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Attitudes of ninth grade male and female students who participated in the Montana Mathematics and Science Project

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ATTITUDES OF NINTH GRADE

MALE AND FEMALE STUDENTS

WHO PARTICIPATED IN THE MONTANA

MATHEMATICS AND SCIENCE PROJECT

by

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ABSTRACT

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Attitudes of Ninth Grade Male and Female Students who Participated in the Montana Mathematics and Science Project

Directors: Dr. James J. Hirstein, Dr. Patricia Lamphere, Dr. George D. McRae.

The purpose of this study was to investigate whether there were any gender differences in attitudes toward mathematics among 9th grade students who participated in the Systemic Initiative for Montana Mathematics and Science (SIMMS) Project during the 1992-93 school year and to assertain if any changes in attitudes had occurred from fall to spring.

A sample of 98 boys and 81 girls representing 12 SIMMS classrooms was administrated a 40-item opinion survey to assess various dimensions of their attitudes toward mathematics. Using a chi-square statistic, the relationships between attitudes about mathematics by sex and over time, as well as any significant interaction between attitudes and gender over time were analyzed.

Three major questions were addressed: (a) Are there any differences in attitudes toward mathematics between ninth grade boys and girls ? (b) Are there any differences in attitudes of all students apart from gender at the end of the school year compared to the beginning? and (c) Is there any interaction effect between attitude and gender over time?

Results indicated that boys tend to uphold the traditional view regarding male dominance in the subject. Girls are less interested in taking more advanced math courses and indicate less confidence in their ability to do well in mathematics. However, when attitudes apart from gender are considered, some significant differences are noted between students responses in the fall of 1992 compared to their responses to the same statements by spring of 1993.

Mostly however, results of responses to all 40 statements indicate that most students share the same attitudes towards mathematics regardless of gender and that attitudes once formed do not seem to change much over time. To close the gender gap in mathematics, and to improve attitudes towards mathematics overall, intervention and remediation programs must begin at the elementary and especially the middle school grades, when attitudes toward mathematics are formed.

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First of all, I would like to thank the SIMMS Project for allowing me to use the data collected from the first opinion surveys conducted in SIMMS classrooms in Montana High Schools.

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In addition, I am thankful to Richard Lane as well as the system information specialists from Computing and Information Services who contributed technical advice for this project.

I am especially grateful to my husband Dr. Hans Zuuring for his assistance with the statistical design of this study and whose patience and devotion sustained me during this challenging time.

Finally, to my sons Rob and Doug who may see their mother in a different light and may be encouraged to follow their own educational paths, I am thankful for your understanding.

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CHAPTER I

INTRODUCTION

The belief that girls' achievement in mathematics is at a lower level than boys is widely accepted by mathematics educators. By secondary school, especially after the tenth grade, males tend to outperform females particularly in the area of problem-solving and reasoning skills. Furthermore, many young women have low career aspirations and do not perceive mathematics as useful for their future jobs (Fox, 1976; Brush, 1980). Consequently, a disproportionate number of women are "mathematical dropouts" and occupations requiring expertise in mathematics are dominated by males (Fennema, 1990).

Mathematics has been described as a "cultural filter" by Lucy Sells insofar as career choices are limited when only a minimum number of mathematics courses are taken in high school (Schaalma, 1989). Females are thus disadvantaged with respect to their choice of educational and career opportunities since they choose not to take additional mathematics courses. If this trend continues, it is unlikely that there will be equal educational outcomes for males and females. If equity were achieved, there would be no differences in what females and males have learned or how males and females feel about themselves as learners of mathematics (Fennema, 1990). Much research has been motivated by a desire to understand why these inequities exist and how such attitudes might be changed.

The National Council of Teachers of Mathematics (NCTM) has addressed the issue of securing equity in mathematics for all students. Two goals of the NCTM's Curriculum and Evaluation Standards for School Mathematics are to develop student confidence and to help students understand the value of mathematics (NCTM, 1989). These goals challenge educators to change instructional practices until the mathematical potential of all students has been realized.

The Systemic Initiative for Montana Mathematics and Science (SIMMS) Project has responded to the call for curricular reform. The SIMMS approach is consistent with the principles that guided the NCTM's standards for school mathematics and with constructivist learning theory in general. The SIMMS Project promotes the constuctivist notion that knowledge is actively created by students through their own exploration, thinking, reflection and communication about mathematics (Lott & Burke, 1993).

One objective of the SIMMS Project is to give more attention to the needs of female students. In this regard, the SIMMS curriculum emphasizes a wide variety of activities, accounts for multiple learning styles, and utilizes appropriate differentiated modes of instruction (Lott & Burke, 1993). Such an effort may reduce the negative effects of sex-role stereotyping, foster more positive attitudes toward mathematics, and encourage all students to pursue the study of mathematics.

Students bring a wide variety of attitudes and beliefs to the mathematics classroom. The SIMMS curriculum has identified the following metamathematical core attitudes:

1. Mathematics is useful.
2. Doing mathematics is more than doing computations.
3. Mathematics is accessible to students of all physical, mental, and learning abilities or disabilities.

4. Mathematics affects all careers.

5. Mathematics is not a spectator activity.

6. Learning mathematics is affirming of my race, culture, gender and language.

7. Doing mathematics is more than just following rules.

8. Doing mathematics is problem-solving.

9. Doing mathematics is reasoning and arguing.

10. Doing mathematics is communicating and discussing.

11. Doing mathematics is seeking connections.

12. I can do mathematics.

13. I can access mathematics in a meaningful way.

14. I can learn mathematics.

15. I can make mathematically informed decisions.

(Lott & Burke, 1993, p.9)

Attitudes are thus regarded as an important component of instruction for the SIMMS curriculum. Research has shown that a more positive attitude towards mathematics motivates students to strive toward higher achievement and participation (Neale, 1969; Armstrong & Price, 1982; Shaughnessy, 1983). Students who like mathematics and believe they are good at it tend to take more mathematics (Armstrong & Price, 1982). Thus, if attitudes toward mathematics are less positive, performance and interest in the subject will ultimately be affected.

Several definitions of attitude have been offered. Callahan (1971) defines attitude simply as children's liking or disliking of mathematics. Rokeach (1972) defines attitude as an organization of several beliefs focused on a specific object or situation predisposing one to respond in some preferential manner, while Cattell (1968) regarded attitude as an interest in a course of action. Attitude according to Aiken (1970) is commonly considered to be partly affective or emotional and to some extent includes a certain level of anxiety. An operational definition of attitude, on the other hand, specifies the actual activities or operations required to measure or identify the terms (Wallen & Fraenkel, 1991). For example, the National Assessment of Educational Progress (NCTM, 1981), the International Association for the Evaluation of Educational Achievement (USNCC, 1986), and the Fennema-Sherman Attitude Scales (1976) measure attitudes according to students' responses on opinion surveys using a five-point Likert scale. For purposes of this study, attitudes will be regarded as a multidimensional phenomenon measured by student responses to statements designed to determine their opinions about mathematics.

