Gender, Text, and Discussion: Examining Intellectual Safety in the Science Classroom

Barbara J. Guzzetti

Arizona State University, College of Education, Division of Curriculum & Instruction, Tempe, Arizona 85287-0311

Wayne O. Williams

Corona del Sol High School, Tempe, Arizona 85284

Abstract

It is clear from the extant literature that gender inequities exist in a myriad of ways in science classrooms. Past research, however, has been conducted solely from researchers' observations and has neglected to investigate students' awareness of and reactions to their own experiences. Hence, this study focused on students' perceptions of gender differences in instructional activity and talk about that activity in physics and honors physics classes. Data analysis showed that although teachers may be unaware of gender inequities, students of both sexes are not unaware of such inequities. Females explained their fears of offering their opinions and participating in activities like labs and small-group or whole-class discussions. Differential language patterns were found for males and females, particularly when discussion was structured and rewarded for refutation. Explanations are offered for these disparities and suggestions are given for addressing gender bias in science classrooms.

It has been well documented that science classrooms are not gender fair (Bazler & Simonis, 1991; Bianchini, 1993; Tobin, 1988). Teachers, texts, and the forms of instruction they perpetuate contribute to gender inequities in science instruction. For example, research tracing changes in science textbooks over time has shown that current texts have failed to eliminate barriers to women in science (Bianchini, 1993). Science textbooks are criticized for their unequal treatment of genders, with illustrations, photos, and texts of males far outnumbering those of females, despite the approximate 50/50 male/female ratio of our population (Bazler & Simonis, 1991).

In addition to the proclivity of science textbooks to favor males, researchers speculate that the tendency for boys to achieve higher than girls in science may be a result of more opportunity to engage in academic tasks (Tobin & Garnett, 1987). Their behavior shows that teachers have differential expectations for students' responses in activities like teacher-led discussion. In teacher-led, whole-class discussion, boys are spoken to more frequently and are asked more higher-order questions (Becker, 1991; Hall & Sadler, 1982). Teachers in science classrooms elaborate more on males' responses than females' responses in large-group discussion of scientific concepts (Jones & Wheatley, 1990).
Recent research on discussion about concepts in science text shows that whole-class discussion is dominated by males (Hynd & Guzzetti, 1995). In fact, male dominance of activity, and talk about that activity is so common in science classrooms that national television has presented the problem (NBC News Dateline, Failing in Fairness). Discussion that disenfranchises females is especially detrimental in science since researchers argue that it is particularly important to discuss ideas when students’ theories are contradicted by scientific thought (Alvermann & Hynd, 1989). Because students’ intuitive but nonscientific ideas are tenacious, conceptual change is not likely to occur unless a new idea is shown to be applicable to new situations (Strike & Posner, 1985).

One powerful way to accomplish the active construction of new scientific conceptions is through interactive discussion requiring students to provide evidence to support their positions (Alvermann & Hynd, 1989; Guzzetti, Snyder, Glass, & Gamas, 1993). Students report discussion to be an activity that contributes most to science learning (Tobin & Garnett, 1987). Yet, both true discussion (characterized by dominance of student talk, students talking with each other and speaking in phrases and sentences) and recitation-type discussion (the teacher asks a question and the student provides the answer [Alvermann, Dillon, & O’Brien, 1987]) is dominated by males (Tobin & Garnett, 1987).

Why do discussion patterns favor males in science classrooms? Lemke (1990) provides an initial response to this query, reporting that males rather than females tend to define the appropriate way to “talk science.” He found that science teachers took a student’s arguments on a position more seriously when they were assumed to have come from a male.

Further explanation is provided by Lafrance (1991), who cites three reasons for males’ domination of talk in classrooms. First, Lafrance posits that there is a “cultural proclivity for seeing any talk by women as too much talk” (p. 5). Second, social pressures require that females should be good listeners; their verbal participation is seen as less important than their ability to be attentive to others. Third, women are discouraged from talking by such verbal and nonverbal means as gaze aversion, delayed feedback, interruptions, and withholding of active listening responses, like nods or requests for elaboration. Hence, it is not necessary for teachers to be overtly sexist, but to merely follow socialization conventions to encourage gender bias.

Sadker and Sadker (1985) observed students in more than 100 classrooms and found that at all grade levels, and in all subjects, boys dominated classroom communication. Tannen (1992) also reports that males dominate whole-class discussion, whatever the topic. She recommends that lessons include small-group discussion. This recommendation is challenged, however, by the finding that male adolescents in science classrooms dominate every type of classroom interaction (Morse & Handley, 1985).

