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The Effect of Same-Sex Grouping Versus Mixed-Sex Grouping on Mathematics Achievement and Attitudes of Academically Gifted Fourth and Fifth Grade Females in the Urban Classroom

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THE EFFECT OF SAME-SEX GROUPING VERSUS MIXED-SEX GROUPING ON MATHEMATICS ACHIEVEMENT AND ATTITUDES OF ACADEMICALLY GIFTED FOURTH AND FIFTH GRADE FEMALES IN THE URBAN CLASSROOM

by

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A Dissertation submitted to the Faculty of Old Dominion University in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

THE EFFECT OF SAME-SEX GROUPING VERSUS MIXED-SEX GROUPING ON MATHEMATICS ACHIEVEMENT AND ATTITUDES OF ACADEMICALLY GIFTED FOURTH AND FIFTH GRADE FEMALES IN THE URBAN CLASSROOM

Martha J. Tompkins
Old Dominion University, 1994
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Reports of the neglect of gifted students in America's schools and the inadequate mathematics involvement of females have made educators aware of a crisis in public education. Attitudes and opportunities are believed to be major influences in helping females become more involved with mathematics courses and careers. The research project examined the effect of same-sex groups versus mixed-sex groups on mathematics attitudes and achievement in fourth and fifth grade females in a mathematically gifted pilot program at a magnet center. The experimental study was analyzed with Multivariate Analysis of Variance (MANOVA), Analysis of Variance (ANOVA), Regression Analysis, Post-Hoc tests, and Fishers Exact Test (a version of Chi-square). The General Linear Model was used because the groups were unbalanced (unequal). Achievement was measured in January and May with the Comprehensive Test of Basic Skills (CTBS). The Fennema-Sherman Mathematics Attitudes Scales was used to assess mathematics attitude in December and in May.

Females in the experimental classrooms were grouped with other females for all cooperative work for five months during the experiment. Females in the control group were grouped in traditionally mixed-sex groups for all cooperative group work. All other instruction, requirements, teaching styles, and other classroom activities remained the same. Two teachers, one at fourth and one at fifth grade, taught both the control and
Experimental groups.

No statistically significant differences were found in attitude or achievement and no statistically significant relationships were found between attitudes and achievement. However, significant results were found in the frequency of student responses to the grouping arrangement. Students in the same-sex groups report significantly more positive comments and significantly less negative comments about the grouping arrangements. Students in the mixed-sex groups report significantly less positive comments and significantly more negative comments about the grouping arrangement. This finding is significant at the .005 level and supports the need to have same-sex grouping for females in mathematics classes.

Boys do not have the same social problems and are more likely to accelerate themselves through course selection (Brody & Fox, 1980; Campbell, 1986; M. Sadker & D. Sadker 1994a). Problems do exist for minorities, immigrants, African-Americans, and females in science and mathematics fields (Ascher, 1987; Kamii, 1990; Gordon, 1993). Excelling in mathematics can be enhanced through same-sex groups for students. The mathematics program and the same-sex groups provide an environment in which females are challenged to actively participate and excel. The program provides females opportunities appropriate to their abilities, cognitive development, learning style, and achievement. Positive attitudes and high achievement scores provide evidence that the advanced mathematics program for mathematically gifted females has successfully addressed factors in the environment that can affect participation in mathematics, enjoyment of mathematics, and confidence in learning mathematics.
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Chapter I. Introduction

The student most neglected in terms of realizing full potential, is the gifted student in mathematics. Our mathematical ability is a precious societal resource, sorely needed to maintain leadership in a technological world. (Heid, 1983, p. 22)

A quick glance at statistics comparing the achievement of males and females reveals that males far surpass females in all areas of eminence as well as in most areas of what may be termed "success." There are many possible explanations as to why females, despite abilities apparently equal to those of males, pursue neither courses nor careers requiring advanced mathematics. It might be stated that, at least where mathematics is concerned, 50% of the population is underachieving. (Cramer, 1989, p. 128)

Mathematical ability, knowledge, and talent are the building blocks upon which advanced technology is built. There are societal and educational conditions which strengthen the building blocks creating a strong foundation of knowledge. For women especially, there are conditions which weaken the structure or even prevent the mathematical foundation from being built. These conditions exist in society, in homes, and in classrooms. This study will examine how certain classroom grouping practices enhance or inhibit female attitudes and achievement in mathematics.

General Statement of the Problem

Mathematics is viewed as a critical filter in the technologically advanced workplace of the future (Beauvais, Mickelson, & Pokay, 1985). This filter precipitates a crisis which looms over the future of mathematics, especially in urban schools (Kamii, 1990). The crisis became apparent when the results of a national survey of graduates' academic skills revealed weaknesses in mathematics and science (Stokes, 1990). A report from the United States Education Department alluded to a "quiet crisis" because neglect of our talented and gifted students did not help them reach their potential or prepare them for the work force (Ross 1993). The report (National Excellence - A Case for Developing America's Talent) further states that the future of our country is at stake, because if our gifted and talented
students are ignored, America will be unable to compete in the global economy. The report compared students in the United States with those of thirteen other countries and found the top 1% of American students ranked thirteenth in algebra and twelfth in geometry and calculus. In college preparatory mathematics, Japanese students at the fiftieth percentile scored higher than the top one-fifth of the United States students. Deficiencies are found in the areas of science and mathematics, areas in which females are underserved and where the country has a growing need. High school graduates fail to acquire the mathematics knowledge and problem solving skills necessary to work in high technological careers (Meece, Parsons, Kaczala, Goff, & Futterman, 1982; Ross, 1993; Stokes, 1990). As science fields expand and become more complicated, the mathematical models needed to help us explain and analyze new ideas become more complex (Gallagher, 1985). Most jobs in the year 2000 will require either no skills or more advanced skills, such as statistical analysis; many of these advanced skill jobs will require mathematics knowledge (B. Anderson, 1990).

