Explicit Versus Implicit Questioning: Inviting All Children to Think Mathematically

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**Background/Context:** Open-ended, or implicit, questioning has been described as central to reform teaching in mathematics. However, concerns about equity have caused some researchers to question whether this kind of teaching is productive for all children.

**Purpose:** This study explores the role that implicit and explicit questions played in encouraging mathematical thinking in an elementary mathematics class taught by a reform-oriented teacher.

**Setting:** The study took place in a third-grade classroom located in a small urban school.

**Participants:** Participants in the study were a European American teacher, a student teacher, and 19 third-grade students in an ethnically and socioeconomically diverse classroom.

**Research Design:** The study drew on ethnographic interpretive methods to collect data through a yearlong observation of 5 focal students in the third-grade classroom. Conversations during mathematics class were audio-recorded and transcribed. Data also included written field notes, student work, informal interviews with children, and formal interviews with the teacher. Analysis began with open coding of the transcripts and field notes and proceeded to more fine-grained coding and examination of other data.

**Data Collection and Analysis:** Analysis showed that implicit questions seemed to privilege some children, particularly those who shared the language and cultural practices of the teacher, whereas explicit questions allowed a wider variety of children to participate competently in the mathematics classroom.

Over the last two decades, most mathematics educators have moved toward a shared belief that teacher talk that is open-ended, probing, and
neutral toward right and wrong answers offers more opportunities for students to learn significant mathematics than talk that is narrow, directive, and authoritative (Forman & Ansell, 2001; Lampert, 2001; Moyer & Milewicz, 2002; National Council of Teachers of Mathematics [NCTM], 1991, 2000; Simon & Schifter, 1991). More recently, educators concerned with equity issues have begun to question whether this more open teaching style, which I will call reform teaching, is effective for all children, particularly for children who belong to minority groups, who speak English as a second language, and who are poor (Ball, Goffney, & Bass, 2005; Lubienski, 2000). The purpose of this article is to explore one intersection of reform teaching and equity issues by examining teacher questioning practices in a reform-oriented elementary classroom located in an urban school with a diverse student body.

The NCTM standards documents (1991, 2000), which have played a major role in shaping the shared conception of reform teaching, promote indirect teaching practices, such as encouraging student discussion, asking for justification, and providing time for exploration of challenging problems, rather than direct teaching practices, such as lecturing, modeling, and drilling of correct procedures. These indirect teaching practices are seen as strategies that promote process skills, such as reasoning, communicating, and problem-solving, in addition to content knowledge of mathematical strands such as number, geometry, and data. Throughout this article, I will use the word reform to describe teaching that includes process skills as well as content, and the word traditional to describe teaching that is more narrowly focused on content. Many have argued that reform practices lead to deeper learning of mathematics by all children (e.g., Blanton, 2002; Cobb, Gravemeijer, Yackel, McClain, & Whitenack, 1997; Heaton, 2000; Lampert, 1990; Van de Walle, 2004; Yackel & Hanna, 2003), and others have claimed that these practices are particularly important for children who belong to groups that traditionally have not been successful in mathematics classrooms (Davidson & Hammerman, 1993; Ladson-Billings, 1997; Moses & Cobb, 2001; Trafton & Claus, 1994; White, 2000). For instance, Haberman (1991) contrasted practices like the offering of challenging problems and the asking of open-ended questions with the “pedagogy of poverty,” which “emphasizes repetition; drill; convergent right-answer thinking; and predictability” (p. 290).

In contrast, others have suggested that some of these reform practices, which may be productive for majority, middle-class children, may not best serve children from nondominant cultures (Ball et al., 2005; Lubienski, 2000). Both inside and outside of mathematics education, many have argued that children excluded from the dominant culture need explicit
instruction in content and practices that may be automatic for others. In her book on literacy, Delpit (1995) argued that children who are not taught “the codes of power” (p. xvi) at home need direct instruction about these codes, which, among other social practices, include ways of speaking and listening, ways of behaving, and attitudes toward adults. Calling the opposition between reform and traditional teaching a “false dichotomy” (p. 46), Delpit advocated a middle ground where children engage in work that promotes creativity and critical thinking, as well as in work that makes the standards of the larger community explicit. Researchers in mathematics education have just begun to explore what this middle ground might look like. In particular, Boaler (2002) has suggested that the fact that some reform practices may disadvantage some students does not necessarily mean that traditional practices would provide more learning opportunities for these same students. Instead, she suggested that “the differences between equitable and inequitable teaching lie within the different methods commonly discussed by researchers” (p. 240). In her work, she identified several practices—such as making real-world contexts accessible and teaching children to explain and justify—that made mathematical discussions productive for diverse children in an urban school. She recommended that researchers continue to explore ways that teachers can enact practices such as mathematical discussions and problem-solving with an eye toward variations that promote equity. This article seeks to build on this work by exploring the ways that various kinds of questions can support students in learning significant mathematics.

**LITERATURE ON QUESTIONING IN MATHEMATICS**

Research on teachers’ questioning practices has tended to emphasize moves away from direct, single-answer questions and toward open, probing questions (Lampert, 2001; McCrone, 2005; NCTM, 1991; Vacc, 1993). For example, Lampert talked about beginning lessons with questions like, “Okay, who has something to say about A?” as a way of teaching students “that mathematical talk can have a broad range, and not just be about right and wrong answers to teachers’ questions” (p. 145). The 1991 NCTM standards document presents a list of questions similar to Lampert’s as examples of good questions, including questions like, “How did you think about the problem?” and “Does that make sense?” (NCTM, 1991, pp. 3–4). In addition to promoting reasoning and justification, these questions can also be considered implicit rather than explicit. That is, not only is a wide range of answers possible, but a wide range of *kinds* of answers is possible. As Lampert said, students could respond to her
question, “Who has something to say about A?” by offering an answer, providing a description of their thought processes, asking a question, or evaluating the problem in some way. The question itself does not provide clues about the kind of answer desired by the teacher. Thus, it can be considered an implicit question, as opposed to an explicit one, that does provide clues about the kind of answer the teacher expects.

