Higher Order Teacher Questioning of Boys and Girls in Elementary Mathematics Classrooms

JEFFREY W. WIMER
CAROLYN S. RIDENOUR
KELLI THOMAS
A. WILLIAM PLACE
The University of Dayton

ABSTRACT **The interaction patterns of teachers and students in public and private urban schools was investigated specifically to explore higher order teacher questioning. On the basis of a review of the literature, the authors speculated that patterns of student response to higher order teacher questioning would differ by student gender. Higher order questioning encourages students to think critically, and, therefore, is powerful for learning. Lower order questioning, however, taps only the memorization of facts. The results from this study suggested no gender difference in students' responses to higher order questioning. The 16 teachers observed used predominately lower level questioning patterns in their classrooms.**

Key words: gender differences, teacher questioning, urban schools

In a landmark study sponsored by the American Association of University Women (AAUW; 1992), researchers investigated self-esteem, school experiences (including interest in mathematics), and career motivation of over 3,000 schoolchildren in Grades 4–10. The study received national visibility and raised concerns about gender discrimination in our nation's schools. The researchers found that both boys and girls showed the most enthusiasm for mathematics in the elementary years (81% of girls and 84% of boys). By early adolescence, 72% of the boys and 61% of the girls remained enthusiastic. Student enthusiasm might act as a mediating variable, a positive attitude motivating students to seriously engage in studying mathematics.

By high school, however, 25% of the boys and 15% of the girls considered themselves good at mathematics. The boys reported that mathematics and science were not useful topics, whereas the girls reasoned that they were "just not smart enough" to do well in mathematics and science (AAUW, 1992). Although students may have been reflecting popular cultural and sexist stereotypes in the study, learning mathematics is important for school success. Moreover, educators should be cognizant of their role in teaching mathematics to both boys and girls. Flanders (1970) stated the following:

> Teaching behavior is the most potent, single, controllable factor that can alter learning opportunities in the classroom. Equalizing educational opportunities depends, in the last analysis, on: How often does the teacher ask questions? [and] What kinds of questions are asked? . . . We need to know what actually takes place in our classrooms. (p. 13)

Recent studies by the Educational Testing Service (1998) indicate that gender is a pertinent issue in the analysis of mathematics performance in schools. The study of gender dynamics in relation to mathematics achievement has been popular since the early 1970s, and the research findings continue to show differences between boys and girls (Sadker, 1999). In most studies, boys show superiority in mathematics achievement (Freidman, 1989; Hanna, Kundinger, & Larouche 1990; National Council of Teachers of Mathematics, 1989, 1991). The purpose of this study was to investigate one reason why this disparity in achievement might exist; whether level of questioning by the teacher might differ for boys and girls. If teachers do direct more higher order questions to boys, then this pattern may lead boys to achieve at higher levels than girls. (A *higher order question* is a query that asked the students to respond at a higher level than factual knowledge.)

We focused on the teacher's role in the classroom, even though the data we collected came from the students to

Address correspondence to Carolyn S. Ridenour, Department of Educational Administration, School of Education & Allied Professions, University of Dayton, Dayton, OH 45469-0534. (E-mail: Carolyn.Ridenour@notes.udayton.edu)

whom the teacher was directing questions, as we attempted to capture one aspect of the student–teacher interaction. Teacher questioning is one side of the coin; the other side is the student, the direction of that question. Examining differences in how any two students are questioned raises the issue of whether they might elicit particular questions from the teacher. Perhaps one student demonstrates an attentiveness and body language that connect with the teacher. Perhaps a student's appearance of willingness to respond (or unwillingness to respond) triggers the teacher's question. The relationship between teacher and student is symbiotic—one affects the other. Recording either partner in the dynamic, we reasoned, provided evidence about the interaction itself. The roles played by one partner, the teacher, could be inferred then from the behavior of the other partner, the student.

We grounded our conceptual framework, which focused on teachers, in several bodies of knowledge. Exploring gender differences in teacher questioning can be related to literature in at least the following four areas: (a) the salutary effect on children's learning when teachers engage in questioning, especially questions designed to elicit critical thinking; (b) investigations showing that, even despite the best intentions toward fairness, teacher behaviors can inadvertently reinforce rigid gender stereotypes; (c) the pervasive influence of the social and cultural milieu in which schools operate; and (d) the importance of mathematics proficiency for student learning.