What then can science teachers do to ensure equal learning opportunities? A plethora of evidence exists suggesting that teachers are generally unaware of gender differences in talk and classroom participation (Jones & Wheatley, 1990; Tobin, 1988). When teachers are aware, they may consider such differences to be the expected norm, be too involved in the day-to-day business of instruction to deal with the problem, or be unaware of how to cope with it (Tobin, 1988). Hence, conditions for change must include the teacher’s own awareness of the problem, willingness to deal with it, and viable ways of doing so.

Purpose of the Study

This study was undertaken for the purpose of examining gender differences in participation in learning counterintuitive science concepts. We were directed both by our Advisory Council members, and by the extant literature (Tobin, 1988), to explore gender disparity in classroom
discussion that might impede learning. Krockover and Shepardson (1995) have called for qualitative studies to provide “fuller, richer images” of the conditions that perpetuate victims of oppression in scientific literacy. This study was conducted to respond to calls like these to describe how females are disenfranchised in learning science. During the course of our study, the students in the classes we observed also focused our attention on these issues. As a result of these directives, the study explored gender differences in classroom interactions, and students’ awareness of and reactions to those differences.

Several unanswered queries that concern both students’ and teachers’ behavior guided our inquiry. Because past research has provided researchers’ analyses, based on their observations of students and teachers, we were interested in exploring students’ perceptions, based on their own experiences. We asked, if teachers are unaware of gender differences in science classrooms, are students also unaware? If students are aware, what are their reactions? How do those reactions affect their attitudes toward and performance in science?

Another set of questions yet to be addressed by research focused on the teacher. We asked, how can teachers who were previously unaware of gender bias become alert to these inequities? Once alerted, what can teachers do to address the problem?

Methods

Sample

To answer these questions, a purposive sample of two high school physics classes (one physics and one honors physics class) was selected for case study. (We define case study as Stake, 1994, does: the complete study of a bounded and integrated system.) We chose these classes because of the teacher’s goals and instructional methods, and his willingness to become a co-researcher. (The teacher, Wayne Williams, is the second author of this manuscript.)

The school is situated in a college city in the Southwest U.S. on the outskirts of a major metropolitan area. Located in the fastest-growing and most affluent side of town, Corona del Sol High School initially looks more like a resort than a school. Although built in 1978, the brick building appears to be brand new, complimented by the spotless landscaping of rock gardens and palm trees. Visitors are greeted by soft-rock music piped outside and security guards who whisk around campus with walkie talkies in electric vehicles. The campus is spacious, complete with its own bookstore, well-equipped media center, theater, and greenhouse that received local notoriety during the study. An aura of orderliness permeates the atmosphere, belying the fact that a police substation was opened on campus. This action was intended to discourage the weekend drive-by shootings at the temporary buildings by gangs from a neighboring community. The school is also assigned a part-time police liaison officer who keeps careful records from year to year on incidents of crime on campus. In addition, the school has a full-time At-Risk Coordinator who works with the 25% of the school’s population in danger of dropping out.

Wayne Williams is a veteran teacher with 30 years of teaching experience in the Southwest US. He taught high school physics in a mountain community for 4 years, at another high school in this urban district for 10 years, and has been teaching at this school since it opened. Wayne has also spent the past 6 summers teaching a course in creativity at a state university. Described by the principal as “the best teacher in the state,” Wayne was the high school physics teacher for three other physics teachers in the district, including the school’s current science department chair. Two experiences have especially shaped Wayne’s instructional approach—training in addressing students’ misconceptions in science (sponsored by a grant from the National Science
Foundation), and an executive development course from AT&T at Bell labs on working in teams.

These emphases were particularly relevant in light of the study’s focus on inequities in activity and discussion around counterintuitive concepts. Wayne’s goal in structuring his instruction is to foster teamwork and cooperation. To accomplish this objective, written team rules of conduct are posted, including admonitions like, “respect each person,” “share responsibility,” “criticize only ideas, not people,” “question and participate,” and “listen constructively.” Wayne reinforces these edicts by fostering and rewarding group work. For example, Wayne checks recorded laboratory results for the entire group, with each member receiving the same number of points as the randomly chosen spokesperson. Wayne verbally encourages students to discuss and agree among each other. Using a pilot analogy, he often inquires who the “wing man” (responsible for double checking calculations) was for the group. Conceptual tests are completed and graded as a group effort.

