
Wagner, D. (2007). Students' critical awareness of voice and agency in mathematics classroom discourse. *Mathematical Thinking and Learning*, 9 (1), 31-50.

Students' Critical Awareness of Voice and Agency in Mathematics Classroom Discourse

David Wagner

Faculty of Education

University of New Brunswick, Canada

This account of my extended conversation with a high school mathematics class focuses on voice and agency. As an investigation of possibilities opened up by introducing mathematics students to what Fairclough (1992) called "critical language awareness", I prompted the students daily to become ever more aware of their language practices in class. The tensions in this conversation proved parallel to the tension in mathematics between individual initiative and convention, a tension that Pickering (1995) called the "dance of agency." Participant students in this classroom-based research resisted the idea of linguistic reference to human agency, though their actual language practice revealed some recognition of human agency.

"You shouldn't use any voice, you should use the general voice. I've termed it the general voice because I'm cool and I can make my own terms." These are the words of Joey¹, a 17 year old boy, reflecting on his use of the *I* voice in mathematics class. I engaged Joey's high-school mathematics class in a semester-long conversation with a view to raising their "critical language awareness." Joey's proclamation, together with its context, illustrates some possibilities that can be opened up when mathematics students become more aware of their language practice. This particular instance of critical language awareness drew attention to how personal pronouns relate to what Pickering (1995) called the "dance of agency" (p. 21).

¹ "Joey" is a pseudonym, as are the names of other research participants in this account.

This article has two foci. I describe aspects of a substantial attempt to introduce critical language awareness into a mathematics classroom. I also consider the tension between the individual student and the discipline of school mathematics, a tension that became more evident in this particular experience of raising mathematics students' critical awareness of their language practice. The research reported here was framed by the question:

What is the effect of students' mediated use of discourse analytic tools to explore the mathematics discourse that surrounds them?

During the course of the research, the methodology allowed me to address two key questions:

1. What challenges and possibilities emerge when critical language awareness is introduced in mathematics classrooms?
2. What can researchers learn from conversations with mathematics students about their language practice?

With regard to the second question, this particular instance of students becoming increasingly aware of their use of personal pronouns gave insight into where the students found their place within mathematics classroom discourse.

Attending to School Mathematics Discourse

As a result of her extensive study of secondary school mathematics writing, Morgan (1998) identified the need for students to become more aware of their language practice. She lamented the poor reflection of students' mathematics in their writing, even their good mathematics. Her work focused on written language practices in the mathematics classroom. I suggest that similar challenges exist for oral communication.

Since Pimm (1987) introduced discourse analysis to mathematics education scholarship, there has been growing interest in the nature and form of mathematics classroom discourse. In particular, this interest has been focussed on lexical and grammatical features (e.g. Rowland, 2000; Morgan, 1998; Weingrad, 1998; L. Bills, 2000; Herbel-Eisenmann, 2000; C. Bills, 2002; Phillips, 2002; Gerofsky, 2004). Discourse can also be approached in other ways. Mathematics educators have considered mathematics learning discourses with an interest in semiotics (e.g. Duval, 1999; Radford, 2002), genre (e.g. Pimm and Wagner, 2003; Gerofsky, 2004), post-structuralist hermeneutics (e.g. Brown, 2001), conversation analysis (e.g. Barwell, 2003), and socio-cultural milieu (e.g. Cobb et al, 1992).

I value discourse analysis because we can use it to focus both on mathematics as a discipline and on the related discipline of school mathematics at the same time. When the participants in a discipline make grammatical choices (usually subconscious) to form their utterances, these structural choices relate to the participants' understanding of the structure of the discipline and their position in it. From analysis of the discursive practice, which is an artefact of classroom culture and of individuals' participation in that culture, we are afforded insight into the participants' sense of relation to the discursive system. Mathematics educators have recently become increasingly interested in this relationship (e.g. Evans, 2000; Fiori et al, 2004; Hannula et al, 2004). Discourse analysis is one tool for investigating this relationship.

The form of discourse analysis and the nature of its benefits can vary according to the orientation of the research. I want to do more than *describe* mathematics classroom discourse: I want to look at it *critically*. Descriptive analysis is the norm for studies of lexico-grammatical forms in discourse, but a critical orientation asks different questions.

Linguists Chouliaraki and Fairclough (1999) have constructed a framework for analyzing discourse for critical purposes. With this framework, they encourage the use of discourse analysis to identify "the range of what people can do in given structural conditions" (p. 65). I suggest that this purpose is well-suited to mathematics students. The introduction of critical discourse analysis in an educational setting has been termed *critical language awareness* (Fairclough, 1992.) Such awareness equips students to use language powerfully. More importantly, it also teaches them to problematize language and to recognize that language problems are inherent in the discourse. To address a range of issues relating to critical language awareness, Fairclough sought to collect examples from "diverse educational contexts – primary and secondary schools, colleges of further and higher education and universities" (p. 17). However, all his examples involve language arts and language-acquisition classes. My research investigates the introduction of critical language awareness in a *mathematics* classroom.

Morgan (1998), who employs critical discourse analysis to inform educators, concludes her book by calling for heightened language awareness amongst mathematics students. Like her, I want both mathematics students and educators to benefit from increased language awareness. Though there is much potential for analyzing classroom discourses for other purposes – for example, to say what form these discourses *ought* to take – students have little control over the discursive systems in their mathematics classrooms. I believe they could benefit from exploring various ways of living within the discourse space they encounter daily. I am not interested in quantifying these benefits. Rather, I look for examples of students considering the range of possibilities available for them to participate in this space.