Research on questioning has not paid a great deal of attention to the ways that context or differences in students might impact what is considered competent questioning (Carpenter, Fennema, Franke, Levi, & Empson, 1999; Mewborn & Huberty, 1999; Moyer & Milewicz, 2002). In their study of preservice teachers’ question-asking during diagnostic interviews, Moyer and Milewicz described three hierarchical categories of questioning—checklisting, instructing rather than assessing, and probing and follow-up—which they used to evaluate the questioning skills of the preservice teachers they studied. Their focus remained tightly on the preservice teachers during the interviews rather than on the ways that different students responded to questions. Similarly, in their discussions of questioning, Carpenter and his colleagues emphasized the skills that teachers must have in choosing problems and selecting open-ended questions, rather than the skills that teachers must have in adapting their instructional practices to meet diverse needs in their classrooms. Teaching mathematics in equitable ways will require an exploration of the ways that diverse students respond to various kinds of questions, as well as examinations of teachers’ use of these questions.

THEORETICAL PERSPECTIVES ON RACE AND LANGUAGE

This article is framed by the lens of culturally relevant mathematics pedagogy (Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Ladson-Billings, 1995, 1997), which asks researchers to attend to ways that students’ racial and cultural identities interact with their learning of mathematics. Ladson-Billings (1995) described culturally relevant pedagogy as teaching that is committed to developing students’ academic excellence, cultural competence, and critical consciousness. Most relevant to this article is the notion of cultural competence. Students of different cultural backgrounds and language practices are likely to respond in different ways to classroom language and instructional practices (Cazden, 1988; Dyson, 1997, 2003; Heath, 1982) and therefore are likely to feel different degrees of cultural competence in the classroom. Ladson-Billings (1997) argued that European American middle-class students are more likely to feel culturally competent in mathematics because current teaching practices tend to draw on familiar cultural
values, such as “efficiency, consensus, abstraction and rationality” (p. 699), whereas many African American students might feel more competent working in classroom cultures that emphasize other values, such as “orality,” “communalism,” and “movement” (p. 700). The teaching and learning of mathematics and students’ and teachers’ cultural experiences of race are linked together. Students come to the language and practices of the mathematics classroom with rich histories of how to behave and communicate. Researchers who draw on theories of cultural competence argue that matches (and mismatches) between students’ communicative histories and the communicative practices of the classroom are important to consider when evaluating the competence of classroom mathematical performance.

In this article, I do not want to treat race as an independent variable. That is, I do not assume that there is a causal relationship between a child’s racial identity and his or her performance in the mathematics classroom. However, I do want to acknowledge the relevance of race in classroom interactions. In sociocultural ethnographic research, human interactions are seen as causal, rather than traits such as race, gender, or mathematical ability. Omi and Winant (2004) wrote about this as “the performatory aspect of race” (p. 10), where race is seen as continually acted out in various ways by various people. Thus, race is understood as performed rather than as a fixed biological category; however, “the enormous number of effects race thinking (and race acting) have produced” (p. 9) are possible objects of study. For example, in her article, Ladson-Billings (1997) referred to the stereotype of a mathematician as a White glasses-wearing male. This stereotype contributes to a discourse in which the performance of mathematics aligns with the performance of a European American racial identity as well as a discourse in which the successful performance of mathematics may be seen as conflicting with the performance of being African American. In similar ways, the way that questions get asked and answered in the classroom may be seen as performances not just of mathematics, but of race, gender, and ethnicity.

This is the perspective I adopt as I work to describe classroom interactions between a European American teacher and the (mostly) minority children in her classroom. In telling stories about the classroom, I identify children by race as a way of helping others to think about the ways in which race may be tied up in other features of classroom life. My major concern in this article is to explore the ways that various kinds of questions provided and constrained learning opportunities for the particular children I studied, rather than to detail a pedagogy for African American or other minority students. For this reason, I attend to the ways that language was used in the classroom and consider the ways that “race
thinking” and “race acting” in our schools may play a role in the interpretation of students’ performance in the classroom.

METHODOLOGY

The goal of the current study is to reexamine teacher questioning in reform classrooms in light of equity concerns about the need for explicit language and direct instruction by keeping both the teacher and the students in focus. To do this, I asked the following research questions:

- What questioning practices are used by a teacher in a reform-oriented elementary classroom located in a minority-majority urban school?
- What opportunities for competent participation do various questioning practices make possible for students?

I pursued these questions through ethnographic methods because, as Erickson (1986) wrote, one of the benefits of ethnographic studies is that they act against the “invisibility of everyday life” by “making the familiar strange and interesting” (p. 121). Adopting ethnographic methods, such as the taking of field notes, the transcription of conversation, and the coding of data, allowed me to closely examine the ways that teachers and children interacted during reform-oriented practices and to consider unfamiliar interpretations of their words—for instance, that an explicit question promoted more, rather than less, mathematical thinking. As Erickson and Gutierrez (2002) pointed out, educational treatments are “locally constructed social ways of life involving continual monitoring and mutual adjustment among persons” (p. 21) rather than static and predictable interactions such as those that occur among particles, cells, and compounds. Because of this fluidity, Erickson and Gutierrez argued that smaller scale qualitative studies that look closely at what a treatment is must come “logically and empirically prior” to large-scale studies that ask whether a treatment works. In this case, examining the use of open-ended questions in one classroom with a diverse student population raises issues that can be attended to in future studies—both large and small scale—in other contexts about what constitutes an open question and about which qualities of these questions might be important in communicating with diverse children.

SETTING AND PARTICIPANTS

Blythe Elementary is a small K–5 school serving about 300 children. Like
many urban schools, Blythe’s student population is minority majority. During the year of the study, about 60% of its students were African American, and about 20% were European American. Asian American and Hispanic students made up nearly all the remaining 20%. About two thirds of Blythe’s students received free- or reduced-lunch during the year in which data were collected. The demographics of the class I studied mirrored the population of the school as a whole. The class as a whole had 19 students for most of the year, 9 boys and 10 girls. Of these children, 10 were identified as African American on enrollment forms; 4 as European American; 3 as biracial; and 2 as Asian American. Both Asian students were Hmong and both spoke English as a second language.

