement is expected. Rotman (1988) contended that when examining processes in mathematics, we need to consider whether they are *inclusive* or *exclusive*. He differentiated between these two types of processes in terms of what they imply for the reader. An *inclusive* process (e.g., *consider, define, prove*, and their synonyms) demands "that the speaker and hearer institute and inhabit a common world or that they share some specific argued conviction about an item in such a world" (p. 9). Inclusive processes, Rotman argued, construct the reader as a "thinker." In contrast, an *exclusive* process requires only that "certain operations meaningful in an already shared world be executed" (p. 9). For example, when a reader is instructed to "build," an *exclusive* process, s/he must carry out this specific activity. Rotman claimed that exclusive processes construct the reader as a "scribbler" who performs actions. In order to do mathematics, people need to both scribble and think. We used his classifications for interpreting processes in the transcripts.

Along with modality and verb choice, personal pronouns have been identified as markers of positioning (Fairclough, 2001; Wetherell, 2003). The detailed look of Pimm (1987) at teachers' use of *we* is relevant. Often in mathematics teaching, the teacher uses the pronoun *we* when addressing students, but it is not always clear to whom *we* refers: the teacher with the mathematical community; the teacher with the students; the teacher as an individual (the royal *we*); the students; or any combination of these. Rowland (2000) shows how the pronoun *you* can be ambiguous in a way similar to *we*: like *we*, *you* is "an effective pointer to a quality of thinking involving generality" (p. 113). 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.

2.2.3 Second phase computer analysis

The second program, MonoConcPro (Barlow, 2002), a concordancing software, was used to complete two tasks that provided additional information to help in the interpretation of the authority bundles. First, we used this program to generate concordance tables, which show all the bundles from the database in their contexts. These tables included the target bundle in the center with 50 words before and after the bundle. These tables are important for interpretation, especially because MonoConcPro facilitates deeper investigation of the context by linking each instance of the target bundle to its place in the original transcript. When we needed to examine a longer stretch of text around the bundle, we clicked on the instance in the concordance table, and MonoConcPro immediately took us to the place in the corpus where that instance occurred.

Second, the program facilitates the compilation of collocation (co-location) lists, which identify words that are commonly used together. Looking at words that appear frequently in relationship to one another can help to understand context. As Halliday (1978) pointed out:

> "Much of the meaning of a text resides in the sort of foregrounding that is achieved by this kind of environmentally motivated prominence [...] as a realization of particular elements in the social context"(p. 145).

In lexical bundle analysis it is important to see which words appear one word to the right of the target word or bundle (R1), two words to the right (R2), and so on. Here we use the list of collocations to investigate the bundles that ended with *to* (e.g., *you are going to*, *we are going to*) because the verbs that followed *to* help to see what kinds of processes were being foregrounded. For example, "we are going to put our books away," foregrounds a social focus whereas "we are going to consider what happens when we hold the area constant and change the perimeter," foregrounds a mathematical focus. Focusing on the verbs also helps us see if the learner is constructed as a scribbler (as in the first example) or a thinker (as in the latter example).

The concordance and collocation charts were further analyzed to attend to authority and positioning related to the bundles. Each author examined each individual stance bundle list to search for themes and then across the bundles to search for themes. As we searched for themes, we struggled with what to include in the article. Because we were examining such an expansive data set, there were many examples that we could include and ideas that we could have shared, but we focused on aspects that relate to authority. Many of the themes that we came to consensus on and decided to report here were related to the types of obligation that we explained in Section 1. We grouped the bundles into sub-groups based on the obligation that seemed to be encoded; that is, there seemed to be sets of stance bundles that encoded obligations to the teacher, the discipline (in more and less explicit ways), and a set that suggested personal latitude. The stance bundles are summarized by sub-group in Table 2 are used to organize Section 3.