Research Questions and Hypotheses:

The objectives of this study are to determine (1) the effect of gender, (2) the effects of time of year, and (3) the interaction between time and gender, on the attitudes toward mathematics, of ninth-grade SIMMS mathematics students in Montana high schools. Three main research questions were posed.

1. Are there any differences in attitudes toward mathematics between ninth grade

boys compared to ninth-grade girls ?

2. Are there any differences in attitudes toward mathematics of students from fall to spring ?

3. Is there any interaction effect between time of year and gender differences in attitudes toward mathematics ?

The null hypotheses for this study are:

1. There are no significant differences in attitudes toward mathematics between ninth-grade boys and girls.

2. There are no significant differences in attitudes toward mathematics of all students before and after their first year in SIMMS.

3. There is no significant interaction effect between time and gender specific attitudes toward mathematics.

Attitudes are an important component of the SIMMS philosophy regarding curriculum. Consequently, monitoring students' opinions about mathematics will lead to increased understandings that will enable modifications of the SIMMS curriculum and instructional practices. Educators who reconstruct their approaches to improve attitudes and enhance learning opportunities for all students will ensure that students attain mathematical power.

CHAPTER II

LITERATURE REVIEW

Emphasis in recent years has been on discovery methods of learning, teaching to multiple learning styles, and incorporating activities that promote an understanding of the usefulness of mathematics in the 'real' world. One of the goals of the first mathematics assessment of the National Assessment of Educational Progress (NAEP) was for students to appreciate mathematics, i.e., enjoy and realize its usefulness (Carpenter et al. 1980). Underlying this objective is the belief that attitudes play an important role in the learning of mathematics. Favorable attitudes toward a subject have been hypothesized as leading to students' willingness to learn more about the subject and to increase their intrinsic motivation to learn (Neale, 1969; Shaughnessy, 1983; Shumway, 1980).

Neale (1969) suggested there is an interaction between attitude and achievement. Students who express positive attitudes toward mathematics perform better on mathematics tests than students who do not like mathematics (Armstrong,1980; Boswell & Katz, 1980; Tsai & Walberg, 1983). According to Selkirk (1975), students develop poor attitudes when they do not do well or when they find mathematics uninteresting. Conversely, students have good attitudes when they perceive mathematics as useful and interesting (Callahan, 1971; Armstrong, 1980). Some studies showed, however, that attitude toward learning mathematics only plays a limited role in achievement. Studies by Crosswhite (1972) and Armstrong (1980) indicated a low positive correlation between attitude and performance.

However, the correlation between attitude and achievement was higher for girls; performance in mathematics was more predictable from girls' attitudes than was boys' (Behr, 1973; Boswell & Katz, 1980). Other studies found differences in both attitude and achievement in favor of boys at the junior high school level and beyond (Hilton & Berglund, 1974; Keeves, 1973; Simpson, 1974).

Evidence that attitudes toward learning mathematics become increasingly less favorable as children progress in school was substantiated by a longitudinal study by Anttonen (1968) and by results from the second NAEP (Carpenter et al., 1980; NCTM, 1981). Anttonen compared attitudes toward mathematics of students in the fifth- and sixth-grades and then again six years later. His research showed a decline in favorable attitudes towards mathematics, as measured by a 94-item inventory.

Similar results from the second NAEP in 1977-78 showed that mathematics was the least favorite subject of the 17-year-olds compared to other school subjects and third favorite subject among 13-year-olds. The pattern of response changed drastically regarding attitudes toward mathematics from age 13 to age 17. Overall, results indicated that although a majority of students reported that they liked mathematics, only 59% of 17-year-olds liked mathematics compared to 69% of the 13-year-olds and only 38% of 17-year-olds wanted to take more mathematics (Carpenter et al. 1980; NCTM, 1981).

Studies of children in the elementary school years found no significant differences in mathematical knowledge of boys and girls based on a variety of measures (Engle & Lerch, 1971; Fennema, 1974; Steffe & Van Engen, 1966; Stern & Keislar, 1967). Many studies contend there are relatively few sex-differences in computational skills at the elementary level (Maccoby & Jacklin, 1974) while other studies found that girls tended to score higher than boys on computational skills (Anastasi, 1958; Marshall & Smith, 1987). As early as the seventh and eighth grade, boys have been found to outperform girls on difficult pre-college level tests of reasoning ability. Male high school students as a group, perform better than female high school students in mathematics achievement tests (Benbow & Stanley, 1982; Clark & Grandy, 1984; Fennema & Carpenter, 1981). By the ninth and tenth grades, some studies showed that mathematics achievement was higher for boys, especially when higher-level cognitive tasks involving mathematical reasoning or spatial visualization skills were measured (Carry & Weaver, 1969; Kilpatrick & McLeod, 1971; Lesser, Fifer & Clark, 1965).

Although females achieve at levels equal to males in elementary school, gender differences favoring males begin to appear during the middle school years (Marshall & Smith, 1987). Attitudes toward mathematics are fairly stable after the sixth grade. (Fennema & Sherman, 1977; Fennema & Sherman, 1978). According to Fennema (1981), the middle school years are the crucial ones in the development of sex-related differences in attitudes towards mathematics. Studies indicate that the junior high school years are a critical turning point in the determination of attitudes toward mathematics.

A cross-sectional sample of students in grades 2, 6, 7, 8, 9, 10, and college was questioned on their attitudes toward arithmetic and mathematics using Dutton's scale. After the ninth grade, females had significantly poorer attitudes toward mathematics than males

(Dutton, 1968). A study by Callahan (1971) asked 366 eighth-grade students to estimate when their favorable/unfavorable attitudes developed. Forty-seven percent of the students surveyed pointed to the sixth and seventh grade as the years when their attitudes toward mathematics were formed.

Other studies indicate that females are significantly less confident than males in their ability to learn mathematics after the 6th grade (Fennema & Sherman, 1977). Even when gender achievement scores were similar, studies showed that confidence in learning mathematics was lower for girls than for boys (Sherman, 1976). From grade nine on, sex differences become increasingly significant.

According to some researchers, differences in mathematical aptitude and attitude between the two sexes are the result of cultural expectations and sex-role development (Norman, 1977). Different cultural reinforcements over time, which shape the career and educational goals, interests, and achievement of the two sexes, is reflected in corresponding differences in mathematical performance. (Aiken, 1970; Astin, 1968; Hilton & Berglund, 1971). According to Fox (1974) social role perceptions of females contribute to a lack of confidence in their ability to do mathematics.

