CLASSROOM PRACTICES AND MOTIVATION TO STUDY MATH

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Previous studies have shown that sex differences in attitudes toward both one's self as a math learner and mathematics as a subject area emerge in junior high school (see Eccles Parsons, 1984 and Meece et al., 1982 for reviews). Several investigators have suggested that classroom experiences in the upper elementary grades and in junior high school might contribute to this decline in girls' attitudes toward math. Two particular mechanisms have been suggested: differential treatment of boys and girls within classrooms and differential impact of similar experiences on boys and girls. More specifically, with regard to differential treatment, it has been suggested that teachers, especially during the junior high years, pay more attention to boys than girls and engage boys in more of the kinds of interactions that foster self confidence and interest in math and science. Furthermore, it has been suggested that these differences in teacher-student interaction may be most marked among the brightest students in the class (see reviews by Brophy, 1985; Eccles Parsons, 1984; and Meece et al., 1982).

With regard to differential impact, several investigators have suggested that some classroom environments may be more "girl-friendly" than others. In particular these investigators have suggested that competition, social comparison, and sexists materials may undermine girls' motivation to study math. In contrast, cooperative learning opportunities; high levels of more private individualized instruction rather than public instruction; active encouragement by a warm, friendly and fair teacher; and stress on the value of doing math have been suggested as characteristics of classrooms that facilitate girls' motivation to study math (Brush, 1980; Casserly, 1975, 1979; Kahle, 1983; Parsons, Kaczala, & Meece, 1982; Stage et al., 1985)

The two studies summarized here address these two mechanisms using both low and high inference procedures. The first study (Study 1) used a low inference observational procedures derived from the dyadic coding systems of Brophy and Good (1974) and Dweck et al., (1978) and a teacher questionnaire to assess differential treatment of boys and girls and to relate these differences to student motivation. The second study (Study 2) used high inference student ratings of the classroom environment to assess between classroom characteristics and to relate these more global characteristics to student motivation. Both studies were specifically designed to allow us to assess the relation of classroom experience to student motivation. Too often researchers interested in the socialization of sex differences in achievement behaviors seem content to document the existence of sex differences in the socialization variables they are studying. However, the mere existence of a sex difference on a socialization variable does not prove its importance in explaining sex differences in achievement behavior. The

difference might be important, but then again it might not be. Indeed, it may be that boys and girls develop different achievement patterns not because they are treated differently but because similar teacher behaviors affect boys and girls differently. If so, then interactional variables that do not differ across boys and girls may play just as strong a role in shaping or reinforcing sex differences in achievement behaviors than interactional variables that do differ by sex of student. The importance of any socialization experience for explaining sex differences in achievement behaviors needs to be established rather than inferred. These studies were designed with this goal in mind.

To accomplish this goal, we had our students fill out an extensive questionnaire assessing their achievement-related beliefs and attitudes regarding both math and English. The students in Study 2 also rated their classroom environment and their teacher on a wide range of characteristics commonly linked to motivation. Finally we coded the student-teacher interactional information in Study 1 at the student level. Consequently, in both studies we have been able to test for the relationship between classroom experience and student motivation. While not proving the causal impact of classroom experience achievement outcomes, these correlational procedures at least confirm or disconfirm the existence of a relationship between these sets of variables, and thus provide a first step in the investigation of the the causal impact of classrooms experience on boys' and girls' achievement beliefs and behavior. I'll describe each study and then relate this work to the work of Pat Casserly, Liz Fennema, Jane Kahle, and Penny Peterson in discussing classroom-level policy recommendations.

Study 1

The main student sample in Study 1 consists of 428 students from 17 math classrooms in grades 5, 6, 7, and 9. There were 3 fifth and sixth grade classrooms, 8 seventh grade classroom, and 6 ninth grade classrooms. Ten hours of observations coded at the individual student level were completed in each of the classrooms. Teachers' expectations for each student were measured by having the teacher rate each child in his/her class in terms of the child's math ability, the child's potential performance in future math courses, the level of the child's effort in math that year, and the grade the teacher expected the child to get that year. Students' beliefs and attitudes regarding math were assessed with a survey questionnaire which 275 students filled out in their classroom about 2 weeks after the completion of the observations. Results of this study are summarized here. More details on the classroom findings can be found in Parsons, Kaczala, and Meece, 1982. Results from a second sample of approximately 200 junior high school students given the same questionnaire and observed using the same coding system will be discussed where appropriate. These students were members of twelve different seventh-ninth grade math classes.

Classroom Interaction Patterns

The coding system, derived from the Brophy/Good Dyadic Interaction Coding System (Brophy and Good, 1974), focused on academically relevant student-teacher interactions that involved a student and the teacher in direct dialogue with each other. Each interaction was coded in terms of the initiator (student or teacher); whether the interaction was private or public; the type of question being asked (academic, discipline, self-referrant); how the student got into the interaction (raised a hand, called out an answer, was called on without volunteering); the nature of the student's response (correct, incorrect, non-responsive); the nature of the teacher's feedback (no explicit response, simple affirm or negate, prolonged interchange with additional opportunites for the student to respond, ask another student the answer, provide explanatory feedback, provide correct answer); and the affective intensity and direction of the feedback (positive and negative; high, medium, low). Based on the work Dweck and her colleagues (Dweck et a., 1979), we also coded whether academic feedback focused on the academic content of the answer or on the form in which the answer was given. In addition, all incidences of conduct feedback (both positive and negative) were recorded, as were all explicit incidences of causal attributions for any student's performance and all explicit statements regarding the teacher's expectations for a student's, or a group of students', performance on an upcoming task. Finally, we began by noting all incidences of a teacher either explaining why a child might want to be able to do the assigned math work or doing something explicit to make the assignment enjoyable or to tie the assignment to some enjoyable quality of mathematics. These incidences were so rare we stopped looking for them.