2.2.4 Member check

The final part of our analysis involved a member check. In fact, this was typical practice in the project work. Almost all of the analyses we did and the articles we wrote were shared with the teacher-researchers for their input, feedback, and additional interpretations. After we reached consensus about the authority bundles and had a draft of our findings written, Herbel-Eisenmann shared some of the concordance tables with the teacher-researchers at

Table 2 Stance bundles categorized by obligation and choice

	Lexical bundle
Personal authority	Want you to do
	What I want you
	You to do is
	I would like you
	I want you to
	You want me to
Demands of the discourse as authority	Do you have to [a]
	You don't have to
	Do we need to[a]
	We need to do
	You need to do
	We have to do
	Do we have to
	You have to do
	Going to have to
More subtle discursive authority	You are going to
	We are going to
	So we're going to
	So I'm going to
	And I'm going to
	We're going to do
Personal latitude	You want to do
	Do I need to
	Am I going to
	What do we do
	Do you have to[a]
	Do we need to[a]
	Are we going to
	Do you want to
	I was going to
	Are you going to
	If you want to
	I'm not going to

[a] Denotes the two bundles that appear in two sections

the next project meeting. In particular, she gave all of the teacher-researchers the concordance table for *I want you to* because it was the most pervasive stance bundle. She also shared four of the concordance tables that we identified as offering more choice (*if you want to, are you going to, you want to do,* and *do we need to*). The teacher-researchers worked in pairs and each pair examined the table for *I want you to* and then one of the other concordance tables. The teacher-researchers were asked to read through the table and think about the purpose they thought that set of words served in the mathematics classrooms. After the teacher-researchers spent about 30 min talking in pairs, each pair reported back to

the group. This whole-group discussion was videotaped and transcribed. In almost every instance, the teacher-researchers independently confirmed what we report here. In fact, in some cases they even confirmed the ways in which we parsed the data. For example, one teacher-researcher identified the word *if* as "softening the directive" (PM, 8/18/07). We include some of the teacher-researchers' observations in the section in which we report and discuss the findings in order to illustrate the interpretations they offered as well as some of the concerns that these authority bundles raised for them. We demarcate these comments by indicating they were spoken by the teacher-researchers, rather than writing about "teachers" as we do when we report our interpretations and findings from our analysis. In the next section, we report the findings generated from the analysis described above.

3 Obligation and choice

The most striking feature of the stance bundles is the degree with which people are assumed to be obligated to a particular storyline. Related to this, the storylines reference particular kinds of positioning that assume certain things about the teacher, the students, and the 'discipline' of mathematics. We organized the stance bundles based on to whom or what they indexed obligation and based on whether choice was encoded: in each part, we address specificities of the register illuminated by the bundles that encode classroom participants' relational agency. We point out that, although we use these themes to organize this section, there is overlap among them—two of the 31 bundles appear in more than one section because they served more than one purpose.

3.1 Drawing on personal authority

The most obvious bundles for considering positioning are the ones that include more than one personal pronoun, especially those stance bundles that located "I" as the subject and "you" as direct object. As noted by Fairclough (2001), personal pronouns are strong markers of personal positioning. The stance bundles that include two personal pronouns are:

- I want you to
- what I want you
- I would like you
- you want me to

Two other bundles are related to these because they almost always follow the pronoun *I*:

- you to do is
- want you to do

All but three instances of *you to do is* had the word *I* prior to the bundle, and 87 of 92 *want you to do* instances were of the form "I want you to do" or "I __ want you to do". Two of these bundles were closely related—*what I want you* and *I want you to*. In fact, many of the instances of these two bundles overlapped, as did other bundles, including *want you to do* and *you to do is*. Many of the instances of each of these were part of the seven-word bundle *what I want you to do is*. Seven-word lexical bundles are nearly impossible to find in lexical bundle analysis. In some of the classroom transcripts, we even saw teachers say *what I want you to do is, I want you to*. When the teacher-researchers saw this, they were

surprised that they sometimes used a personal plea twice in their instructions to students. They wondered what impact this might have on students.

The following are two examples of excerpts that included one of the bundles that encoded the teacher's authority, and the student's trusting compliance. (In all transcripts given, "Tr" represents the teacher, "Fs" a female student, and "Ms" a male student. Italics draw attention to other keywords that we discuss in our interpretations of the examples. All names are pseudonyms.) In the first example, the student was positioned as a passive follower of instructions:

> Tr: So what I want you to *do* is don't use these actual numbers. I don't want you to *type* in the actual numbers, I want you to *use*, like, *go* back to the ninety degree. Right? And so AB, this one's your long side, so *take* this...