Higher Order Questioning

Perhaps the best known and most widely used paradigm in education is the Bloom, Englehart, Furst, Hill, and Krathwohl (1956) taxonomy. This typology assumes that the cognitive level of the question is determined by the response requested by the teacher. Bloom and colleagues described the hierarchical classification system as it relates to student learning as follows: "What we are classifying is the intended behavior of students—the ways in which individuals are to act, think, or feel as the result of participating in some unit of instruction" (p. 78). Higher level cognitive functioning has been presumed to be more likely when students are engaged in synthesizing or evaluating information than when they are engaged in simple recall of information. Educators commonly have assumed that teachers who ask higher order questions that promote analysis, synthesis, and evaluation rather than lower order questions that rely on recall of information, foster critical thinking skills.

In their original work, Bloom and colleagues (1956) described *knowledge level questions,* the lowest level of the cognitive domain, as follows:

> The major behavior tested in knowledge is whether or not the student can remember and either cite or recognize accurate statements in response to particular questions. Although somewhat more than rote memory is required for knowledge, the form of the question and the level of precision and exactness required should not be too different from the way in which the knowledge was originally learned. (p. 78)

The authors also verified what we classified as *low-level questions* as such when they wrote:

> Because of the simplicity of teaching and evaluating knowledge, it is frequently emphasized as an educational objective out of all proportion to its usefulness or its relevance for the development of the individual. In effect, the teacher and school tend to look where the light is brightest and where it is least difficult to develop the individual. (p. 34)

For a low-level question, therefore, the response from the student generally required straight memory rather than more complex cognitive operations. In contrast, at the higher levels of the cognitive domain, Bloom and his co-authors described a different requisite learning on the part of the student, for example, at the level of synthesis. Even though their example came from teaching science, the overall message can easily be applied to teaching mathematics, as the following description indicates:

> It is probable that tasks involving synthesis objectives provide a wider kind of experience than those involving mainly acquisition of ideas. In elementary school science, for example, pupils may work as a group defining important problems dealing with combustion, proposing hypotheses . . . planning simple experiments. . . . Such activities should foster productive thinking, . . . Over several years, experience in this form of learning should produce profound changes in many abilities and traits. . . . Because such experiences involve the relating of ideas, methods, values, etc., they probably foster interrelation of outcomes better than experiences which do not require genuine problem solving. And this in turn probably contributes to better retention and generalization, particularly of problem-solving processes, to other situations. (p. 167)

In other words, we assumed in our study that higher level questioning leads to higher level learning. There are also studies suggesting that higher order questions tend to elicit higher level cognitive responses (Lamb, 1976; Martin, 1979). Wilen and Clegg's (1986) findings revealed that effective teachers ask high-level cognitive questions. Moreover, other studies have reported that thinking (and learning) is elevated beyond mere memorization when teachers ask questions higher than the level of simple recall (Perry, Vanderstoep, & Yu, 1993; Redfield & Rousseau, 1981; Samson, Strykowski, Weinstein, & Walberg, 1987; Winne, 1979). Within the urban community in which this research took place is an overrepresentation of students that schools and teachers have not served effectively; in this locale, measured learning outcomes compared less favorably with those of surrounding suburban and rural schools. Therefore, it is even more crucial than it may be in the surrounding communities that the level of teacher questioning be high so that these students have the best opportunities to acquire necessary critical thinking skills.

Gender Stereotyping

Ideally, most teachers endeavor to treat students equitably, although fairness in the classroom may not occur automatically. For example, Sadker and Sadker (1994) reported that teachers ask boys more questions than they ask girls, particularly questions involving academic content. Furthermore, other studies have suggested that teachers give more constructive feedback to boys than to girls (Jussim & Eccles, 1992; Kelly, 1988), and these inequities in student–teacher interactions have been reinforced in the curriculum. For instance, Klein (1985) reported that females were less likely to be studied in history or read about in literature, and teachers were more likely to frame mathematics problems in the masculine voice. Also, Scantlebury (1990) discovered that teachers in preservice training programs had traditional gender role attitudes regarding the abilities and talents of boys and girls. For example, the teachers believed that all boys liked trucks and all girls preferred dolls. When the teachers were made aware of their gender-biased interactions in the classroom, they behaved no differently, according to a study by Gould (1995). The teachers did not show gender favoritism on a conscious level, but rather, it was exhibited in the subtle language they used with their students (Hendrick & Stange, 1989).

Cultural and Social Influence

Why is mathematics more challenging to girls? Some researchers suggested that cultural and media messages promote female appearance rather than mathematics ability. According to Fredrickson, Noll, Roberts, and Quinn (1998), women concerned with their looks perform poorly on mathematics tests. Furthermore, mathematics underachievement in girls is advanced through behavior patterns and social expectations (Kramarae & Trichler, 1990).