Research Method

Assuming that mathematics classrooms would benefit from increased critical language awareness, an important question remains: How can it be brought about effectively? I have begun to answer this question by analyzing transcripts of interviews in which students responded to audio-taped excerpts of themselves working on pure mathematics investigations (Wagner, 2003). These interviews did not focus on language per se, but the analysis is instructive for applying critical language awareness to the mathematics classroom, especially because the audio excerpts highlighted the students taking initiative in mathematical exploration. In this analysis, I suggested that the students themselves ought to analyze samples of their own classroom discourse because they know their context well. Understanding the context of a discourse is necessary for critical discourse analysis: Chouliaraki and Fairclough (1999) emphasized the importance of an ethnographic component of critical discourse analysis.

I chose to work closely with one group of mathematics students for an extended period of time. I spent an entire 19-week semester with a grade 11 pure mathematics class of students who intended to attend university. I co-taught the course with the regular teacher and daily collected video and audio records of classroom discourse. The class met four days a week for 66 minutes, and with an additional 132-minute class on Tuesdays. I would describe the participant teacher as traditional in the way she structured her classroom, her lessons, and her assessment. When I taught, I tried to fit my more interactive approach to her structuring: I taught alternate days and she expected me to address a particular outcome each day. Clearly, this arrangement had implications for the result of my attempts to raise the students' awareness of their discourse.

By directing the students' attention to their own utterances, I tried daily to engage the students in discussion about our language practices in the class. The forms of my language-related prompts were different on the days that the participant teacher was teaching than on the days that I taught. Furthermore, I continually adjusted the form of my prompts in response to the students' receptiveness to earlier prompts.

The primary data of this research comprises the daily classroom interaction about language. These interactions were usually similar to group interviews lasting between two and 15 minutes. In a sense, they were longer because they drew upon months of shared experiences in the mathematics classroom. Our conversations about language often continued from one day to the next. A few times we had extended interactions about language, including a full class devoted to role-playing. I often had small informal interviews with students during class, but most of these were not recorded because of technical constraints. In addition to our classroom interaction about language, I asked the participant students to write accounts of their experiences with language in relation to their mathematics learning and I interviewed the participant teacher and some of the students outside of class. Six students participated in multiple interviews, each lasting a half hour or more.

These six were chosen because of their enthusiasm in class discussion about language. Ten students who participated very little in class discussion participated in shorter interviews. When I asked the students to write accounts of their experiences with language, not all of them gave me written responses. One prompt received only one reply, albeit a very lengthy one, and other prompts received replies from most of the class.

This research was an investigation of possibility in the sense described by Skovsmose and Borba (2004) in their methodology for critical mathematics education:

[D]oing critical research means not only to consider what is taking place but also to consider what could have taken place and what could be imagined as possible alternatives to what is taking place. Doing critical research also means to explore *what is not there* and *what is not actual*. To research also what is *not* there and what is *not* actual means to investigate *what could be* (p. 211, emphases in original).

Following their model, I saw the 'original situation' of the participant class as a situation that I wanted to transform. I imagined a situation in which students would notice aspects of their language practice and through this noticing become more aware of the nature of mathematics and of possibilities for them to relate to the mathematics.

My agenda was not the same as the students' agenda for this class.² In fact, our agendas, or what Skovsmose and Borba (2004) termed "imagined situations", kept changing as we were responding to one other. Therefore, I could not expect the classroom developments to follow my plan. Indeed, I needed to expect disruption, to welcome it. This expectation would include acceptance of students' resistance to language awareness. Valero and Vithal (1998) illustrated the importance of disruption in research settings and argue against typical research methodologies that assume and promote stability. Indeed, just as Valero and Vithal realized from the research they report, I am realizing that the times when I felt most resisted were frequently the most generative times, both for me and for the participant students. The stream of conversation relating to personal pronouns is one such time.

² Valero (2004) drew attention to the flawed assumption that school children want to learn mathematics. I would add that research reporting that refers to participant children as *students* betrays such an assumption. For example, when I, in this article, refer to the participants as students, I am implying that they intended to learn the prescribed curriculum. This is only partially true. I also resist calling these participants *children*, because that word carries other baggage (including the implication that these people do not have anything to offer adults, an idea that I am trying to challenge in this article). From the actions of the participant children, it was clear to me that other intentions often eclipsed their desire to learn the required mathematics. Furthermore, from their accounts of their goals in this particular mathematics course, they, like the boys in Valero's account, were more interested in achieving a satisfactory grade that would earn them passage to a desirable future and less interested in the mathematics itself.

Critical Language Awareness in Action

Passive Resistance

The participants in this research found various ways to resist my attempts to raise their awareness of language. I characterize their general lack of cooperation as *passive resistance* because their response to my prompts could not be described as outright rebellion. Rather, the participants typically responded to my prompts with either literal silence or with shallow, disinterested but compliant answers. Furthermore, students often evaded interviews even though they maintained an expressed willingness to spend some of their free time in interviews. In classroom discussions, although I varied the form and context of my prompts throughout the term of our engagement, I did not find a strategy that I would consider generally successful for raising language awareness.

While the participant students' resistance was significant in itself, it became especially important as a context in which to view the exceptions to their passivity. The exceptions, in which students became engaged and persistent, reflect some of these students' real concerns about the mathematics classroom discourse that had been a part of their daily lives for the past eleven years.

Attending to Agency

Joey's proclamation, with which I began this article, has its roots in one of these exceptions. In this stream of conversation, Joey and some of his classmates argued with me about a particular language feature. It started when I led the students in a conversation about human initiative in mathematics. We looked at voice in their utterances to discuss who has agency in the discourse, who has control over the way the mathematics is done and expressed. Their initial interpretations of their personal pronoun use were very different than my interpretations, but we all learned something through this tension. After I present some highlights from this particular conversation, I will show how the tension in our discussion about their language practice was similar to tensions inherent both in mathematics and in the language used to express mathematics.

The conversation began early in our semester together. As an exercise to develop the students' ability to locate agency in utterances, I read them a newspaper article about a popular singer. I read one sentence at a time and asked the class to identify who, if anyone, was said to be making things happen: Who had agency? After this exercise, I asked them to watch for agency in our mathematics class.