Here the students followed step-by-step instructions from the teacher, who did not give justification for the process, and did not seem to create space for student decisions. The storyline evoked might 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 might look for when anticipating forthcoming danger. The second example engaged different storylines though the student still seemed to be positioned as obliged to do the teacher's bidding:

> Tr: All right. *Look* at the number on the board. I want you to *look* at it. I want you to *think* about the number. I want you to *think* about what the number means, what each place value means. I want you to *think* about how you would say that number. Don't put your hands up, you're just thinking.

This example shows how a teacher's direction of mathematical processes has both social and mathematical significance (a phenomenon also described by Morgan (2006)). The students were doing mathematics under the direction of the teacher, and the teacher made the decisions—controlling the agenda and deciding what actions to take. Students were required to think about what they were doing, and about how they might use this understanding to engage in conversation with someone else. The storyline evoked might be a coach readying players for a game: "Visualize the situation, plan your action."

In both cases, the students were positioned as people who trusted the teacher to make good decisions about what should be done. This compliance did not invite students to question their teacher's guidance in either case, yet the role of the student varied. In the first case, the verbs (which are italicized in the transcript) were scribbler verbs (using Rotman (1988) distinction), for which the students were cast in a storyline that had them working independent from human interaction. The student "types," "goes back," and "takes." The second case featured thinker verbs, positioning the students to interact with each other. The student "looks," "thinks," and "says." Both kinds of positioning appeared in all of the classrooms.

The pervasiveness of the bundles listed here shows that there is an expectation in secondary mathematics classrooms to be obliged to the teacher. The role of the teacher is to tell students what they should be doing. Of this particular set of bundles, only *you want me to* included student utterances and in all three instances the students asked for specific information about what their teachers wanted them to do, e.g., "Do you want me to copy the steps down off the board?" 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 behavior. As typical with pervasive bundles, this may seem obvious, but we reiterate that other viable structures are possible—for example, students working on their own projects and asking their teachers to provide support when students deem it necessary.

There are many questions one can ask about a storyline that has students complying with their teacher's wishes without question. These stance bundles direct us to ask two questions, both of which we know from our own classroom teaching experiences to be significant for teachers and students. 1) Why might the student do what the teacher wants? 2) How necessary is this obligation? 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. If personal obligation is the only reason for students to engage in mathematics, then this construction might marginalize a student who does not like the teacher. In many cases, providing mathematical reasons for engaging in the activities at hand would probably be more compelling. One teacher-researcher raised this concern when he said, "you're inserting yourself as the agent or the reason they're completing a specific action. 'I want you to do this.' It's not based on what it's gonna get you [mathematically]. [...] As a student [...] I'm doing it because the teacher [...] is telling me to do it or wanting me to do it." Additionally, there is an assumption that all students would discern that underlying this personal obligation often is a mathematical reason. Yet, it is possible that not all students have this cultural capital. Zevenbergen (2001) noted that working class students might be less likely to negotiate such implicit expectations successfully. If activity is directed through personal obligation, the mathematical significance of the activity may not be apparent to all students. As one of the teacher-researchers said in response to examining the bundles, "It's not really collaborative because you have the authority to demand it and they don't have permission to refuse it."

3.2 Demands of the discipline as authority

Some of the other bundles suggested that there were alternatives to the storylines of students following their teacher's guidance without question. The first alternative we consider resembles personal authority because there is still an authority external to the student, but it is different because there is a suggestion that this authority exists external to the teacher, too. Some bundles that exemplify this authority structure featured the personal pronoun *we*, including:

- we have to do
- we need to do
- do we have to
- do we need to

This *we* has been described by Pimm (1987) as including the reader/listener, whether they consent or not. Related to this kind of *we*, the generalizing sense of the pronoun *you*, described by Rowland (1992), appeared often in some of the bundles—not referring to a particular person, but suggesting that all persons see or do things the same way:

- you don't have to
- you have to do
- you need to do
- do you have to

Although we characterize the pronoun *you* in these bundles as generalizing, in any instance it is debatable to what extent the pronoun has the generalizing sense and to what extent it refers directly to the students. As shown by Wagner (2007), for students 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 feature of these *you* bundles that sets them apart from the bundles that have a more literal, person-particular *you* was the auxiliary verbs that suggest obligation, namely *have to* and *need to*. There is a strong sense that mathematics follows external authority. This verb form also appeared in another bundle, which was often preceded by the pronouns *you* and *we*:

- going to have to

In the following example of a class going over homework, the initial uses of *you* seemed to refer to the particular students in the class, who were inventing a situation to fit certain criteria. The shift to *you have to* was a shift to a generalization—for something to be a "multiplying situation" certain things must be in place, regardless of the context. The shift to generalization is characteristic of mathematical thinking, but also has implications for authority and positioning.