Unfortunately, the disparity in mathematics performance between boys and girls shows increases as children grow older and social influences are manifested (Callahan & Clements, 1984; Dossey, Mulis, Lindquist, & Chambers, 1988; Fennema & Carpenter, 1981; Shaughnessy, Haladyna, & Shaughnessy, 1983). Boys develop greater self-confidence in mathematics than do girls over time (Claire & Redpath, 1989). Petry (1996) theorized that self-confidence in mathematics has allowed students to confront failure effectively. According to Petry, failure has been an important step to overcome in the process of learning mathematical concepts. In other words, rather than being immobilized by failure, students incorporate the experience into an unbroken chain of learning and maintain momentum, despite the failure. Such resilience may be manifested differently in boys than in girls, and its dynamic affected by stereotypes. Thus, it is important for teachers to recognize and understand that preconceived attitudes and expectations about boys and girls are likely to have an effect on children, particularly in their mathematics classrooms.

Importance of Mathematics

During the past 2 decades, curriculum and instruction in mathematics have undergone scrutiny and change. For example, the National Council of Teachers of Mathematics (NCTM) promoted the establishment of high expectations in mathematics for all students (1989). Governors of the 50 states developed national goals (U.S. Department of Education, 1991, 1992) through which they envisioned that by the year 2000, students in the United States would score the highest in mathematics internationally. These national groups promoted the development of good mathematics skills because mathematics achievement leads to job placement for high school graduates (Petry, 1996). Furthermore, disadvantaged students (sometimes overrepresented among urban schoolchildren) who are required to take higher level mathematics classes in high school are more likely to go on to college than those disadvantaged students who do not study higher level mathematics (Pitsch, 1991).

Method

Setting

A study at a midsized midwestern university was designed to explore the culture of urban schools from which students leave and the schools to which students move as a result of a privately funded scholarship program (PFSP). The PFSP provides lottery-selected, low-income families with scholarships for their children to use toward tuition at the school of their choice. The data that we analyzed in this study were collected through systematic classroom observations that were one component of a much broader in-depth investigation of school culture. Parental choice of a school for their children, the researchers assumed, might be grounded in their perceptions of school life, including the culture or climate of the school. The ways in which teachers interact with students in classroom lessons are, in the PFSP study, one of several indicators of school culture. Within this larger cultural study, we conducted our more focused study of teacher questioning behaviors.

The researchers (four doctoral students, including two of the authors) spent 1 full week in May 1998, in four public and four private elementary schools, collecting data on teacher questioning as well as on other qualitative and quantitative data. Teachers were initially referred to the researchers by the building principal. This process resulted in a possible selection bias because the principals might have been more likely to identify the best fourth-grade teachers in the building. We reasoned that, if this occurred and if our results showed that the best teachers showed gender differences in frequency of higher order teacher questioning, the magnitude of the problem of gender bias was more serious than it might have been with more average teachers. If fourth-grade teachers were unavailable, as an alternative, we asked third-grade teachers to participate.

When approached by the researcher at each site, all teachers who were identified consented to being observed. The teachers who participated were similar to other teachers in the public and private schools we visited. We have no reason to suspect that they differed in any significant ways in terms of their gender, race, years of experience, or expectations of students.[1] The researchers conveyed to the teachers that they intended to observe teacher–student interaction. The teachers were asked to give written consent to the following statement:

> We are studying the effects of the implementation and operation of a scholarship program of both public and private schools in [county]. We are curious about the daily educational (teaching and learning) experience of children, teachers, and parents in schools. We are specifically interested in observing life in the classroom—the dynamics of teaching and learning. We will be observing two or three 3rd and 4th grade classrooms to make notes about student and teacher interaction and curriculum. We may observe more than once in a classroom. The observations will take place at times that are convenient for you. We will be unobtrusive and will not interrupt the regular classroom activities. You may conclude the observation at any time without penalty from the researcher or from your principal.

The text of the form continued with assurance that classroom data would be aggregated with observations from other classrooms and other schools and that individual teachers and classrooms would not be identified. The teachers were assured that they were not being evaluated and that their names would not be recorded in the data set. Our agreement with the schools was that annual reports of our findings would be shared with principals and teachers of each school to use in ways that might improve teaching and learning.

Data Collection

The data were collected through systematic observations of mathematics lessons in third- and fourth-grade classrooms during May 1998. Some classrooms were observed multiple times, and, to avoid a reactive effect, we analyzed only data from the first lesson with each teacher. Presumably, teachers would be less influenced to use a particular teaching methodology, such as asking more higher order questions to girls than to boys, the first time the researcher observed them than in subsequent lessons. Sixteen lessons were observed from 11 teachers in public schools and from 5 teachers in private schools, including 12 fourth-grade and 4 third-grade mathematics lessons. All but 2 of the 16 teachers were women, and they were divided evenly by race (see Table 1 for a description of the teachers and the classes).