In subsequent conversations, the students did not seem to care that there was no evidence of human agency in their mathematics textbook language. For example, when I asked them to identify who had agency in the sentences on a particular textbook page, they noticed that the wording obscured agency except in

the story part of word problems, but they did not find this feature remarkable. Though I have concerns about such obfuscation, which are partially addressed in Herbel-Eisenmann and Wagner (2005), I did not raise the issue with them because I wanted to listen to what *they* noticed and found significant. Their lack of interest in the phenomenon at this point suggested that they thought an absence of human agency means that agency is insignificant in mathematics. I would argue that this absence is *not* insignificant.

In this initial conversation about agency, I did not give the students a definition of the word *agency*. Instead, I wanted their sense of the word to develop by using it. However, my simple question, “who is said to be making things happen?” was similar to Pickering’s (1995) description of agency. He described choice and discretion as the classic attributes of human agency, and passivity as its antithesis. Nor did I discuss with students how they discerned the agency in each sentence.

Pickering (1995) also avoided “defining” agency though his whole book is about agency. When he introduced the term, he equated *agency* with *doing things*: “One can start [thinking about science] from the idea that the world is filled not [...] with facts and observations, but with *agency*. The world, I want to say, is continually *doing things*” (p. 6, emphasizes his). In her overview of educational and social research on discourse, MacLure (2003) argued that it is appropriate to avoid definitions because they assume a binary distinction between words and meaning.

For example, the word *voice*, which was important to this conversation with students, carries multiple meanings, each of which informs the others. In the conversations that followed, we focused our attention on the voice of sentences. The word *voice* can be used in various ways. Grammatically speaking, sentences with active voice (as opposed to passive) reveal a human agent who makes something happen. For example, if the subject of a sentence is *I*, then the speaker is likely to be taking initiative in some way. (“I dropped the ball” employs an active voice, whereas “The ball was dropped” employs a passive voice.) The word *voice* can also refer to the level of input a person has in a discourse. For example, Carter’s (1993) use of narrative inquiry as a methodological tool draws out the *voice* of teachers: “[T]he issue of voice centres on the extent to which the languages of research on teaching [...] allow for the authentic expression of teachers’ experiences and concerns” (p. 8). Thirdly, the word *voice* can refer to a person’s unique character. These different senses of the word *voice* are interrelated. When I speak or write with the active voice, as opposed to the passive voice, I am not masking my agency in the situation. By referring to my agency I suggest that I am making a contribution to the situation. And when I make contributions, I tend to do so in my own unique way. I express my voice.³

³ As Bakhtin (1953/1986) noted, this idea of *having* voice, or possessing it, is complex. My utterances can be expressions of my word, another’s word and even a neutral word, all at once.

Students Responding to their Texts

A few weeks after our initial discussions about agency, students were given the following question on a written test (Figure 1).

Consider the quadratic function $f(x) = (x - 1)^2 + 3$. Explain how you can tell which of the following is its inverse:

$$y = \sqrt{x-1} + 3 \quad y = \sqrt{x-3} + 1 \quad y = \pm\sqrt{x-1} + 3 \quad y = \pm\sqrt{x-3} + 1$$

Figure 1. A test prompt asking for explanation

The next day, I used an overhead projector to show the students some samples of their responses to this question. Without indicating that I wanted to talk about language features in their writing, I showed and described two longer responses. Then I showed the following set of excerpts from four other student responses (Figure 2). I had transcribed all of these responses so that classmates would not recognize one another’s work.

Excerpt 1: “We switch around the x & y (inverse) & do the work.”

Excerpt 2: “Switch the y and the x and find the value of y .”

Excerpt 3: “You switch the x and y and then solve for y which will give you the equation of the inverse line.”

Excerpt 4: “I can tell by switching the y and the x in the original equation & then solving for y .”

Figure 2. Four responses to the test prompt

I asked, “Do you notice anything interesting about these four?” After a long silence, one student noticed that they all contain the word *switch*. I responded by asking which words were different. This student was attending to commonalities in the language, not to differences, which is a distinction that relates to the difference between descriptive and critical orientation to discourse. After another extended silence, I simply circled the initial word in the first, third, and fourth samples – the personal pronouns *we*, *you* and *I*. Laughter erupted. Laughter marked the beginning of a few of the most animated discussions about language in this research. It seemed to serve as a marker of interest.

I asked which answer was the best. A girl, Rory, answered, “the second one”, but I did not acknowledge her answer because I only heard it later while listening to the audio record of the lesson. After class she told me the reason she preferred the second excerpt was that it was hers. However, it was not hers. It was actually her friend’s answer, though Rory’s response shared the same passive voice. Perhaps she was claiming ownership of the form of the voice rather than of the

whole response. Or perhaps she was adopting her friend's words as her own words, which Bakhtin (1953/1986) suggests to be a common occurrence.

A boy said he preferred excerpt 4 – “the one with *I*”, he said – because that was the one he wrote on the test. He recognized his work. Ironically, except for this one instance, he did not support the idea of referring to humans in mathematics class. This boy, who had recently emigrated from Russia, asked me at the end of the research engagement if *Signot* could be his pseudonym. He told me that it was a common name and that it means *anonymous*. I find it significant that he chose a pseudonym whose meaning he claimed is *anonymous* in Russian, just as he supported the anonymity of humans in mathematics.

Matt, a high-achiever, responded to the four excerpts: “Well, obviously [the test question] asks you to tell how *you* can tell which of the following is its inverse. So you're not saying, ‘well, my partner, the guy sitting beside me....’” This boy noticed the leading nature of the question's wording: “Explain how *you* can tell” He was suggesting that it is natural to answer a *you* question with an *I* answer. (I have noted the phenomenon of conversation participants following and resisting each other's linguistic structuring in interview contexts in Wagner, 2003.)