This observational system yielded 50 meaningful units by codes. To facilitate interpretation of the student-teacher interaction data, we divided the interactional variables into three types: teacher style variables (interactions primarily under the teacher's control; e.g. praise following a correct answer, use of public criticism), student style variables (interactions controlled primarily by the student, e.g. student initiated private interactions), and joint style variables (interactions requiring initiative of both the student and the teacher, e.g. number of interactions initiated by the teacher with a student who has raised his/her hand). Many of the differences we found in interaction patterns were as much a consequence of student characteristics as of any sexist orientation of the teacher. By explicitly pointing out the major controlling party or parties for each of our interaction variables, we hope to sensitize the reader to the need to be

cautious in interpreting the meaning and origin of any differences that might emerge.

Based on previous research, on our theoretical predictions, and on the frequency of occurrance, we focused our analyses on 36 variables; 28 frequency count variables and 8 proportional variables (See Parsons, Kaczala, and Meece, 1982 for more details on the selection of these variables). The 8 proportional variables focused on the relative frequency of praise and criticism and on the relative focus of one's praise and criticism on academic content, academic form, and conduct, e.g. percent of one's praise (criticism) focused on academic content, proportion of one's interaction yielding praise (or criticism). These variables were used to compare our results with those of Dweck et al., 1979 and to provide an estimate of the general affective experience of each student.

Because several investigators have suggested that teacher-student interactions depend on the teacher's perceptions of the student's ability level as well as on the student's gender, we included both student's gender and the teacher's expectation for the student in our analyses.

Table 1 lists the frequency count for each behavior as a function of the students' sex and ability level. Low teacher expectancy females received more praise and asked more procedure questions than expected; high teacher expectancy females received fewer teacher-initiated dyadic interactions but asked more questions, engaged in more total interactions, and had more of their public responses negated (announced publically as incorrect) than other groups. Females in both groups received less criticism and asked more questions than males.

Low teacher expectancy males received more criticism, more teacher-initiated interactions, engaged in fewer response opportunites, and received fewer affirms than the other three student groups. In contrast, high teacher expectancy males received fewer teacher-initiated interactions but received more affirms than other students.

As has been true in several recent studies using this type of coding system, one is struck in these data by the relative lack of sex differences in teacher treatment of the students. With the exception of criticism, of which the low teacher expectancy boys clearly got more than their fair share, teachers treated boys and girls differently in only four ways: they initiated an unusally high number of private dyadic interactions with low teacher expectancy boys, they addressed an unusually high number of direct questions and work praise at low teacher expectancy girls, and they were more likely to provide boys with some form of short feedback following an incorrect answer than girls. The other differences reflect student or joint style variables and can not be attributed to the teacher. Furthermore, high teacher expectancy boys and girls were involved in fairly comparable patterns of interactions with their math teachers.

While we can not determine from our data the reasons teachers might have for the patterns of differential treatment that did emerge, three of the four differences make sense in light of Cooper's analysis of teacher strategies (1979). Cooper argued that teachers use strategies that direct potentially disruptive students into private interactions rather than encouraging them to participate in public interactions. The low teacher expectancy boys appeared to be <u>the</u> group that was giving these teachers the most trouble. It would make sense then for these teachers to try to discourage these boys from public interactions through the use of public criticism and to encourage them to engage in more private dyadic interactions by initiating such interactions with them. In contrast, the low teacher expectancy females did not appear to be a source of disruption; instead the teachers may have perceived them as too docile and uninvolved. If so, then the teachers' treatment of this group also seems an appropriate remedial strategy.

The data just described are aggregated at the group level. Since we are primarily interested in psychological processes that occur at the level of the individual student, we needed interactional data aggregated at the level of the student. Since not all students were present for all 10 days of observation, we could not use each student's frequency counts; instead, the frequency counts for each of the 28 frequency variables were converted to mean frequencies per session observed. The 8 proportion variables were already in a form that could be used for analysis at the level of the individual student. Every student has a score for each of these 36 variables; even though for many of the variables this score is 0. These variables were then used to relate experience to motivation, as well as to assess differential treatment on the proportional items.

In terms of differential treatment, the frequency differences essentially mirrored the effects just reported. Few sex differences emerged on the proportional items. In fact, contrary to what we had predicted, we did not find any evidence that teachers were praising and criticizing boys and girls for different behaviors. Both boys and girls got most of their praise (93 percent) for good work and most of their criticism (92 percent) for bad conduct. Boys did, however, get more of the latter and we could not determine whether they deserved more or not.

The general pattern of few sex differences other than amount of criticism was replicated in our second sample of junior high school classrooms. In this sample, the low teacher expectancy boys again stood out in terms of the level and amount of

criticism directed at them by their teacher. In addition, in this second sample, the girls had a higher percentage of their praise directed at the quality of their academic work than did the boys. No other interactional variables yielded sex differences consistent enough across classrooms to be significant.

But does teacher treatment affect motivation? Not much. As one would expect, the boys and girls had different attitudes toward math. Boys thought math was easier to master than did the girls; boys also had higher expectations for success in future math courses and in jobs requiring math skills. To make matters even worse, the high teacher expectancy girls had less confidence in their math ability than did the high teacher expectancy boys, even though they had done as well as the boys in previous math courses and their current math teachers had equally high expectations for them. Finally, these sex differences were more marked among the ninth graders than among the seventh graders. In fact, by ninth grade, the girls also felt it was less important and useful to study math than did the boys.

Correlations across the sexes and within each sex provided the first test of the relations between classroom interaction variables and attitudes. Few significant relations emerged and the general pattern was similar for boys and girls. Positive attitudes were associated most strongly with the teacher expectation measures taken from the teacher rating form. These positive correlations held up even when the relations of past performance to both the teacher expectation measure and the students' attitudes were statistically controlled. Apparently, teacher expectations are being conveyed to the students and are influencing the students' attitudes. Exactly how is not clear from our data since only two of the observational variables correlated significantly and substantially ($\underline{r}>.20$) with the teacher expectation measure; and even these two correlated only for boys.

Among the observed interactional variables, work criticism had the strongest, most consistently effect on student attitudes. Boys and girls who received more work criticism had more positive attitudes toward math; they thought math was easier, had more confidence in their own math ability, and had higher future expectations. While this result may seem counterintuitive, work criticism occured very rarely in this collection of classrooms. Perhaps these teachers used work criticism only when they expected a student to do better. If so, then work criticism could convey a positive message despite its surface negativity.