Many studies cited by Sherman (1976) show that girls who take mathematics as a requirement at the elementary grades and girls who elect to take mathematics at the secondary level do very well. Contrary to popular belief, Sherman further determined there is no evidence that girls do not enjoy mathematics or are not intrigued by problem-solving. Even when there are no significant differences in achievement, studies by Fennema and

Sherman show that females are still less confident than males of their abilities (Fennema & Sherman, 1978).

After the 10th-grade, an increase in negative attitudes results in an increased selectivity in taking advanced mathematics, with fewer females electing to do so (Fennema & Sherman, 1977; Fennema & Sherman, 1978). Research shows for example, that among 1972 Berkley freshmen, 57% of the boys compared with 8% of the girls had taken four years of high school mathematics. Even when both sexes have taken an equal number of mathematics courses, ability differences still exist, indicating that the amount of mathematics education is not the only factor involved (Norman, 1977).

After controlling for cognitive differences, Sherman and Fennema (1977) found that of 716 tenth- and eleventh-grade students who differed with regards to their intent to take mathematics, differences were also found with respect to their responses to nearly all of the items on the Fennema-Sherman Mathematics Attitude Scale. Furthermore, both male and female students in the top half of their class scored significantly higher than the students in the lower half of the class on all affective variables measured on the Fennema-Sherman attitude scales except for responses to statements about mathematics as a male domain. Despite the differences in attitudes, more boys than girls in both the top half and lower half of their class in mathematics achievement intended to continue their study of mathematics (Sherman & Fennema, 1977).

The notion that boys are innately better at mathematics than girls has been suggested by studies about precocity in mathematics. Significantly more males have been identified as precocious and there are fewer reports of genius among women. In a study by Fox (1975), students throughout the state of Maryland who scored above the 98th percentile on a numerical subtest of a standardized achievement test were identified as precocious. These 1519 students, consisting of 592 girls and 927 boys, in the seventh, eighth, ninth and tenth grade then took the Standard Achievement Test in mathematics (SAT-M). Of the 61 students who scored above 660 on SAT-M, only seven were girls. Benbow and Stanley (1983), found similar results when they surveyed a large sample (39,820) of seventh grade students. Despite essentially equal ability, 18.2% of the boys compared to 8.6% of the girls scored over 500 on the SAT-M.

The traditional view of mathematics as a male domain has been verified historically insofar as there have been relatively few female mathematicians compared to the number of male mathematicians. Prior to the 18th century, Hypatia was the only noteworthy female mathematician. Since then, Sophie Germain, Sonja Kovalensky and Emmy Noether have achieved some importance. (Iacobacci, 1970). In a study of 1320 sixth and eighth-grade students, Fennema and Sherman (1978) found significant differences between males and females. They found that males stereotyped mathematics as a male domain at significantly higher levels than females.

Attitudes toward mathematics in adults can be traced to childhood (Morrisett & Vinsinhaber, 1965). The stereotypical view that females do not do as well in mathematics as males may be reinforced by parents, teachers, school counselors, or peers (Casserly, 1980; Fennema, 1977). Sex differences in career interests may be the result of societal stereotypes, social pressures, or a lack of suitable role models (Armstrong & Price, 1982). Thus, the importance of socio-cultural factors that encourage girls to pursue the study of mathematics and to enter mathematics-related fields needs to be emphasized. Parents and teachers especially must become aware of the increasing need for mathematics in the job world and the role that women must play (Sherman, 1976).

There is some indication that the perceived parental attitude of mother and father toward the student as a learner of mathematics influences the student's own attitudes toward mathematics. Students who believe that parents do not expect them to get high grades in mathematics will not regard mathematics as important to learn (Fennema & Sherman, 1978; Sherman, 1976). Significant effects were found regarding parental expectations and role-modeling in mathematics achievement by Armstrong (1980).

The attitudes of teachers also seems to be a factor in encouraging girls to pursue the study of mathematics. A study by Armstrong and Price (1982) found that students who perceive their teachers as encouraging tended to take more mathematics. Assuming that teachers' attitudes can be communicated to students, teachers can ultimately affect the attitudes and performance of students in mathematics (Sherman, 1976). Studies of students in the sixth, seventh, and eighth grades by Fennema and Reyes (1981) revealed that teacher/student interaction in the mathematics classroom was in favor of males, insofar as teachers initiated more interactions with boys.

Teachers must create environments in which all students are encouraged to pursue the study of mathematics. Instruction according to Fennema and Behr (1980) should be organized according to an individual's strengths. For example, a student with high visual or verbal aptitude will do better when content is presented in these modes. The SIMMS project emphasizes multiple learning styles and instructional modes. Some studies however, indicate that modern, innovative courses in mathematics that are student-centered do not improve attitudes more than traditional programs (Demars, 1972; Joyner, 1974). Furthermore, discovery methods have not been found to be superior to expository methods in changing attitudes toward mathematics (Struder, 1972). Powerful societal factors and socialization experiences are more influential in gender differences in both attitude and achievement (Meece & Parsons, 1982).

Differences in attitude of both boys and girls toward mathematics consist not only of affective components of likes or dislikes, but also cognitive ones such as attitude toward numbers, computations and word problems. Attitude survey results from the second NAEP indicated a majority of both 13-year-olds and 17-year-olds agreed there is always a rule to follow in solving a mathematical problem. Since most of their mathematical experiences have been rule-oriented, their responses are understandable (Carpenter et al., 1980). However, a majority in both age groups also felt that knowing how to solve a problem was as important as getting a solution. Thus, they were also aware that understanding the underlying process involved was also an important component of problem-solving (Carpenter et al., 1980).

Ability and achievement in mathematics are undoubtedly influenced by a complexity of cognitive and affective factors, including attitudinal ones. Consequently, changes in attitudes involve a complex interaction among many variables, including course content, method of instruction, teacher, student, parental and peer support, and other variables (Leake, 1974).

CHAPTER III

METHODOLOGY

Population and Sample:

The population for this research was students enrolled in ninth-grade SIMMS mathematics classes in Montana high schools during the 1992-93 school year. There were 10 high schools that volunteered to pilot the SIMMS modules during the first year of the project. The sample was selected so that each of the school size classifications was represented; namely, AA, A, B, C, and private. Out of a total of 26 possible SIMMS classrooms, 12 were designated as focus classes. The students in the 12 focus classes are representative of the general school population in Montana.

The sample consisted of 179 students (98 male, 81 female) enrolled in a SIMMS class in the fall of 1992 and who remained in a SIMMS focus class until the end of the school year. The students may have changed class periods but they still had the same teacher. Those students who dropped out of SIMMS by spring of 1993, or who were enrolled in the spring but not in the fall semester, were excluded.