After hearing these opinions, I offered an interpretation that I hoped would provoke resistance, but there was no time for immediate response. I said that the subjects of these sentences were interchangeable. In mathematics it does not matter who does something, because the result should be the same no matter what. I summed up by saying, “In mathematics, people don't matter.”

My plans to pursue this conversation about voice and to relate it to issues of agency were disrupted when we missed a few classes in a row. Such disruption is typical of classroom-based research. A four-day long weekend and an extra-curricular class engagement intervened. When we resumed, I had planned to prompt a discussion about agency by interrupting the flow of a mathematics conversation when students used pronouns interestingly. I failed to do this because of the difficulty of noticing language use in action and because I did not want to interrupt important mathematics.

Upon reflection, I realized that I myself was experiencing difficulty doing the very thing I wanted the students to do – pay attention to their language practice while using language for mathematics. Because I was concentrating on communication *about* mathematics, language itself was for me at this time a transparent, non-problematic medium. Adler (2001) called this tension the “dilemma of transparency” in her account of the dilemmas facing teachers in multilingual mathematics classes. While it is normal to use language as though it is transparent, at times it is valuable to become aware of language as a mediating resource.

Adler's observation that multilingual environments naturally draw attention to language is borne out in my research by the fact that it was the multilingual students who were the most engaged in discussion about our language practice. Joey, who was the most active participant in our conversation about personal

pronouns, told me that in his mother tongue, Chichewa (an official language in Malawi), personal pronouns are rarely used. This is not unique to his culture. For example, scholars working to capture the oral history of North American Aboriginals (Marks Dauenhauer, & Dauenhauer, 1999) noted the confusion caused by different cultures' ways of referring to protagonists in stories. Clearly, Joey's extraordinary attention to personal pronouns is related to his knowledge of various languages. I am reminded that there are many factors from outside the classroom (and from outside clinical interviews) that have significant impact.

To avoid repeating my problem with noticing language in practice, I *began* the next day's class by continuing the conversation. This was a departure from my earlier attempts to *integrate* discussion about language into the lesson. The students immediately engaged in the conversation even though a week had elapsed since our brief discussion of voice in their writing. I put the same group of four student responses (Figure 2) on the overhead projector, with the initial pronouns still circled. Here is an excerpt from the student response (“DW” refers to my utterances):

DW: I said, “In mathematics it shouldn't matter who is doing the work.” The subject of any sentence is interchangeable. [...] Is what I said true? And, if not, when is the subject interchangeable and when is it not?

Joey: I think you should, well personally, I think you shouldn't use *I*, *you*, or *we* or *me* or whatever because if you say “you switch,” that means that somebody else has to do something different. You know what I'm talking about?

DW: ... telling someone what to do.

Joey: No, because if you, like, “you switch” something and if somebody else decides to not switch you're making that one person switch it. It's all wrong. Shambles.

Generalization and Agency

Joey and others articulated a literal interpretation of these personal pronouns. They did not seem to see the possibility of *you* being used in a general sense. Rowland (2000) noticed “the use of the vague, unmarked ‘you’, functioning as a vague ‘generalizer’” (p. 109), but he claimed that “this matter seems to have escaped analytical attention with regard to English speech” (p. 76). Bills (2002) provided evidence that higher-achieving students use *you* in this general way, but there is no indication that the students in his research consciously used the generalizing form of *you*. It was clear that the students in my research had not seen this usage as a possibility before we compared the four responses shown in Figure 2. Their oversight should not be surprising considering that, as Rowland noted, even linguists have made this oversight. I saw an opportunity to help these students become aware of a practice to which they had already been exposed.

Indeed, they regularly used *you* in a general sense without realizing it. For example, in Matt's response to the test prompt shown in Figure 1, he switches back and forth between voices, which include the general *you* voice:

First thing, I know the first two are not a quadratic, because it is only a positive square root. When you do a square root of a number, the number can be positive or negative. e.g. $\sqrt{4} = 2 \rightarrow 2 \times 2 = 4$ or $\sqrt{4} = -2 \rightarrow -2 \times -2 = 4$. Therefore it has to be written $\pm \sqrt{4}$. When figuring out the inverse, first switch the *y* and *x* variable. I need to isolate *y* to have a quadratic equation, so I subtract 3 from both sides [...].

He begins with an *I* voice ("I know the first two..."), switches to a general *you* voice ("When you do a square root..."), then to a passive voice ("it has to be written"), then to imperative ("first switch the *y* and *x* ...") and back to an *I* voice ("I need to ...").

In the next class period, I challenged Joey by quoting from the incident excerpted earlier and then quoting from his participation in mathematics discussion. I said:

Joey said, "I think you shouldn't use *I* or *you* or *me* or *we* or whatever because if you say 'you switch' that means somebody else has to do something different." Then, ten minutes later, he said, "say you are on a test, what would you round this one to?" And he did the exact opposite of what he said.

At the time, we had a rule that no student could participate in discussion about language on two consecutive days (to promote wider participation). Joey gestured to make it clear he wanted to speak although the rules prevented him from doing so. The laughter died down after I promised Joey the last word and he resigned himself to not speaking until then. Following his tacit agreement, a classmate defended Joey's word choice by describing how he was addressing a particular person: "Joey's just asking you what *you* think with his question." I responded by quoting another more obvious instance of Joey using *you* in what I considered to be a general sense: "You know you have degree two" Another classmate described Joey's language choice this way: "It's putting pretty much what you did from their perspective." Other students said the same thing, that this *you* voice represented an individual trying to relate his own experiences in such a way as to help others understand his experiences from their own perspectives. I resisted their interpretation and gave invented examples of people using the general *you* voice in everyday life, but I did not call it a "general" voice. For example, I asked,

Do you notice people on the news using *you* like that? Maybe they're interviewing someone who went through a bombing attack. And they'll say, 'first I jumped for cover and then you know, when you're in a situation like this and you've got'

As with the mathematical utterances, the students resisted my interpretation, giving plausible literal interpretations of the pronoun *you* for every one of my examples.