The relation between praise and students' attitudes was less clear and varied by sex. In particular, high levels of praise and high proportions of praise focused on work were associated with confidence in one's math ability for boys <u>only</u>. Praise did not appear to have similarly positive effects on girls' self-concepts. Recall that praise was used most liberally with low teacher expectancy girls. These girls were also the recipients of unusually high levels of teacher-initiated response opportunities. If this pattern of teacher behavior reflected a strategy to draw these girls into classroom discussion, as suggested earlier, then it is unlikely that these girls would interpret this praise as a sign of high teacher expectations. Rather they probably interpreted it for what it was, a positive gesture designed to make them feel comfortable and more willing to volunteer to participate in the future.

Summary

In summary, then, student sex was related to student-teacher interaction patterns but not in the manner predicted by Dweck et al., (1978). Instead, the effects largely replicated the findings reported by Brophy and Good (1974): girls as a whole received less criticism than boys and high teacher expectancy girls received less praise than other student groups. Low teacher expectancy boys got a disproportionate amount of criticism and teacher-initiated dyadics while low teacher expectancy girls received more praise especially in response to teacher-controlled questioning. Thus, although these teachers, on the average, appeared to be treating high expectancy boys and girls fairly similarly, they appeared to be using different control strategies for low expectancy boys and girls. They acted as though they were trying to draw the low teacher expectancy girls into public participation and the low teacher expectancy boys into private interaction. Other than these few differences, boys and girls were treated similarly and even these differences were small.

While classroom experiences appeared to have some effect on student attitudes, these effects were not very large and were clearly less powerful than students' own performance and teachers' expectations, neither of which differed by sex of student. And for both boys and girls, the impact of any particular experience seemed to depend on the subjective meaning the child attached to the experience. These meanings may well differ across boys and girls, especially since teachers' behaviors relate to their own attitudes differently depending on whether the target child is a male or female. Students' are undoubtedly aware of these subtle variations in the meaning of teacher behavior and should respond accordingly.

To the extent that boys and girls were influenced by different experiences, the girls appeared to be more reactive to criticism and less receptive to the effects of praise than the boys; but these differences again were slight and not consistent across measures.

These data suggest that differential within-classroom treatment of boys and girls may not be as large a contributor to sex differences in attitudes toward math as is commonly believed. But the analyses reported thus far were performed on the entire sample. It is probable that the effects of teachers' behaviors are different across classrooms. For example, some teachers may treat boys and girls differently, whereas others may not. By collapsing across all of our teachers, these effects would be masked. To explore this possibility, we selected from the sample of 17 classrooms the five classrooms with the largest sex difference in the students' expectations for themselves and the five classrooms with no significant sex difference on the measure of student expectations and compared them on two levels. First, we compared the two types of classrooms in terms of general teaching practices, teacher style, and student behavior in order to get a picture of variations in general classroom climate. Then, we compared the classrooms in terms of the specific behaviors of the students within the classrooms.

However, before proceeding to discuss these comparisons, it is important to note whether it was the boys' or the girls' expectations that were related to classroom type. To test this we used Analysis of Variance with classroom type and student sex as the two independent variables and student expectations as the dependent variable. Boys' expectancies did not differ across the two types of classroom while girls' did; in fact, girls' expectancies in the high difference classrooms were lower than the expectancies of the other three student groups.

Classroom level comparisons. While few significant differences emerged, these classrooms clearly differed from one another. Stepwise regressions were performed to determine which interactional variables best discriminated between these two classroom types. Six variables emerged as significant predictors: total dyadics, total open questions (questions answered by a student who raised his/her hand prior to being called upon), total criticism, total conduct criticisms, total criticisms in teacher-initiated response opportunities, and total work praises (listed in order of importance). In general, (as you can see on Table 2) teachers in the high sex-differentiated classrooms were quite critical, in many case using very pointed sarcasm to put a student in his or her place; they also tended to use a public teaching style rather than a more private teaching style and to rely heavily on student volunteers for answers (coded as open questions). In contrast, teachers in the low sex-differentiated classes were less openly critical toward their students, tended to rely on a more private teaching style characterized by a high proportion of student-teacher conference-like interactions, and took a more active role in calling on specific students for answers rather than relying on volunteers.

These results suggest that girls' attitudes toward math are more positive in a class characterized by a high proportion of private teacher student dyadic interaction relative to the time spent in public recitation, by relatively high levels of teacher control over the public recitiation when it occurs, and by classrooms characterized by positive teacher emotional support. This same pattern has emerged in our second sample of junior high school classrooms. Using a similar procedure, we divided these 12 classrooms into two groups: the 6 with the least sex difference in the students' self perceptions and the 6 with the most extreme sex difference in the students' self perceptions. These two types of classrooms also differ primarily in terms of the proportion of time spent in private student-teacher interactions versus the time spent in public recitation and in terms of the degree to which the teacher controls who participates in public recitation rather than relying on volunteers. And, once again, the girls' self perceptions are highest in the more private and teacher-controlled recitation classrooms.

There is some evidence that girls are less likely than boys to thrive, academically speaking, in an environment that is competitive and male dominated (see Peterson and Fennema, 1985; Webb and Kenderski, 1985). It seems quite possible that classrooms characterized by relatively high reliance on public recitation and on student volunteers seem relatively more competitive and threatening to students than classrooms characterized by relatively high reliance on private student-teacher interactions and on teacher-controlled recitation, provided that the teacher uses this control to encourage participation from everyone rather than a chosen few (Brush, 1980). If this is true, then we might well expect that girls would find these more private classrooms more congenial and, consequently, would develop more positive attitudes toward math in such environments.

It is important to note that the logic underlying this proposal does not depend on sex differentiated treatment by the teacher as a causal explanation of sex differentiated beliefs and attitudes among the students. Instead, it suggests that sex differences in student learning and in students' attitudes could come about because similar environments affect boys and girls differently, primarily because boys and girls enter those environments with different views of the world and different learning histories. The extent to which this process is operative raises intriguing questions for those of us interested in fostering sex equity in education.