Although rather homogeneous in their achievement and career goals, the 55 students in Wayne’s two sections represented a wide range of ethnic and cultural backgrounds, including Asian (9%), European American (85%), Hispanic (4%), and Native American (2%). Sixteen percent (9 students) were foreign-born, from countries like Czechoslovakia, Chile, India, Kuwait, Poland, and Taiwan. The regular physics class had almost twice as many males as females—15 of the 24 students were males and 9 were females. The honors physics class, however, was about evenly divided, with 14 females and 17 males. Students’ socioeconomic status was readily apparent by the abundance of designer labels evident on their clothing, including Bum Equipment, Guess, Esprit, and Liz Claiborne.

The teacher noted no differences in achievement between the physics and honors physics students. Many of the regular physics students were not enrolled in honors physics because they could not fit it into their schedules. Students could be placed into honors physics simply by parent request. As a result, Wayne used about the same lesson plan with both sections. He did note, however, that both his honors physics and regular physics students had the same alternative conceptions as students in the school’s basic physical science class for non-college-bound students.

*Researchers*

The Principal Investigator for this study (the first author) was trained in naturalistic inquiry by one of the contributors to an early volume of case studies in science education (Stake & Easley, 1978), who has published methodological advice on conducting naturalistic research in science education (Smith, 1982). The Principal Investigator has also conducted other naturalistic studies that investigated instructional activity (Guzzetti, 1989, 1987; Guzzetti, Hynd, Skeels, & Williams, 1995). In addition, she teaches an introductory research methods course that includes exposure to naturalistic methods. Her Research Assistants were graduate students who had training in naturalistic techniques.

The Co-Researcher/Teacher (the second author) has had 30 years of experience in what Goodman (1985) refers to as “kid watching.” He has won numerous awards for his teaching, including a Presidential Award for Excellence in Teaching, and was recognized as the National Science Teachers’ Association Teacher Awardee for 1995.

*Data Collection*

Data were collected during an 8-month period, with near daily observation of two sections (physics and honors physics) from the first day of school until the end of March. Three
researchers (the Principal Investigator and two Research Assistants) observed most often singly, but at times together. Data were gathered by several methods, particularly direct observations captured in field notes or audio-recorded. Field notes reflected anecdotal or near-verbatim record, separated from inferences, comments, and questions.

These data were triangulated by other sources. Questionnaires were designed by the Principal Investigator and the Co-Researcher/Teacher. Semistructured and informal interviews were also conducted, which were either audio- or video-recorded. These interviews were transcribed to written record. Documents like lesson plans, worksheets, lab assignments, and lecture notes were also collected.

Member checks were conducted with both the teacher and student informants. Data and findings were shared with students to elicit their reactions. Periodically, students would ask to read the researchers’ field notes and would comment on them. The teacher reviewed the interviews, questionnaires, and summaries of analyzed data.

Data Analysis

Data were organized for analysis by using the computer program Ethnograph version 4.0. This program formats data (like interviews and observations) from a word processor into numbered lines. Data can then be stored, organized, coded, and retrieved.

Data were analyzed by constant comparison (Glaser & Strauss, 1967). In this analysis, data are first annotated and then coded by emerging categories. These categories are compared continually, revealing patterns that result in data-based propositions.

Findings

Gender Differences in Classroom Interaction

From the first week of observation, we noted the same types of gender differences in participation typically reported in the literature. We were particularly interested in small-group activity due to the extant controversy about small groups. Tannen (1992) recommends that lessons include small-group interactions to address gender inequities in whole-class discussion. Other researchers, however, have found male dominance in all types of science activity (Morse & Handly, 1985).

Gender inequities were most evident in our observations of team work in laboratory assignments, consistent with Tobin’s (1988) observation that females are less likely to be involved in operating lab equipment. A summary of observation notes by a Research Assistant dated August 31, 1993 reads: “Only the boys in each team operate the experiment, whereas the girls just sit there and record the data.”

The Principal Investigator’s field notes also reflect one group’s stereotypical assignment of roles by gender in a lab on friction:

[Observation, 3/9/94, pseudonyms used in the remainder of the paper]:

Sam: Let’s do a list of our surfaces.
Ellen: O.K.
Gary: [to Ellen] You’re the scribe today.
Ellen: O.K.
Sam: I am so tired.
Ellen: Why?
Sam: I was working till one o’clock last night.
Ellen: The smart one’s tired!
Ellen: [to researcher] Sam wants to be a physics teacher.
Researcher: Sam wants to be a physics teacher?
Ellen: Yes, he does.
Researcher: [to Sam] Really?
Sam: Yeah.
Researcher: [to Ellen] So, you let him do it? You let him make the observations?
Ellen: Yeah
Researcher: [to Ellen] And you act as secretary?
Ellen: Yeah.

