DISBURSING AUTHORITY AMONG MATHEMATICS STUDENTS

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This longitudinal case study of a high school mathematics teacher paying attention to the way authority works in his classroom follows him from one school to another. His students' resistance to his wish for them to exercise their own authority was frustrating. He eventually had an explicit discussion about authority with them, which seemed to catalyse change. We analyse the classroom discourse in the various settings using categories that describe authority relationships in mathematics classrooms.

Mathematics is often characterized as having an interest in certainty. Thus authority is central to the discipline. Mathematics comprises truth claims, which are supposed to be authoritative. Authority is far from simple in mathematics classrooms. For the past few years, we have worked with teachers to consider ways of developing their repertoires for handling authority issues. This paper presents a case study of one teacher's experience working with authority, both to understand how he considers authority and how he negotiates it in his practice. His situation had special challenges relating to authority because he changed schools part way through the research. In a new school he had to develop students' confidence in his authority.

AUTHORITY IN MATHEMATICS CLASSROOMS

Authority is one of the many resources teachers employ for control 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). This relationship is highly negotiable and students rely on a web of authority relations including friends and family members as well as the teacher (Amit & Fried, 2005). Educational research related to teacher authority often makes distinctions between different types of authority (e.g., Amit & Fried, 2005; Pace & Hemmings, 2007). Most relevant here are the distinctions made between being an authority because of one's content knowledge and being an authority because of one's position (e.g., Skemp, 1979). Pace (2003) showed that these become blended as participants interact in classrooms.

We demonstrated this blending in a recent computer-aided corpus analysis of pervasive language patterns in mathematics classrooms; classroom discourse encodes the structuring of authority in many ways (Herbel-Eisenmann & Wagner, 2010). The most common pervasive discourse patterns explicitly called on the teacher's *personal authority* (e.g., 'I want you to…') and suggested the expectation that students rely on the authority of their teacher. Another prevalent authority structure suggested that the discipline had to be followed, which we called *demands of the discourse as authority*. Language patterns that include combinations like 'we need to' and 'we have to' explicitly identify obligations suggesting that anyone must follow certain rules. These rules, which come from outside the personal relationships, may be attributed to the discipline of mathematics (or perhaps the discipline of school mathematics). A related authority structure suggested a discourse that obscured the presence of authority but in which actions were predictable, which we called *more subtle discursive authority*. With this category there is no explicit reference obligation, but rather a sense of predetermination. Discourse that include patterns like ‘we are going to’ and ‘it is going to’ suggest that there are no decisions to be made. The results are inevitable. Because participants in the discourse do not have authority, the authority rests outside somehow. Other less common patterns suggested *personal latitude*, which recognized that classroom participants could make decisions, and thus had authority.

This distinction between personal authority and disciplinary authority has also been explored through the lens of positioning theory (Wagner & Herbel-Eisenmann, 2009). When people grant authority to the discipline (which is *transcendent* or outside the experience of people participating in the discourse) through their practices, it is different from authority being granted to people with agency in the classroom (who are *immanent*). As Schoenfeld (1992) pointed out, however, the development of internal authority is rare in students, who have “little idea, much less confident, that they can serve as arbiters of mathematical correctness, either individually or collectively” (p. 62).

Even if we agree that students should develop their own sense of mathematical authority, it is problematic to say that teachers should cede their authority. Teachers are reluctant to entertain the idea of giving up authority, partly because of the implications for the teacher’s necessary social authority, but also because they know that their mathematical authority is necessary for teaching. Chazan and Ball (1999) confront this tension through descriptions of two teaching situations, in which they were reluctant to express their authority but realized the necessity of it. Yet, little has been done to date to try to better understand authority and positioning issues in a “reform” mathematics classroom. As Chazan and Ball stated, being told “not to tell” is not enough.

BACKGROUND, DATA, AND CASE STUDY

Prompted by the corpus analysis described earlier, we entered a 3-year collaboration with mathematics teachers in Atlantic Canada who expressed interest in considering the way authority works in their classrooms. After interviewing each teacher at the outset, we recorded 15 consecutive sessions of a mathematics class they each chose. The group of teachers met with us about once every six weeks during the research. Further classroom recording was done when they wanted to try new things related to authority. In addition to video recording, we used voice recorders to capture more local audio of group work. We also interviewed the participant teachers periodically and sometimes interviewed students who were in the classes that were recorded.

