Chapter 4

Equity in a Mathematics Classroom: An Exploration

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Over the past decade, reforms in mathematics education have called for "authentic" mathematical practices in the classroom. Recently, emphasis on equity in mathematics education has increased. These recommendations—authentic practices and equity—raise questions. How does one "see" equity in the classroom? How does one interpret authenticity? And are authentic mathematical practices and equity compatible?

Focus has shifted to the view that becoming a mathematician (or learning mathematics) does not simply mean acquiring a body of mathematical knowledge and skills, but rather acquiring "mathematical habits of mind" (Cuoco, 1998) or "mathematical dispositions" (Schoenfeld, 1992). Social practice theorists—and a growing number of educators—realize that mathematics is a social activity, a matter of beliefs, habits, and dispositions as well as skills (Cobb, 1996; Hall, 1996; Hall & Stevens, 1995; Lampert, 1997; Lave, 1988; Schoenfeld, 1992). If so, then—

> we may do well to conceive of mathematics education less as an instructional process (in the traditional sense of teaching specific, well-defined skills or items of knowledge), than as a socialization process. In this conception, people develop points of view and behavior patterns associated with gender roles, ethnic and familial cultures, and other socially defined traits. (Resnick, 1988, p. 58 as cited in Schoenfeld, 1992)

When mathematicians are engaged in actual processes of constructing mathematical knowledge, they make conjectures, test them against counterexamples or try to prove them, and revise their initial conjectures in an iterative process. Some mathematics educators have suggested that the goal of teaching mathematics should be "to bring the practice of knowing mathematics in school closer to what it means to know mathematics within the discipline" (Lampert, 1990; see also Ball, 1993, 1995; Cobb, Wood, & Yackel, 1991; Richards, 1991). One of the major ways to do so is to introduce students to the language and usage—the discourse—of the discipline. For example, the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics* (1989) called for children to "talk mathematics" and for teachers to help them construct knowledge, learn to think in multiple ways about ideas, reflect on their own thinking, develop convincing arguments, and eventually extend the arguments to deductive proofs. One result of this reform effort has been the suggestion that students construct and produce their own knowledge rather than receive "ready made" knowledge (NCTM, 2000).

Recently, a growing number of mathematics educators have recognized the need to move toward more equitable mathematics education (Ball, 2003; Linn & Kessel, 1996; Schoenfeld, 2002). Ball, for example, questions the relative silence of the mathematics education community. Echoing George Hein she asks, "How do concerns for equity play a role in the design of our efforts to improve mathematics and science instruction?" She suggests going beyond the rhetoric of "all students" or "high expectations" to address the "vast problems of educational inequalities that permeate U.S. schooling" (Ball, 2003).

Many reform initiatives reflect this trend. For example, *Principles and Standards for School Mathematics* (NCTM, 2000) includes a separate Equity Principle: "Excellence in mathematics education requires equity—high expectations and strong support for all students." Mathematicians and mathematics educators agree that "all students must have a solid grounding in mathematics to function effectively in today's world. The need to improve the learning of traditionally underserved groups of students is widely recognized; efforts to do so must continue" (Ball, Ferrini-Mundy, Kilpatrick, Milgram, Schmid, & Schaar, 2005, p. 2).

Although we hear a growing call for equity in mathematics education, we still need to explore what it looks like in practice. Schoenfeld notes that "like its antecedent [the NCTM 1989 *Standards* document], *Principles and Standards* can (despite its nearly 400 pages of densely packed text) be accused of being long on vision and somewhat short on detail. It identifies some essential goals, but does not provide a blueprint for achieving them" (2002, p. 15).

This chapter illustrates ways to look at how both equity and "authentic" mathematical practices play out in the daily interactions of a classroom. It examines some of the practices adapted from the mathematical community through minute-by-minute interactions in the classroom to better understand—and raise questions about—the social practice of mathematics and mathematics education. I share ways to examine and analyze interactions, providing a grounded framework for exploring classroom activity, to move us toward more equitable practices in the mathematics classroom.

THEORETICAL BACKGROUND

My examination of classroom interactions is guided by two theoretical perspectives: social practice theory and science studies. My analysis also draws on sociolinguistic tools aligned with those theoretical frameworks. Those frameworks are by no means independent of each other. Instead, they are "irreductionist" frameworks (Kaghan & Bowker, 2000) that account for individual agency as well as social structure and view a social order as continually produced and reproduced through ongoing practices and interactions.

Social Practice Theory

In this chapter, I use the concept of social practice to account for the complexity of human thought and actions as they take place in everyday life (Lave, 1988). The premise of social practice theory is that every activity—including the practice of school mathematics—is socially situated and occurs in a specific time and place, under particular historical and political conditions. (For example, the No Child Left Behind Act is a recent political condition that has had a direct influence on public school practices.) To understand social practice, one must look at what people do and say in their daily practices, and attend to politics and inequalities in resources and power.

Social practice theories highlight the interdependency of agency and structure, and seek to describe the dialectical relationship between them and understand the "interweaving of personal life and social structure" (Connell, 1987, p. 61). Those theories go beyond the dichotomy of structural determinism and psychological theories of agency. Understanding the relationship between social structure and individual actions is not a trivial matter. For example, to theorize this interdependency Giddens (1984) developed structuration theory, based on the idea that structure both influences and is influenced by human actions. In his view, actions have both intended and unintended consequences, and actors know much but not all about the structural ramifications of their actions.