Diana Emerson, the European American teacher in the third-grade class where my study was situated, had a great deal of experience, both as a classroom teacher and as a part of a university teacher education program. She had been teaching at Blythe Elementary for nearly 30 years, and throughout that time, she participated in university study groups about mathematics and welcomed student teachers, university undergraduates, and faculty into her classroom. I chose Diana’s classroom as a site for this study because it was recommended to me by a number of university teacher educators. I wanted to locate the study in an ethnically and economically diverse classroom with a teacher who used reform mathematics practices and who had warm relationships with the students she taught. A number of faculty members recommended Diana’s classroom to me when I expressed these criteria.

To guide my observations of Diana’s mathematics class, I chose five focal students as an “anchor points” (Dyson & Genishi, 2005, p. 49) for my attention. The goal of these anchor points was to provide multiple vantage points for me to observe the classroom. That is, rather than examining the mathematics class as a whole, over the course of the year, I observed this class from the perspectives of these 5 students. This close observation allowed me to attend to under-the-breath comments, physical reactions, and participation habits of particular students, which provided me with a richer picture of the mathematics class. I alternated observations among my focal students. When observing students, I typically sat next to them or behind them. I took notes in a notepad on my lap and placed my tape recorder in a visible but discrete location, such as on an empty table nearby. Although I did not formally interview these students, I frequently asked questions during and after class about particular comments, participation choices, and written work. Because I wanted to observe diverse experiences in the classroom, I purposefully chose focal students who were situated differently in terms of ethnicity, gender, perceived mathematical ability, frequency of participation in
whole-class conversations, and physical location in the classroom. I limited my observations to these 5 students because I wanted to observe each student at least three times to see how his or her participation varied across different content and kinds of lessons. Table 1 describes the ethnicity, gender, and typical performance in mathematics class of each of the focal students. All these students except Jerome passed the third-grade standardized test in mathematics, which was given in the fall (although results were not reported until much later). Students changed seats every couple of months, but initially these 5 students were chosen because they sat in different quadrants of the room, in addition to the other kinds of diversity they represented.

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<tr>
<th>Name</th>
<th>Race</th>
<th>Gender</th>
<th>Additional Information</th>
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<tbody>
<tr>
<td>Aliah</td>
<td>Biracial</td>
<td>Female</td>
<td>Aliah left the classroom twice a week to attend the district’s gifted and talented program. She spoke rarely in whole-group settings.</td>
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<tr>
<td>Ben</td>
<td>European American</td>
<td>Male</td>
<td>Ben spoke occasionally in whole-group discussions and tended to work by himself in small-group settings. He was described as an excellent math student by Diana and many of the children.</td>
</tr>
<tr>
<td>Caitlin</td>
<td>African American</td>
<td>Female</td>
<td>Caitlin spoke infrequently in whole-group conversations but was often an enthusiastic participant in small-group settings. Diana described her as “trying hard.”</td>
</tr>
<tr>
<td>Jerome</td>
<td>African American</td>
<td>Male</td>
<td>Jerome participated occasionally in whole-group discussions and preferred to work alone in small-group settings. He was described as “struggling” by Diana.</td>
</tr>
<tr>
<td>Marcus</td>
<td>African American</td>
<td>Male</td>
<td>Marcus participated frequently in whole-class discussions and in small-group settings. Marcus was seen as a good, although not exemplary, mathematics student.</td>
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</table>

I decided to use Table 1 as a rhetorical move, recognizing that readers may need a quick way of keeping track of the students I spent an academic year getting to know. However, it is important to note that the clean lines and categories of this table are problematic. Although it is not my intention, labeling Jerome as African American, male, and struggling works to make each of these categories stable, as opposed to performed, and worse yet, it works to conflate them. One of the challenges of writing
an article like this is balancing the usefulness of writing about ethnicity, gender, and ability with a theoretical stance that recognizes these categories as continually performed rather than fixed.

**MY ROLE AS A RESEARCHER**

Initially, I conceived of my role in the classroom as that of a participant observer. I planned to sit close to children, watch what they did and said, and record as much as possible. When children turned to me to ask for mathematical help or for clarification, I responded that either I was uncertain of the requirements or was too busy with my own work. I did interact with the children, primarily by asking questions about choices they made that day in their written work or in their classroom participation. I intended for these questions to provide me with insight into their perspectives, rather than to serve pedagogical purposes aimed at their mathematical learning. Although I maintained this kind of engagement throughout the year, I came to see it as a particular kind of participation, rather than as a lesser involvement than an ethnographer who takes on the role of teacher assistant, or as a greater involvement than one who observes but does not question students.

For example, during one observation, I followed Caitlin, one of my focal students, to a neighboring table to watch her work with a partner. After about 10 minutes, Caitlin’s partner looked up at me and asked, “Why are you watching us? Are we bad?” I assured her that they were not bad, but “interesting.” The girls seemed to accept this and went back to work; however, as I continued to reflect on this exchange, I realized that although none of my focal children had ever asked why I was watching them, this did not mean that they did not have their own explanations for why they were chosen. (Similarly, other children in the classroom almost certainly had their own explanations for my choices about whom to watch.) Some of these explanations were likely related to the very phenomena I was there to study: who is good at math, who is struggling, what mathematical practices are worthy of attention. Similarly, the children used my observations for their own purposes. Once, when accused by a student teacher of failing to complete a task with manipulatives, Jerome pointed silently to my notebook, where I had written a meticulous record of his solution strategy. The children in this classroom taught me that it is impossible to “simply” observe; their work and their words *would* have been different if I had not been present. However, I believe that my presence over the course of the year minimized the disruption I caused because I became a regular feature of the classroom environment.
DATA COLLECTION