We also observed other small-group activity and discussion about that activity that provided additional evidence of gender bias among students. Observation of a group working together through written problems to be graded showed how a male student dominated the group and disenfranchised a female:

[Observation 1/18/94: Jason reads each problem aloud and gives the answer to the group]:

Jason: Number 11 is acceleration. Number 12; Inertia is mass.
Jason: [to researcher] What do you think?
[Researcher declines to participate].
Jason: Number 13.
Betty: Is 13 B?
Jason: [sarcastically] Yes, Betty, you are learning. Number 14 would be less. 16 is B. 15 is A. Stacey, did you get B for 17?
Betty: Isn’t 18 B? Because gravity is acting . . .
Jason: [interrupting] Betty, put in a number before you talk to me. Number 18 is C. I just proved it to you with a number. 2 = 10/5. This is a democracy, the majority wins. Quit slowing us down!
Sally: [to Jason] Why do you confuse everyone with your formulas?
Jason: They work for everything else.
Betty: [to researcher] No one listens to me! Gravity is acting. I put my answer for 13 as B; Billy and Jason put C.

This incident involving Betty’s and Jason’s talk in a small-group laboratory activity is a striking example of Tromel-Plotz’s (1985) observation about women in conversation with men:

They are forced into lower positions in the discussions by men not giving them a chance to talk, by men disregarding what they say when they do get a chance, by men not taking them seriously as equal participants in the discussion. Women have fewer conversational rights than men—e.g., the right to finish a turn, the right to be not disturbed while speaking, etc. Those who have more rights, more power, can more easily be successful. Success is constructed for the more powerful and not for the most able. (p. 3)

In addition to gender inequities in small-group activity and discussion, we found gender differences in whole-class discussion, particularly when structured and rewarded for refutation. Wayne customarily gave 5 extra points (highest grades went to those who had the highest points) to students who could correctly argue their views. Wayne structured refutation as a rhetorical style by secretly appointing a “shill,” a class member who before class was provided with a logical, but incorrect, response to a central question to be posed in that day’s discussion. Shills were also rewarded with extra points if they could convince others of the wrong answer.
Students were aware that Wayne had a habit of doing this, but were never told who the shill was, or when a shill would be planted. Wayne called this discussion “inquiry training.”

This form of discussion was especially interesting to us as a potentially powerful way of impacting students’ learning. Meta-analysis of studies from both reading and science education revealed that written forms of refutation are one of the most effective means of learning counterintuitive science concepts (Guzzetti et al., 1993). Hence, we believed that equal access would be particularly important in verbal forms of refutation.

Our analysis of field notes, however, documented that girls spoke only rarely in refutational discussion. In these situations, it was always the same few girls who volunteered to speak. When girls did refute, their refutational patterns were characteristically different than the boys. The boys would overtly argue with each other, with statements like, “That’s wrong because...” Girls would usually pose their refutation to their peers indirectly as a question, like, “Have you thought about...” or “Shouldn’t that be...?”

One possible explanation for these differences may be that prior research has shown women to be less confrontive and more inclusive in their interactions (Tromel-Plotz, 1985). Writers on gender and language characterize women’s speech as insecure or lacking in confidence (Lakoff, 1975). Others, however, resist such designations (Dubois & Crouch, 1975; Edelsky, 1979), arguing that questions rather than pronouncements, for example, provide social grace rather than reflect insecurity (Tromel-Plotz, 1985). Simply by listening, it is hard to say whether insecurity or an inclusive style is at the root of these girls’ participation patterns. Self-report data (to be reported later) lead us to believe, however, that the girls were feeling insecure rather than being inclusive. By refuting less frequently and by posing their refutations as a query, the females were being consistent with socially learned norms of gender-appropriate language behavior.

Students’ Awareness of and Reactions to Gender Bias

Early in the study, students were asked to critique their current science textbook by telling us what they liked and didn’t like about it. Wayne used three texts: Conceptual Physics (Hewitt, 1985) for in-class assignments, Physics: Principles and Problems (Zitzewitz & Murphy, 1990) for honors physics, and Physics: Its Method and Meanings (Taffel, 1986) for the regular physics class.

This request provided initial evidence that students are well-aware of gender bias in science classrooms. One female student, Camilla [name used with her consent] in honors physics volunteered to be videorecorded as she reported her interpretations of subliminal messages she received from the photos and illustrations in her section’s textbook. Camilla’s text gave her the dual message that physics is for males, because women cannot accomplish much:

Camilla: Women aren’t mentioned in this science textbook at all. I mean, they are in a couple incidents, but not to the proportion that men are, which just further proves that science is a male-dominated field.

Researcher: And you’re flipping right now through the pages. You’re looking at some of the photos and illustrations. What do you see there?