In another attempt to theorize the relationship between agency and structure, Bourdieu (1977) introduced the concept of *habitus,* which is a system of dispositions, a set of acquired patterns of thought, behaviors, and tastes that constitute the link between social structures and human actions. For example, a child who grows up in a family and culture that strongly believes in creationism and goes to a school that emphasizes the theory of evolution might not easily understand the teacher's scientific discourse, might rely on different material to make meaning (Bible vs. scientific documents), and might feel alienated in terms of beliefs. The consequences of paying attention to those differences can be significant in terms of student participation in the classroom, and beyond.

Many studies indicate that children often experience difficulty in classrooms that are organized according to assumptions about the use of time, space, language, and instructional strategies that are different from those in their homes (Heath, 1983; Labov, 1970; Martin, 2000; McCollum, 1989; Philips, 1970; Willis, 1981). Although some studies attribute poor achievement to individual characteristics, social practice theorists closely examine the social and historical conditions under which students operate and have found other explanations. For example, Paul Willis studied working class boys in England. Through an examination of students' day-to-day interactions and the educational and social systems, he found that underachievement was related to their poor and working class background and was more often a result of rebellion against school authority than ability. Moreover, he argues that their rebellious behavior prepares them (sometimes consciously, sometime not) for working-class jobs. Willis found that working-class boys (the "lads") tended to articulate a counter-school culture, which in its most basic dimension is "entrenched general and personalized opposition to 'authority'" (1981, p. 11). The lads resisted with "a continuous scraping of chairs," "continuous fidgeting," "comic newspapers and nudes under half-lifted desks melt into elusive textbooks," and more. In contrast, the conformists ("the ear'oles") "invest[ed] in this formal structure, and in exchange for some loss of autonomy accept[ed] the official guardians to keep the holy rules" (p. 22). They paid attention, their gaze was focused on the teacher, and they did homework. Other studies have described how African-American students are ridiculed by one another for "acting white," which is defined as behaviors characteristic of Caucasian students, for example, getting good grades, liking classical music, raising their hands in class, and dressing in a certain way. Social practice theorists argue that such day-to-day interactions contribute to the production and reproduction of social structures.

The foregoing two examples identify social trends and cannot be assumed true for every member of a particular group. Although class, gender, or race may play a role, individual agency cannot be neglected. For example, Martin (2000) studied African American middle school students who succeeded in mathematics. Although some of their peers viewed success in mathematics as "acting white," the students studied had strategies that allowed them to simultaneously achieve academic success and social survival. Many maintained small friendship groups of "nerds" or "good kids," and dismissed the ridicule of "bad kids." Grantham-Campbell (2005) focused on successful Native Alaskan students and the cultural processes involved in their success. She found that Native students who succeed in "doing school" are able to suspend incidents of cultural conflict and maintain a calculated mistrust of the schooling process. These same students are able to separate from the dominant "image" of Natives and cultivate an "identity" drawn from positive experiences and relationships. For example, when a student council calendar used a photograph of Natives drinking, a Native student, in an act of defiance, dressed traditionally to counter the negative representation of Native people.

Science Studies

To make sense of classroom interactions, I also draw on a body of work—science studies—that analyzes *science* as a social practice. This branch of science studies focuses on examining the processes through which scientific knowledge is produced. The approaches taken by science studies scholars vary, but to some degree, they all assume that scientific knowledge—as well as other knowledge—is socially constructed—"made" collectively by many actors, both nonhuman and human. Those researchers investigate how claims become "facts," and how and why credit is allocated. I borrow these notions, and take the perspective that scientific "facts" are constructed by multiple actors.

Science studies researchers view scientific knowledge not as inevitable discoveries, but rather as productions of social, cultural, and material processes. Often "scientific facts" are understood as claims about truth. Many science studies scholars view such claims in a pragmatic way—meaning that a scientific claim is "true" if it "works" to the extent that relevant communities believe the claim. In that way "truth" is viewed as an historical construction, which can explain how knowledge is actually produced and claims become facts.

Early science studies focused on "science in the making." Through ethnographic-style fieldwork in laboratories, researchers made detailed accounts of the construction of scientific facts (Knorr-Cetina, 1981; Latour, 1979; Lynch, 1994) that described how scientific knowledge is accomplished through messy work. They found that successful scientific practice depends on multiple factors absent from positivist accounts of science. What emerged from these studies is that scientific facts are neither given nor discovered, but rather are outcomes of complex negotiation processes.

One of the first studies of this kind was *Laboratory Life* (1979). It describes the process by which scientific facts in a biology laboratory were gradually stripped of the conditions under which they were developed and became "black boxes"—claims whose validity and internal nature were not questioned. Latour argues (1986) that a claim alone is neither fact nor fiction; instead it is made so by other claims. Making a scientific fact includes gathering sufficient resources, enrolling or enlisting allies (human and nonhuman), and persuading others that the claim is a fact. Common ways to enroll allies (both human and nonhuman) are to cite other papers; use specific representations, such as graphs; drop names; and be associated with authoritative figures in the field. In short, the construction of a fact depends on interpretations and on who picks it up. Claims may involve dissent—a minority perspective that challenges a majority opinion. Dissent within science is expected. It plays dual roles: delegitimizing particular claims by exposing missing evidence or faulty thinking and legitimizing science as an institutionalized form of truth-seeking that evolves with new information.