Procedure:

Students in the focus classrooms were administered a survey designed to measure student attitudes about mathematics. The mathematics attitude survey consisted of 40 statements about the study of mathematics (Appendix A). The statements were selected from the second international mathematics study conducted by members of the International

Association for the Evaluation of Educational Achievement (IEA) from the NAEP studies and from the Fennema-Sherman Mathematics Attitude Scales. The items on the attitude survey were divided into four categories, each containing ten statements, to measure the following constructs related to attitudes about mathematics:

Mathematics and Gender: This category was designed to determine whether equity for males and females has been achieved.

Mathematics and Myself: This category was designed to determine students' perceptions of themselves as learners of mathematics.

Mathematics as a Process: This category dealt with students' perceptions of mathematics as process-oriented rather than rule-oriented and where mathematics is regarded as a dynamic subject with opportunity for creativity rather than a rigid body of knowledge.

Mathematics and Society: This category was designed to measure students' view of the usefulness of mathematics in everyday life and the importance of mathematics in their own career plans.

The items in each construct are given in Appendix B. The 40 statements combined were distributed randomly onto one instrument. This 40-item instrument was administered as an opinion survey to SIMMS students during the fall of 1992 and again during the spring of 1993. Students were asked to read each of the 40 statements and to respond to each statement on a five-point Likert scale. Numerical values were assigned to the responses, with a weight of five given to the response that indicates strongest agreement to the statement. The responses were further recoded so that 'strongly agree' and 'agree' were combined into one category 'agree', while 'strongly disagree' and 'disagree' were similarly recoded to 'disagree'. Those who were undecided were assigned a 'missing value' code and their responses were excluded from the analysis. Thus, the number of students who responded to each statement varies.

Data Analysis:

The responses to each statement are reported as percentage distributions and presented in Appendix C as cross-tabulations for males and females by SIMMS/Fall and SIMMS/Spring within each of four categories:

1. Mathematics and gender.
2. Mathematics and myself.
3. Mathematics as a process.
4. Mathematics and society.

Some preliminary results were analyzed during the 1992-93 school year by computing a 'total' score for each student as well as means and standard deviations for all students. A student's 'total' score was the cumulative total of all scores assigned to their responses to each of 10 statements in a category. Results analyzed in this manner seemed to mask any significant differences that might be detected between fall and spring survey responses to individual statements; therefore, this approach was discarded. Since the variations in responses to each statement by males versus females, are of particular interest to this study, no attempt has been made to report a 'total' score from responses to all statements in a category.

Since the same subjects were surveyed at the beginning of the 1992-93 school year in September and again at the end of the school year in May, some of the differences in attitude can be compared over time. The distribution of responses between the SIMMS/Fall and SIMMS/Spring opinion survey will be examined independent of gender and using Pearson's Chi-square test statistic at the .05 level of significance. Likewise, the distributions of responses showing attitude by gender will be analyzed without regard to time. Finally, any interaction between gender and factors inherent in time, will be examined using the difference of estimated probabilities (Goodman, 1963) as a measure of interaction. To determine any changes in attitudes by gender over time, the probabilities of response for SIMMS/Fall versus SIMMS/Spring by gender are estimated by:

$$\hat{p}_{ijk} = \frac{\hat{n}_{ijk}}{n_{.jk}} \qquad \text{for } j = 1,2 \qquad k = 1,2$$

where i is the response variable at two levels, (1= agree, 2 = disagree), j is the gender factor (1 = male, 2 = female), and k is the time (1 = SIMMS/Fall, 2 = SIMMS/Spring).

The difference of estimated probabilities suggested by Goodman is calculated by:

$$\hat{\Delta} = (\hat{p}_{111} - \hat{p}_{121}) - (\hat{p}_{112} - \hat{p}_{122})$$

The estimated standard error of Δ is given by :

$$(s^*)^2 = \sum_{j,k} \frac{\hat{p}_{1jk}\ \hat{p}_{2jk}}{n_{.jk}} \quad \text{for } j = 1, 2 \quad k = 1,2$$

The hypothesis of no interaction is tested using a chi-square statistic with one degree of freedom.

$$\chi^2_{(1)} = (\hat{\Delta})^2 / (s^*)^2$$

<u>Research Questions and Hypotheses</u>

The objectives of this study are to determine (1) the effect of gender, (2) the effects of time of year, and (3) the interaction between time and gender, on the attitudes toward mathematics, of ninth-grade SIMMS mathematics students in Montana high schools. Three main research questions were posed.

1. Are there any differences in attitudes toward mathematics between ninth-grade boys compared to ninth-grade girls ?

2. Are there any differences in attitudes toward mathematics of students from fall to spring ?

3. Is there any interaction effect between time of year and gender differences in

attitudes toward mathematics ?

The null hypotheses for this study are:

1. There are no significant differences in attitudes toward mathematics between ninth grade boys and girls.
2. There are no significant differences in attitudes toward mathematics of all students before and after their first year in SIMMS.
3. There is no significant interaction effect between time and gender specific attitudes toward mathematics.

Limitations of the Study

The sample for this study was not randomly selected from all students enrolled in high schools throughout Montana and students were not randomly assigned to classrooms. Only schools that volunteered to participate in the SIMMS project were considered. Also, self-reporting techniques were used which are subject to bias since students may respond to questions as they feel they are expected to, or to appear in a more favorable light. Furthermore, there is no control group in this design, so any attitude changes occurring during the period may be attributed to effects or events other than the SIMMS curriculum. Finally, over-time analyses do not include matched pairs; therefore, changes in individual student's attitudes from fall to spring are not possible to measure.

CHAPTER IV

RESULTS

Analysis of the responses includes the frequency distribution of responses to statements on the opinion survey when significant differences occur. Statistically significant differences were determined through the application of a Pearson's chi-square test at the $\alpha = .05$ level. Results are analyzed to show statistically significant differences in opinions between female compared to male participants as well as for all students over the entire 1992-93 school year. Any significant interaction between gender and opinion reported at the beginning versus the end of the school year is reported in Table 7 using Goodman's measure of interaction. Percentage responses to all statements are presented by gender and with a breakdown by fall and spring survey results regardless of significance in Appendix C. The statistical analysis of significant results begins with attitudes about "mathematics and gender", followed by "mathematics and myself", "mathematics as a process", and finally "mathematics and society."

1. Mathematics and Gender

The attitudes of students that reflect a gender-specific outlook were investigated by 10 statements (Appendix B). Significant chi-square results and percentage distributions by sex are presented in Table 1.