The teacher in this case study, Mark (pseudonym), had taught mathematics and physical sciences for 4.5 years prior to this study. He was teaching grades 9-12 mathematics in a rural high school with approximately 150 students. Mark chose a grade 12 classroom for us to observe and record. The student's families generally had incomes lower than average, compared to others in the province, and even lower yet compared nationally. Many parents worked in the forest industry and/or commuted about 1-1.5 hours to a larger centre for work. After the first year of our work together in this research project, Mark took a position in an urban school with well over a thousand students. Now instead of being the only mathematics teacher in the school, he was one of many. He taught multiple sections of grade 9 mathematics and grade 11 physics. Students did not know him so he had a sense of having to establish his authority both mathematically and as a teacher who cares for his students. Mark's situation provided a setting in which we could explore the case of how a teacher considers and enacts authority in changing contexts (i.e., from a familiar context where he was comfortable and established in a small school to an unfamiliar context with different demographics in a much larger school).

As is common in case study research, the data and analyses were interwoven. We began with talking to the teachers about authority, were able to observe them teaching, and had continued conversations with them about their considerations. We iteratively sought and discussed the patterns we observed and modified the interview questions and observations as needed (Yin, 2006), e.g., we recognized that changing schools could allow particular aspects of authority to surface and thus agreed to observe almost every day as his school year began. We realized that Mark's situation was an interesting case of a teacher grappling with authority in two different contexts over a period of time. Thus, we present this longitudinal case study in chronological sequence (Yin, 2006).

CONSIDERING AUTHORITY AS CONTEXT CHANGES: THE CASE OF MARK

Talking with Mark about Authority in the Familiar Context

In the initial interview with Mark, he was asked about his role as a mathematics teacher, to which he replied, "The students look at you as their sole source of knowledge, very few [take] the initiative to go and find answers on their own. […] Like, if you run through investigations with them, by the time you get to the end they look at you and go 'Why didn't you just tell us that?' […] They're quite reluctant to accept the authority really." His use of the word *investigations* connected with "Investigations" in the textbook he was using, which described them as "a situation in which students explore a new skill or concept [and include] questions designed to lead students to a more thorough understanding" (Barry et al, 2001, p. viii). Mark's conceptualisation was quite focused on authority and was, of course, skewed by participation in this research.

When asked more focused questions about authority, Mark's attention moved toward the "Focus" and "Check your Understanding" work following investigations in the class textbook. When asked, "What or whom do your student see as authorities in their classrooms?" he said:

> Mark: I don't think they look beyond [us math teachers]. They feel like we should have all the answers. And sometimes they don't realize that sometimes we have to go look for answers as well. So even though we demonstrate that the authority is found in other places, like textbooks and other colleagues and things like that, they still, … they're focused right in on their teacher. Their teacher must have all the knowledge.

When asked what would happen if he were to disagree with the textbook, he stated "they'd have a hard time believing me over the textbook." He recalled, however, situations in which he went through answers with his students who were then convinced that there was an error in the textbook. Nevertheless, Mark's focus in this interview somehow switched from developing understanding to "getting answers."

When asked, "How do students know what to do in mathematics?" Mark did not seem to understand the question. Perhaps the idea that students do what their teacher tells them was hegemonic and, thus, the question did not make sense. When we clarified the question as asking about how students decide what to do when addressing a problem, he said, "Some of them that have actually remembered previous teachings will just… automatically go to the rules they've previously learned." They would look at the examples he gave, but "some will just constantly ask you, 'What do I do now?', 'What do I do now?', 'What do I do now?'" Mark's frustration with students' dependence was palpable.

Mark was asked to draw a diagram that illustrates the way authority works in his classroom. To start the diagram, he was given a blank piece of paper with a dot in the middle, which he was told represented him. Mark completed his diagram (Figure 1) with a physical representation of the classroom, showing the arrangement of students, who are smaller dots, the blackboard (the straight line), a bookshelf with texts (also authoritative dots) that students can refer to, and his desk at the back of the room. Some students have larger dots because they were recognized as having more authority than the others.