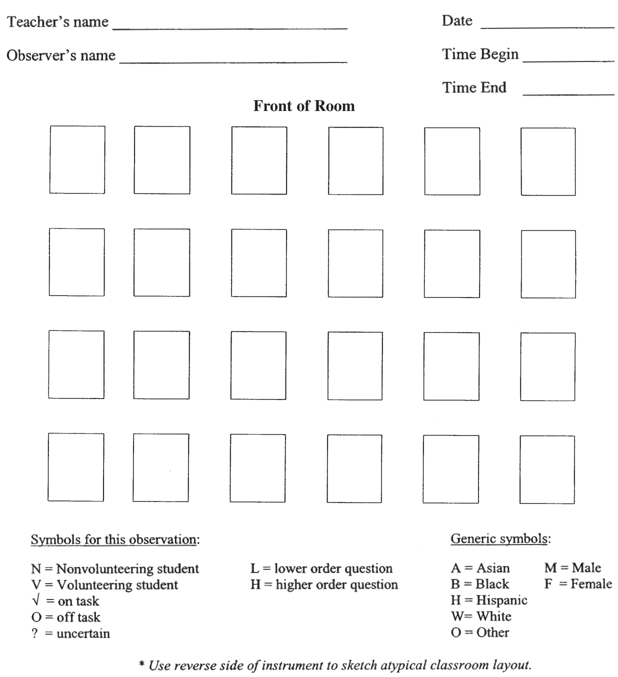
The researchers used a systematic classroom observation instrument (see Figure 1) adapted from Sadker and Sadker (1997). The instrument was used to identify each student in the classroom on a grid by location in the room, by race, and by gender. The researchers recorded the level of each question asked by the teacher and identified the student who was called on to answer the question. The researchers made no attempts to shield the coding process from the teacher. Identifying the student as the unit of measure of teacher questioning made sense, because we coded the type and direction of each question whether or not the student had a response for it. In other words, student response was not of interest to the researchers.

Table 1.—Profile of Teacher, Grade Level, and Class Size in 16 Mathematics Lessons Observed

Teacher identification	Teacher gender	Teacher race	Grade level	Number of students in class
Public schools (11 teachers' lessons)				
Teacher 9	Male	African American	4	9
Teacher 10	Female	African American	4	6
Teacher 11	Female	Caucasian	4	7
Teacher 12	Female	African American	4	5
Teacher 13	Female	African American	4	6
Teacher 14	Female	African American	4	10
Teacher 15	Female	African American	4	9
Teacher 16	Female	African American	4	19
Teacher 17	Female	African American	4	21
Teacher 18	Female	Caucasian	4	27
Teacher 20	Female	Caucasian	3	20
Private schools (5 teachers' lessons)				
Teacher 1	Female	Caucasian	3	25
Teacher 4	Female	Caucasian	3	26
Teacher 6	Female	Caucasian	3	17
Teacher 7	Female	Caucasian	4	20
Teacher 8	Female	Caucasian	4	22
Total				249

Note. Teachers 9, 10, 11, 12, and 13 taught in schools with a special student-centered instructional approach that resulted in small class sizes.

Figure 1. Systematic Classroom Observation Instrument



The researchers had been trained by a faculty member with research expertise who initially used a videotaped classroom situation for coding. After debriefing of this training and a discussion of higher order and lower order questions, subsequent practice sessions were held on four occasions in a fourth-grade classroom at a school that was not part of the study. The following example questions were "operationally" defined and identified as higher order questions in this study:

Why would you calculate a percentage in this case?
How would you use multiplication and division here?
What if the number were 10 instead of 5?

Examples of lower order questions as identified in this study include:

How many eggs are there in a dozen?
What answer did you get?
What is the "+" called?

Our rationale for data collection was based on the following assumptions. Within the classrooms of the teachers who participated in this study, a wide variety of instructional strategies were used. Two schools, for example, used a student-centered instructional approach in small groups. No matter what teaching approach was employed, we assumed that the teacher controls the discussion. For example, it is the teacher who determines whether volunteers or nonvolunteers will be called on. It is not unusual for teachers to have predispositions to that effect. Similarly, each teacher decides whether follow-up questions will be asked. Follow-up questions are more or less likely in the context of the individual lesson.

Our design was limited in that we did not control for the instructional strategies used in the classroom or for any predispositions in classroom management and discussion that the teachers might have had. Moreover, from class to class, when teachers pose individual questions, several scenarios are possible. Some possible scenarios include (a) There may be many volunteers to answer or no volunteers to answer, (b) only girls may volunteer, (c) only boys may volunteer, (d) teachers may call only on volunteers, and (e) teachers may call only on nonvolunteers. Other possibilities also are conceivable. Our assumption was that the teacher controls the questioning. The gender of those ultimately called on was our focus. We assumed that whether those called on with higher order questions were boys or girls contributed valuable data in demonstrating patterns of questioning by gender. The researchers also took field notes that included descriptive comments related to the nature of the teachers' instructional strategies; these materials were not included in this analysis.