Camilla: That when they tend to use people, they always tend to use males, especially in stereotypical situations, like here in Chapter 10... When they decided to choose somebody lifting weights, it would have to be a male, even though women do lift weights. And when it’s somebody pushing cars, it would have to be a male, even though women drive a lot and their cars do break down and they do have to push their car. Just really subtle things like that.
Researcher: How many pictures of women did you find in there?

Camilla: I found two so far. [There are color pictures on almost every page.] I found one on the same page. It's like men can push cars, and then women could push lawnmowers, which is... I mean, it just subconsciously implies that, you know, having it on opposite pages means that men could just push a lot more than women. And I found another one. I found one right here; she is just lying there. And if you compare this [swimsuited woman reading while floating on an air mattress] to this [man lifting weights], it sort of tells you that you're never going to accomplish too much [as a woman]. I found another picture... it had a man and a woman in it and it was talking about careers. I forgot where it was exactly, but the woman was the assistant and the man was the one in charge. And that's just slightly disturbing.

Camilla's insights echo those from research identifying the illustrations as the most blatant source of gender bias in science textbooks (Walford, 1981). A decade later, it appears that nothing has changed since Walford's (1981) examination of physics texts that pictured men involved in vocational and recreational activities, like playing marbles and making music, while women were portrayed in more passive pursuits, like sunbathing and reading.

These insights are consistent with the finding that physical science, more so than life science, is seen as a man's field (Kahle & Lakes, 1983). Hence, textbooks like Camilla's become both the medium and the message. From a female student's perspective, textbook publishers appeal to those they perceive have the most interest in and future inclination toward physics:

Camilla: On the front cover, it shows a baseball bat hitting a baseball, and baseball has always been thought of as a sport that males play. Females usually play softball, but baseball is something that is extremely male dominated. By putting it in front of a physics book, it shows that physics is also really male dominated because when most people think of baseball, most people will admit that it is male dominated, even though women do play baseball, it is still male dominated, so by putting something that is not gender neutral on the cover, you're favoring one gender over another.

Researcher: Why do you think textbook publishers and authors do that?

Camilla: I think because they think if they show an equal amount of pictures between men and women, then the guys might loose interest maybe. Because science is always seen as a male-dominated field, not as much now as it used to be, but it still is, and it just seems, I don't know, it would be like if you start to use gender-appropriate roles, then science just fits into the role of, you know, the gender appropriate male role, and science textbooks reflect that.

Researcher: When you say gender appropriate, do you mean gender traditional?

Camilla: Yeah.

Researcher: Earlier you told me that you thought it meant that publishers expected that men would succeed in science, but that women would not. Do you still think that?

Camilla: Yeah. I really do because they expect that men would be the ones to go to college.
Further examination of *Physics: Its Principles and Problems* (Zitzewitz & Murphy, 1990) shows that this text was created by males authors, a male consultant, male illustrators, and male photo editors. Most of the reviewers were high school teachers, the majority of them men. Through its illustrations, photos, and captions citing the accomplishments of male scientists, the textbook provides the message that science is the activity of men. Discouraged by this text, Camilla states that although she really likes physics, her career goal is to be a history, not a science, professor.

As we reflected on interviews like these and our observations, we wanted to know if what was so apparent to us as observers was as apparent to the students as participants. Until we shared our data, Wayne was unaware of gender inequities in his classes’ discussions. We wondered if the teacher was unaware, would the students be, also?

To answer this query, we designed and administered a questionnaire that assessed students' personal preferences in classroom talk. The questionnaire assessed students' choices for a lab partner, nominations of the most knowledgeable and most talkative students, their likelihood of refuting a shill, their frequency and enjoyment of whole-class and small-group discussions, and their perceptions of any gender differences in classroom discussion. Questionnaires were returned by 96% of the regular physics students (15 males and 8 females) and 67% of the honors physics students (10 males and 10 females).

Analysis of the questionnaires from the physics class (where there were about twice as many males as females) showed the most striking evidence of students' awareness of gender inequities. Students were asked, “Do you notice any differences in the ways boys talk in class or how often they talk in class versus the way the girls talk in class or how often they talk? If so, what are those differences?” Responses showed that females especially were well-aware of gender inequities. All of the girls reported that they noticed gender differences in how often and the ways boys talk in class, and all of the girls nominated a male as the person who talked most in class.

Comments from the girls focused on intimidation, including remarks like, “The boys are loud and obnoxious and they try to show off, so it intimidates girls from asking questions because they might get made fun of”; “The boys make stupid comments on everything; the girls keep quiet and to themselves”; “The girls are much more subdued. The guys in this class are so extroverted that they intimidate a lot of the girls”; “They [the boys] haven’t grown up yet!”