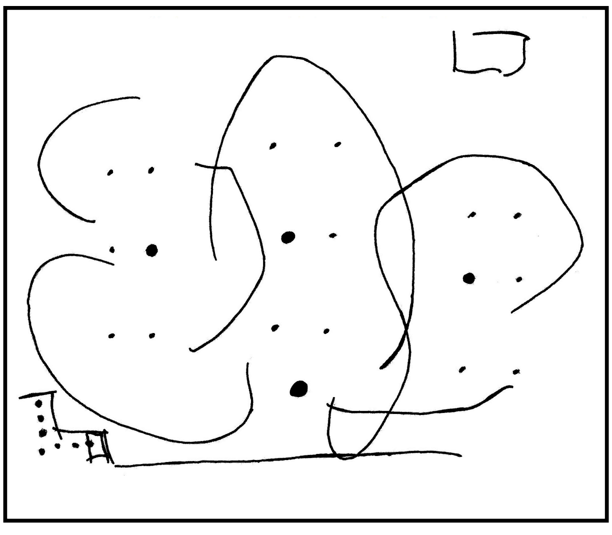

Figure 1

When drawing, Mark talked about balance and said that authority should be spread throughout the classroom. Thus he arranged seating plans to spread the students regarded as authorities around the room, and he himself moved around to avoid fixing authority in one place. His elaboration is interesting and compelling. It relates to positioning, but unlike most scholarship on positioning that uses physical relationships as metaphors for interpersonal relationships, his conceptualization recognizes the effect of physical positioning. In addition to being a schoolteacher, Mark is a coach who runs sports camps. His conceptualization reminds us of play sheets, and he talked about the need for every student (like every player) to follow the directions of the "coach" as they make decisions within the coach's system.

Observing Mark Teach in the Familiar Context

Mark's classroom had examples of each type of authority described earlier from the findings of the corpus analysis. Thus it would be hard to characterize positioning of students in his classroom in one way. He positioned himself as having personal authority by asking students to do things without giving reasons for them to do these things. For example, in our first observation, when Mark turned on his projector, a student asked, "Are these notes?" Apparently, this boy relied on Mark's authority when deciding what to write and what not to write in his notes. Later on, Mark had the students graph $y = x^2$ by saying, "What I need you to do now is just to sketch this graph, okay?" Because the students did not know why he was asking them to draw the graph (except that he needed them to), significant decisions about how to sketch the graph were difficult for them to deal with. Thus a boy asked Mark how to scale the axes.

Mark also positioned the authority of the discipline of mathematics as being transcendent. He marked the discursive power of the discipline in the same session by referring to vocabulary definitions coming from outside the classroom: "We're starting exploring having to find instantaneous rates of change—how fast things are changing at that very moment. So what is it? Technically speaking, it is the change in the dependent variable over an infinitely small change in the independent variable."

In addition to direct reference to outside authority, Mark deferred to a transcendent authority more subtly by using language that suggested their work was entirely predictable—for example, before allowing students to work out a problem, he said, "So we're going to get 4188." There was no doubt what would happen, thus the actions of people in the classroom were deemed redundant.

We were most interested in the ways in which personal latitude was evident. Students asked Mark questions often. For example, in the first session we observed, Mark said, "We calculated average rates of change over various periods or various intervals, right? But what if we start bringing that interval closer and closer and closer together?" and a boy responded by asking, "What happens if they touch?" The boy showed authority to direct the conversation by asking about things that Mark did not appear to be addressing. Mark responded with a show of his mathematical authority by answering the question, saying, "Then you get an instantaneous rate of change." As Mark continued, he positioned the mathematics as being responsive to their intentions: "If we want to find the instantaneous rate of change on a particular graph…" Perhaps this acknowledgement was rhetorical because findings such rates of change was demanded by the curriculum

Also in this same class session, a girl asked Mark if there was an easier way to write about the interval $0 \leq x \leq 4$. A boy asked if the method being discussed would always give the rate. In the first half hour of class (all whole class discussion), 5 of the 11 students took initiative to ask questions. Mark set the agenda (following the curriculum) but students exercised their agency by thinking about what eventualities they might face and asking Mark for clarification that might help them face these eventualities.

The personal latitude expressed by students in Mark's class could be attributed to various factors. Most importantly, Mark was responsive to their questions and thus encouraged more, but there were other factors. Intimacy had a chance to develop with the small class that comprised a relatively stable cohort over twelve years.

Negotiating Authority in an Unfamiliar Context

The circumstances that supported the discourse that Mark and his students grew into did not follow him to his new school. In the new context, Mark had to negotiate with his students their positioning with no personal history. We agreed that recording the initial classes could be revealing, and noticed that Mark and his class settled into a positioning structure that was significantly more reliant on him as an authority. Although there was a perceived need for him to establish his authority, he continued to desire a situation in which the students would develop their own authority. Having to adjust to a new large school themselves, these grade 9 students may have felt lost and thus more reliant on their teacher.