At the end of September, I started weekly observations of Diana’s classroom during math time. I visited weekly until the end of April, alternating observations among focal children in the classroom. I audiotaped observations and wrote field notes immediately afterward, following ethnographic traditions (Emerson, Fretz & Shaw, 1995; Erickson, 1986). In addition, I used the audiotapes to transcribe all dialogue in the classroom. I made copies of assigned student work, assigned pages of the textbook, pages of teacher’s guides, standards documents, and assessments that were referenced. I also took notes on what was written on the board or the overhead projector. I took notes about the physical setting of the classroom each week. Table 2 summarizes data I collected. I decided to do “mini-interviews” with the focal student I observed each day rather than more formal interviews at the end of the project. This allowed me to ask children about actions immediately after they occurred and provided some insight into children’s perspectives about their participation in the mathematics classroom. For example, one afternoon, Aliah raised her hand to answer just two questions during the class period in which I observed her. During a pause for independent work, I asked how she

<table>
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<tr>
<th>Type</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>Observations of elementary Classroom</td>
<td>22 observations of math class (audiotaped and transcribed)</td>
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<td></td>
<td>Breakdown of observations of focal students: Aliah, 3; Ben, 4; Caitlin, 6;</td>
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<tr>
<td></td>
<td>Jerome, 5; Marcus, 4</td>
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<td></td>
<td>1 observation of science</td>
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<td></td>
<td>1 observation of literacy</td>
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<td></td>
<td>1 observation of recess</td>
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<tr>
<td>Lesson plans</td>
<td>Copies of 4 months of Diana’s plans</td>
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<tr>
<td>Interviews</td>
<td>Three informal interviews of Diana, audiotaped and transcribed. Each approx. 10 minutes.</td>
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<td></td>
<td>1 formal interview of Diana, audiotaped and transcribed, approx. 60 minutes.</td>
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<td></td>
<td>Informal interviews with a focal student during each observation (22 total), approx 2–3 minutes, audiotaped and transcribed.</td>
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<td>Mathematics curricula</td>
<td><em>Mathematics Advantage</em> by Harcourt School, third-grade student book and teachers’ guide</td>
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<td></td>
<td>Investigations by TERC, teachers’ guide</td>
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<tr>
<td>Student work</td>
<td>15 pages of journal entries by each focal student</td>
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<tr>
<td></td>
<td>2 classroom assignments by each student in class</td>
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<td></td>
<td>2 classroom assignments by each focal student</td>
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decided which questions to try to answer, and she told me, “I like the ones with number answers.” Of course, often children could not or would not articulate their reasons for participating or not. I was frequently told by students that they “just knew” the answer to some questions and that they did not raise their hands for others because they were “hard.” I did not use children’s comments during these interviews as primary data, but used the comments to deepen my interpretations of classroom interactions.

DATA ANALYSIS

When I completed data collection, I began analysis by using open coding (Emerson et al., 1995; Erickson, 1986) on my field notes of classroom episodes. My data record included more than 400 pages of transcripts and descriptions. To reduce these data for analysis, I developed several major categories based on the open coding. The most relevant for this article was “genres of teaching.” These codes labeled particular communicative events (Cazden; 1988; Tannen, 1984), which were marked by shared ways of speaking and interacting, topics of conversation, and continuity of participants. The most common genres I identified in this classroom were whole-class mathematical discussions, small-group work, practice sessions, whole-class question-answer sessions, individual work, and teacher-child individual work. For the purposes of this article, I focused on episodes of teacher-child individual work and whole-class discussions because these two genres allowed me to look at practices with opportunities for participation in reform-oriented mathematics, such as mathematical discussions and problem-solving, and at teacher questions. I coded episodes as “reform oriented” when the teacher encouraged students to reason, communicate their thinking, evaluate the thinking of others, or solve problems. Within my data set, I identified 45 different episodes of whole-class discussions (sometimes two or more of these episodes occurred within one observation, such as before and after individual work) and 14 episodes of teacher-child individual work.

I then broke the 59 episodes from across the year into smaller conversation segments, looking at question exchanges between the teacher and one child or the teacher and several children around one or two questions. I coded these small segments by identifying the kinds of questions asked, the types of student responses, and evidence of competent (or incompetent) participation. I then used this analysis to develop the assertions in this article.

After coding the data, I sorted the smaller segments of data by code. For example, I took all the exchanges in which explicit questions were
asked and compared them across students, kinds of tasks, and types of responses. I made notes on key similarities and differences among several chunks of similarly coded data. I then looked for relevant statements made by the children during the informal interviews and statements made by Diana during both informal and formal interviews, and used these to enrich my interpretation of events. Table 3 shows three examples of how I moved from raw data, to more focused codes, to narrative assertions.

**THINKING ABOUT KINDS OF QUESTIONS**

Initially, I had expected to find two broad categories of questions in my data: implicit, reform-oriented questions and explicit, traditional questions. That is, I expected that questions aimed at encouraging students to reason, communicate, and problem-solve (reform questions) would be open-ended and unspecific, such as “Why?” or “What do you notice?” I also expected to find explicit, traditional questions—questions for which only one correct answer was expected, for which the teacher clearly signaled what kind of answer she was expecting, and that focused on mathematical content rather than process skills. However, during analysis, I found these two categories to be unproductive because they contained too many disparate ideas. For instance, Diana frequently asked individual children, “Do you agree with this solution?” when another child presented an answer to a problem. This was an explicit question. It identified one student who was expected to respond, narrowed the range of appropriate responses, and directed the student’s attention to evaluating another student’s answer. However, it was also a question that required children to analyze the work of their classmates and, following the norms of this classroom, to offer a sentence or two about their own reasoning. It was a question that seemed to be both explicit and reform oriented. As a result of trying to classify questions like this one, I decided that I needed to work along two axes: from reform to traditional and from implicit to explicit. Questions that I considered explicit were firmly embedded in a context from which children could draw possible answers, whereas, implicit questions required students to decide on a context in which to locate their answers. Table 4 classifies a few exemplar questions that Diana used in whole-class lessons.
Table 3. Examples of Codes and Assertions