Student level comparisons. In the next set of comparisons, we used the student level data to assess whether boys and girls were treated differently in either of these two types of classrooms and whether these sex differences varied across the two types of classrooms. Several interesting sex differences emerged in these analyses. In the low difference classrooms, girls interacted more than boys (gave more responses, asked more questions, initiated more interactions); they also received more praise for work and criticism for form than boys. In high difference classrooms, boys interacted more and received more praise for their work and criticism for their form.

We next divided the sample into the high and low teacher expectancy groups discussed earlier. As you can see on Table 3 and 2a, in general, high teacher expectancy boys and girls were treated quite differently in these two types of classroom. High teacher expectancy girls interacted the most, answered the most questions, received the most work and form praise and the least criticism in the low sex-differentiated classrooms. In contrast, high teacher expectancy boys were accorded the most praise and interacted the most in the high sex-differentiated classrooms. High teacher expectancy girls were accorded the least amount of praise of any of the eight sex-by-teacher-expectancy-by-classroom-type groups in the high sex-differentiated classrooms.

The sex by teacher expectancy interactions were particularly interesting in the high difference classrooms. In these classrooms, the classic teacher expectancy effects emerged only among the boys; that is, high teacher expectancy boys in these classrooms received more attention, more rewards, and less criticism than low teacher expectancy boys. In contrast, the high teacher expectancy girls in these classrooms were not treated in the manner predicted by the teacher expectancy literature. In fact, if anything the low teacher expectancy girls in these classrooms were accorded the classic high teacher expectancy pattern, especially in terms of response opportunities and praise, while the high teacher expectancy girls were basically ignored and given virtually no praise or encouragement.

What about the low difference classrooms? The high teacher expectancy girls fared very well in these classrooms; they dominated the interactions and received the most praise. But, while the high teacher expectancy boys got less praise in these classrooms than did the high teacher expectancy girls, the pattern of its distribution across high and low teacher expectancy children was equivalent for the two sexes. In this social climate, there was no overall sex difference in expectancies despite the fact that the girls both got more praise and interacted more than the boys.

These data suggest that being in a classroom in which praise is used differently for boys and girls has a detrimental effect on all girls but not on boys. Only the girls' expectations differed across these two types of classrooms. Furthermore, the relatively high levels of praise given to the low teacher expectancy girls in the high sex-differentiated classrooms did not appear to have the facilitative effect on their attitudes one would expect; they had lower expectations for their own future success in mathematics than any of the other 7 sex by teacher expectancy by classroom type groups.

One can not infer from these data that praise itself is responsible for the expectancy differences in these two classrooms. In fact, the correlation between amount of praise and attitudes was nonsignificant for girls in both types of classrooms. Rather, it appears that it is the pattern of praise across the various subgroups that is critical. Boys and girls had equivalent expectancies when the relative distribution of praise and criticism was similar for both sexes. In other words, where teachers are fair in their use of praise and criticism.

These data suggest that general classroom climate may be more important than differential treatment in undermining girls' motivation. In particular, the data in this study suggest that competitive, hostile, chaotic classrooms in which teachers treat students very differently are not especially condusive to positive attitudes toward math among girls. Other studies discussed earlier suggest similar classroom characteristics. The data from Study 2 provide a more direct test of these predictions.

Study 2

Study 2 is part of a large, longitudinal study of the transition to junior high school. It includes over 3500 students, their parents, and their math teachers drawn from 12 school districts in Southeastern Michigan. The data reported here focuses on 110 sixth grade math classes. Student attitudes toward math and student perceptions of their teacher and the classroom climate were collected as part of a larger battery during the Fall and Spring terms. Building on the strategy developed in Study 1, we calculated sex differences in each classroom on the following attitudes, beliefs, and self perceptions: plans to continue taking math if it were not required, worry about getting math assignments in on time, worry about having to work fast on hard assignments, self-concept of math ability, expectations for success in math, utility value of math, intrinsic value of math, continuing motivation in math, finding math frustrating,, general worry about math work, general test anxiety in math, somatic signs of math anxiety, and perceived task difficulty. These differences were standardized across classrooms and these scores were submitted to a complete linkage cluster analysis to identify types of classrooms. The analyses reported here are based a four cluster solution.

We were able to identify four distinct classroom types; these are listed on Table 4. As you can see, in Type 1 classrooms boys were significantly more positive than girls on each of the following variables at each wave: plans to take more math, self-concept of math ability, expectations for math success, utility value of math, intrinsic value of math, finding math frustrating, math test anxiety, somatic signs of math anxiety, and perceived task difficulty. The boys in these classes were also less worried about math at wave 2 (Spring). We will call this type boy-advantaged. In Type 2 classrooms, there were few sex differences and those that were significant were quite small. These classrooms, however, were more girl-favoring then average on the anxiety variables. In Type 3 classrooms, the girls were significantly more positive at both waves than the boys on the following variables: plans to take more math, self-concept of math ability, expectations for math success, utility value of math, and intrinsic value of math; however, the girls in these classrooms reported more somatic signs of anxiety than boys. We'll call this type moderately girl-advantaged. In Type 4 classrooms, the girls were significantly more positive than the boys on the following variables at wave 2: plans to take more math, worry about getting school work in late, expectations for success in math, and intrinsic value of math; the girls were significantly more favorable than the boys at both waves in their self-concept of their math ability and at Wave 1 they were less test anxious. The sex differences approached significance on several other variables; in each case, the girls had the more positive attitudes. We'll call this type strongly girl-advantaged.

Clearly these classrooms differ in the degree to which boys and girls have different attitudes toward math. Type 1 is the most boy-advantaged; Types 3 and 4 are the most girl-advantaged.