Understanding the context and design of this study is important for interpreting the results. Consider the stereotypes about female inferiority that have been prevalent in our educational culture. That is, some persons believe (no matter how illogical) that girls are unable to do mathematics and science because they are generally more affectionate, gentle, and sensitive when compared with boys who tend to be more aggressive, independent, and ambitious (Oskamp, 1991). Academic performance myths have persisted in our culture, and, unfortunately, they influence our expectations and views of boys and girls in school. According to the AAUW's report, "Teachers are not always aware of the ways in which they interact with students. Videotaping actual classrooms so that teachers can see themselves in action can help them develop their own strategies for fostering gender-equitable education" (p. 129). Therefore, we opted to perform a field experiment to explore teacher questioning under naturally occurring conditions. We believe that this method is less susceptible to bias than self-reported measures that often yield socially acceptable or politically correct responses.

The fact that more than one researcher gathered the data represents a threat to its reliability. However, specific strategies were employed to increase interrater reliability, including in-depth planning and training. An adaptation of the Kappa statistic (SPSS, 1996) was calculated to measure interrater reliability. The PFSP research team began meeting 5 months prior to the data collection in May 1998, during which time aspects of data collection, as well as other issues related to the PFSP project, were addressed. The researchers also attended several meetings to discuss and build consensus regarding the definitions of higher order questions and lower order questions. The sessions were directed to sharpening the judgment skills of the researchers. They participated in training sessions for classroom observations in which videotapes were used to practice collecting data as well as to establish a shared understanding of the data to be collected. After the training, the researchers observed an actual classroom lesson on three occasions to take estimates of levels of agreement among raters. Following the joint observation, the researchers debriefed and discussed characteristics of higher and lower order questions.

The logic of the Kappa[2] measure (SPSS, 1996) was applied to the data collected during the joint classroom observations, resulting in a possible value ranging from 0 (no agreement) to 1 (complete agreement). With regard to the level of questions as recorded by the researchers, the first 10 questions asked in the observed classes were analyzed for each of the three observations, admittedly a limitation because it constitutes a fairly low *N* from which to make this estimate. Although two of the observations did not produce particularly strong Kappa values for level of questioning, one observation resulted in relatively strong Kappa values. For the second classroom observation, six of the questions had Kappa values of 1.0, indicating complete agreement, and four of the questions had Kappa values of .66. The training sessions, discussions, and correlation measures of the study combined to enhance the reliability of the data collected.

Results

It was apparent that higher order questions were asked infrequently in the classrooms that we observed. About half of the students were asked lower order questions, a much higher frequency count than for those who were asked high-

Table 2.—Students to Whom Teachers Directed Higher Order and Lower Order Questions During Mathematics Lessons

Gender	Number of questions asked: 0	1	2	3+	Total number of students asked questions
Higher order questions					
Boys (*n* = 118)	96	18	1	3	22
Girls (*n* = 131)	115	11	3	2	16
Total (*N* = 249)	211	29	4	5	38
Lower order questions					
Boys (*n* = 118)	60	34	7	17	58
Girls (*n* = 131)	68	34	13	16	63
Total (*N* = 249)	128	68	20	33	121

Table 3.—Students to Whom Teachers Directed or Did Not Direct Higher Order Questions During Mathematics Lessons

	Students asked no higher order questions		Students asked at least one higher order question		Students	
Gender	*n*	%	*n*	%	*N*	%
Boys	96	81.35	22	18.64	118	47.38
Girls	115	87.78	16	12.21	131	52.61
Total	211	84.73	38	15.26	249	100