Latour also describes the process through which a scientific statement goes through different modalities as it becomes a "hard fact"—from speculative hypothesis to proved statement to unspoken assumption. The modalities of a statement are modified through scrutiny in laboratories and conferences: how other scientists in the field cite it, certify it by assuming it is proved, and finally just assume that it is true. A scientific fact (black box) may spread to multiple communities yet have different meanings in each, becoming in Latour's words an "immutable mobile." Einstein's relativity theory as commonly understood is an example of an immutable mobile.

Assigning credit and invisible work

Steven Shapin (1989) documented instances of how 17th century chemist Francis Boyle assigned credit. Technicians were credited only when mistakes were made. When experiments went well, Boyle took full credit and the technicians were not mentioned. Other scholars have noted that an idea or a concept is rarely, if ever, developed solely by an individual and that making a fact includes erasure of elements that made it a "hard fact." Star (1991) calls these erased elements "invisible work." Once an idea is attributed to an individual, we often create a history in which other contributors become invisible and their contributions are erased (see, for example, Latour & Woolgar, 1979; Latour, 1987; Star, 1991a, 1991b; Strauss et al., 1985; Traweek, 1988).

Researchers have documented how work done by members of specific groups may become invisible: "rendering certain kinds of work invisible, reifying invisible things, and then secretly, privately, or duplicitously claiming the resources rightfully belonging to the work" and to the workers, who are often members of a marginalized group (Star, 1991, p. 279). This finding is consistent with findings of studies of women who enter such male-dominated professions as science and firefighting (Chetkovich, 1997; Eisenhart & Finkel, 1998; Ong, 2002; Traweek, 1988). For example, Chetkovich (1997) found that women firefighters were made invisible in different ways: excluded from conversations, spoken about as if they were not present, and denied credit for work they did in the firehouse. Classroom studies reveal that when females demonstrate competence in mathematics and science classrooms, teachers and male peers often refuse to acknowledge their achievements, and the girls themselves downplay their own ability. Moreover, they often deliberately position themselves to resolve such tension, usually by opting out of the conversation (Elkjaer, 1992; Ong, 2002, Tobias, 1990; Volman et al., 1999).

Sociolinguistic tools

Social practice theory—combined with science studies—offers productive theoretical orientations for exploring classroom discussion. Studies conducted by sociolinguists and educational ethnographers offer tools for analysis that are aligned with those frameworks. Sociolinguists consider power relationships to understand patterns in communication. For example, they look at utterances in conversations, patterns of utterances, and conditions under which utterances are produced, for example, getting the floor. I briefly outline some of their approaches, including the patterns of communication, discourse of disagreements, use of turns of talk, and register.

Patterns of communication: Everyday and classroom

Although I do not seek to perpetuate stereotypical behaviors, an important point to recognize is that communication in the reformed classroom may reproduce everyday patterns of communication. Lakoff (1975) argues that in general, females belittle and indicate doubt about the ideas they share more often than males do. Males are also seen as pursuing status by trying to win debates about ideas (Tannen, 1990; Tannen & Bly, 1993). In studies of classrooms, Noddings (1992) found that females' patterns of communication are less direct (and less aggressive) than males' patterns. Phelan (1993) talks about the ways females act incompetently and rely on the knowledge of boys who act competently in science classrooms. These and other studies, for example, Cockburn (1985), Goffman (1977), Lie (1995), and Ong (2002), portray traditional gender roles in which females are depicted as generally supportive collaborators in classroom interactions. Conversely, males are generally portrayed as dominant individuals, obtaining, directing, and holding the conversational floor for extended periods.

A number of secondary school studies illustrate how gender influences the interactions in mathematics and science classrooms (Brophy, Guzzeti, & Williams, 1996; Kahle, 1990; Morse & Handley, 19985; Tobin & Garnett, 1987). Ong's study of undergraduate female minority students in physics explored the multiple strategies those students employed to "perform invisibility," including not taking responsibility for their own stances, bringing their own opinions in the names of others, and disengaging from discussions when they felt confronted in public. Lee (2004) also suggests that East Asian discourse is in general cooperative and harmonious, owing to its emphasis on "saving face."

Some of those findings have led to reforms intended to foster greater equity and close the achievement gap, such as sex-segregated mathematics and science programs in middle schools, and the creation of such programs as EQUALS. Those approaches are designed to restructure patterns of communication and increase the participation and engagement of typically nondominant participants.

Discourse of disagreements

Research on disagreements in everyday settings shows that often those who disagree try to mask their disagreement by restating, pausing, and self-repairing, for example, "um that, that one, [pause] um—zero has to be an odd, an even number." Moreover, the initial disagreeing party will often avoid using the term "disagree" because holding a disagreeing position can be uncomfortable (Davidson, 1984; Goodwin & Goodwin, 1987; Pomerantz, 1984).

However, public disagreements in a classroom setting during lessons on subject matter reveal a different pattern. Engle and Greeno (1994) differentiate *conceptual based* disagreements from *interpersonal* disagreements. In contrast with tentative and uncomfortable discourse displayed in interpersonal disagreements, participants in "conceptual based" disagreements quite eagerly engage in and announce their disagreements. Conceptual based disagreements follow the norm to "challenge ideas, not people," allowing safer participation—whereas interpersonal disagreements are mainly driven by personal, everyday reasons. Whereas conceptual based disagreements focus on explanations of concepts (in this chapter, on mathematical concepts), Engle and Greeno note that they also include social and interpersonal motivations that are managed in different ways than interpersonal "everyday" disagreements. They argue that participants in conceptually focused disagreements need to simultaneously satisfy multiple interpersonal and conceptual goals. For conceptual based conversation to be successful, participants must find ways to make their conceptual disagreements explicit while avoiding having it threaten the face-saving of the party they disagree with.