We next compared these four classrooms on a cluster of variables assessing the students' perceptions of their classroom environment. Factor analysis was used to extract factors from this scale. These factors are depicted in Table 5. As you can see these variables measured the following constructs: the degree to which the students' rate the teacher as unfair to students, the extent of competition among the students, the opportunity for cooperative interaction among the students, teacher valuing of math, and the extent of social comparison among students. Based on our previous findings and on the growing girl-friendly classroom literature, we predicted that students in classroom Types 3 and 4 would view their teacher as less unfair and as valuing math more than students in classroom Types 1 and 2. Similarly, we predicted that students in classroom Types 3 and 4 would report lower levels of competition and social comparison among the students than students in classroom Types 1 and 2. Finally, we predicted that students in classroom Types 3 and 4 would report more opportunity for cooperative interaction than students in the other two classroom types.

To test these predictions, class means were generated for each construct and profile analyses were performed comparing the classroom types across these constructs. This profile is illustrated in Figure 1. To make the profiles more easily interpretable all constructs are coded in the girl-unfriendly direction; that is, low scores should be more favorable to girls than high scores. As you can see, our predictions are supported for every construct except the opportunity to engage in cooperative interaction at Wave 1. Furthermore, there is a consistent linear pattern with Type 1 and 2 classrooms having the most girl-unfriendly characteristics and Type 3 and 4 classrooms having the most girl-friendly characteristics, particularly at Wave 2. We followed this general profile analysis with a series of pair-wise profile analyses and analyses of variance. These results confirmed our conclusions. In particular, Type 1 classrooms had higher scores on all variables expect the Wave 1 cooperative interaction construct than either Type 3 or Type 4 classrooms. The most extreme differences between Type 1 and both Type 3 and Type 4 classrooms occurred on the social comparison and the teacher valuing of math constructs. The two girl-friendly classroom types reported less social comparison and more teacher valuing of math than the boy friendly classrooms. Finally, classroom Types 3 and 4 did not differ from one another on these 5 classroom climate constructs.

These results are very intriguing. Both girl-advantaged classroom clusters differed from the other two clusters in similar ways and in ways consistent with our predictions. Why is Wave 1 task structure an exception? In some of our pilot data, we found that being allowed to talk with classmates and work with classmates during math was predictive of social comparison behavior. Apparently, although these structures allow cooperation, they may also make social comparative interactions possible. Perhaps, having too much student-to-student interaction at the beginning of the year promotes the early emergence of social comparison and competition in the classroom. Reports of high levels of interaction can also reflect a classroom with little teacher control. Data in Study 1 suggested that girls had more favorable attitudes toward math in classrooms with more private, dyadic interaction patterns. Girls in particular may not like the unruliness that can accompany more laise-faire classroom task structure (Blumenfeld et al., 19XX). If so, then the opportunity for lots of student-to-student discussion at the beginning of the year may be anxiety provoking for some girls. We hope to test both of these possible explanations in the future.

Summary

The data from Study 1 clearly indicate that the impact of classroom experiences on students' self perceptions depends on their subjective meaning to the students. To advocate that teachers should avoid criticism or give praise more freely overlooks the power of the context in determining the meaning of the message. Praise was positively related to self-perceptions only in the group, in this case boys, in which it, in fact, conveyed information about the teachers' expectations. Among girls, a group for which the teachers' use of praise did not covary with their expectations, praise was not related to either the girls' self perceptions or to their perceptions of their teachers' expectations.

What role do the teachers play in perpetuating sex differences in math attitudes? Our data suggest that differential treatment may be one factor, although not a very powerful or ubiquitous factor. Girls have lower expectancies for themselves in those classrooms in which they are treated in a qualitatively different manner than the boys. And while this differential treatment was not characteristic of most of our classrooms, these results do suggest that the most math-able girls are not being nurtured to the same extent as are boys in some classrooms. The causal implications of this difference need to be established.

Our data also suggest that general classroom climate may play an important role in reinforcing sex differences in achievement attitudes, beliefs, and performance. Certain kinds of educational environments may facilitate boys' achievement while either dampening or having little positive effect on girls' achievement. These are summarized on Table 6. Relying on public recitation and student volunteers emerged as two such environmental characteristics in Study 1, probably because these characteristics covary with social comparison tendencies and with the domination of the teacher-student public interaction by a few, highly vocal, highly competitive individuals who are usually white males. Competitive goal structures, social comparison among students, and low levels of teacher valuing of math emerged as important environmental characteristics in Study 2. Similar characteristics have emerged in the work of Liz Fennema, Penny Peterson, Pat Casserly, and Jane Kahle. In each of these studies, classroom dynamics that are linked to competition among the students and to high levels of ability-assessment motivated social comparison seem to have a negative impact on the girls. Some boys, in contrast, seem to benefit from such dynamics. Whether such competitive dynamics also undermine the motivation of some boys needs to be assessed. It seems likely, however, that such dynamics are not especially condusive to the motivation of boys who are having trouble with math or science. They, like the girls, may find such dynamics unpleasant. (See Eccles, Midgley, and Adler, 1984, for discussion of impact of general classroom level variations on student motivation and self perceptions).

The remedy for such differential effects is not clear. Should we educate boys and girls differently so that each experiences "the educational environment" best suited for his or her needs? Probably not, especially since variations within sex make identification of such ideal environments for each sex impossible. Instead, educators at all levels need to be aware of the fact that children may respond to similar educational experiences in different ways. Then we can work toward a balance between providing both boys and girls with all types of educational experiences and helping both boys and girls acquire the skills necessary to benefit maximally from various types of learning environments.

A second characteristic that emerges with some regularity across these studies is the teacher's valuing of math. Girls appear to fare better in classrooms in which the teacher communicates the value of math and science to the students. This communication can consist of subtle practices such as using interesting posters and classroom displays or more direct expressions of the importance of math and science. It can also consist of the active provision of career-relevant information and individual career guidance.

General Conclusions

In summary, we, like many others, have found small but fairly consistent evidence that boys and girls have different experiences in their classrooms. However, these differences seem to be as much a consequence of preexisting differences in the students' behaviors as of teacher bias. Nonetheless, when differences occur, they do appear to be reinforcing sex-stereotyped expectations and behaviors. In addition, we have found some evidence that boys and girls respond differently to similar experiences. These results indicate that similar treatment may not yield equitable outcomes for both boys and girls. They point, in particular, to the differential impact of practices that foster a competitive climate in the classroom.