Figure 2. Students Asked and Not Asked Higher Order Questions

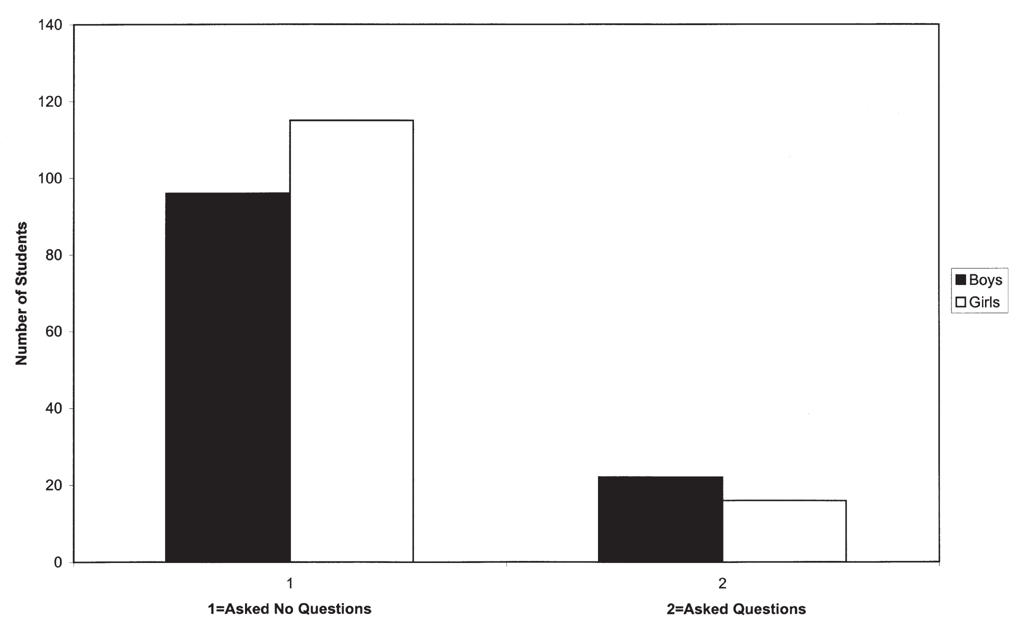


Table 4.—Students Asked Higher Order Questions During Mathematics Lessons

Gender	Student responses—volunteered to answer		Student responses—did not volunteer to answer		Students answering higher order questions
	n	%	*n*	%	*N*
Boys	7	29.16	17	70.83	22
Girls	9	50	9	50	16
Total	16	38.09	26	61.90	38

Note. The row totals for boys and girls do not add up because 2 of the boys and 2 of the girls were represented in both groups. In other words, they both volunteered and did not volunteer to answer questions. An actual 38 students answered higher order questions; there was an actual total of 42 responses to higher order questions.

er order questions; the frequency distributions for boys and girls separately were similar (see Table 2). Of the 249 students, 121 were asked lower order questions (approximately 48%); only 38 of them were asked higher order questions (approximately 15%). See Table 3 for the proportion of higher order questions asked of boys and girls.

From the results on Table 3, it is clear that the proportion of higher order questions to no higher order questions for all students (a 15% to 85% ratio) was similar to the ratio within each gender group. For boys, the ratio was 18% to 81%; for girls, the ratio was 12% to 87%. Figure 2 graphically displays these clear patterns for boys and girls.

Of the 42 higher order questions (directed to 38 students), more questions were directed to those not volunteering to answer (26) than to those volunteering to answer (16; see Table 4). An equal number of girls who were called on had volunteered as had not volunteered, a pattern that differed for the boys. About two thirds of the boys were asked questions, although they had not volunteered.

The results from this study suggest that girls were not asked fewer questions than were boys in urban elementary mathematics classrooms and that both genders experienced a low frequency of being asked higher order questions. Moreover, the findings suggest that boys are more likely to be called on when they do not volunteer than are girls. Those findings are suggestive of gender patterns but are not conclusive. Because previous research findings have indicated the positive effects that higher order questioning can have on students' cognitive outcomes (Redfield & Rousseau, 1981; Samson, Strykowski, Weinstein, & Walberg, 1987; Wilen & Clegg, 1986; Winne, 1979), one would anticipate observing that behavior among teachers during mathematics instruction. However, the practice of asking higher order questions was used minimally in these classrooms.

Discussion

The AAUW (1998) study, "Gender Gaps: Where Schools Still Fail Our Children," suggests that the gender gaps in mathematics achievement have narrowed in the past 6 years. Perhaps the gap simply does not exist in some types of schools. Could it be, for instance, that in low-income schools teachers distribute their attention more equitably? Or, could level of teacher questioning generate student learning at higher levels of comprehension for both boys and girls? To the extent that higher order questioning might be an explanation for narrowing those achievement differences, this study is relevant. The fact that girls did not appear to be asked fewer questions than boys demonstrates that, for this sample of classrooms at least, that type of gender bias was probably not present.

If it is the case that the principal directed the researchers to the better teachers, then the dearth of questioning might be a concern. If one assumes that questioning is an important pedagogical strategy, then why was it so limited in these classrooms? On the other hand, that same higher level of expertise might explain that these better teachers did not discriminate between boys and girls in the questioning that did take place.

The results of this study may support previous findings that gender bias in mathematics does not begin to appear until adolescence (AAUW, 1992). However, a different sample, including higher grade levels, would be needed to test this hypothesis. The use of higher order questioning as a teaching strategy for mathematics lessons fosters the development of students' mathematical skills (Rowan & Robles, 1998). Furthermore, for future vocational and academic success, students must develop the ability to think critically, solve problems, reason logically, and communicate ideas. Through the use of higher order questioning, teachers can enable students to make sense of, reason about, solve, predict, and apply mathematics (Rowan & Robles).