<table>
<thead>
<tr>
<th>Classroom Transcript</th>
<th>Codes</th>
<th>Interview Comments</th>
<th>Assertion</th>
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</table>
| Diana put a dime on the screen.  
D: What is this?  
Child: A dime  
D: What's it worth?  
Child: 10 cents.  
D: I like the way you remembered to say cents. | single-answer  
student solves  
student confident  
explicit | Diana said she wanted to review for the state test in this lesson. | This is an example of a traditional, explicit question answered correctly. |

Problem: How many different kinds of sandwiches could you make with 3 different filings and 2 different kinds of bread?  
(One child wrote "6" on the overhead. Diana addressed another child.)  
D: Why does this make sense?  
Child: What?  
D: Why does this make sense?  
Child: I don't... I don't get that question. That's hard.  
D: Why would it make sense for the answer to be 6 sandwiches in this problem (pointing to the problem)?  
Child: Because all the filings can go with all the kinds of bread. You can make 6 different ways. I have a picture. | reform problem  
multiple answer  
imPLICIT | This is an example of a question aimed at promoting student reasoning.  
The student did not understand the original question but was able to answer when it was rephrased more explicitly. |

Problem: How many squares would each person get if they shared this Hershey bar?  
Diana: Aliiah, how many would each person get?  
Child: 6  
D: How did you figure out the answer is 6?  
Child: 6 plus 6 is 12.  
D: Why did you add 6 and 6?  
Child: I had two groups of six so I could add or multiply.  
child named  
single answer  
correct answer  
multiple answers  
explain thinking  
follow-up  
names key math  
explicit  
competent answer | Aliiah said she answered because she knew her answer was right and it was easy to say what she did. | This is an example of a question that asks students to explain thinking but focuses student attention on a particular issue. |
The questions in the top row require students to communicate their reasoning about a problem or to offer justifications for their own thinking, and the questions in the bottom row require students to compute or recite memorized information or to discuss strategies for doing so. In some ways, it is difficult to evaluate these questions outside the classroom context in which they occurred. For instance, the question, “If you haven’t memorized your facts, what can you do to get the answer?” might be considered a reform question because it offers the possibility for students to reason or justify their thinking. However, this question was asked as part of the introduction to a timed test, with the stated goal of offering students ways to find answers if they had not memorized their facts. The purpose was to promote fast computation, not to explore student thinking. I classified it as implicit because the question did not signal the kinds of responses that were expected, so some students did offer commentaries on ways they broke apart and put together numbers before being redirected by the teacher toward test-taking strategies such as counting on fingers, looking for multiple problems with the same answer, and starting with easy problems.

Questions in the first column forced students to figure out a way to answer the question from multiple possibilities. For instance, when asked, “What do you notice?” students might focus on patterns, the way numbers are written, correctness or incorrectness, or other features of the problem. Similarly, the answer to “What do you do to add two-digit numbers with regrouping?” might begin with lining up the problem, or with adding the ones column, or with an explanation of the regrouping process. In contrast, questions in the second column direct students’ attention much more narrowly. Rather than saying what she noticed, Caitlin must say whether she agrees or disagrees with a given answer.

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<thead>
<tr>
<th>Table 4. Kinds of Questions</th>
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<tr>
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<tr>
<td>Reform</td>
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The questions in the top row require students to communicate their reasoning about a problem or to offer justifications for their own thinking, and the questions in the bottom row require students to compute or recite memorized information or to discuss strategies for doing so. In some ways, it is difficult to evaluate these questions outside the classroom context in which they occurred. For instance, the question, “If you haven’t memorized your facts, what can you do to get the answer?” might be considered a reform question because it offers the possibility for students to reason or justify their thinking. However, this question was asked as part of the introduction to a timed test, with the stated goal of offering students ways to find answers if they had not memorized their facts. The purpose was to promote fast computation, not to explore student thinking. I classified it as implicit because the question did not signal the kinds of responses that were expected, so some students did offer commentaries on ways they broke apart and put together numbers before being redirected by the teacher toward test-taking strategies such as counting on fingers, looking for multiple problems with the same answer, and starting with easy problems.

Questions in the first column forced students to figure out a way to answer the question from multiple possibilities. For instance, when asked, “What do you notice?” students might focus on patterns, the way numbers are written, correctness or incorrectness, or other features of the problem. Similarly, the answer to “What do you do to add two-digit numbers with regrouping?” might begin with lining up the problem, or with adding the ones column, or with an explanation of the regrouping process. In contrast, questions in the second column direct students’ attention much more narrowly. Rather than saying what she noticed, Caitlin must say whether she agrees or disagrees with a given answer.
The questions in the reform-implicit box resemble those most often recommended to teachers as effective questions (e.g., NCTM, 1991; Vacc, 1993) because they are seen as eliciting higher level thinking and because teachers of many grade levels and content areas can incorporate them easily into their repertoire. That is, their acontextuality is seen as a strength because these questions can be “good questions” in many kinds of lessons. Many of the explicit-reform questions were more specific versions of their implicit counterparts. For instance, instead of simply asking “Why?” Diana asked a student to tell her why he was adding 32 and 32. However, this difference in phrasing was important—not only because the second question asked children to attend to particular features of the mathematics being discussed, but also because students in the classroom responded differently depending on the type of question asked. The following two sections explore these different responses to both implicit and explicit reform questions. Understanding how these questions operated in the classroom requires looking at their use in the context of classroom interactions, which takes space. To provide this space, the role that traditional questions (both implicit and explicit) played in the classroom is not discussed here.

DIFFICULTIES IN RESPONDING TO IMPLICIT REFORM QUESTIONS

By far, reform-implicit questions were the most likely to be met with silence when asked during whole-class lessons. Early in the year, Diana pointed to the numbers 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 on the board and asked students to tell her what they noticed. No one raised his or her hand except Ben, a European American boy frequently identified as “good at math” by the teacher. After a few moments, Diana remarked, “I know more than one person knows this.” When she made the question more specific by asking students to focus on the ones place, several students raised their hands. Diana called on Marcus, an African American boy, who said that the ones place would “always be a zero or a five in that pattern.”