Studies relying more on case-study approaches have provided stronger evidence of the impact of teachers on student' career plans and decisions. For example, women working in male-dominated fields often report that a particular teacher played a very important role in shaping their career choice (Casserly, 1975, 1979 Boswell, 1979). These teachers often helped by providing active career counseling and making the value of math and the girls' potential and natural abilities clear to them. Unfortunately, few students encounter a teacher who encourages them to consider a wide range of careers. Instead, most teachers reinforce traditional behavior and occupational plans for both boys and girls independent of where the student's interests or talents might lie (Eccles & Hoffman, 1984). For example, mathematically-gifted girls are less likely to be

identified as such by their teachers than are comparably talented boys. Similarly, girls who drop out of the math curriculum, or out of other nontraditional majors in college, often attribute their decisions to a teacher who actively discouraged their interests (Fox, Brody, and Tobin, 1980).

The work summarized here suggests that teachers can favorably affect girls' preparation for math and science-related occupations if they create a non-competitive learning environment and provide active encouragement, exposure to role models, sincere praise for high ability and good performance, explicit advice regarding the value of math and science, and explicit encouragement to both boys and girls and their parents regarding the importance of developing their talents to the fullest and aspiring after the best jobs they can obtain (Casserly, 1975, 1979; Eccles and Hoffman, 1984). Most math teachers do none of these things. For example, we recorded less than a dozen instances of a teacher explaining the value of math and very few instances of a teacher explaining proactively the intrinsic value of engaging in any academic activity in over 400 hours of classroom observation. We also rarely observed a teacher providing any form of career counseling. Thus, although teachers can help overcome sex-stereotypes and promote more sex equitable educational outcomes, they rarely do. As a consequence, most students leave each classroom pretty much as they entered it, neither more or less sex-stereotyped in their beliefs and future goals. Furthermore, Brush's (1980) work suggests that competitive climates may be more common in math classrooms than in English or social studies classrooms. To the extent that girls find competitive climates unpleasant, we may have identified one classroom characteristic that contributes to the preference girls have for English and social studies.

To increase the participation of girls in math and science, it will be necessary to change these classroom experiences. Since our data focus on classroom-level dynamics, our policy recommendation is aimed at that level. The most likely policy change for this level involves modifying the requirements for credentialling and for continuing education. Specifically, we recommend that sex equity training be a required part of such programs. This training should provide teachers and prospective teachers with information regarding the importance of the classroom dynamics outlined in this paper as well as the important role teachers can play by providing career guidance as an ongoing part of their math and science instruction. Given that children come to class with well-learned sex-role stereotypes, it is our opinion that equal treatment is not enough. Teachers must play an active role in creating a positive attitude toward math and science and in bolstering girls' confidence in their math and scientific abilities. Our data suggest that they can accomplish these goals by using "girl-friendly" teaching styles (non-competitive and tied to practical experiences), by using techniques that make the importance and the interest value of math and science salient, and by providing active career guidance.

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Table 1

Frequencies of Observation Variables For Boys and Girls

For Whom Teachers Have High and Low Expectancies

Variables	Total Frequency		Female				Male			
			Low Expectancies		High Expectancies		Low Expectancies		High Expectancies	
	Frequency	n[a]	Frequency	n	Frequency	n	Frequency	n	Frequency	n
Teacher Style Behaviors										
Teacher-initiated dyadics [b]	291	(155)	60	(36)	51[c]	(33)	126[d]	(47)	54[c]	(39)
Direct questions[e]	671	(224)	172[d]	(47)	179	(61)	153	(58)	167	(58)
Teacher-initiated interactions	1078	(306)	253	(67)	265	(79)	309[d]	(80)	251[c]	(80)
Response opportunities yielding criticism[b]	672	(207)	107[c]	(36)	131[c]	(44)	272[d]	(62)	162	(65)
Response opportunities yielding work criticism	18	(16)	1	(1)	3	(3)	6	(5)	8	(7)
Conduct criticism[b]	619	(189)	98[c]	(32)	123[c]	(38)	253[d]	(56)	145[c]	(62)
Total work criticism[b]	41	(34)	4	(4)	6	(6)	19[d]	(14)	12	(10)
Total criticism[b]	727	(219)	117[c]	(41)	137[c]	(47)	297[d]	(64)	176	(67)
Response opportunities yielding praise	174	(92)	49	(23)	35	(18)	40	(23)	50	(29)
Response opportunities yielding work praise	154	(86)	45	(23)	30	(17)	32	(19)	47	(27)

Table 1 (continued)

Frequencies of Observation Variables For Boys and Girls

For Whom Teachers Have High and Low Expectancies

Variables	Total Frequency		Females: Low Expectancies		Females: High Expectancies		Males: Low Expectancies		Males: High Expectancies	
	Frequency	n	Frequency	n	Frequency	n	Frequency	n	Frequency	n
Teacher Style Behaviors (cont.)										
Total work praise	295	(137)	83[d]	(32)	63	(32)	72	(34)	77	(39)
Total praise	319	(141)	90[d]	(32)	69	(33)	80	(36)	80	(40)
Attribution statements	88	(64)	13[c]	(10)	22	(19)	26	(18)	27	(17)
Negates with feedback[b]	97	(59)	13	(7)	22	(13)	34	(18)	28	(21)
Ask other	129	(86)	28	(22)	41	(21)	30	(23)	30	(20)
Sustaining feedback	263	(154)	58	(34)	65	(42)	59	(32)	81	(46)
Negates with sustaining feedback	36	(29)	10	(6)	12	(10)	5	(5)	9	(8)
Student Style Behaviors										
Student-initiated procedure questions[e]	221	(106)	66[d]	(25)	73	(33)	38[c]	(23)	44[c]	(25)
Student-initiated dyadics	1491	(321)	311	(67)	416	(86)	364	(78)	400	(90)
Student-initiated questions[e]	969	(199)	219	(38)	409[d]	(59)	157[c]	(48)	184[c]	(54)