Lampert, Rittenhouse, and Crumbaugh (1996) have noted that the public airing, criticizing, and defending of ideas during public class discussions can potentially disrupt friendships and social relationships, especially if others lose face (Goffman, 1972). Furthermore, people may vary in their tolerance of, and comfort with, disagreement. Such variation may have its roots in *habitus*—individual dispositions or preferences of sociocultural groups. Important considerations in examining equity issues in the mathematics classroom are to discern the multiple reasons for engaging in public disagreements and to explore the habitus of the players.

Turns of talk

Everyday conversation is composed of speech between at least two people, organized by turns. The turn is the period of talk for each speaker. Ideally, one person speaks at a time; but this is not always so in a discussion. In formal situations, such as public lecture or rituals, turns of talk are often allocated by a facilitator or predetermined according to participants' roles. In an unstructured, spontaneous conversation, however, participants must determine in the moment when it is appropriate to take a turn. Sacks, Schegloff, and Jefferson (1974) suggest that certain rules govern the turn allocations in a conversation.

Classrooms may be unique because they are neither "formal" nor "informal." Sociolinguistic studies in education explore turns of talk and how they are allocated in the classroom. Verplae (2000) classifies the allocation of classroom talk into four distinct types: (1) the teacher's selection of a child who has not volunteered, (2) the student's response to the teacher's bid, (3) a student's request to speak while others are speaking (e. g., by raising his or her hand), and (4) a student's interruption of another speaker and the teacher's permission to that student to continue.

Philips describes different strategies used by students to take a turn of talk during classroom discussion. She also points out the unique situation in classroom discussions, in which the teacher plays an important role in allocating turns to talk. Schuman argues that a count of the number of turns taken by a participant is insufficient, rather one should ask how that student obtained the privilege to get the floor or, even more revealing, to take it.

A number of studies rely on turns of talk, length of turns, talk interruptions, and the teacher's nomination to the speaking floor to analyze how such issues as gender and race play into classroom interactions (Bousted, 1989; Kramarae & Treichler, 1990; Sadker & Sadker, 1990; Spender & Sarah, 1980). They found that students' cultural backgrounds, gender—in general what we might call their *habituses*—were correlated with the kinds of interactions they had in the classroom. These studies often adopt the perspective that the classroom is a microculture of the outside world, in which talk may form an important arena for the reproduction of gender, race, and class inequalities in human relations and social interaction (Baxter, 1999, p. 83).

A study by LaFrance showed that when compared with males in classroom discussion, females rarely are nominated to talk, talk less when they have the floor, and are interrupted more often (LaFrance, 1991). Similarly, Jones (1989) found that during classroom discussions, fewer females than males initiate questions or call out answers. Biggs and Edwards (1994) observed that teachers in multiethnic primary school classrooms interacted less frequently with children of color and that interactions with those students were less elaborate and shorter in duration.

Teachers are important figures in the classroom. Lampert (1990) notes, "The teacher has more power over how acts and utterances get interpreted, being in a position of social and intellectual authority, but these interpretations are finally the result of negotiation with students about how the activity is to be regarded" (pp. 34–35).

Register

The linguistic term *register* refers to the particular kind of language used in specific situational contexts. Particular kinds of activities require particular kinds of language. Often the nature of an activity can be determined by the style of language used during the activity. In this sense, language reflects the activity.

The mathematics register is made up of specific uses of language for mathematical purposes. It includes the words and syntax of spoken and written mathematics and their meanings. An implicit requirement to use language in certain ways exists in the mathematics classroom. Teachers introduce and model "mathematical" language. In part, learning school mathematics involves learning a specific register.

The school mathematics register has a specialized vocabulary and syntax. It contains both discipline-specific language (e.g., *isosceles, pi*) as well as words used in everyday language (e.g., *odd, even, complex*). For example, the word *show* in the context of a mathematics lesson often means to prove or justify an idea. However, in an everyday context, it can mean to "display" or "point out."

Although certain features of the mathematics register can be isolated and identified, the language used in mathematics classrooms cannot be regarded as a fixed or distinct set of words. Young students may sometimes conflate meanings of mathematical terms they learn in school with everyday meanings, or they may use two different meanings of a word in the same sentence. One example comes from a student in the lesson that is the subject of this chapter. Figure 4.1 shows two different meanings of the word *halves*, which she wrote in her journal.

In this description, "split in hafe" might have the everyday sense of two equal

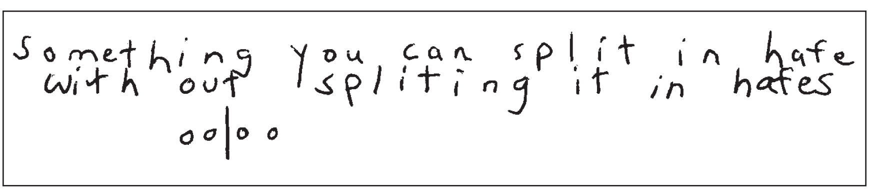


Figure 4.1. A student's journal entry giving two different meanings of the word halves.

pieces of the whole (in this instance, the four circles), but the "hafes" refer to fractions—one of two equal pieces of a circle.

In this chapter, I consider school mathematics as a social practice in which teachers and learners use language to construct mathematical meaning. Mathematical meaning is constructed in part through specific linguistic practices associated with a mathematical register; moreover, learning mathematics is very much a matter of learning to speak using the appropriate register in the classroom.