Table 1

Analysis of "Mathematics and Gender" Statements by Sex

Statement	Percent Responding	Agree	Disagree	n	Chi-square	df	p
4. Girls can do difficult math problems just as well as boys.	Male	95.7	4.3	186	4.47	1	.034
	Female	99.4	.6	157			
18. It is more important for men to learn mathematics than women.	Male	8.7	91.3	172	7.5	1	.006
	Female	1.9	98.1	159			
27. Men are not better than women as scientists and engineers.	Male	73.3	26.7	146	19.13	1	< .0001
	Female	92.5	7.5	147			
29. It's hard to believe a female could be a genius in mathematics.	Male	12.5	87.5	176	6.39	1	.011
	Female	4.6	95.4	153			
39. Women are certainly logical enough to do well in mathematics.	Male	91.9	8.1	173	10.16	1	.001
	Female	99.3	.7	152			

Responses to the statement "girls can do difficult math problems just as well as boys," indicate that although a majority of both boys and girls agreed with this statement, a significant proportion of boys compared to girls also disagreed. Although over 90% of both males and females disagreed with the statement that it is more important for men to learn mathematics than women, males were much more likely to agree than females ($p = .006$). Over one-fourth of the boys disagreed with the statement that men are not better than women as scientists and engineers compared to only 7.5% of the girls. The Pearson chi-square statistic for this statement was calculated to be 19.13 with significance at $p < .0001$ level. When percentage responses of students to the statement that it's hard to believe a female could be a genius in mathematics are examined, results show that over 12% of males agreed with this statement compared to less than 5% of females ($p = .011$). Analysis of the percentage responding to the statement that women are certainly logical enough to do well in mathematics indicated that although over 90% of both boys and girls agreed with this statement, a significant proportion of males also disagreed ($p = .001$). Thus significant sex differences at the $p \leq .05$ level are found for responses to five statements about "mathematics and gender" described above.

When attitudes of all students about "mathematics and gender" statements are compared only in relation to time, independent of sex, significant chi-square results occur in responses to three statements (see Table 2). Although a majority of students disagreed with the statement "boys have more natural ability in mathematics than girls," a significantly higher proportion agreed with this statement by spring. Similarly, responses to the statement "it's hard to believe a female could be a genius in mathematics" indicated a significant change in the proportion of students who agreed with this statement by spring ($p = .03$). The percentage of students who disagreed that women are certainly logical enough to do well in mathematics also increased significantly from fall to spring ($p = .004$).

Table 2

Analysis of "Mathematics and Gender" Statements Over Time

Statement		Percent Responding Agree	Disagree	n	Chi-square	df	p
22. Boys have more natural ability in mathematics than girls.	Fall	3.9	96.1	153	3.9	1	< .05
	Spring	9.6	90.4	156			
29. It's hard to believe a female could be a genius in mathematics.	Fall	5.4	94.6	167	4.95	1	.026
	Spring	12.3	87.7	162			
39. Women are certainly logical enough to do well in mathematics.	Fall	98.8	1.2	162	8.39	1	.004
	Spring	92.0	8.0	163			

2. Mathematics and Oneself

Attitudes related to "math and myself," by gender, show significant chi-square results in responses to five statements (see Table 3). Percentages of agreement or disagreement by gender, are also summarized for these five statements in Table 3. Results show that almost two-thirds of the boys agreed they could handle more difficult mathematics compared to slightly less than half of the girls ($p = .01$). Furthermore, since only a total of 81 girls chose to express a definite opinion on the matter, the majority were undoubtedly undecided. The girls were about equally divided between agreement and disagreement about the statement "math is one of my worse school subjects;" however, over two-thirds of the boys disagreed ($p = .002$). When the responses of males and females to the statement "I try to do my best school work in mathematics" are compared, results show that a significantly higher proportion of females agreed with this statement ($p = .04$).

Table 3

Analysis of "Mathematics and Myself" Statements by Sex

Statement	Percent responding	Agree	Disagree	n	Chi-square	df	p
10. I think I could handle more difficult mathematics.	Males	65.2	34.8	112	6.42	1	.011
	Females	46.9	53.1	81			
16. Math is one of my worse school subjects.	Males	31.4	68.6	156	9.42	1	.002
	Females	49.2	50.8	130			
19. I try to do my best school work in mathematics class.	Males	75.7	24.3	144	4.02	1	.04
	Females	85.5	14.5	124			
33. I am often discouraged with my mathematics class.	Males	42.2	57.8	147	5.12	1	.02
	Females	55.8	44.2	129			
38. Mathematics is easier for me than my other school subjects.	Males	46.7	53.3	137	19.35	1	< .0001
	Females	20.2	79.8	114			

However, males are less likely to be discouraged with their mathematics class than females ($p = .02$). When responses to the statement that mathematics is easier for me than my other school subjects are examined, results show that almost 80% of the girls disagreed while the boys were about equally divided in their opinions ($p < .0001$). Thus significant results were found in a comparison of male and female responses to statements in the category "mathematics and myself."

When attitudes in the category "mathematics and myself " are examined apart from gender, significant chi-square results are found in responses to three statements (see Table

4). A substantial increase in agreement from fall to spring was found when responses to the statement "I think I could handle more difficult mathematics" are examined.

Table 4

Analysis of "Mathematics and Myself" Statements Over Time

Statement	Percent Responding	Agree	Disagree	n	Chi-square	df	p
10. I think I could handle more difficult mathematics.	Fall	50.0	50.0	94	4.23	1	.04
	Spring	64.6	35.4	99			
31. It's easy for me to talk in front of my math class.	Fall	25.8	74.2	132	21.1	1	< .0001
	Spring	52.7	47.3	148			
38. Mathematics is easier for me than my other school subjects.	Fall	24.2	75.8	120	11.18	1	< .001
	Spring	44.3	55.7	131			

Over 64% of all students agreed with this statement by spring compared to only 50% during the fall survey ($p = .04$). A dramatic reversal in responses to the statement "It is easy for me to talk in front of my math class" occurred from fall to spring. Over 50% of students agreed with this statement by the end of the school year, compared with only one-fourth of the students during the fall survey ($p < .0001$). Similarly, responses to the statement that mathematics is easier for me than my other school subjects showed an increase in the percentage of students who agreed from 24% in the fall to 44% by spring ($p < .001$).

3. Mathematics and Society

Significant chi-square results are found in an analysis of a breakdown of attitude and gender for only two statements (see Table 5). Over sixty percent of males agreed they would like to work at a job that lets them use mathematics while females expressed much less interest in a career that uses mathematics ($p < .001$). Although the majority of both males and females disagreed with the statement "mathematics is not needed in everyday life," significantly more males than females agreed.

Table 5

Analysis of "Mathematics and Society" Statements by Sex

Statement	Percent Responding	Agree	Disagree	n	Chi-square	df	p
17. I would like to work at a job that lets me use mathematics.	Males	62.8	37.2	121	11.2	1	< .001
	Females	38.8	61.3	80			
23. Mathematics is not needed in everyday life.	Males	18.2	81.8	176	4.72	1	.03
	Females	9.5	90.5	137			

When only the relationship between attitude and treatment apart from gender is considered, no significant chi-square results are found in the category "Mathematics and Society".