> Tr: How did you know that you had multiplying? What was it that you were trying to do in your story to make sure you had multiplying? What did <u>you have to do</u> with those two numbers to make sure that it was a multiplying situation? Remember the idea of fraction of a fraction? We've been talking about that a lot. You're taking part of a fraction.

This next example is more complicated, partly because there is another potential agent of authority. The teacher positioned the textbook with authority, referring to it as *they*. Whether this attribution referred to the authors or to the textbook personified does not matter; *they* can be taken as representing the discipline of mathematics. (For detailed analysis of the use of "they" in relationship to mathematics textbooks, teachers and students, see Herbel-Eisenmann (2009), and for theorization of how people are positioned as mediums of the discipline of mathematics, see Wagner and Herbel-Eisenmann (2009).)

> Tr: *They* want you to give them a problem in which the answer is in between a certain number that *they* give. So what does that force you to have to do, you guys? Just think about the thinking that has to go on inside your mind to be able to do this. What do <u>you have to do</u> that's different than me just saying, "OK, solve this problem." How is the thinking to do that problem different from the thinking that you've got going in sixteen? Go ahead.
> Fs: Um...it's different because you are thinking in your head which one would equal that because you're already trying to equal something, instead of trying to figure out what it equals. You know it has to equal a certain answer, or else the problem's wrong.
> Tr: Would you say it's more complicated?
> Ss: Yes. [...]
> Tr: That goes along with Tori. It's like you gotta get the answer to know whether the problem's going to fit. Would you guys agree? I said it's more complicated a minute ago, but would you agree that *they're* forcing you to think even more than if *they* just said, "Solve this problem?" Deeper thinking, yeah, so it's kind of like *they're*, *they're* going to good things, here. *They're* making you practice, but *they're* also making you think more deeply. The more you understand about this, the more you can think like this. All right, so we need to come up with a fraction and a whole number whose product is a whole number. Lee?

In this case, the teacher explicitly differentiated the textbook's demand on students from the kind of teacher demand that was based on the teacher's personal authority. The textbook placed a social demand on the student to perform a particular task, but in order to perform this task there was yet another kind of demand—certain choices must be made for the mathematics to work out. This was the generalizing *you* because these choices were independent of personal context.

Note how the "discourse" operates: here the mathematical task was positioned as something that made students think deeply, more deeply than merely practicing skills or just solving problems. The pervasive speech patterns contribute to the development of a storyline that gives a sense of inevitability to mathematics. In these storylines, 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 implications for authority and positioning and that there are alternatives to this storyline.

3.3 More subtle discursive authority

A more subtle sense of obligation with the external discipline also appeared in the stance bundles. These did not feature auxiliary verbs that encoded obligation (like *need to*, for example*)* but there was still a sense of inevitability:

- you are going to
- we're going to do
- we are going to
- so we're going to
- so I'm going to
- and I'm going to

One might say these bundles represented thinking ahead, but this was a special kind of forward thinking, giving 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, or a storyline in which the teacher and students were subject to an established, inevitable mathematical procedure external from the particular humans in the classroom.

The teacher-in-control storyline typically featured a social focus with the teacher defining arrangements and setting tasks—for example, "All right. We are going to be working on—everybody write down in your planner, since we don't have it written down yet..." This situation was much like the positioning in which the teacher positioned him- or herself in authority over students, though with less concern for politeness: the teacher declared what the students would do instead of asking the students to do something.

The inevitable mathematics storyline was typically associated with content. For example, in this instance the teacher was directing the student's action to use algebra tiles to represent the factors of a quadratic expression:

Tr: On number three you're probably gonna have to lay the pieces out to get number three and number four. Pull out your two *x*'s and your six ones. Make your rectangle.