METHODS

To understand the 6-minute segment in terms of classroom history, I grounded my findings with a larger-scale analysis of the whole lesson of January 19 and other supplemental data. By traversing past, present, and future accounts, I was able to view the 6-minute segment within a broader context.

In recent studies, educational researchers (e.g., Hall, 1996, 1999; Roth & McGinn, 1998) have focused attention on the material resources—such representations as the number line and classroom drawings, and such written materials as student journals—that mediate learning. I examined how classroom participants used talk and representations as they engaged in what seemed to be "mathematical" disagreements and tried to make sense of the classroom discussion.

To analyze the 6 minutes of video, I borrowed sociolinguistic methods. These include transcribing the episode with attention to details, such as how conversations were initiated, turns of talk, interruptions, speech repairs, and some attention to intonations, gestures, and duration of pauses (Goodwin & Heritage, 1990; Hall, 1996; McNeill, 1992; Sacks et al., 1974). Those methods aim to explicate how people produce interactions and what they accomplish in and through them, and can provide a lens to view the roles, social relationships, and power relationships among participants.

I employed a 6-step process. First, I used a detailed transcription developed by a colleague and myself (Posner & Horn, 1996) according to Ochs's (1979) conventions. In addition, I paid attention to the gestures, physical orientation, and material resources visible in the conversation, as well as to vocal elements. Although I use some different conventions in some transcript excerpts, for the convenience of the reader the line numbers of the transcripts correspond with those used in other chapters of this monograph. However, I have sometimes included additional details about classroom actions that help clarify the analysis. Second, to situate the given segment within a larger context, I examined participants' interactions within the 6 minutes in search of clues about classroom practices and history that contributed to the shape of the conversation. Third, I proceeded to find other examples of those practices in the rest of the available data. Fourth, I followed participants' utterances—as well as possible—into the recent past, because they were asked to reflect about the previous lesson. Examining transcripts from the available previous lessons provided some of the shared history in this classroom. Fifth, I focused on a detailed analysis of two sections of the 6-minute segment.

My sixth step involved an examination of previous lessons. In the midst of the analysis, I realized that to better understand the meaning participants made out of the conversation, I needed to explore their participation prior to this segment to sharpen my interpretation. The sixth step turned the analysis around because it allowed me to eliminate interpretations of events in the given segment that were erroneous owing to lack of context about the scope and sequence of mathematical conversation.

As much as possible, I tried to take into account the possible influences on classroom interactions. To do so, I relied on the research described previously on patterns of interactions in society, particularly in classrooms. One could argue that we do not have enough "evidence" to explain how such categories as race and gender play into the interactions discussed in this chapter. Nonetheless, failing to consider equity issues does not solve the problem. Research suggests that children are aware at all times of race and gender (Pollack, 2004). In particular, children from nondominant groups are aware if the person speaking is African American, Asian, or a girl. We have no reason to assume that this classroom is significantly different. Because race and gender are part of students' identities, part of their *habituses,* the power of those social dynamics is important to recognize.

However, I want to be clear that given the available data, my analysis is by no means an attempt to give an account of what "really" happened in this classroom. As the other chapters of this monograph indicate, the events can be interpreted in different ways.

Researchers have noted (Hall, 1999; Jordan & Henderson, 1995) that analyzing a segment of conversation without understanding its context can result in misinterpretation, even if we assume that participants in some instances are exhibiting the methods by which they carried out the activity. Moreover, by close analysis of talk in interactions out of context, we might end up with what Hall (1999) describes as "the crisis of interchangeability." That is, insufficient context may render the activities of different people indistinguishable.

The question of what constitutes enough context (Latour, 1987; Ortner, 1984) always lingers. The contextual boundaries I have drawn in this analysis are defined by the data available and the scope of the questions I chose to investigate. Although no definite answer can be given to what "actually" happened, my intention is to offer a possible, reasonable interpretation that takes into account participants' *habituses* (as afforded by the data available) and to lay the groundwork for a meaningful discussion of equity in mathematics classrooms. Rather than draw definitive conclusions from the data, I raise important questions to consider, particularly questions that have an impact on instructional practices. The intent of this analysis is to offer an interpretation of the 6-minute video segment that might be useful and relevant to other classroom situations, with the goal of moving us toward more equitable mathematics education.

DATA

The discussion in the 6-minute video segment analyzed is a continuation of an earlier discussion by a third-grade classroom on the nature of odd and even numbers on January 19, 1990. For a social practice theorist, the 6-minute segment lacks sufficient context to adequately analyze interactions with respect to equity. In addition to the 6-minute segment, however, I was able to view supplemental data sources, including three preceding mathematics lessons of this particular classroom (in which even and odd were discussed), the remainder of the lesson from which the 6-minute segment was extracted, journal entries of students and teacher (which include reflections on this particular lesson), and demographic information about the students.

Although the 6-minute segment and supplemental data sources provided a window into this classroom, I note that the video was recorded by an unknown person, under unknown conditions. Collecting data is always a subjective and selective activity (Goodwin, 1994; Hall, 2000). We highlight, include, and exclude according to our own perspectives and preferences. Those omissions and inclusions can lead to distortion and misinterpretation. This statement is true for any act of perceiving or recording data, including our own interpretive acts when we analyze those data.

An important consideration when addressing equity issues in the classroom is to explore how the demographics of the students and teacher might affect mathematical conversations (e.g., power dynamics, turns of talk, cultural preferences). Fortunately, those data were available. The demographics are shown in Appendix 2 to this monograph. As we can see in Appendix 2, this classroom contained 9 white and 10 black students, 9 male and 10 female students; 13 of the 19 students were proficient in the English language.