4. Mathematics as Rule or Process

No significant chi-square results by gender are found for responses to any of the statements in this category. However, when only the relationship between time and attitude is examined for all students, two statements showed significant differences in attitudes about mathematics as a process (Table 6). A significantly higher proportion of students agreed with the statement that math is a set of rules by springtime. Similarly, significantly more students disagreed that new discoveries are constantly being made by the end of the school year than in the fall.

Table 6

Analysis of "Mathematics as Rule or Process " Over Time

Statement	Percent Responding	Agree	Disagree	n	Chi-square	df	p
5. Mathematics is a set of rules.	Fall	62.5	37.5	120	7.14	1	< .01
	Spring	77.8	22.2	135			
24. New discoveries in mathematics are constantly being made.	Fall	97.6	2.4	126	4.71	1	.03
	Spring	91.4	8.6	128			

5. Interaction between Attitude by Gender Over Time

An analysis of the interaction between gender differences in attitudes toward mathematics and responses over time was conducted using Goodman's measure. Significant interaction occurs in only two areas if $p < .1$ (see Table 7) A chi-square of 5.55 with $p < .02$ is calculated for the statement "women are certainly logical enough to do well in mathematics." A chi-square of 3.34 with a $p < .07$ calculated for the statement "it's hard to believe a girl could be a genius in mathematics" showed significantly more agreement with this statement among males by springtime. These analyses indicate which responses of males and females are influenced over time.

TABLE 7

Analysis of Attitudes toward Mathematics Over Time for Males and Females

Statement		Percent Responding				Chi-square	df	p
		Fall		Spring				
		Male	Female	Male	Female			
29. It's hard to believe a female could be a genius in mathematics.	Agree	6.6	3.9	18.8	5.2			
	Disagree	93.4	96.1	81.2	94.8	3.34	1	< .07
	n	91	76	85	77			
39. Women are certainly logical enough to do well in mathematics.	Agree	97.6	100.0	86.4	98.7			
	Disagree	2.4	0.0	13.6	1.3	5.55	1	< .02
	n	85	77	88	75			

CHAPTER V

DISCUSSION

The response patterns for statements about attitudes toward mathematics suggest that there are some significant differences among students. The first question asked in this study was intended to expose possible differences in attitudes between girls and boys. The review of literature portrayed a male bias about mathematics as a male domain. Results of this study supported these findings. Analyses of "mathematics and gender statements" by sex and over time showed significant chi-square values for responses to statements that "it's hard to believe a female could be a genius in mathematics" and "women are certainly logical enough to do well in mathematics." As suggested by Goodman's measure of interaction, a male bias in this area seems to increase with time.

Research does not reveal many outstanding female mathematicians, a fact that does not imply that women are inherently inferior to men in mathematical ability. When responses to the statement that boys have more natural ability in mathematics than girls are considered, results show that most students disagree with this statement. However, significantly more students agreed with this statement by spring compared to fall. A search for reasons for the increase gives rise to speculation that as research has suggested, male achievement exceeds that of females as students progress in their study of mathematics. Exact "cause and effect" relations are difficult to establish since there is an interplay at work of many extraneous variables.

Boys were also more likely to agree that it is more important for men to learn mathematics than women and that men are better than women as scientists and engineers. Research findings indicate that females choose to pursue careers as scientists and engineers at a level that is significantly lower than do men. One interpretation implies that there is a strong male bias about these professions which pressures women to avoid these occupations.

A second category of statements investigated by this study was to determine how students feel about themselves as learners of mathematics. The review of literature provided evidence that females express less confidence than males in their ability to learn mathematics. Results of this study are consistent with these findings. Boys expressed more confidence in their ability to handle more difficult mathematics than females. Similarly, when fall and spring results are compared, a significantly higher proportion of students agreed with this statement by spring. Research suggests that confidence in learning mathematics declines as females progress in school. When results of this study are examined for analysis by sex-by-time, (see Table C-2) there is a decrease noted in the percentage of females who agreed with the statement compared to an increase in the percentage of males who agreed, a finding that seems to substantiate the evidence of previous research.

Compared to girls, a significant proportion of boys also found mathematics easier than their other school subjects. Girls indicated they were also more discouraged with their mathematics school work than boys. Also, more girls than boys reported that mathematics is one of their worse school subjects. These results imply that females have a less positive self-concept of their mathematical abilities than do males.

One interesting finding related to the statement “it's easy for me to talk in front of my mathematics class” was the dramatic reversal in opinion about this statement for all students from fall to spring. In the fall survey, over three-fourths of the students disagreed with this statement; however, by spring more than half of the students agreed. It seems likely that a SIMMS classroom, where co-operative learning, discussion, and group presentations are commonplace, would facilitate this turnaround.

Research has suggested that students’ perception of the usefulness of mathematics is strongly associated with participation and achievement. Responses to the statements about “mathematics and society” showed that an overwhelming majority of males would like to work at a job that lets them use mathematics while of the girls who were not undecided, and there were only 80 of them, almost a third disagreed. Thus it appears that girls do not perceive mathematics as a useful endeavor to the same extent as do boys. It is therefore also unlikely that girls will pursue the study of mathematics at the same level as boys.

The final category of statements analyzed concerns students’ views about mathematics as rule or process. Overall, while most students felt that mathematics is a set of rules, the majority also agreed that mathematics helps one to think logically and that there are different ways to solve most mathematical problems. Why this is so cannot be attributed to any one factor.

The issue of attitude differences in mathematics learning is complex. In order to explain these differences, one must have an understanding of the myriad of factors underlying the formation of attitudes. The values and expectations of both the individual and society must be incorporated into a holistic view of that individual. More explicit information is also needed about specific schools, classrooms, and teachers to explain the influence each has on attitude development.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

The development of positive attitudes toward mathematics is one of the goals of the SIMMS Project. Therefore, it was important to acquire baseline data on student attitudes about mathematics, especially during 1992-93, the first year of the project. Research suggests that attitudes affect the learning of mathematics. Thus, educators need to understand what kinds of student attitudes are present in a classroom to offset what might become a negative reaction to the study of mathematics.

Previous research implied that significant differences do exist between males and females concerning how they view themselves as learners of mathematics. Males tend to stereotype mathematics as a male domain, females continue to express less confidence in their abilities in mathematics and girls are less likely to choose careers in math-related fields. Results of this research support these findings.

Research has determined that confidence is an underlying factor that motivates students to elect to study more advanced mathematics. A majority of girls in this study felt they could not handle more difficult mathematics. Consequently, they will probably avoid taking more advanced mathematics courses, thus limiting their future career opportunities and perpetuating the notion of their inadequacy. The process seems cyclical. Males, on the other hand, expected to use mathematics in their future jobs and expressed confidence they could deal with more difficult mathematical problems. Students who are confident in themselves as learners of mathematics will continue to enroll.