Responses from the male physics students were not as consistent. Almost all of the males (93%) nominated a boy as the person who talked the most in class, but only 50% of them stated that they noticed gender differences in classroom talk. Those who did included comments that characterized male talk as aggressive, like, “Guys talk more—they’re more outgoing and outspoken”; “Girls say the stupidest things. The boys rule the class”; “The boys say more intelligent things”; “Guys are louder and more aggressive to learn. Girls just sit there, but girls ask more questions than boys, I think”; “Boys are louder” “The boys in this class are much more outgoing and outspoken. The girls are very quiet and don’t join in the in-class conversation as much.”

Self-reports about participation in refutational discussion were directly opposite for males and females. About one half (47%) of the males reported that they were very likely to refute a shill, whereas 60% of the females stated that they would not. Comments from the girls were characterized by self-doubt and a lack of self-confidence, like, “I’m not very likely to refute because five extra points will come up again. I’m never really sure of my answers”; “I’m not very likely to refute. I don’t know enough about (or am not confident enough in my knowledge of) physics to debate about it.” By contrast, comments from males were more likely to be characterized by self-assertion and self-esteem, like, “I’m very likely to refute—I believe in
myself and my opinions”; “I like to argue”; and “I would literally kill them because five points means a lot to me.”

A related incident further demonstrated the lack of self-confidence girls experienced in physics. Fifty percent of the male students (and 28% of the females) chose one Asian female as the classmate who knew the most about physics. At the end of the first semester, she had the highest number of points in the class. A male remarked, “She just doesn’t ever try to show the class how much she knows; she keeps to herself.” When this student was informed of her nomination, she was incredulous:

I don’t think of myself like that at all! Physics is my hardest class. I don’t like to talk in class. I’m not sure of myself. Talking in class is not my favorite activity. I have a lot of math background. I took a math class at ASU in the summer. My math background helps me. [Interview, 3/22/94]

Although about equal numbers of male (53%) and female (60%) physics students reported that they often participated in whole-class discussion, several students, both male and female, defined participation as listening. Comments included remarks like, “I feel I can learn better with other’s input”; “Silently to myself I participate”; “Sometimes I participate, but I really just listen to what others say”; “I like to know what everyone thinks.” In the honors physics class, only one female expressed a proclivity to talk in whole-class discussions, and then only if she was positive of her ideas. By contrast, 40% of the males in this section stated they participated often in their class discussions.

The honors physics class showed similar response patterns to the regular physics class. In response to the query about gender differences, 80% of the females reported that males dominated discussion. Their comments characterized males’ talk as pompous and oppressive: “There may be more guys speaking out because they think they’re more scientifically gifted”; “More guys in this class seem to be more opinionated and stubborn”; “Males feel the need to express their opinion more. They have to let you know you are wrong”; and “Boys are more confident and self-righteous while girls tend to question more and be more willing to admit they’re incorrect.” Most males in the class were also aware of their dominance (60%). Their few comments about it characterized the girls as nonparticipatory: “Girls are more reserved in discussion. Outside it’s a different story” and “Boys talk more because they are traditionally more involved in physics.”

As in the physics class, refutational discussion in honors physics was likely to attract males’ participation and discourage females. Fifty percent of the boys stated they were likely to argue a point, whereas 70% of the girls reported they would not. Girls’ fear of repercussion or of being wrong was the most common reason: “I’m not likely to refute. They will probably bite off my head”; “I wouldn’t argue because I’m always wrong anyway.” Some males shared this fear, as evidenced by one who replied, “I would rather either get it right on my own or get it wrong without anybody knowing about it.”

Whole-class discussion in honors physics that did not include refutation wasn’t much more likely to attract females’ participation. When asked how often they talked in whole-class discussion and why, typical responses from girls were, “Not very often. I am a listener”; “Not very often because I don’t want to be wrong”; “I’m not smart enough to contribute anything”; “Not very often. I like hearing what everyone else has to say.”

Males were most likely to be chosen as lab partners by both sexes in both sections (75% of the females and 87% of the males in physics, and 70% of the females and 80% of the males in honors physics). Their most common reason was that they boy nominated was smart and understood the labs. (One third of the students chose the male student, Sam, who wants to be a
high school physics teacher.) In the honors physics class, 100% of the girls and 90% of the boys nominated a male as the most knowledgeable classmate. Twenty percent of these students (3 male and 1 female) voted Camilla as the student who spoke the most in class. Eighty percent of the votes, however, went to boys.