Each of the forms described above from the previous context appeared in this class—personal authority, disciplinary authority, and personal latitude—but this group was much more dependent on him. In order to change the dynamic, Mark chose to devote time to challenge students with questions about authority. Approximately two months into the term, he started a class telling students about the research participant teachers' interest in authority. The following excerpt comes from near the beginning of the class session:

17	Mark:	We're looking at [authority] not necessarily the way that you guys probably think of authority. We're not talking about necessarily who's in charge, per se. That kind of authority. Like police kind of authority. Now that does play a little bit of a role in a classroom obviously. But we're looking more at authority as to the holder of knowledge. Who is the holder of knowledge? Am I?
18	Students:	No
19	Mark:	Okay
20	Girl:	It's us.
21	Mark:	Okay. Good. There're lots of sources of authority. Right? If we're talking about mathematical authority, there're lots of sources. Correct? I am, I guess. I consider myself **a** source of mathematical authority in

> the classroom. But, I also consider each and every one of you guys a source of mathematical authority. […] the whole idea is to disburse the authority a little bit more so that it's not just one big source, and that's the only place where you can get information, the only place you can think of as being a source of knowledge, a source of information. The idea is to make yourself your own source of authority.

Mark then displayed with his projector 2 + 3 = 5 and 2 + 3 = 7. He asked which expression was true and why. Many students seemed frustrated. At first, students said that they know 2 + 3 is 5 because teachers said so, but eventually a girl explained why it has to be five; she grouped two fingers on one hand with three on her other hand, and said, "We learned it when we were younger—the counting numbers. We used our hands to count, and adding numbers. Through the years you kind of adapt to it being five."

Next, Mark displayed two further equations, 2 + 3 x 5 = 25 and 2 + 3 x 5 = 17. One boy said, "It depends on how you do BEDMAS" (Brackets, Exponents, Division & Multiplication, Addition & Subtraction). Mark revoiced this statement and the class erupted. One voice stood out saying, "If you do it right you get 17, if you do it wrong you get 25." When Mark asked who decided on this order of operations the students guessed names: you (i.e., Mark), Stephen Hawkings, Albert Einstein. The students concluded that the convention was passed down through generations, but were vague about how the convention started. Someone suggested "the beginning of time."

After this, Mark was no longer following a plan and he was speaking about as much as the students (usually he spoke much more than the students). Significantly, the students began exercising agency by making demands of him. 31 minutes into the conversation a girl said, "You are asking a hard question. An example would be really helpful." Mark responded with a scenario in a game and another girl interrupted, "No, a *real* life example." Then Mark started using an example from when he built his deck, but students argued for an example from *their* real life, not *his*. When he used the example of choosing mobile phone packages, the class was finally content with that example.

When Mark challenged his students with questions about authority, they exercised authority by telling him how to teach them. Reflecting on the conversation, one student said to Mark, "You asked all these questions but they didn't have answers." The conversation was about 44 minutes, evidencing the students' interest and Mark's dedication to developing a different authority structure in class.

Mark's Reflection

We were curious about how this exchange would change the classroom dynamic. Again, it was not possible to characterise the class as fitting one authority structure because personal authority, disciplinary authority and personal latitude continued to appear. Mark noted, however, that the students began to ask question. They were becoming like the class in his previous school. Some of this change may have been related to the passage of time with him, but we think the conversation he had about authority made a difference, too.

In a formal presentation to teachers later in the year, Mark characterized these students as "very frustrated," "not engaged in their own learning," and "passive participants," at the beginning of the year and he recognised a move to "students questioning," "asking for alternative methods," "demanding explanations," and "giving their own examples of problems they wish to know." He also gave an example from five months later: a student asked him to demonstrate a certain kind of problem, and others gave further directions to him about what they wanted demonstrated, and even posed their own problems. He saw this as a shift toward students taking more authority for their own learning.

OUR REFLECTION

In this case study we can see how authority is central to mathematics classrooms and to Mark's position as a teacher. This position is especially significant in the establishment of classroom routines at the beginning of a semester (or year), and even more so when the teacher is new to the community. The case raises questions for us. First, in relation to Mark's positioning in the classroom, we wonder how much of his perceived need to establish authority was necessary. It is important to be *an* authority in mathematics and to be *in* authority to some extent as a teacher, but it is also important to establish a routine in which each student sees him/herself as *in authority* of his/her own learning so that s/he too could become *an authority* in mathematics. The students themselves probably had similar struggles—wanting to be independent of Mark while depending on him for guidance in various ways. Yet, little is known about the dynamic.

Second, we reflect on Mark's explicit discussion about authority with his students. The importance of mathematics teachers to "step out" or have meta-conversations about norms has been demonstrated (Cobb, Yackel, & Wood, 2003; Rittenhouse, 1998). Authority is central to these norms, so we argue that meta-conversations about authority in mathematics classrooms can help students come to terms with their mathematics. Further research on teachers using such strategies is needed.

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