On reflection, I can see how their interpretations actually described the general sense of the pronoun *you*, but in a way I had not considered. These students were describing mathematical communication as an attempt to bridge a diversity of perspectives. They were describing a discourse that promotes a sense of everyone seeing the same things in the same way. This explains the general *you* voice and even the mathematics class *we* voice that Rowland (2000) and Pimm (1987) remarked on and discussed.

Rowland (2000) claimed that mathematics teachers employ the *we* voice with the intent of drawing students into complicity, hoping to trap them in tacit agreement. Pimm (1987) also referred to the normalizing force of the inclusive pronoun *we*: "The least that is required is my passive acquiescence [...] I am persuaded to agree to the author's attempts to absorb me into the action" (p. 73). What about mathematics students? Would they also have such a normalizing agenda? I prefer Pimm's other explanation for the use of the *we* voice. The *we* can refer to the anonymous collective of mathematicians, people who do things right. It refers to convention.

Students who want to show they are members in this collective of people who do things right have the *we* voice at their disposal: "We switch the *x* and *y* variables to find the inverse." Yes, a real collective, a real *we* does find inverses in this way. *We* is literal. *You* is too: "You switch the *x* and *y* variables to find the inverse." If *you* want to be part of the collective, the people who do things right, *you* will do things the way the collective does things. *You* is literal, even when it is used in its generalizing sense.

The literal usages of these pronouns refer to convention, to what Bakhtin (1953/1986) called the *neutral word*. Though it can be read as literal, Bakhtin characterized the neutral word as belonging to no one. These "personal" pronouns can be taken as literal and as general affectations at the same time. My participant students were not wrong to find literal explanations for the pronouns. Though I wanted them to see that these words refer to an abstracted other, I realized on reflection that their interpretation and mine were not incompatible. Though the discipline of mathematics comprises a collective of real *individuals*, it can be experienced as an abstracted other because most of the individuals in the collective are not present at any given time (and some are dead).

My interpretation of the students' emerging understanding was supported a week later in an interview with Joey when he made the proclamation I quoted at the beginning of this article: "You shouldn't use any voice," Joey's proclamation is significant when it is considered in its context. By introducing his own terminology, he demonstrated his individual human agency, his capacity to explore varying ways of participating in mathematics discourse. Furthermore, in his

thinking about language, he touched upon important characteristics of mathematical thinking – generalization and abstraction. His move from seeing particular perspectives in mathematics to envisaging a general, conventional perspective exemplifies a tension at the heart of mathematics.

The Expressive Form of the Dance of Agency

Pickering (1995) identified this tension in his account of historical scientific and mathematical advances. He identified different types of agency – human, material and disciplinary – but he did not consider material agency significant in mathematics. Human agency can be resisted by physical reality (material agency) or by conceptual systems (disciplinary agency). When scientists and mathematicians follow the established patterns of their disciplines they surrender to disciplinary agency. It is when they take initiative with open-ended modeling and cross-discipline conversation that they extend present cultural and conceptual practices and, in so doing, demonstrate their human agency. Pickering termed the tension between human and disciplinary agency in such instances a “dance of agency.”⁴

Boaler (2002, 2003) drew on Pickering’s metaphor to describe good mathematics class discourse. While Pickering focused on global cultural extension, Boaler was more interested in local extensions of discourse, particularly in mathematics classrooms. In her depiction of traditional classrooms, students simply follow the paths set before them. They surrender to the disciplinary agency. By contrast, Boaler promoted classroom discourse that prompts students to take initiative, to demonstrate human agency. While Pickering focused on scientific, disciplinary advancement, Boaler addressed the importance of each individual mathematics student’s human advancement. I suggest that the strong presence of the student *I* voice in Boaler’s (2003) exemplar demonstrates human agency within the classroom disciplinary setting.⁵ For example, in Boaler’s exemplary class, the student Ryan moves from an *I* voice to a generalizing *you* voice as he describes his move toward generalization:

⁴ Though Pickering (1995) rejected the possibility of material agency in mathematics, I think that the question should be pursued: What is the nature of material agency in mathematics? Namukasa (2004), who interpreted children’s mathematical investigations from an enactivist perspective, ascribed agency to the concrete manipulatives the children had at hand as they engaged in their exploration. Her assertion merits elaboration.

⁵ A high density of the *I* voice does not necessarily suggest strong human agency. For example, Evans’ (2000) exemplar transcripts of interviews with adults also featured a strong incidence of the *I* voice. However, in this case it is probably attributable to the metalinguistic nature of the conversation more than it is to personal agency. That being said, metacognition probably supports the development of a sense of personal agency.

I’m trying to find a general formula for the, this triangle (obtuse). Because *I* knew that the triangle used to find the height is right there [...] *I* did um 180 minus theta, because if *you* know, if *you* know that angle right there is theta, then *you* know that the two combined have to be 180. (p. 10, emphasis mine)

As Ryan moves from the *I* voice to *you* voice, he shifts from past to present tense. It seems he first saw himself doing mathematics, using the past tense and *I* voice to report on it, and then shifted to addressing a community of mathematicians interested in general truths, using the present tense and the general *you* voice. This mathematical move toward abstraction and atemporality is noted by Balacheff (1988), who listed de-personalisation and de-temporalisation, along with de-contextualisation, as characteristics of proof and explanation language.

Boaler, with her promotion of reform classrooms, would likely characterize my participant class as a traditional class. The students mostly followed and practised mathematical procedures that were given to them. Because of their traditional, passive frame of reference, it was a challenge for me to draw out their *I* voices in conversation about language and about mathematics. In this class, the teacher was seen to be the human face of the discipline’s agency, and the discipline was the dominant partner in the dance of agency.