ANALYSIS

Classroom Culture

The mathematical pedagogy used in this classroom was intended to reflect practices of the mathematics community, as viewed by Lakatos (1976). The teacher describes this pedagogy as “based on a fallibilist epistemology” (Ball, 1988, p. 5). It adopts a “*particular perspective* on the nature of mathematical knowledge and activity” and “views the mathematical practice as a discourse community concerned with common questions and engaged collaboratively in pursuing and assessing mathematical ideas and in which more than traditional proof counts” (Ball, 1991, p. 46).

In this classroom, as in any classroom, were expectations that participants would behave and communicate in certain ways. As in the classroom depicted in *Proofs and Refutations* (Lakatos, 1976; see, e.g., pp. 76–77), claims, definitions, conjectures, and statements were attributed to individuals, and students and teacher referred to “Sheena’s definition,” “Mei’s conjecture,” and “Sean numbers." Students routinely made conjectures and claims, justified their positions, generated examples and counterexamples, transformed claims, and used the mathematical register. Teacher and students used a particular register, speaking of "conjectures," "proving," and "definitions."

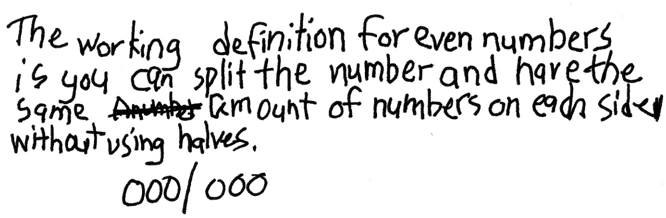
Students and teacher used the words agree and disagree in reference to both people and ideas (see Table 4.1; see also Table 4.4 in this article's Appendix).

Table 4.1
Use of Agree, Agreement, Disagree, Disagreement in the January 19 Lesson

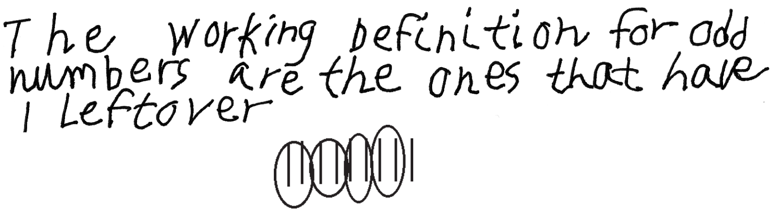
	With a person	With an idea	Unclear
Agree/agreement	9	11	5
Disagree/disagreement	8	9	6
Total	16	18	11

Previous three lessons

In the three previous lessons, the class discussed the nature of even and odd numbers. Sheena offered a definition, and Mei revised it. It became the "working definition" for even numbers (see Figure 4.2). Because the third graders could not come to a consensus about the evenness or oddness of zero, the teacher suggested that they organize a meeting on January 18 with the fourth graders to further dis-



I would say the definition for an even number is, is two equal, two of the same numbers on each side without halfs.



Well, an odd number is something that has one number left over … After you circle the two's.

Figure 4.2. Definitions for even and odd in student journal entries and utterances.

cuss the matter. In that meeting, participants contemplated whether zero is even, odd, even and odd, or just a special number.

During the January 19 lesson, the teacher repeatedly asked students to reflect on past lessons, particularly on the previous day's meeting with the fourth-grade class. During the January 19 class, "Ofala's definition" for odd number (see Figure 4.2) became another working definition.

The nature of even numbers was discussed on January 19. In particular the class discussed whether zero is even or odd. Several meanings of *even* were discussed, including definitions based on (a) the number line, (b) "two equal things make it," and (c) groupings of twos. Each of those meanings was associated with a particular kind of representation (see Figures 4.2 and 4.3). Distinctions related to meaning, definition, and property were not discussed.

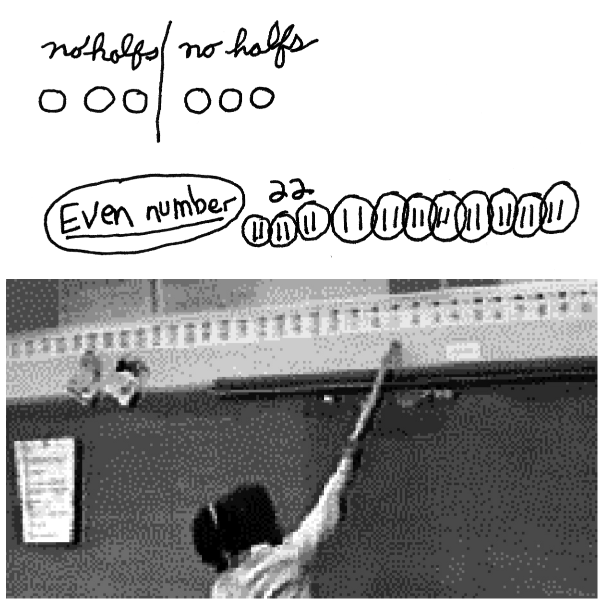
A summary of the sequence of lessons, and of the class's working definitions, is shown in Table 4.2.

Analysis of the 6 Minutes on January 19

With this "history" as a backdrop, I next proceed with a detailed examination of two segments within the 6 minutes.

First segment: Is zero odd or even?