There should be no differences in how students feel about themselves as learners of mathematics. An innovative curriculum such as SIMMS could explore the context in which girls view mathematics and to what extent they perceive the value and usefulness of mathematics to their own future job opportunities. Teachers must create an environment that will encourage girls to pursue the study of mathematics until the differences that exist among students in attitude and achievement are by choice and not determined by gender.

Research must continue to expand the understanding of the underlying mechanisms that determine students' attitudes about mathematics. A longitudinal study that would follow a subgroup of SIMMS students throughout their four years of high school would allow researchers to establish correlations between attitudes and certain performance patterns as well as to assess the effects of curriculum and other intervention programs on changing attitudes. In order to reduce the confounding factors inherent in an analysis of possible effects of the SIMMS curriculum in changing attitudes, a control group experimental design is essential. Included in this design should be some sort of paired-analysis to ascertain whether any individual students have changed their attitudes over time.

Schools undoubtedly reflect the cultural values and expectations of the society in which they function. A complexity of factors have produced the attitudes that students bring with them into the classroom. Educators should undertake an intensive study of individuals to assess the characteristics of students who have certain attitudes. Information should be disseminated to the public and workshops held to enable parents to support the mathematical progress of their children.

The research base surrounding the study of attitudes is enormous. What do all the results mean? Researchers must use the data to arrive at generalizations and to provide some theoretical foundations regarding student attitudes about mathematics. This study has provided a composite sketch of students' attitudes about mathematics in 12 ninth-grade SIMMS classrooms. Through inservice training, teachers should receive knowledge of these attitudes and their potential impact for the classroom learning environment in mathematics. Teachers must continually refine approaches to enhance the learning of mathematics for all students. When students perceive that mathematics is useful in everyday life and learn to utilize their own mathematical skills and reasoning abilities to solve real world problems, they will achieve mathematical power.

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APPENDIX A

MATHEMATICS OPINION SURVEY:

SIMMS STUDENTS

MATHEMATICS OPINION SURVEY:
SIMMS STUDENTS

The following pages contain a series of statements to determine the opinions of students about mathematics . There are no right or wrong answers. For each statement, you are to express your agreement or disagreement.

Directions: Read each of the following statements about mathematics.
If you "strongly agree" with the statement, fill in A on the answer sheet.
If you "agree" with the statement , fill in B on the answer sheet.
If you are "undecided" whether you agree or disagree with the statement, fill in C on
the answer sheet.
If you "disagree" with the statement, fill in D on the answer sheet.
If you "strongly disagree" with the statement, fill in E on the answer sheet.

1. Mathematics helps one think according to strict rules.
2. Mathematics is a useful and worthwhile subject.
3. I am looking forward to taking more mathematics.
4. Girls can do difficult math problems just as well as boys.
5. Mathematics is a set of rules.
6. I have little use for mathematics out of school.
7. Taking advanced math is a waste of time for girls.
8. Mathematics is harder for me than it is for most other students.
9. Mathematics helps one to think logically.
10. I think I could handle more difficult mathematics.
11. Jobs that use mathematics are better suited for men than for women.
12. Most of mathematics has practical use on the job.

13. Males are no better than females in mathematics.

14. Most people do not use mathematics in their jobs.

15. Mathematics will change rapidly in the near future.

16. Math is one of my worst school subjects.

17. I would like to work at a job that lets me use mathematics.

18. It is more important for men to learn mathematics than women.

19. I try to do my best school work in mathematics.

20. There are different ways to solve most mathematics problems.

21. No matter how hard I try, I cannot understand mathematics.

22. Boys have more natural ability in mathematics than girls.

23. Mathematics is not needed in everyday life.

24. New discoveries in mathematics are constantly being made.

25. There is always a rule to follow in solving a mathematics problem.

26. I cannot understand how some students think mathematics is fun.

27. Men are not better than women as scientists and engineers.

28. It is important to know mathematics in order to get a good job.

29. It's hard to believe a female could be a genius in mathematics.

30. Mathematics is useful in solving everyday problems.

31. It is easy for me to talk in front of my math class.

32. Trial and error is not very useful in solving mathematics problems.

33. I am often discouraged with my mathematics school work.

34. Girls need to know mathematics just as much as boys do.

35. A knowledge of mathematics is not necessary in most occupations.

36. Mathematics is a good field for creative people.

37. I can get along well in everyday life without mathematics.

38. Mathematics is easier for me than my other school subjects.

39. Women are certainly logical enough to do well in mathematics.

40. Learning mathematics involves mostly memorizing.

APPENDIX B

STATEMENTS CLASSIFIED ACCORDING TO CATEGORIES

Math and Gender

4. Girls can do difficult math problems just as well as boys.
7. Taking advanced math is a waste of time for girls.
11. Jobs that use mathematics are better suited for men than women.
13. Males are no better than females in mathematics.
18. It is more important for men to learn mathematics than women.
22. Boys have more natural ability in mathematics than girls.
27. Men are not better than women as scientists and engineers.
29. It's hard to believe a female could be a genius in mathematics.
34. Girls need to know mathematics just as much as boys do.
39. Women are certainly logical enough to do well in mathematics.

Math and Myself

3. I am looking forward to taking more mathematics.
8. Mathematics is harder for me than it is for most other students.
10. I think I could handle more difficult mathematics.
16. Math is one of my worst school subjects.
19. I try to do my best school work in mathematics class.
21. No matter how hard I try, I cannot understand mathematics.
26. I cannot understand how some students think mathematics is fun.
31. It is easy for me to talk in front of my math class.
33. I am often discouraged with my mathematics school work.
38. Mathematics is easier for me than my other subjects.

Math as a Process

1. Mathematics helps one think according to strict rules.
5. Mathematics is a set of rules.
9. Mathematics helps one to think logically.
15. Mathematics will change rapidly in the near future.
20. There are different ways to solve most mathematics problems.
24. New discoveries in mathematics are constantly being made.
25. There is always a rule to follow in solving a mathematics problem.
32. Trial and error is not very useful in solving mathematics problems.
36. Mathematics is a good field for creative people.
40. Learning mathematics involves mostly memorizing.

Math and Society

2. Mathematics is a useful and worthwhile subject.
6. I have little use for mathematics out of school.
12. Most of mathematics has practical use on the job.
14. Most people do not use mathematics in their job.
17. I would like to work at a job that lets me use mathematics.
23. Mathematics is not needed in everyday life.
28. It is important to know mathematics in order to get a good job.
30. Mathematics is useful in solving everyday problems.
35. A knowledge of mathematics is not necessary in most occupations.
37. I can get along well in everyday life without mathematics.