Okay, how many rows?
Ms: Two.
Tr: So that goes on the outside. Then what's in one row?
Ms: One times, I mean one *x* plus three.
Tr: Um hum. That one <u>you are going to</u> have to lay out the pieces so you've got your two *x*'s and you've got your six. Make your rectangle. ...

Here the teacher knew what the students would have to do to create the rectangle with the algebra tiles in order to represent the product of 2(*x*+3). As in the above set of bundles, the auxiliary verb phrase *will have to* suggests an obligation to comply. The *you are going to* bundle bears the same kind of compulsion but is less overt. If the teacher knew the student was going to do something, it implied there was little choice because the actions were inevitable.

Positioning theory makes clear the reality that roles are fluid. In any situation, participants can position themselves in multiple ways, establishing and changing their roles and acting to establish and change other people's roles. The kinds of positioning suggested by the stance bundles we have described so far, however, are relatively similar to each other because the roles they cast for students are about the same. In each storyline that we identified, the student was positioned as a follower, either of the teacher or of the external force thought about as "mathematics," which may be represented by textbook authors. This latter force is much like the former one because the teacher is taken as the medium of mathematics or mathematics textbook authors and thus positioned with authority, leaving the student with the familiar role as follower. In these ways, the stance bundles discussed so far served the purpose of assuming students were obligated to the teacher or to the discipline in more or less explicit ways, and thus closing down the discourse for alternative viewpoints. The positioning theory also reminds us that there are other storylines possible in mathematics classrooms, with other kinds of positioning for students. We turn now to the stance bundles that indicated personal latitude or encoded choice. These stance bundles, we argue, can encode an underlying message of alternatives and have the potential to open up the discourse.

3.4 Personal latitude

Some of the stance bundles give glimpses of storylines that position students as having some authority, and thus inviting them to exercise agency. Because students were positioned with some authority in these bundles, it is useful to consider in which areas they were permitted personal latitude. One observation about the nature of personal latitude encoded by these bundles was that these incidences were not consistent across the classrooms. Though these bundles were used in multiple classrooms, the ways in which they were used differed. There was more consistency within a single teacher's use of these bundles and less consistency across the corpus. It was not clear to us what the idiosyncratic character of the bundles represented. Just as any conversation presents one with multiple possibilities for storylines, this idiosyncratic nature of the data allows various interpretations. We speculate about the reasons for the idiosyncrasy of these stance bundles after we have shared and discussed some examples of them.

The following bundles and their contexts suggested that teachers were making choices, which could substantiate their personal authority. Thus there was recognition that humans do make choices in mathematics:

• am I going to
• do I need to

- I'm not going to
- I was going to

In the first two of these, the teachers' utterances were interrogative, indicating that there was a question about what s/he was doing. The other two demonstrated a change in direction. Thus all four suggested a situation that required choice.

Other stance bundles showed that even novices in the discourse (referenced by teachers as *you*) could make choices when doing mathematics. The bundles that invoked storylines that had students making decisions included:

- if you want to
- do you want to
- you want to do
- are you going to
- 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 or referencing authority, it is important to recognize that students can take them either way.

The teacher-researchers recognized the potential rhetorical meaning of the bundle *if you want to*. They talked about this bundle as being "a sneaky way of asking [students] to do something," pointed out that this bundle made it "appear as if [students] had a choice but they really didn't," and said they thought that this was one way that, mathematically, they let students know that some of their choices were "optional, especially if it helps you understand" the mathematics. With respect to *you want to do*, the teacher-researchers thought the choice of the verb "do" made it seem as if mathematics always involved doing something, especially if there was an absence of thinking verbs. They also thought that this construction was "sort of being used rhetorically to regain control of the classroom... [because] it puts the responsibility back on the students to initiate some action."

The possibility for multiple interpretations was even more 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. When *you* and *we* seemed to refer directly to the participants in the classroom, however, as in many of the instances of the bundles listed here, the effect could be significantly different. These instances asked participants to articulate their choices. When the teacher-researchers discussed *are you going to*, they pointed out that some of the words around this bundle invited multiple responses. They thought the majority, however, seemed to have a finite set of answers. This kind of decision-making was also clear in the following bundles:

- do we need to
- do we have to
- do you have to
- 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.