In the 6-minute segment, the teacher started the lesson by stating her agenda to



"Two equal things make it"

"Groups of twos"

Number line

Figure 4.3. The representations associated with meanings for even.

Table 4.2

Occurrences in the Four Lessons

January 16	January 17	January 18	January 19
How to add and subtract numbers using the number line.	Discussion of the definitions of odd and even numbers (including Sheena's) posted on the chalkboard.	Meeting with the fourth graders.	Discussion of whether zero is even or odd.
Ofala offers a method to add numbers.	Betsy's method for comparing odd and even numbers, relying on the number line.	Three different ideas about zero are discussed: Zero is a special number.	Sheena says that zero has to be even, based on the number-line pattern.
Sheena's definition of even number, revised by Mei.	Disagreements between Sheena and Sean.	Zero is even and odd: "Well, I think zero is even and odd because nobody can really prove that it's even or odd."	Sean disagrees.
	Discussion of whether zero is even or odd.	Zero is even, argument based on the number line.	Nathan thinks that zero is special.
	Sean argues that one is even throughout the lesson. Other students disagree.	The nature of even and odd numbers is discussed at length.	Sean says that six could be even and odd.
	Lucy offers a definition of *even* based on the number line.	Discussion of whether zero is nothing or a number.	Discussion of what Sean means, contributions from several students.
	Lucy offers a conjecture: if a number ends with an odd, it is odd; with an even, it is even.	Discussion of the "use" of odd and even numbers. Argument that if all numbers would be even, we would not need a distinction between even and odds.	After the lesson, the teacher writes in her log about "Sean's discovery."
	Betsy says that on the basis of the number line, zero has to be odd.		
	Sean: zero is not a number, extended argument with him. Teacher asks students to stop arguing with Sean.		

Note. Events of the 6 minutes on January 19 are indicated in the box in the rightmost column.

solicit students' experiences from the previous day's discussion with the fourth graders. One of the students, Sheena, made the first attempt to answer the teacher's request. Sheena described how the previous day's discussion with the fourth graders had helped her better understand the nature of zero. The teacher then asked her to give a particular example of how she revised her understanding, and the following exchange occurred:

			Transcript commentary
6[1]	Sheena:	Well, I didn't think that zero was—zero, um—even or odd until yesterday. They said that *it could be even* because of the ones on each side is odd, so that *couldn't be odd.* So that helped me understand it.	*Evidence that Sheena appears to understand odd and even as mutually exclusive. She refers the alternation of even and odd on the number line.*
7	Teacher:	Hmm. So y— So you thought about something that came up in the meeting that you hadn't thought about before? Okay.	
8	Sheena:	(*nods*)	
9	Teacher:	Other people's comments? Sean?	

Sheena tells the teacher how what other people ("they") said in the previous day's meeting helped her understand how zero "could be even" and "couldn't be odd" on the number line (6)[1]. Then the teacher reiterated what Sheena said about how the previous day's discussion influenced her thinking. They both appear satisfied with this exchange (7, 8). Then the teacher solicited additional comments from other students (9).

Instead of providing the teacher with comments regarding his own experience, Sean continued to discuss Sheena's ideas, and engaged her in the following disagreement:

			Transcript commentary
10	Sean:	Um, I—I—I just want to say something to Sheena, when sh— what she said about um that, that one, um—zero has to be an odd, an even number bec— I disagree because, um, because what what two things can you put together to make it?	*Sean changes the teacher's agenda. He refers to the "two things make it" definition.*
11	Sheena:	Could you repeat what you said, please?	
13	Sean:	Okay, um, I disagree with you because, um, if it was an even number, how— what two things could make it?	*Note that Sean disagrees with "you" rather than "your idea."*

1 The number indicates line number of the transcript.

14 Sheena:	Well, I could show you it. [Moves toward the chalkboard and points to the number line above the chalkboard.] Um, I forgot what his name was—but yesterday he said that this one [points to the 1 on the number line] and each—this one is odd and this one [points to the –1 on the number line] is odd, so this one has to be even.	*Again, Sheena appears to understand odd and even as mutually exclusive.*
15 Sean:	But, that doesn't mean it always is even.	*Does Sean think that even is a changeable property?*
16 Sheena:	It could be even.	*Sheena softens her claim from "has to" to "could."*
17 Sean:	It could be, but . . .	
18 Sheena:	I'm not saying that is has to be even. I meant that it could be.	*Sheena maintains the change from "has to" to "could."*
19 Sean:	You said it was.	

Through this exchange, Sheena seemed to change her position a number of times. In the beginning, she stated that zero could be even and couldn't be odd (6). After a short exchange with Sean, she concluded that "zero has to be even" (14). Yet few turns later, she stated that what she meant was that "it [zero] could be [even]."

Using the multiple lenses of social practice theory, science studies, and sociolinguistics, we ask, Did Sheena change her understanding about the nature of zero through the work of the disagreement? Was she convinced by Sean's argument? Did she understand the difference between claims for necessity and claims for possibility? Was she confused? Or simply holding a space for what others had previously said?

Both Sheena and Sean provided justifications for their positions. Although Sheena's position seemed to have changed, the justifications she gave for both positions were similar. Both heavily depended on alternating patterns on the number line. In contrast, Sean's justification, which was given in the form of a question (10, 13), suggests that he used a different definition of even numbers, in which even numbers are made out of two things. (We have yet to determine what the "things" are.) Did Sean and Sheena use different representations differently to think about even numbers and, as a result, misunderstand each other? Was representation the core of their disagreement? Was their disagreement conceptually based or interpersonal or both?