The National Council of Teachers of Mathematics (1991) developed professional standards for teaching mathematics that emphasize the role of the teacher in mathematics classrooms. Another standard presented by NCTM elaborates on the teacher's role in classroom discourse. The assertion made is that teachers should encourage student participation in classroom discourse through (a) higher order questioning, (b) students' clarification and justification of their ideas, (c) use of mathematical language, and (d) listening and responding to students' ideas.

In a study of questioning in first-grade mathematics classrooms in Japan, Taiwan, and the United States, Perry, Vanderstoep, and Yu (1993) found that teachers in the Asian countries asked significantly more higher order questions than did their U.S. counterparts. The authors speculated that the kinds of questions asked in Asian classrooms may contribute to the development of more complex mathematical understanding by the children in those classrooms. In the urban public and private elementary classrooms observed in this study, teachers asked an average of only three higher order questions during a mathematics lesson. Some of the teachers asked no higher order questions.

The analysis reported here is embedded within a wider study of school choice, a program of research examining cultures of two categories of schools—those schools from which parents choose to remove their children and those in which parents choose to enroll their children. In a market climate in which parents exercise choice, one might expect pressure for change in classroom instruction, particularly where student mathematics achievement needs bolstering.

Although teacher–student interaction, particularly that related to patterns and levels of questioning, reveals one quality of instruction, any conclusions related to the impact of gender are difficult to make. These findings are inconclusive. Perhaps, as our study shows, student gender may be less a factor than it has been historically. On the other hand, Sadker (1999) reported that researchers generally continue to find, as they did 25 years ago, that "teachers unconsciously make males the center of instruction" (p. 24).

Further study regarding student gender bias is warranted. The overall pattern of higher and lower level questioning deserves continued attention, even though gender differences did not seem to be in evidence here. A study with a stronger design, including random assignment and tighter controls on type of instruction and class size, for example, is justified. A study that focuses on teachers, rather than on students, is needed. A further look at the nature of questioning students who volunteer and who do not volunteer to answer could add to the knowledge base as well. Connecting level of questioning with students' responses would reveal whether the assumptions about the worth of higher order questioning are borne out.

Higher level and lower level questions have their place in the classroom; vigilant teachers employ both types when the need arises. Even if teachers understand the need to change their classroom practices in mathematics instruction, for many it is unclear how they should undertake such change. Teaching in the United States has historically been a profession in which teachers in isolation have developed best practices without sharing knowledge with others in the profession. Therefore, it is important that teachers who want to monitor or change their classroom practices have access to the support and resources necessary to do so.

NOTES

We wish to acknowledge the contributions to this research by the following members of the research team: Thomas J. Lasley, Kathryn Kinnucan-Welsch, Carolyn Talbert-Johnson, Melva Newsom, Mary Anne Angel, and Reva Cosby.

1. Most of the teachers we observed were ultimately participants in the wider cultural study of schools of which this study was a part. In interviews with those teachers, we became acquainted with their backgrounds, their demographic profiles, their expectations of themselves and their students, and their perceptions about their experiences as teachers.

2. Kappa is a measure that shows whether the level of rater agreement is different from that expected by chance alone. $\kappa = (po - pe)/\ 1 - pe$, where *po* = observed proportions (sums) in the diagonal cells (interactions where researchers agreed on the level of questioning); and *pe* = expected proportions (sums) in the diagonal cells (interactions where agreement on the level of questioning was expected).

REFERENCES

American Association of University Women. (1992). *Shortchanging girls.* Washington, DC: Author.

American Association of University Women. (1998). *Gender gaps: Where schools still fail our children* [On-line]. Available: www.aauw.org

Bloom, B., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *A taxonomy of educational objectives, handbook I: The cognitive domain.* New York: David McKay.

Callahan, L. G., & Clements, D. H. (1984). Sex differences in rote-counting ability on entry to first grade: Some observations. *Journal for Research in Mathematics Education, 15,* 378–382.

Claire, H., & Redpath, J. (1989). Girls' and boys' interactions in primary classrooms. *Gender Equality Teams. Occasional Paper No. 2.* London: Elthorne Professional Centre.

Dossey, J. A., Mulis, I. V. S., Lindquist, M. M., & Chambers, D. L. (1988). *The mathematics report card: Are we measuring up? Trends and achievement based on the 1986 national assessment.* Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1998, November). *ETS study finds more gender similarities than differences in educational performance* [On-line]. Available: http://www.ets.org

Fennema, E., & Carpenter, T. (1981). Sex-related differences in mathematics: Results from national assessment. *Mathematics Teacher, 74,* 554–559.