A similar interaction occurred when Diana asked students how they would solve an addition problem “without pencil and paper.” Only Ben and one other student immediately raised their hands. However, when Diana rephrased her question to ask who could solve the problem using “mental arithmetic,” many hands went up. Although Diana intended to present the same mathematical task with both questions, the first version left many students unclear as to the task at hand. (In response to the first question, one student sitting next to me whispered, “I’d ask to borrow a pen.”)
In another lesson designed to prepare students for an upcoming standardized test, students had to solve a story problem by adding 53 and 23. The worksheet gave “26” as one of the possible answer choices. Diana asked the class, “Why is this not a good answer?” Several students called out that it was wrong. However, Ben was the only student to loudly announce that the answer did not make sense because 26 was less than 53, one of the numbers being added. Diana immediately followed up with him, asking about how estimation might help prevent mistakes. Although other students may have been able to make a comment similar to Ben’s given either more time or linguistic support that asked them to focus on the numbers given in the problem, Ben’s ability to immediately figure out the kind of answer that Diana wanted drew attention to his ideas first.

These frequent interactions worked to place a spotlight on Ben, who was often in the position of rescuing the class when no one else would raise his or her hand to speak. (Incidentally, this was not a position that Ben occupied unwillingly. Typically, Ben would not raise his hand to answer most questions asked, but would wait until he saw that no one was willing or able to answer the question.) After one of these interactions in January, Diana asked the class to listen closely to Ben’s explanation. Then she asked the class, “Why should you listen to Ben?” Charlie called out, “Because you think he’s smart.” Jerome added, “You think he’s right.” Diana quickly disagreed, saying that the others should listen so they could learn to answer these kinds of questions as well.

At the end of the year, most students were no more likely to answer these kinds of reform-implicit questions than they were at the beginning. However, many of them had deeply entrenched beliefs in Ben’s mathematical ability, which were revealed in interactions such as the one just described and in small-group work, where students routinely deferred to Ben even when they had correct answers and Ben did not. Ben’s ability to routinely interpret the meaning of Diana’s questions supported students’ views of him as “good at math” as much as his explanations of his thinking did. Just as classroom exchanges often worked to frame Ben as a good math student, they also worked to frame other students as struggling, at least in the public discourse. Marcus, an African American student, routinely solved all problems asked of him, participated frequently in small groups, and quickly mastered his multiplication facts. However, in whole-class discussions, he often appeared to be struggling when responding to reform-implicit questions because he could not immediately identify the kind of response Diana desired.

At the beginning of a lesson, which Diana had told the children would focus on rounding, Diana wrote the following on the board:
She asked students to write in the journals about what they observed and then raise their hands. After a few moments, Marcus raised his hand, and Diana called on him.

Marcus: It’s even.
Diana: Why?
Marcus: Odd?
Diana: Why?
Marcus: Even?
Diana: Now they’re back to even. When I say “why,” do I mean you’re wrong?
Marcus: No?
Diana: You need to tell me why. If you don’t know, you need to say “I just guessed. I don’t know.” (smiling and shrugging)
Marcus: I don’t know.

Diana drew a number line on the board from 0 to 800, with slashes at each hundred. She asked the students to look at the numbers and think about rounding. Marcus put 73, 730, and 703 in correct places on the number line. He drew arrows from these numbers to the hundreds numbers they rounded to; however, he did not raise his hand again when Diana asked students what they had done.

In this episode, Marcus did not get to demonstrate his mathematical competence publicly, although he did privately in his journal, and Diana made a point of looking at his work and praising him, saying, “You did a really nice job explaining your thinking in here. I can really tell you see the relationships between those numbers.” Marcus interpreted Diana’s “why” as a cue that his answer was wrong. Diana expressly denied that this was her intent; however, like many teachers, she was slightly more likely to ask “why” when students answered incorrectly. In this case, it is not clear if Diana was asking why Marcus said the numbers were even as opposed to odd; why he chose the category of even/odd as important; or why he chose to focus on the numbers in the second column (which were all even) as opposed to the numbers in the first column. Because her question did not narrow possible responses for Marcus, he had a wide range of interpretations to choose from, including the one he chose: that
“why” was code for wrong. Given his prompt response to the number line, it seems likely that Marcus could have made a statement about the relationship between the numbers on the board and the nearest hundred; however, the open question “why” left him struggling over Diana’s intent, rather than the mathematics. In talking about the lesson later, Diana said that she wished she would have phrased the initial question differently so that the children would have been more likely to focus on the numbers in the first column being rounded to the nearest hundred; however, she said she had chosen an open question because she wanted to hear students’ thinking. In addition, in her follow-up, she wanted to take the opportunity to remind students that a teacher asking why did not mean that an answer was incorrect.

A conversation like this in the public space has consequences beyond Marcus. For other students trying to decide whether they too might raise their hands and participate, Marcus’s eventual admission of “I don’t know” after the confusing even-odd exchange could seem discouraging. Throughout the year, only 6 of the 19 students in the class responded without prompting from Diana to reform-implicit questions in whole-class discussions even though all but two students participated in whole-class discussions nearly every day when other types of questions were asked. Only Ben answered them frequently and with confidence. The 6 students who volunteered to answer reform-implicit questions included 3 of the 4 European American students in the classroom, each of whom spoke in similar ways to Diana. These students’ dialects, vocabulary, and vocal pacing sounded very similar to Diana’s, and although the 2 European American girls who responded did not provide as many correct answers as Ben did, they rarely misinterpreted the intent of Diana’s questions.