Table 1 (continued)

Frequencies of Observation Variables For Boys and Girls

For Whom Teachers Have High and Low Expectancies

Variables	Total Frequency		Females: Low Expectancies		Females: High Expectancies		Males: Low Expectancies		Males: High Expectancies	
	Frequency	n	Frequency	n	Frequency	n	Frequency	n	Frequency	n
Joint Style Behaviors										
Total Response opportunities	2003	(309)	413	(63)	563	(83)	433[c]	(75)	594	(38)
Open questions	950	(180)	188	(41)	279	(47)	199[c]	(43)	284	(49)
Total dyadics	1780	(349)	371	(73)	467	(90)	488[d]	(87)	454	(99)
Total interactions[a]	5034	(413)	1052	(85)	1520[d]	(112)	1150[c]	(101)	1312[c]	(115)
Affirms	1340	(275)	268	(58)	377	(72)	277[c]	(64)	418[d]	(51)
Negates	277	(132)	46	(25)	96[d]	(32)	72	(37)	63	(38)
Student-initiated questions yielding praise	14	(12)	0	(0)	6	(4)	2	(2)	6	(6)
Student-initiated questions yielding criticism	7	(6)	2	(2)	1	(1)	2	(2)	2	(1)
Total N		428		89		114		105		[illegible]

[a]Number of students having non-zero frequencies.

[b]The proportion of interactions involving males significantly greater than that involving females, $p < .05$.

[c]Lower frequency than one would expect based on proportion of sample included in this group, $p < .05$.

[d]Higher frequency than one would expect based on proportion of sample included in this group, $p < .05$.

Table 2

Effect of Classroom Type on Mean Frequency of Behavior per Child per Class Period.[1]

Behavior	Classroom Type: High Sex Differentiation	Low Sex Differentiation
Teacher Style Behaviors		
Total Praise	.065	.030
Total Conduct Criticism	.227	.112
Total Criticism	.251	.117
Teacher-initiated Dyadics	.041	.093
Student Style Behaviors		
Student-initiated Dyadics	.192	.240
Joint Style Behaviors		
Open Questions	.387	.180
Total Dyadics	.344	.586
Total Answers	.602	.362
Total Response Opportunities	.659	.379

1 All differences significant at the .05 level or better.

Table 3 Sex by Classroom Type by Teacher Expectancies: General Summary

ITEM[1]	FLL	MLL	FHL	MHL	FLH	MLH	FHH	MHH
open questions		L	H		H	LL[3]		HH[2]
student answers		L	H		H	LL		HH
student-initiated procedure questions	L	LL	HH	LL		L	L	L
response opportunities		L	H		H	LL		HH
praise during response opportunities	L	L	H	L		LL	LL	HH
praises for work		LL	H	L	H	L	LL	HH
praises for work and form		LL	HH	L	H	L	LL	HH
student-initiated interactions		L	H		HH	LL	L	H
total interactions		L	H		HH	LL	L	H

FLL:female, low difference classroom, teacher expectancy low
MLL:male, low difference classroom, teacher expectancy low
FHL:female, high difference classroom, teacher expectancy low
MHL:male, high difference classroom, teacher expectancy low
FLH:female, low difference classroom, teacher expectancy high
MLH:male, low difference classroom, teacher expectancy high
FHH:female, high difference classroom, teacher expectancy high
MHH:male, high difference classroom, teacher expectancy high

1 All three way interactions significant at the .006 level.

2 HH = Highest group

3 LL = Lowest group

Table 3a

Sex by Classroom Type by Teacher Expectancies[a]

	Low difference classrooms				High difference classrooms				
	Low teacher expectancy		High teacher expectancy		Low teacher expectancy		High teacher expectancy		
	Females	Males	Females	Males	Females	Males	Females	Males	Grand mean
Teacher-Style Behaviors									
Praise during response opportunities	.03	$.02^{x}$	.05	$.01^{x}$	$.11^{Y}$	$.02^{x}$	$.01^{x,y}$	$.12^{X}$	.05
Total praise for work	.08	$.02^{x}$	.12	$.04^{x}$	.14	.05	$.02^{x}$	$.17^{X}$	.08
Student-Style Behaviors									
Student-initiated procedure questions	$.05^{x}$	$.02^{x}$	$.09^{x}$	$.04^{x}$	$.24^{X}$	$.02^{x}$	$.03^{x}$	$.05^{x}$	.07
Student-initiated interactions	1.0	$.69^{x}$	1.9^{X}	$.56^{x,y}$	1.6^{Y}	$.88^{x}$	$.61^{x,y}$	1.4	1.1
Expectancy[b]	4.95^{N}	4.98	5.28^{M}	5.53	3.4^{n}	4.48^{N}	4.70^{m}	5.58^{M}	
Joint-Style Behaviors									
Open questions	.15	$.03^{x}$	.48	$.01^{x}$	.42	.28	.16	$.63^{X}$	.27
Response opportunities	$.32^{x}$	$.24^{x}$	.75	$.15^{x}$	.75	.50	$.29^{x}$	1.1^{X}	.51
Total interactions	1.23	1.00^{x}	2.15^{X}	$.67^{x,y}$	1.85^{Y}	1.15	$.76^{x,y}$	1.75^{Y}	1.33

[a] All 3 way interaction terms signigicant at $p < .01$.

[b] Student questionnaire item; scale 1-7, 7=highest; M,N and m,n: significant differences were determined using *a priori* t-tests.
Note. X,Y;x,y: within each row a capital letter signifies a mean which is significantly greater than all means superscripted with a corresponding lower case letter; significant differences were determined using Tukey's HSD, $p < .05$.