Perhaps students in both classes preferred boys as lab partners because they were the most active in laboratory activity. Most often, our field notes reflected boys manipulating the equipment, verbally providing the observations, and females recording the data in lab notebooks. Although most girls appeared to passively accept this, one girl in honors physics, Marcey, expressed her frustration to the researcher at a team member's mistrust of her active participation.

[Observation 3/7/94: Researcher is observing Elaine's lab group. Marcey from another group comes over to Elaine and begins to confide something in her. Marcey appears upset, as she is red in the face and her voice is stressed]:

Marcey: He treats me like I don't know anything knowledge wise.
Researcher: A boy in the group?
Marcey: Umm humm.
Researcher: Does he take over the group?
Marcey: No, not really. There's two people who do all the calculations and controls.
Researcher: Who are the two people in the group?
Marcey: Bill and Oz. Everybody seems to be fine except Oz. This is the first time I've ever felt discriminated against because I'm a woman. I'm not the only one that thinks that. I thought maybe I was just imagining it so I was like kind of ignoring it, and I said something to Rob and he agreed.
Researcher: Rob agrees? Is Rob in your group?
Marcey: Yeah. He noticed it, too.
Researcher: So, what does Oz do?
Marcey: Every time I offer to do something, like if I offer to record the data, he has to do it, too. The vibes I get from him is that he has to do it to do it correctly. Something like that.
Researcher: Why do you think he has that attitude?
Marcey: I don't know. But, he doesn't do it with anyone else in the group. So it makes me feel like he does it with me because I'm a girl. That's what I think.

Elaine: I think know why he does it. Because Oz is from a different culture. He wasn't raised in the United States. That crossed my mind.
Marcey: Yeah. That crossed my mind, too.

Although these girls attributed what they interpreted to be overt sexism to cultural differences, other explanations may have been possible. Oz's father is a professor in solid state science. Oz's mother was a physician in Poland during the 12 years Oz lived there, but she has been unable to pass the licensing exam in the United States, so in Oz's words, "she just sits around the house." Oz's career ambition is to go into a physics- or math-related field. On 3/11/94 Oz told the Principal Investigator, "My Dad used to read physics to me when I was little. He was working on his Ph.D. and it helped him to read it aloud." Oz's "take-charge" behavior was also evidenced in other ways:

[Observation, 3/11/94]: Oz walks over to his lab group. He is telling them to copy his lab book. He tells them what to write. Marcey points out to Oz that he needs to put a zero in front of his numbers. Oz says, "Sometimes I don't think much."
Whether actual or imagined, however, Marcey’s perception that she was being discriminated against by Oz due to her gender was real to her. She was too upset to continue in her lab group, and felt the need to confide in a friend. Her perceptions took her off task.

Data from these three sources (questionnaires, interviews, and observations) provided us with ample evidence that although teachers may be unaware of gender inequities, students are not unaware of such inequities. Prior to reviewing the results of the questionnaires, Wayne was not aware of any gender differences in his classes. Although our focus was not on the teacher, our field notes tracing students’ participation showed that Wayne used the seating chart to call on fairly proportionate numbers of males and females in class. When asked about gender differences in achievement, Wayne stated that he thought that the girls did as well as the boys. He elaborated on 3/9/94:

Some of my best students as far as test scores and results are the girls. I’ve had two students accepted to the NSF National Youth Camp [in past years] where they pay all expenses for 2 weeks and they only select two from each state and two of my students that have been selected have both been girls.

We knew that both the male and the female students were aware of gender differences, but we did not know how they would react when we presented these data to them during one of the last class periods of the year. In response to his increasing awareness of gender inequities as we shared and collaborated on our data, Wayne grouped by gender for lab assignments after we had withdrawn from the site. We were curious to find out how the students reacted to these groupings.

With these questions in mind, we presented our data and findings to the students in both sections. Students’ reactions were most pronounced in the regular physics class, where there were twice as many males as females. After reading the overhead transparency with comments from females like, “The guys are so extroverted they intimidate a lot of the girls” and “The boys haven’t grown up yet,” a group of 6 boys who sat near each other broke out in unified song. Rather than expressing their embarrassment, they indicated their solidarity and pride in their oppression by singing the Toys R Us song, which has words to the effect, “I don’t want to grow up, I don’t want to grow up, because if I did, I couldn’t be a Toys R Us kid.” Following this outburst, one girl asked us, “See our point?”