Joey, Matt, Signot, and some of their classmates were able to overcome the typical patterns of discourse in this traditional class. When they expressed their own voices and resisted the dominant voice of their teacher, they began a more vibrant dance of agency. Significantly, the students who expressed their linguistic agency were also the most vocal expressing their mathematical agency. Joey was the boldest in the class, the most willing to suggest a new approach to a problem. Signot was a willing participant in classroom conversation about mathematics, but his mathematical ideas were often hard for the rest of us to understand. Matt, who was different from Joey and Signot in that English was his first language, suggested new approaches less often, but his suggestions tended to be taken as being more sophisticated mathematically.

In the interview in which Joey made his proclamation about the general voice, I asked him if he typically noticed himself using *I*, *you* or *we* voices in his mathematics. He responded: “I’m always thinking in the *I* form when I’m doing my math. I don’t know why. It’s just, I’ve always thought that way. Because I’m always doing something.”

In addition to using an *I* voice, Joey expressed his personal agency in mathematics by adapting his everyday vocabulary to express his mathematical ideas. He used what Pirie (1998) referred to as *quasi-mathematical* language, language which is not likely to be understood by someone not part of the class. For example, to describe the graph Joey expected from the function $y = x^4 - 2x^3 - 12x^2 + 40x - 32$, he asked the regular classroom teacher, “Shouldn’t there be a masher amount of hills and valleys?” I had never heard the word *masher* before, but I assumed from

the context that it was roughly equivalent to the word *large*, because there would be a large number of local maxima and minima, which this teacher sometimes called *hills* and *valleys*.

I suggest that the form of human agency in Joey's utterance relates to what Chapman (2003) called *transformational freedom*: "Students with transformational freedom are those who have the facility to use language appropriate to the situation. They can express the same meanings in more mathematical or less mathematical language" (pp. 48-49). Further, Chapman argued that transformational freedom is a mark of a successful mathematics student: "[S]tudents who are successful in school mathematics display transformational freedom in their language practices, whereas students who are less successful rely on signals from the teacher to make transformational shifts" (p. 133). For example, the high-achieving Matt is not very careful about his word choice in his answer to the mathematical prompt given earlier. His inconsistent use of personal pronouns is almost imperceptible if we attend to the mathematics he is describing.

Although Joey was not a high-achieving mathematics student, he showed his facility with a range of language forms and with shifts from one form to another. Joey does not contradict Chapman's assertions, because she claimed that transformational freedom is a mark of success, one mark among others. This is not to say that relatively unsuccessful students cannot display transformational freedom or other expressions of human agency. Furthermore, as a pair of Joey's classmates told me in an interview, many students use the form of their language to give the teacher a particular impression of their skill. They said, for example, that they sometimes used more technical language to mask their insecurity.

Though Joey was expressive with his human agency, there were other challenges for him. He tended not to succeed on formal assessments, which tested his rote knowledge and rule-following. Walkerdine (1988) was instructive on this:

While conflict and rule-challenging provide proof of masculinity, only that directed at the overthrow of the discourse itself, the teacher's right to 'mastery', provides the [...] evidence of real understanding or 'brains', 'brilliance', and so forth. [...] The challenging is difficult for it threatens the teacher's control and yet simultaneously provides the desired evidence. (p. 209)

The regular classroom teacher often expressed her surprise at Joey's inability to succeed on tests because she was impressed with his oral classroom contributions, in which he regularly displayed the "brilliance" Walkerdine (1988) described. Clearly, human agency is not a sufficient capacity for a student to succeed in mathematics. Perhaps Joey needed to attend more closely to the discipline to complement and contextualize his personal mathematical and linguistic initiative. I am suggesting a dynamic balance between rule-following and rule-breaking – a dance.

With his proclamation about the general voice, Joey displayed his awareness that he can make decisions about how to say things in mathematics class. He showed this awareness by inventing terminology, by saying that he was rejecting the *I* voice and the *you* voice (even in its general sense) and by adopting a passive voice to reflect mathematical necessity – that utterances should be generally true, independent of the perspectives of particular people. I suggest that the fact that he broke his own rule regularly, by using an *I* voice and a *you* voice to express generality, should not lead us to discount his sense of human agency. He confidently expressed his intention regarding language practice even while he knew that his language choices often contradicted these intentions.

Ironically, Joey seemed to be using his human agency – relating to language choice – to reject human agency in mathematics. He said that he (and others) should not use the *I* voice (nor the *you* voice or the *we* voice). Had he followed his own directive, he would have cut himself off from participating in the dance of agency between his own understanding and the conventional demands of mathematical discourse. However, he did not follow his own directive. Joey, more than any other student in his class, regularly exercised his *I* voice. It is conceivable that Joey's growing ability to articulate his linguistic agency strengthened his inclination to engage in the mathematical dance of agency. It is because of this possibility that I think critical language awareness belongs in mathematics classrooms. Unfortunately, Joey's engagement in oral discussions about mathematics was not a sufficient factor to ensure his success in this traditionally-structured classroom.

Reflection

At the outset of this article, I noted two potential benefits of researching students who attend critically to their language practice. Most of this article has used an example of a particular group of students in a particular context to show how students can become aware of a range of possibilities for positioning themselves within the discourse. The conversation also provided insight into these students' perspective on their personal positioning within mathematics. This example cannot, however, be generalized. It does not prove that critical language awareness belongs in every mathematics classroom. Adler (2001) claimed that it is necessary to pay some attention to language when teaching mathematics, but it is a different thing to give *critical* attention to mathematics classroom language.

A question for educators who are interested in raising awareness of language is *how* to do it and for what reasons. Because my researched classroom situation was different from regular classrooms in some significant ways, this article's account cannot be translated blindly into any other mathematics classroom. In addition to my pedagogic reasons for wanting the students' critical awareness of language to increase, I had another agenda – the collection of data for research.