Flanders, N. A. (1970). *Analyzing teacher behavior.* Reading, MA: Addison-Wesley.

Fredrickson, B. L., Noll, S. M., Roberts, T. A., & Quinn, D. M. (1998). That swimsuit becomes you: Sex differences in self-objectification, restrained eating, and math performance. *Journal of Personality and Social Psychology, 75,* 269–284.

Freidman, L. (1989). Mathematics and the gender gap: A meta-analysis of recent studies on sex differences in mathematical tasks. *Review of Educational Research, 2,* 19–42.

Gould, C. (1995). *High ability girls and the setting: Do teachers' interaction patterns change?* Paper presented to the AAUW preconvention symposium, Orlando, FL.

Hanna, G., Kundiger, E., & Larouche, C. (1990). Mathematical achievement of grade 12 girls in fifteen countries. In L. Burton (Ed.), *Gender and mathematics: An international perspective.* London: Cassell Educational.

Hendrick, J., & Stange, T. (1989). *Do actions speak louder than words: An effect of the functional use of language on dominant sex role behavior in boys and girls.* (Technical Report, 14, 1–29). Norman: University of Oklahoma, College of Education. (ERIC Document Reproduction Service No. ED 323 039)

Jussim, L., & Eccles, J. S. (1992). Teacher expectations: Construction and reflection of student achievement. *Journal of Personality and Social Psychology, 63,* 947–961.

Kelly, A. (1988). Gender differences in teacher-pupil interactions: A meta-analytic review. *Research in Education, 9,* 1–23.

Klein, S. (1985). *Handbook for achieving sex equity through education.* Baltimore: The Johns Hopkins University Press.

Kramarae, C., & Treichler, P. A. (1990). Power relationships in the classroom. In S. L. Gabriel & I. Smithson (Eds.), *Gender in the classroom: Power and pedagogy.* Urbana and Chicago: University of Illinois Press.

Lamb, W. (1976). Ask a higher-level question, get a higher-level answer. *Science Teacher, 43,* 22–23.

Martin, J. (1979). Effects of teacher higher-order questions on student process and product variables in a single-classroom study. *The Journal of Educational Research, 72,* 183–187.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics.* Reston, VA: Author.

Oskamp, S. (1991). *Attitudes and opinions* (2nd. ed.). New York: Prentice-Hall.

Perry, M., Vanderstoep, S., & Yu, S. L. (1993). Asking questions in first-grade mathematics classes: Potential influences on mathematical thought. *Journal of Educational Psychology, 85,* 31–40.

Petry, N. G. (1996). *Variables predictive of student success in honors pre-algebra.* Unpublished doctoral dissertation. University of Dayton, OH.

Pitsch, M. (1991, September). Six districts to require algebra, geometry for all students. *Education Week.* p. 11.

Redfield, D. L., & Rousseau, E. W. (1981). A meta-analysis of experimental research on teacher questioning behavior. *Review of Educational Research, 51,* 237–245.

Rowan, T. E., & Robles, J. (1998). Using questions to help children build mathematical power. *Teaching Children Mathematics, 4,* 504–509.

Sadker, D. (1999). Gender equity: Still knocking at the classroom door. *Educational Leadership, 56*(7), 22–26.

Sadker, M., & Sadker, D. (1994). *Failing at fairness: How America's schools shortchange girls.* New York: Scribner.

Sadker, M., & Sadker, D. (1997). *Teachers, schools and society.* Boston: McGraw Hill.

Samson, G. E., Strykowski, B., Weinstein, T., & Walberg, H. J. (1987). The effects of teacher questioning levels on student achievement: A quantitative synthesis. *The Journal of Educational Research, 80,* 290–295.

Scantlebury, K. (1990). *A study of the implementation of equitable teaching strategies by preservice teachers after an inservice program.* Unpublished doctoral dissertation. Purdue University, Indiana.

Shaughnessy, J., Haladyna, T., & Shaughnessy, J. M. (1983). Relations of student, teacher and learning environment variables to attitude toward mathematics. *School Science and Mathematics, 83*(1), 21–37.

SPSS. (1996). *Base 7.0 Applications Guide.* Chicago, IL: SPSS, Inc.

U.S. Department of Education. (1991). *America 2000: An education strategy.* Washington, DC.

U.S. Department of Education. (1992). *World class standards for American education.* Washington, DC: U.S. Government Printing Office.

Wilen, W. W., & Clegg, A. (1986). Effective questions and questioning: A research review. *Theory and Research in Social Education, 14,* 153–162.

Winne, P. H. (1979). Experiments relating teachers' use of higher cognitive questions to student achievement. *Review of Educational Research, 49,* 13–50.