What were students’ explanations for gender differences in classroom talk? One of the singers described the males as cocky. Another boy volunteered that much of their talk in the classroom was due to male bonding. (One of the girls in this class explained that many of these boys had several classes together.) Mark stated, “Guys stand out more in this [physics] class.” Jason agreed, explaining, “There are a lot of aggressive boys in this class.” Brian observed that the girls are timid and not as outgoing, especially in this male-dominated class. Sarah added, “The guys are willing to take more risks.”

When queried about their observations on working in same-gender lab groups, the males generally conceded that it was to their disadvantage, whereas the females agreed that it was to their advantage. Males reported that their lab groups “got more done” when they had girls in the group. The females observed that “It worked better having girls in the group. We got it done faster.”

It was also interesting that females were reluctant to react to our data, and refused to elaborate on their complaints in a whole-class discussion. Even the girls who had confided in us on a one-to-one basis would not expand on their remarks in front of their peers. One girl stated that “it just isn’t worth it.”
Discussion

The extant research in science classrooms has focused on teacher–student interactions and efforts to change teachers’ behavior (Jones & Wheatley, 1990). Past research has neglected to recognize that the teaching–learning process is not always teacher-driven. Our observations in secondary science classrooms lead us to agree with Tobin (1988) that efforts to change the patterns of students’ engagement should be directed to both teachers and students. We believe that focusing only on changing teacher behavior would probably not be successful in changing students’ interactions.

In our study, the teacher attempted to address male dominance in laboratory partnerships and discussion by grouping by gender. Although we acknowledge that allowing females to work exclusively together may facilitate their more efficient and active participation, this solution limits students’ access to others’ thinking and does not seem realistic in preparing students to work together in the future. Other teachers have unsuccessfully tried to facilitate students’ leadership capabilities by placing individuals in prominent positions within the classroom, like appointing vocal students to be discussion leaders. Because power relationships among students shift during the course of the academic year, students who were once well accepted by peers as leaders may be rejected later (Alvermann & Anders, 1994). Critical pedagogists theorize that power among peers cannot be bestowed upon an individual by a superordinate, like a teacher (Gore, 1993).

This study provided evidence that despite a teacher’s intentions to be gender fair, the culture of the classroom may subvert or override these attempts. The teacher in this study tried to be equitable by calling on equal numbers of males and females, and by appointing female shills in refutational discussion. Despite these interventions, this form of discussion favored males.

We believe, therefore, that it is important to involve students in changing the dynamics of the classroom. In this study, female students were restrained by their fear of the male students (not of the teacher) and of challenging the social norms that permeated classroom interactions. We also have evidence that merely making students aware of their behavior without intervening may only serve to reinforce it (e.g., males who broke into unified song to celebrate their oppression). Both the males and females, however, demonstrated that secondary science students are articulate, candid, and reflective in giving feedback about their participation. Hence, we agree with Tobin (1988) that students should be involved in providing engagement profiles that would lend insight into classroom processes.

We acknowledge that not all the students in the study recognized the gender disparity in classroom activity and talk. Most often, it was the males who did not see these inequities. This may be because when women talk equally to men, they are perceived to be talking more (Edelsky, 1981). Perhaps when women talk less, they are perceived as talking the same.

Whatever the reason, involving individuals (perhaps on a rotating basis) in recording the frequencies and types of participation of each group member may provide the initial awareness Tobin (1988) has cited as necessary for change. We agree, however, that awareness is not enough (Taylor, 1989; Tobin, 1988). If students were to share their records of participation with each other, self-identify the emerging patterns those records provide, discuss these patterns with each other, and generate ways to address inequities in their smaller laboratory groups, they may become more willing to recognize and confront gender disparity in other instructional activity.

Efforts like these to construct a gender-inclusive curriculum are being attempted in classrooms in other subjects. Methods include involving students in writing self-reflections (Aitken, 1991), critiquing current texts (Gilbert & Taylor, 1991), designing counter-sexist materials
(Taylor, 1989), and discussing gender roles via expanding notions of masculinity (Taylor, 1989). Whichever of these strategies is adapted in the science classroom, the goal should be to address the demonstrated lack of emotional and intellectual safety necessary for success in science for all.

This study was supported jointly by a Faculty Grant-In-Aid from Arizona State University and a Research Grant from the College of Education, Division of Curriculum and Instruction. The authors express their appreciation to Advisory Council members Donna Alvermann of the University of Georgia, Carole Edelsky of Arizona State University, Cynthia Hynd of the University of Georgia, Katherine Maria of the College of New Rochelle, and Anton Lawson of Arizona State University, Department of Zoology. We also thank Research Assistants Todd Anselmo and Shwu Ming Wu.

References


Received November 28, 1994
Revised April 21, 1995
Accepted June 6, 1995