It is tempting, in looking at this episode, to second-guess Diana’s teaching decisions. However, she was working hard to enact the values of reform mathematics as she understood them. Marcus opened the episode by saying that the numbers were “even.” This is true of at least one column of the numbers presented, and Diana could have agreed and then led him toward where she was heading with rounding numbers. Instead, she said “why” because it was her practice to ask this question frequently and because she wanted to offer Marcus the opportunity to make the connection between rounding and his answer himself. In this episode, Diana also attempted to teach the children about her use of the question “why?” by saying that it did not mean she thought the answer was wrong. Diana frequently made these sorts of commentaries on her teaching strategies; however, many children did not seem to internalize them. In April, after nearly a year of similar statements by Diana, Jerome
responded to a “why” question by immediately erasing his answer.

In analyzing this and other episodes in which students had difficulty answering reform-implicit questions, it seemed that students had to divide their attention between the mathematics at hand and the interpretation of the language being used. Sometimes, this interpretive work resulted in amusing miscommunications. For example, after presenting the following problem,

You’re going to the store to buy carpet for a room that is 6 feet by 9 feet. The perimeter is 30 feet. How much carpet do you need?

Diana asked, “What is most important here?” Charlie, one of two Asian American second-language learners in the class, shouted out, “To be polite!” Although Charlie joined in with Diana’s good-natured laughter in response, these kinds of answers encouraged many in the classroom to think of Charlie as a less competent mathematics student than Ben.

SUPPORTING MATHEMATICAL THINKING THROUGH EXPLICIT QUESTIONS

In contrast to reform-implicit questions, explicit-reform questions seemed to offer students opportunities to reason and to provide the support necessary for students to enter conversations productively. In whole-group discussions, many more children chose to respond to these kinds of questions, and their participation tended to be seen as far more competent by the teacher. For example, Caitlin, an African American student who rarely participated in whole-class discussions and never raised her hand to answer a reform-implicit question, spoke with confidence when Diana asked her to say whether she thought another student’s expansion of 730 as 700 + 30 + 1 was correct.

Caitlin: No. No, it’s wrong.
Diana: Can you say why you disagree with Sienna?
Caitlin: There’s an extra one. 700 plus 30 is 730. There should be a zero, not a one.

Here, Caitlin publicly evaluated another student’s answer and provided a reason for her correction, which demonstrated knowledge of place value as well as an ability to put her thoughts into words. Diana’s question focused Caitlin’s attention on the answer to a particular problem and gave her specific directions about the kind of answer expected. This confident exchange stood in contrast to a small-group interaction that occurred after Caitlin had solved a problem that asked how many outfits could be made with four shirts and three pairs of pants. Caitlin drew four
shirts and wrote “3 outfits” on each one. Then she wrote “$3 \times 4 = 12$.” The final prompt on the worksheet said, “Explain your work.” Caitlin, confused, questioned the student teacher, who replied, “What do you mean you don’t get it? You already did the whole thing.” Caitlin said, “I know how to get the answer, but I don’t get how to solve this problem.” For Caitlin, the requirements of “solve” and “explain your work” were mysterious, and she seemed to classify these questions as being a kind of mathematical work that she could not do, unlike finding the answer to particular problems. Although I asked Caitlin briefly about these exchanges after the lessons in which they occurred, she, like most of the focal children, did not clearly articulate differences she saw between the two questions. She told me she was able to answer the questions about Sienna’s answer because they were “easy” and that she had difficulty on the end of the worksheet because it was “hard.” It was during my analysis of the many questions that students called “easy” and “hard” that I noticed differences in how explicitly the questions were phrased.

Unlike implicit questions such as “Why?” “What do you notice?” and “Explain your work,” explicit-reform questions removed ambiguity about the teacher’s purpose in asking questions, which is what seemed to provide children like Caitlin with the confidence to join the conversation. A number of specific strategies seemed to be at play in the asking of these kinds of questions. Often, Diana attached a student’s name to the question, which worked to invite particular children to speak. These explicit questions tended to identify what the teacher saw as important in the problem under discussion (e.g., mental math strategies, rounding, Sienna’s answer). These questions also seemed to follow other questions. That is, rather than opening a discussion, they were almost always used in the midst of a conversation, which at least some of the time helped students to think about their answers in terms of what others had said previously, although sometimes these questions were used to redirect conversations that were not going where the teacher intended, as Diana did in the rounding episode with Marcus.

Finally, many of these questions allowed students to respond silently as a group before they committed themselves to speech. Diana frequently asked students to give her a thumbs up or a thumbs down in response to questions. It is impossible to answer a question like “why?” in this way; however, Diana found ways to encourage students to think when asking yes and no questions. Examples include: “Is there a way to solve this problem without regrouping?” and “Did he find all the arrays?” All children responded to questions like these (admittedly, because Diana demanded that each student take a stand). Some children looked carefully around the room before making a decision; however, Diana frequently called on
these students to explain why they had answered yes or no. These students, buoyed by the knowledge that many of their classmates had interpreted and answered the question in similar ways, often were able to articulate their thoughts more clearly than when asked a more implicit question or when asked a question that was unexpected.

Jerome, an African American boy whom Diana described as “struggling,” rarely answered questions as expected in whole-group discussions. However, he seemed to be better able to participate in conversations that began with a public yes/no question that allowed him to focus in on a specific issue and to feel relatively confident that he was right, as evidenced by the answers provided by the rest of the class. Early on in a discussion about a problem that asked students to figure out how many vegetable pieces had been used in a pot of soup, Jerome shrugged and refused to answer when Diana asked him to tell the class something he had done to solve the problem. However, a few minutes later, she asked the class to put their thumbs up or down to show whether they should add 50 carrot pieces to the total number of vegetable pieces in the soup. After looking around the room and seeing that most students had their thumbs pointed down, Jerome pointed his down as well. Diana called on him and asked why they couldn’t just write down 50 in their list.

Jerome: You have to double it! Double it!
Diana: Why do you have to double the carrots?
Jerome: Because it said to cut them in half.

Jerome had solved this problem in his journal before the discussion began, but when asked to say “something” about his solution, he had nothing to say. However, when asked a specific question about what he had done and when given the additional support of seeing that his classmates agreed, he participated with both competence and confidence.