Table 4

CLASSROOM TYPOLOGIES

Variable	TYPE 1	TYPE 2	TYPE 3	TYPE 4
Course Taking Plans:1	M>F		F>M	
Course Taking Plans: 2	M>F		F>M	F>M
Worry about getting work done: 1				
Worry about getting work done: 2				F>M
Nervous if have to work too fast: 1				
Nervous if have to work too fast: 2				
Self-Concept: 1	M>F		F>M	F>M
Self-Concept: 2	M>F		F>M	F>M
Expectancy: 1	M>F		F>M	
Expectancy: 2	M>F		F>M	F>M
Utility Value Math: 1	M>F		F>M	
Utility Value Math: 2	M>F		F>M	
Intrinsic Value of Math: 1	M>F		F>M	
Intrinsic Value of Math: 2	M>F		F>M	F>M
Frustration with Math: 1	M<F			
Frustration with Math: 2	M<F	F<M		
Worry over Math Work: 1				
Worry over Math Work: 2	M<F	F<M		
Test Anxiety: 1	M<F			F<M
Test Anxiety: 2	M<F	F<M		

Table 4 (continued)

CLASSROOM TYPOLOGIES

Variable	TYPE 1	TYPE 2	TYPE 3	TYPE 4
Somatic Signs of Math Anxiety: 1	M<F	F<M		
Somatic Signs of Math Anxiety: 2	M<F	F<M	F>M	
Task Difficulty: 1	M<F			
Task Difficulty: 2	M<F			
Number of Classrooms	37	33	16	3

Note: 1 refers to Wave 1, 2 refers to Wave 2.

TABLE 5

PSYCHOMETRIC PROPERTIES OF STUDENT CLASSROOM ENVIRONMENT MEASURE (SCEM)

ITEMS IN COMPOSITE	VAR#	Mean	Stand. Dev.	Skew-ness	Factor loading	Reli-ability
Factor I. **Teacher unfairness, unfriendliness**						.73
The teacher cares how we feel.	1021	3.36	.96	-1.23	-.45	
The teacher thinks that some of the students in this class can't do very good math work.	1023	2.26	1.25	.39	.37	
The teacher is friendly to us.	1026	3.48	.82	-1.41	-.63	
The teacher treats boys and girls differently.	1030	1.83	1.05	1.47	.51	
The teacher grades our math work fairly.	1035	3.69	.74	-2.52	-.43	
The teacher treats some kids better than other kids.	1038	1.70	1.08	1.32	.63	
The teacher criticizes us when we do poor math work.	1043	1.82	1.07	1.06	.47	
Factor II. **Competition among students**						.88
Some kids try to be the first ones to answer the math questions the teacher asks.	1028	3.17	.98	-.71	.61	
Some students in this class make fun of kids who answer math questions wrong or make mistakes.	1024	2.41	1.12	.30	.41	
Some kids try to be the first ones done in math.	1033	3.34	.93	-1.06	.58	
Factor III. **Task structure that permits cooperation & interaction**						.49
We get to work with each other in small groups when we do math.	1018	1.34	.70	2.39	.42	
We get to pick which students we want to work with in math.	1025	1.51	.90	1.75	.39	
We can talk to each other during math time.	1031	1.70	.85	1.22	.53	
We help each other with math work.	1036	2.18	.97	.67	.39	

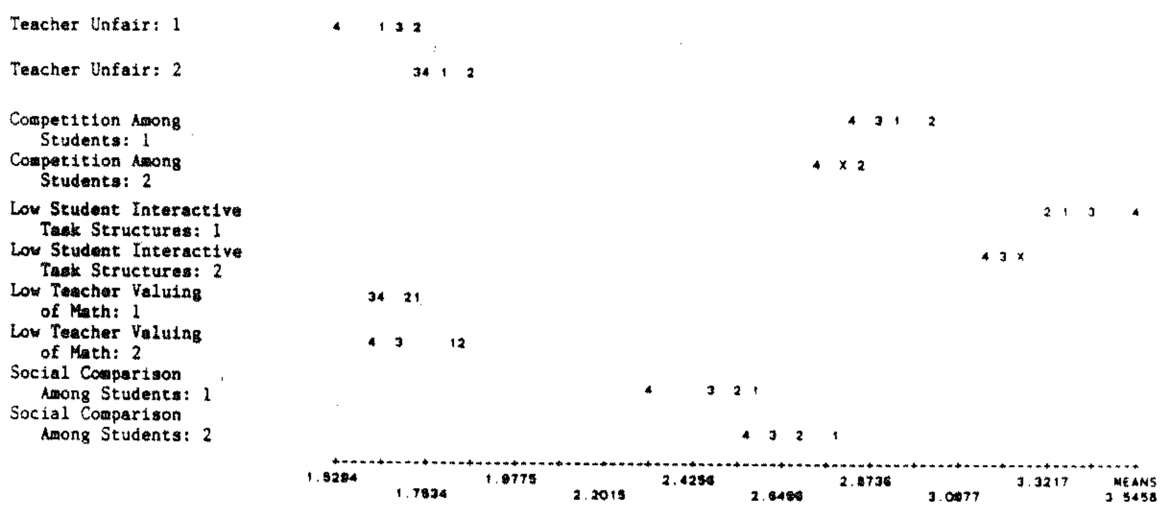
TABLE 5 (continued)

ITEMS IN COMPOSITE	VAR#	Mean	Stand Dev	Skew-ness	Factor loading	Reli-ability
Factor IV. **Teacher's valuing of mathematics**						.57
The teacher tries to make math interesting in this class.	1040	3.28	1.00	-1.07	.54	
The teacher likes math.	1041	3.50	80	-1.41	.38	
The teacher tells us why math is important.	1042	3.05	1.14	-.67	50	
Factor V. **Social comparison behavior**						.50
When math papers are handed back, we show each other how we did.	1017	2.41	.97	.29	.44	
When report cards come out, we tell each other what we got in math.	1032	2.64	1.04	009	.62	

Note. Items are based on a four-point scale: 1=NOT VERY OFTEN, 2=SOMETIMES, 3=USUALLY, 4=VERY OFTEN. The internal consistency reliability coefficients are based on a generalized form of Cronbach's coefficient alpha (Joreskog, 1971)

Figure 1

Profile Analysis for Classroom Types on Classroom Environment Measures



Note: 1=Boy-advantaged Classrooms
2=No Difference Classrooms
3=Moderately Girl-advantaged Classrooms
4=Strongly Girl-advantaged Classrooms