In this way, my motives were different from those one would expect of a regular classroom teacher. However, I suggest two reasons why this difference is relatively minor. First, because my research agenda was based on my belief in the pedagogic value of critical language awareness, my data collection agenda was closely related to my pedagogy. Second, any classroom teacher who tries something new, whether it is directing attention to language or something else altogether, probably looks for evidence of success or failure. In other words, the teacher aims to collect data.

The fact that the participant students were aware of my agenda was probably a more significant factor in what happened than were my mixed motives. The relevant ethics protocols required that the research participants be informed of the intent of the research at its outset. The students knew I was interested in language. Every time I mentioned the word *language* or drew attention to language in another way, students expected something odd to happen, something unique to their particular class and thus not necessary for learning the prescribed content of the course.

Their sense of oddity would change their perception of every task I gave them. By contrast, a teacher in a non-researched classroom could ask innocently a question like, “Why aren’t there any personal pronouns in your textbook?” In such a context, the students would be more likely to expect the question to lead to fruitful dialogue about mathematics. With this expectation, the conversation could develop more naturally. Indeed, when I was a high school teacher, I did ask such questions and the resulting conversations were mathematically rich.

In the researched classroom, I often felt that the students’ orientation to success (getting good grades) interfered with their attention to language. However, the students were happy to be distracted from this agenda when the alternative was something they considered pleasurable. It is important that a teacher’s prompts be perceived as authentic and for the moment. I can furnish this kind of prompt quite naturally because I have an interest in language and I recognize its potential for prompting reflection. However, in a situation coloured by ethical pre-clearance, such “natural” prompting is extremely difficult because there is an obvious externally motivated agenda. My advice to educators who are interested in directing attention to language is to do so out of genuine curiosity and without reference to an external agenda.

I believe that teachers who do find relevant ways of attending critically to language features in their classrooms will be rewarded with insight into important features of mathematics and into their students’ perspective on what they are doing when they participate in mathematics class. However, it is important to note that all we can receive is *insight* into the students’ perspective. We cannot actually see the mathematics classroom from their perspective.

In the conversation about personal pronouns described in this article, and in my conversations with these participants about other language features, a certain amount of provocation was needed to initiate their interest. This provocation, which

to me often felt like bullying, is a significant problem to consider from a research standpoint. At times I wondered whether my forceful way of directing attention significantly skewed the students’ perspective, which is the very perspective I was trying to research. Of course it skewed their perspective! Part of the point of raising critical awareness is that it changes perspectives. It is educative. However, my verbal provocations gave the students opportunity to say no. These provocations somehow invited them to exercise their power. In this conversation they argued forcefully against my strongly-worded claim that there is a way of using the pronouns *you* and *we* in a general sense. These instances of resistance were most significant to me for interpretation because the students’ energy to resist demonstrated to me that they found their point of view significant. While I tried to problematize the mathematics classroom by pointing out the loss of personal particularities suffered in its discourse, these students showed me how they could find themselves in the discourse. They helped me realize that human agency cannot be easily lost.

Still, there are things teachers can do to afford students with an increased sense of human agency. In McLuhan’s (1964) consideration of new technology, he asserted that the medium is the message. This statement can be extended to include language as a technology. If we expect students to *exercise* their personal agency in mathematics, they will need to grow accustomed to *expressing* agency in their utterances. For this to happen, they will need to hear their teachers using expressive voices in their mathematics – particularly the *I* voice – and they will need to be given tasks that provide a context for using this voice, tasks that require personal initiative. Instead of expecting students to respond to and regurgitate their teacher’s mathematics, actions that Wilder (1968) termed “symbolic reflex,” we need to provide tasks that prompt students to exercise what Wilder referred to as “symbolic initiative.” Wilder suggested that symbolic initiative is what makes us human.

Dance is about relationship. However, the relationship itself cannot be observed directly. We see only the dance steps. As we see and feel the moves, we learn something about the relationship. In mathematics, there is a dance of agency between humans and either conventionality or common necessity. This relationship expresses itself in the language that flows among people doing mathematics. If language is the dance step, then awareness of language allows us to understand the relationships between the actors in our mathematics. Though it is important to participate in the dance when we are learning it, at times there is value in attending more closely to the steps themselves.

References

- Adler, J. (2001). *Teaching mathematics in multilingual classrooms*. Dordrecht: Kluwer.
- Bakhtin, M. (1953/1986). The problem of speech genres. In C. Emerson and M. Holquist (Eds.), *Speech genres and other late essays* (V. McGee, Trans.) (pp. 60-102). Austin, TX: University of Texas Press.
- Balacheff, N. (1988). Aspects of proof in pupils' practice of school mathematics (D. Pimm, Trans.). In D. Pimm (Ed.) *Mathematics, teachers and children* (pp. 216-235). London: Hodder & Stoughton.
- Barwell, R. (2003). Patterns of attention in the interaction of a primary school mathematics student with English as an additional language. *Educational Studies in Mathematics* 53 (1), 35-59.
- Bills, C. (2002). Linguistic pointers in young children's descriptions of mental calculations. In E. Cockburn and E. Nardi (Eds.), *Proceedings of the 26th Conference of the International Group for the Psychology of Mathematics Education*, Norwich, UK, vol. II, 97-104.
- Bills, L. (2000). Politeness in teacher-student dialogue in mathematics: A socio-linguistic analysis. *For the Learning of Mathematics*, 20 (2), 40-47.
- Boaler, J. (2002). The development of disciplinary relationships: Knowledge, practice and identity in mathematics classrooms. *For the Learning of Mathematics*, 22 (1), 42-47.
- Boaler, J. (2003). Studying and capturing the complexity of practice – the case of the “dance of agency.” In N. Pateman, B. Dougherty and J. Zilliox (Eds.), *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education held jointly with the 25th Conference of PME-NA*, Honolulu, Hawaii, vol. I, 3-16.
- Brown, T. (2001). *Mathematics education and language: Interpreting hermeneutics and post-structuralism* (revised second edition). Dordrecht: Kluwer.
- Carter, K. (1993). The place of story in the study of teaching and teacher education. *Educational Researcher*, 22 (1), 5-12, 18.
- Chapman, A. (2003). *Language practices in school mathematics: A social semiotic approach*. Lewiston, NY: Edwin Mellen.
- Chouliaraki, L. and Fairclough, N. (1999). *Discourse in late modernity: Rethinking critical discourse analysis*. Edinburgh: Edinburgh University Press.
- Cobb, P., Yackel, E. and Wood, T. (1992). Interaction and learning in mathematics classroom situations. *Educational Studies in Mathematics* 23 (1), 99-122.
- Duval, R. (1999). Representation, vision and visualization: Cognitive functions in mathematical thinking. Basic issues for learning. In F. Hitt and M. Santos (Eds.), *Proceedings of the 21st Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Morelos, México, vol. I, 3-26.