APENDIX C

PERCENTAGE RESPONSES WITHIN CATEGORIES

by SEX, by YEAR

TABLE C-1. Students' Attitudes toward Mathematics and Gender.

Statement	SIMMS/Fall 1992 Percent Responding				SIMMS/Spring 1993 Percent Responding			
	Agree		Disagree		Agree		Disagree	
	Male	Female	Male	Female	Male	Female	Male	Female
4. Girls can do difficult math problems just as well as boys.	52.7*	47.3*	100.0	0.0	53.9	46.1	83.3	16.7
7. Taking advanced math is a waste of time for girls.	50.0	50.0	52.8	47.2	62.5	37.5	53.1	46.9
11. Jobs that use math are better suited for men than for women.	50.0	50.0	50.3	49.7	50.0	50.0	51.3	48.7
13. Males are no better than females in mathematics.	52.9	47.1	44.4	55.6	53.9	46.1	60.0	40.0
18. It is more important for men to learn mathematics than women.	85.7	14.3	49.0	51.0	81.8	18.2	51.3	48.7
22. Boys have more natural ability in mathematics than girls.	50.0	50.0	53.1	46.9	40.0	60.0	52.5	47.5
27. Men are not better than women as scientists and engineers.	45.0	55.0	75.0	25.0	43.1	56.9	80.8	19.2
29. It's hard to believe a female could be a genius in mathematics.	66.7	33.3	53.8	46.2	80.0	20.0	48.6	51.4
34. Girls need to know mathematics just as much as boys do.	53.6	46.4	75.0	25.0	52.2	47.8	75.0	25.0
39. Women are certainly logical enough to do well in mathematics.	51.9	48.1	100.0	0.0	50.7	49.3	92.3	7.7

* of those in agreement, 52.7% were male, 47.3% were female.

TABLE C-2. Students' Attitudes toward Mathematics and Oneself

Statement	SIMMS/Fall 1992 Percent Responding Agree Male	Agree Female	Disagree Male	Disagree Female	SIMMS/Spring 1993 Percent Responding Agree Male	Agree Female	Disagree Male	Disagree Female
3. I am looking forward to taking more mathematics.	63.1*	36.9*	52.9	47.1	61.4	38.6	50.0	50.0
8. Mathematics is harder for me than it is for most other students.	62.9	37.1	58.4	41.6	50.0	50.0	58.4	41.6
10. I think I could handle more difficult mathematics.	59.6	40.4	48.9	51.1	70.3	29.7	45.7	54.3
16. Math is one of my worst school subjects.	41.4	58.6	62.7	37.3	45.5	54.5	61.1	38.9
19. I try to do my best school work in mathematics class.	50.0	50.0	76.0	24.0	51.5	48.5	57.1	42.9
21. No matter how hard I try, I cannot understand mathematics.	52.9	47.1	56.7	43.3	44.0	56.0	57.1	42.9
26. I cannot understand how some students think mathematics is fun.	49.1	50.9	55.4	44.6	50.0	50.0	59.5	40.5
31. It is easy for me to talk in front of my math class.	55.9	44.1	55.1	44.9	57.7	42.3	48.6	51.4
33. I am often discouraged with my mathematics school work.	47.7	52.3	56.7	43.3	44.9	55.1	62.7	37.3
38. Mathematics is easier for me than my other subjects.	75.9	24.1	45.1	54.9	72.4	27.6	43.8	56.2

* of those in agreement, 63.1% were male, 36.9% were female

TABLE C-3 Students' Attitudes toward Mathematics as Rule or Process

Statement	SIMMS/Fall 1992 Percent Responding				SIMMS/Spring 1993 Percent Responding			
	Agree		Disagree		Agree		Disagree	
	Male	Female	Male	Female	Male	Female	Male	Female
1. Mathematics helps one think according to strict rules.	58.1*	41.9*	51.2	48.8	57.7	42.3	46.2	53.8
5. Mathematics is a set of rules.	57.3	42.7	55.6	44.4	57.1	42.9	40.0	60.0
9. Mathematics helps one to think logically..	56.9	43.1	33.3	66.7	56.2	43.8	61.5	38.5
15. Mathematics will change rapidly in the near future.	55.3	44.7	68.4	31.6	53.7	46.3	70.6	29.4
20. There are different ways to solve most mathematics problems.	52.5	47.5	83.3	16.7	57.3	42.7	42.9	57.1
24. New discoveries in mathematics are constantly being made.	56.1	43.9	66.7	33.3	50.4	49.6	63.6	36.4
25. There is always a rule to follow in solving a mathematics problem.	54.1	45.9	52.4	47.6	54.4	45.6	40.7	59.3
32. Trial and error is not very useful in solving mathematics problems.	60.0	40.0	60.8	39.2	63.0	37.0	57.3	42.7
36. Mathematics is a good field for creative people.	53.2	46.8	66.7	33.3	58.4	41.6	54.5	45.5
40. Learning mathematics involves mostly memorizing.	55.1	44.9	56.1	43.9	48.7	51.3	60.4	39.6

* of those in agreement, 58.1% were male, 41.9% were female.

TABLE C-4 Students' Attitudes toward Mathematics and Society.

Statement	SIMMS/Fall 1992 Percent Responding Agree Male	Agree Female	Disagree Male	Disagree Female	SIMMS/Spring 1993 Percent Responding Agree Male	Agree Female	Disagree Male	Disagree Female
2. Mathematics is a useful and worthwhile subject.	55.8*	44.2*	25.0	75.0	56.1	43.9	50.0	50.0
6. I have little use for mathematics out of school.	50.0	50.0	57.4	42.6	52.4	47.6	58.1	41.9
12. Most of mathematics has practical use on the job.	56.1	43.9	75.0	25.0	53.2	46.8	66.7	33.3
14. Most people do not use mathematics in their jobs.	54.5	45.5	56.7	43.3	60.0	40.0	54.5	45.5
17. I would like to work at a job that lets me use mathematics.	67.3	32.7	51.1	48.9	74.1	25.9	44.7	55.3
23. Mathematics is not needed in everyday life.	60.0	40.0	53.2	46.8	80.0	20.0	54.3	45.7
28. It is important to know mathematics in order to get a good job.	55.6	44.4	77.8	22.2	53.9	46.1	75.0	25.0
30. Mathematics is useful in solving everyday problems.	55.4	44.6	66.7	33.3	54.3	45.7	54.5	45.5
35. A knowledge of mathematics is not necessary in most occupations.	66.7	33.3	50.0	50.0	60.9	39.1	51.2	48.8
37. I can get along well in everyday life without mathematics.	68.2	31.8	50.4	49.6	68.2	31.8	57.7	42.3

* of those in agreement, 55.8% were male, 44.2% were female.