Sheena justified her position(s) on the basis of what a third party had argued the previous day. This third party was not present in the classroom during this discussion. That party at first was referred to by Sheena as a general "they" and at a later utterance became more specifically "Um, I forgot what his name was—but yesterday he said" (14). Bringing an explanation in the name of somebody else can be interpreted in multiple ways, from using the other one as an ally to strengthen a claim (Latour, 1987) to a strategy for avoiding personal responsibility in the event that the claim turns out to be "wrong" (Ong, 2002), to the documentation of a historical event. At this point, the reason Sheena brought in the fourth grader as the principal originator of her claim is unclear.

After performing two self-repairs, Sean reiterated Sheena's position inaccurately, stating that she had said zero has to be even whereas she said zero could be even (6). What was Sean disagreeing with? Was he disagreeing with what Sheena actually said (e.g., zero could be even and cannot be odd)? Or was he disagreeing with what he said she said (e.g., zero has to be even)? Sheena may have been wondering about those same questions as she asked Sean to repeat himself (11). A clear mark of disagreement was drawn by Sean's opening statement (10), which were repeated in his subsequent turn (13).

Sean was clear and up-front about his disagreeing status, and repeatedly marked himself as the disagreeing party (10, 13). As Engle and Greeno's research suggests, perhaps for Sean the disagreement was primarily a "conceptual based" one about the nature of zero rather than an "interpersonal" one. However, as the conversation continued, his motivations for disagreeing with Sheena were unclear and might have changed. After the short exchange between Sean and Sheena, Sean challenged Sheena and argued that her explanation did not "mean it [zero] always is [even]" (15). Sheena did not object and replied that "it could be," to which Sean seemed to agree that "it could be but …" (17). At this point, one could expect the disagreement to dissolve, because the engaging parties had reached an agreement that zero could be even. Yet Sean continued, "but …" (17), to which Sheena quickly replied, "I'm not saying that is has to be even. I meant that it could" (18). Her intonation suggested that she expected to end this exchange having stated her agreement with Sean (e.g., zero could be even). Moreover, in addition to clarifying her current position, "I'm not saying that it has to be even," in accordance with the classroom practices, she emphasized her meaning, insinuating that even in the past (if she had said differently) she "meant it [zero] could be [even]" (17). He replied quickly, "You said it was" (18). At this point one wonders if the issue at stake for Sean was not whether zero had to be or could be even (which they seemed to agree about); rather it was whether Sheena was right or wrong.

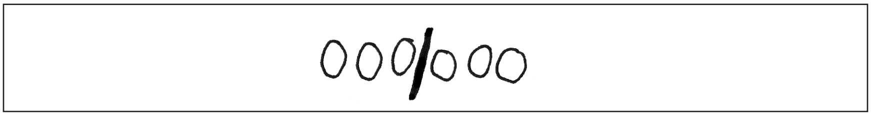
To better understand the meanings Sheena and Sean made out of this exchange, I returned to the previous lessons in which I searched for visible patterns of Sheena's and Sean's behavior as well as their contributions leading to the current discussion. With these brief "histories" at hand, we are better situated to consider the previous questions:

Did Sheena change her understanding about the nature of zero? Was she convinced by Sean's argument? Did she understand the difference between claims for necessity and claims for possibility? Was she confused?

Lessons of January 16, 17, 18, and 19: Sheena

Sheena is an African American girl. She is a native English speaker and is a relatively new member in this classroom (three months, see Table 4.1). On several occasions in the previous lessons, she attributed the justification of her positions to third parties (mainly boys) who were not present during her talk.

Sheena seemed to have a clear grasp of the nature of even and odd numbers. In a previous lesson she provided a verbal definition of an even number: "I'd say that



the definition for an even number is um, a number that you can split." She gave six as an example, "Say you have six, so I'll make this ... and then you want to have it so you can split it in half and so you split what you have, the same amount of numbers on each side." She made a drawing on the chalkboard (see Figure 4.4).

Figure 4.4. Sheena's representation for six.

She defined even numbers as numbers that are "made out of two things" (other numbers). Later, her classmate, Mei, revised Sheena's definition.

> But, I, I don't think they ... yeah, but I still don't think that you could, that you could do it. Well I think what Sheena, I think Sheena should revise to that, even numbers that have the, numbers that you can split that have the same amount on each side without having to have halves.

This definition was discussed at length and referred to as "Sheena's definition" nine times in the three previous lessons. Sheena often used tentative, uncommitted language (e.g., could, might). She did not occupy the public floor often. During the January 17 and 19 lesson, she had 13 and 14 turns (see Table 4.3), and when she did, her turns were mainly allocated to her by the teacher.

Lessons of January 16, 17, 18, and 19: Sean

Sean is a Caucasian boy. He is a native English speaker and was one of the "old timers" in the classroom (two years). Sean was an active participant in classroom discussions and frequently occupied the classroom floor (see Table 4.4). He seemed to be a dissenter; when asked by the teacher later in the January 19 lesson if he was comfortable in that position, he replied that he was.

Teacher: What about you, Sean? A couple of times this week, you've had, you've taken a position that nobody else in the class agreed with. What does that make, does that make you change your mind, how does that make you feel?

Sean: It makes me feel fine.

He was the initiator of many disagreements and frequently used the word *disagree* to mark his position (see Table 4.4). At one point in the January 17 lesson, the teacher explicitly asked students not to further argue with Sean (see Table 4.3 for further details). On other occasions, some students explicitly refrained