In the next few paragraphs, we highlight some of the different ways in which each of these groups of personal latitude bundles seemed to be used. Although all of these bundles encoded choice, the aspects of classroom life they related to varied immensely. We recognize that this section may appear less cohesive than some of the previous sections because of the inconsistency mentioned above, which demands description of different ways these stance bundles were used across the corpus.

For the first list of these personal latitude bundles (*am I going to, do I need to, I'm not going to, I was going to*), we found examples of teachers recognizing mathematical decision-making (e.g., "What am I going to use to claim from the fact that they're perpendicular?") and of them recognizing their social, pedagogical decision-making (e.g., "I'm not going to make this anything to do outside of class"). Within the examples in a mathematical context, the instances that included the pronoun *I* were striking because it seemed to be used by teachers in a generalizing sense, much like the pronouns *you* and *we* are often used in mathematics classrooms. The teacher is then positioned as losing him- or herself as a medium of the discipline, recognizing decision points within mathematical processes—for example, "What do I need to know to find the area?" With the sense of disciplinary demand, the interrogative tone mitigated the storyline associated with similar phrases that were not expressed as questions; the participants' authority to make choices was encoded.

The second set of bundles in this group (*if you want to, do you want to, you want to do, are you going to,* and *are we going to*), with which teachers authorized student agency, we find to be a mix in context. The bundle *if you want to* tended to be mainly about making decisions that seemed social, e.g., taking out a notebook or finding out about missing assignments. About half of the instances of *do you want to* and *you want to do* foregrounded the social. In particular, when *do you want to* was used in a mathematical context, it drew attention to student choices about which aspects of their reasoning to represent, often suggesting that they should justify their choices further. In the more extended form, "what do you want to," teachers often required students to explain or say more by asking questions like "What do you want to do?", "What ratios do you want to pick?" This also occurred frequently with the extended form "how *are you going to*": "How are you going to problem solve this?" These examples were especially powerful in terms of student agency because, in addition to choosing how much reasoning to articulate, students were making choices that demanded justification. Thus, there were two levels of choices students could make.

Another kind of choice represented by these bundles was the students' choice regarding which homework or assigned problems to address—for example, "Which one do you want to do?" and "Do you want to do volume or surface area or both?" Although these may seem like social decisions, they can be mathematical; we are reminded of Brown and Walter's (1990) work on problem posing, which encourages students to decide what mathematical problems to pursue.

Finally, the third set of bundles in this group (*do we need to, do we have to, do you have to, what do we do*), with which teachers encoded storylines that attributed agency to the classroom collective of teacher with students, was less idiosyncratic than the other two sets of bundles in the group. In most of these instances, the teacher asked what known procedure or information needed to be invoked to address a given situation, as in: "How do we change mixed numbers into improper fractions again? What process do we need to do?" and "Okay, who can help me out to write the equation of a line. Bart, what do I need to know?"

In these two examples, we illustrate common uses for *do I need to do* and *do I need to know*, in which the teacher references a known procedure and known information respectively. The former required students to articulate a process and the latter required students to articulate specific information that was needed. Like the bundles encoding

discursive authority (both subtly and not-so-subtly), the expectation was that everyone in the classroom knew their roles. In fact, the teacher-researchers also said that, when they used *do we need to*, it seemed like the expectation was that everyone was going to know what the next step was. Unlike the other stance bundles, however, the interrogative tone of these particular bundles reminded members that they had to identify which procedure fits a given situation, which is a mathematical decision related to what Mason and Spence (1999) called "knowing to act." This identification of appropriate procedures may be seen as a decision point, and as an opportunity for student agency. Since the information was formerly covered in class, however, we suggest that such agency was less significant relative to more explicit invitations to reason and justify mathematically.