A CAUTIONARY NOTE ON DISCURSIVE PRACTICES

Because a large part of this study focuses on questions to which students did not respond as the teacher expected, readers may conclude that Diana was not a competent or an encouraging teacher. There is not space within this article to report the many instances of kindness, laughter, and joy that passed among Diana and her students. Diana’s classroom was often abuzz with activity, from the compost bin complete with worms in the back of the room, to the quiet corners for independent reading. Student artwork, ranging from crayoned self-portraits to coats-of-arms displaying goals for the future, hung on the walls. Mathematics class, far
more often than in many classrooms, was a time of excitement and curiosity. Students calculated necessary ingredients from recipes and made soup, solved problems with multiple answers, and talked and argued with each other in small groups before presenting their work to the class. In addition, Diana actively worked in many instances to fight against racist ideas that students might encounter over the course of their public schooling. Early in the year, she asked students to draw their images of mathematicians and scientists and engaged her students in discussion of the skin color and gender portrayed in their drawings. The stories, problems, and artwork she chose for the classroom intentionally reflected the ethnic and cultural diversity of her students.

It is important to keep the rich social fabric of Diana’s classroom in mind because, as the work of Cobb and his colleagues has demonstrated, reform teaching does not simply arise from using a problem-oriented curriculum or from allowing periods for student discussion, but requires certain moves on the part of the teacher, such as the use of mathematizing language (Cobb, Boufi, McClain, & Whitenack, 1997; Cobb, Gravemeijer, et al., 1997). The current article focuses on the ways that some of Diana’s questioning techniques fell short of enacting reform mathematics practices for all students. However, in other ways, she was routinely successful. For example, students frequently spoke to each other in classroom discussions, worked well on challenging problems in small groups, and represented their thinking on problems using a variety of strategies, including written narratives, diagrams, and pictures. In addition, Diana often put students’ words into mathematical language (such as “tens place” rather than “that side”) and encouraged students to use this language. Over the course of the year, all students in the classroom solved problems in more than one way, used a chart or diagram, and wrote prose to explain their mathematical thinking. These experiences provided opportunities for students to develop mathematical competence that was sometimes not exhibited during public questioning, and provide an important context for considering the practice of asking implicit questions to develop mathematical thinking and reasoning in Diana’s classroom.

IMPLICATIONS

This study contributes to current conversations about whether reform teaching is best for all children (Ball et al., 2005; Boaler, 2002; Lubienski, 2000) by suggesting that explicit questions are not in opposition to reform practices, but a possible support for them. Open, ambiguous questions such as “What do you notice?” may be appropriate for students
who do not have to work to interpret the teachers’ language or cultural practices but may present an obstacle for students who must think about language in addition to mathematics. In addition, students who are not fluent in the register of school speech, as described by Cazden (1988), may need more explicit clues about the timing, syntax, and content of their responses. Future studies are needed to identify what it is that allows some students to respond to implicit questions in ways that are perceived as competent by the teacher. It may be that shared cultural practices between teachers and students provide these supports, or it may be that students’ familiarity with the register of school speech, regardless of the race or culture of the teacher, provides these supports.

This study demonstrated that in some contexts, implicit questions can construct some math students as successful and others as needing support. In a diverse classroom, overlaps among culture, dialect, and race may cause teachers and children to make problematic assumptions about mathematical ability based on students’ responses to implicit questions. For example, in this classroom, Ben’s public competence became a way of performing race, particularly because he was one of very few European American students in the classroom. The challenges that many minority children in the classroom faced in interpreting implicit questions could also be seen as performances of race—and dangerous ones, because they could be read as indications of mathematical competence rather than as varying interpretations of language or body language. This study does not suggest that students from nondominant cultures or who use nondominant dialects and languages cannot engage in abstract thinking and problem-solving. Rather, it fosters Boaler’s (2002) claim that they way teachers enact instructional practices is central to whether these practices are equitable or inequitable. Questions that require students to interpret teachers’ intentions and instructional goals, as implicit questions do, seem to advantage some students. Questioning strategies that removed ambiguity and allowed more children to participate included: naming the person chosen to respond, identifying the mathematical content under discussion, defining the kind of answer expected, and providing opportunities to answer questions as a group before answering individually.

It is important to note that this is a small-scale exploratory study located entirely within one classroom. The fact that the students in this classroom responded in these particular ways to implicit open-ended questions does not mean that other students in other classrooms would necessarily respond in similar ways. However, the aim of ethnographic work is not, as Geertz (1973) said, to show “the world in a teacup” (p. 23). Instead, it is to theorize the local in ways that are meaningful for readers.
Similarly, my goal in this study is not to make generalizations about the ways that open-ended questions are used in all elementary schools with all children. Rather, my goal is to offer a detailed description and analysis of the ways that one mathematical practice—asking open-ended questions—functioned within one classroom. The contribution of this study is both to generate specific hypotheses that may be tested in future work and to contribute to a growing body of work (e.g., Boaler, 2002; Lubienski, 2000) that demonstrates that conversations about quality teaching practices must not be separated from the particular contexts in which these practices are enacted.

Teaching mathematics in ways that are culturally responsive—that is, in ways that allow all students to act in competent ways in the classroom—requires that educators think both about the ways that race and culture might be impacting mathematics teaching and the ways that mathematics teaching might be impacting race and culture. In this study, students’ familiarity with the language and practices of the teacher seemed to have an impact on children’s willingness and ability to answer questions. Thus, question-answering became a way to “perform” race, which makes it important that mathematics educators find ways to engage students in mathematical discussions so that it is possible for all students to have competent public performances.

**Note**

1. I excluded small-group work, practice sessions, and individual work from analysis for this article because I wanted to focus on teacher–child interactions, and the teacher was frequently absent from conversations in these genres. I excluded question-answer sessions from analysis because these conversations consisted only of traditional, fact-based questioning, and I wanted to focus on the teacher’s enactment of reform mathematics in this article.

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