- Evans, J. (2000). *Adults' mathematical thinking and emotions: A study of numerate practice*. London: Taylor and Francis.
- Fairclough, N. (Ed.) (1992). *Critical language awareness*. London: Longman.
- Fiori, N., Boaler, J., Cleare, N., DiBrienza, J. and Sengupta, T. (2004). What discussions teach us about mathematical understanding: exploring and assessing students' mathematical work in classrooms. In D. McDougall and J. Ross (Eds.), *Proceedings of the 26th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Toronto, Canada, vol. II, 491-498.
- Gerofsky, S. (2004). *A man left Albuquerque heading east: Word problems as genre in mathematics education*. New York: Peter Lang.
- Hannula, M., Evans, J., Philippou, G. and Zan, R. (2004). Affect in mathematics education – exploring theoretical frameworks. In M. Johnsen Høines and A. Berit Fuglestad (Eds.), *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education*, Bergen, Norway, vol. 1, 107-136.
- Herbel-Eisenmann, B. (2000). *How discourse structures norms: A tale of two middle school mathematics classrooms*. (Doctoral dissertation, Michigan State University).
- Herbel-Eisenmann, B. and Wagner, D. (2005). In the middle of nowhere: How a textbook can position the mathematics learner. In H. Chick and J. Vincent (Eds.), *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education*, Melbourne, Australia, vol. 3, 121-128.
- MacLure, M. (2003). *Discourse in educational and social research*. Buckingham, UK: Open University Press.
- Marks Dauenhauer, N. and Dauenhauer, R. (1999). The paradox of talking on the page: Some aspects of the Tlingit and Haida experience. In L. Murray and K. Rice (Eds.) *Talking on the page: Editing Aboriginal oral texts* (pp. 3-42). Toronto: University of Toronto Press.
- McLuhan, M. (1964). *Understanding media: The extensions of man*. New York: Signet.
- Morgan, C. (1998). *Writing mathematically: The discourse of investigation*. London: Falmer.
- Namukasa, I. (2004). *Attending and being in a mathematical way: A dynamic view of thinking*. (Unpublished doctoral dissertation, University of Alberta).
- Phillips, E. (2002). *Classroom explorations of mathematical writing with nine- and ten-year-olds*. (Unpublished Ph.D. thesis, Milton Keynes, Open University).
- Pickering, A. (1995). *The mangle of practice: Time, agency, and science*. Chicago: University of Chicago Press.
- Pimm, D. (1987). *Speaking mathematically: Communication in mathematics classrooms*. London: Routledge & Kegan Paul.

- Pimm, D. and Wagner, D. (2003). Investigation, mathematics education and genre: An essay review of Candia Morgan's *Writing Mathematically: The Discourse of Investigation*. *Educational Studies in Mathematics*, 53 (2), 159-178.
- Pirie, S. (1998). Crossing the gulf between thought and symbol: Language as (slippery) stepping-stones. In H. Steinbring, M. Bartolini Bussi, A. Sierpiska (Eds.). *Language and communication in the mathematics classroom* (pp. 7-29). Reston, VA: National Council of Teachers of Mathematics.
- Radford, L. (2002). The seen, the spoken and the written: A semiotic approach to the problem of objectification of mathematical knowledge. *For the Learning of Mathematics*, 22 (2), 14-23.
- Rowland, T. (2000). *The pragmatics of mathematics education: Vagueness in mathematical discourse*. London: Falmer.
- Skovsmose, O. and Borba, M. (2004). Research methodology and critical mathematics education. In P. Valero and R. Zevenbergen (Eds.). *Researching the socio-political dimensions of mathematics education* (PP. 207-226). Kluwer, Dordrecht..
- Valero, P. (2004). Postmodernism as critique to dominant mathematics education research. in M. Walshaw (Ed.). *Mathematics education within the postmodern* (pp. 35-54). Information Age Publishing, Greenwich, Connecticut.
- Valero, P. and Vithal, R. (1998). Research methods of the "north" revisited from the "south". In A. Olivier and K. Newstead (Eds.), *Proceedings of the 22nd Conference of the International Group for the Psychology of Mathematics Education*, Stellenbosch, South Africa, vol. 4, 153-160.
- Wagner, D. (2003). Students and teachers listening to themselves: Language awareness in the mathematics classroom. In N. Pateman, B. Dougherty and J. Zilliox (Eds.), *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education held jointly with the 25th Conference of PME-NA*, Honolulu, Hawaii, vol. IV, 355-362.
- Walkerdine, V. (1988). *The mastery of reason: Cognitive development and the production of rationality*. London: Routledge.
- Weingrad, P. (1998). Teaching and learning politeness for mathematical argument in school. In M. Lampert and M. Blunk (Eds.). *Talking mathematics in school: Studies of teaching and learning* (pp. 213-237). Cambridge: Cambridge University Press.
- Wilder, R. (1968). *The evolution of mathematical concepts*. London: Wiley.