Because students were positioned with some authority in these bundles, it is important to consider in which areas they were permitted personal latitude. Significantly, as mentioned above, the personal latitude bundles were used differently by the different teachers in the corpus. There was more consistency within a single teacher's use of a bundle than across teachers. Just as any conversation presents one with multiple possibilities for storylines, these idiosyncratic data allow various interpretations. One available interpretation was 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 (e.g., they learned the stance bundles), and that they could use it for their own various purposes. For example, it is possible to use language patterns that might promote student agency in problem solving to discourage student innovation. 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); the many discourse communities in which we participate shape the way we use language. When the teacher-researchers discussed the bundles, they often compared their use of a bundle to how they thought they used it in their homes with their partners or children. This demonstrates their realization that discourse practices in schools may have different characteristics than other communities of which they and their students are a part.

4 Concluding comments

In this article, we relate stance bundles to interpersonal positioning. Interpersonal positioning is especially important when considering how the stance bundles encoded authority of the teacher and discipline, sometimes assuming students were obliged to follow and discouraging alternative viewpoints. On the other hand, some of the stance bundles encoded choice, indicating that alternative viewpoints are possible.

This relates to an imperative we see that results from this work—the need for mathematics educators to take seriously questions about the locations and sources of authority in their classrooms. Some stance bundles encoded obligations to the teacher and to the discipline; other stance bundles suggested choices. In order to better understand the ways in which these obligations influence students' experiences in mathematics classrooms, we think it would be important to engage students in conversations about authority, much like Wagner's (2007) "critical language awareness" conversations with students about agency. Students and teachers would do well to ask who should be making decisions about setting their mathematical agendas, about how to pursue their mathematical problems, about justification of their processes, and about the validity of their results. Discussion about these questions would be outside the mathematics register but nevertheless important.

Our intention with this article is to raise awareness about authority structures in mathematics classrooms, and thus promote reflection about alternative structures of authority and possible ways of establishing them that might promote student choice in thoughtful ways. We are not saying that teachers should release their authority in their classrooms completely. We agree with Oyler (1996): making a statement like that would indicate that authority is something that can be given, instead of recognizing that it is always there. Teachers need to use their authority to exercise their responsibilities for both social and mathematical outcomes. Yet, there is a paucity of research related to productive ways to work with authority in mathematics classrooms. To illustrate the kind of response to our research that we envision for educators, we think of the teachers in this research and their professional engagement with issues raised about their discourse practices. With attention to the way they used language and exercised authority, there was the potential for them to become paranoid about how they would interact with students, but instead they became more careful in their consideration of their practices (see Herbel-Eisenmann and Cirillo (2009) for more about their journeys, dilemmas, and learning during this process). They thoughtfully considered good reasons for taking control and expressing authority. Although the stance bundles in our study show a scarcity of student authority and suggest an imperative to invite student authority in mathematics, there are also appropriate reasons for teachers to exercise their authority. Chazan and Ball (1999), for example, described in depth two situations in which they, as teachers, were reluctant to express their authority but realized the necessity of it. They suggested that the mathematics education community needs to better understand the complexities associated with the decisions they make as teachers, but little has been done to try to better understand authority and positioning issues in mathematics classrooms. As Chazan and Ball pointed out, being told "not to tell" is not enough. We need to understand better how to share and use authority in ways that are most productive for the development of students' mathematical and social agency.

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 some of the most compelling examples of changing classroom discourse that resulted in empowering students can be found in literature on teachers' action research (e.g., Grant & McGraw, 2006; Graves & Zack, 1997; Herbel-Eisenmann & Cirillo, 2009; Lee, 2006; O'Connor, Godfrey & Moses, 1998). The insights offered by the teachers in this study showed critical engagement with language awareness. Realities of classroom complexities are always on the teachers' minds.

As mathematics educators recognize how they encode the authority structures that are implicit in their classroom practice, it becomes possible to envision alternatives and to consciously choose what values to communicate. As Apple (1990) pointed out:

> Social and economic values [...] are already embedded in the design of the institutions we work in, in the 'formal corpus of school knowledge' we preserve in our curricula, in our modes of teaching, and in our principles, standards, and forms of evaluation. Since these values now work *through* us, often unconsciously, the issue is not how to stand above the choice. Rather, it is in what values I must ultimately choose. (p. 9)

There are significant questions relating to how authority in mathematics works through us as mathematics educators. 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 can work with researchers thoughtfully to inform this kind of work. After all, they alone have the authority to make these choices in mathematics classrooms.

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