The job force of 2000 will be 85% immigrants, minorities, and females. Many in this job force will not have reached their full potential in mathematics (Kamii, 1990). In the National Excellence in Education report, Ross (1993) reported that gifted and talented students are not challenged and do not achieve. Because of the underachievement in gifted and talented students America must invest time and resources in stimulating one of our greatest resources, humankind. Investing in the educational stimulation of gifted children is one of the most constructive things we can do to benefit our society (Gallagher, 1986).

In a 1992 national study, the American Association of University Women found that women and minorities are at risk due to loss of interest and self-esteem in mathematics and science, areas vital to professional careers and achievement. Economically disadvantaged minority students have less access to educational opportunities and often their talents are unnoticed (Ross, 1993). According to Griffin (1990), some people are willing to ignore whole groups of people, such as African-Americans, minorities, and
women, as being unsuccessful. Yet, it seems obvious that society can not dismiss groups of people who are predicted to become the majority of students in the schools and workers in the United States (Kamii, 1990). If a majority of our workers are technologically incompetent, then America cannot retain its place as a global leader. Workers with no training in computation or the use of symbols and numbers will become “illiterates” (Sells, 1978). Mathematical training and education is necessary to insure technologically competent members of the workforce of the future. This workforce will be mainly comprised of women and minorities.

The importance of mathematics, calculus, and higher mathematics preparation is amply documented in the literature. For example, Borland (1986) states "real damage is being done to girls in our schools and in our society. Girls fail to develop the potential and competence that leads to success in society" (p. 5). Few females take advanced mathematics courses, such as algebra, a course considered a "gatekeeper" for secondary mathematics courses and mathematics careers (Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1985; Griffin, 1990; Kamii, 1990). The United States does not expose enough students to advanced mathematics courses, especially calculus, a course considered a "key" to selective colleges (Useem, 1991). Calculus is also viewed as a "gateway" to more than one half of the college majors, such as the natural sciences, engineering, economics, political sciences, sociology, psychology, and technology (Beane, 1988; Meece et al.; 1982; Sells, 1980; Useem, 1991).

The importance of a solid mathematical background is supported by the findings of several researchers. Sells (1978, 1980) found that calculus is required for most undergraduate majors. Calculus or the lack of the mathematics background needed to take calculus acts as a "critical filter," limiting college choices to humanities, music, social work, elementary education, guidance, and counseling. In a random sample of Berkeley students, Sells discovered 43% of the males and 92% of the females have inadequate mathematics background, thus preventing them from taking calculus at the college level.

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Inadequate mathematics background prohibits job opportunities in many professional careers (Fennema & Sherman, 1986; VanTassel-Baska, 1989). Dweck (1975) found mathematics skills are needed in high status jobs with good financial rewards such as medicine, engineering, architecture, pharmacy, computer science, and physical sciences. Higher and more advanced mathematics preparation in high school and college will lead to financially rewarding careers.

Usually, more advanced mathematics courses will lead to occupations with more status. Higher mathematics preparation, contends B. Anderson (1990), generally leads to higher income and less unemployment. In some cases however, Reis (1987) found economic rewards were missing because women generally earn 60% as much as men. Recent reports confirm that a woman earns 70.6 cents for each dollar a man earns (Bowers, 1994; Nussbaum, 1994). Clark (1983) discovered that two thirds of the women in the United States earn less than $10,000 per year. In 1993, Nussbaum (1994) found 62.2% of women earned minimum wage or less, an amount that puts many women $20.00 above the food stamp level. Clark (1983) discovered the majority of menial and semi-skilled jobs are held by women (80%); therefore, it is not surprising that two-thirds of the women with an IQ of 170 or higher are housewives or office workers. Clearly, we are not utilizing some of our more precious resources, great female minds.

The disparity between the number of boys and girls taking further mathematics courses compounds the problem of the current mathematics and science crisis in this country. Equal opportunity for women is denied by different school treatment and experiences for girls and boys in mathematics (Lindley & Keithly, 1991; M. Sadker & D. Sadker, 1994a). Males get more attention, thus females are often ignored by teachers and are not given a chance to actively participate in class (Ascher, 1987; Luchins & Luchins, 1980; Rathbone, 1980; M. Sadker & D. Sadker, 1994a). An American Women in Mathematics Survey found evidence that differential treatment increases as women advance professionally (Rathbone, 1980). This is evident in the underrepresentation of minorities.
and women in mathematics and mathematics careers (B. Anderson, 1990; M. Sadker & D. Sadker, 1994b). Twice as many boys as girls take advanced mathematics courses (Benbow & Stanley, 1982b; Fennema, 1974; George, 1976). Patterns of taking mathematics courses and attitudes toward mathematics are crucial to female mathematics success (Reis & Callahan, 1989). An increasing number of capable students are deciding not to study advanced mathematics and many more girls than boys make this decision (Fennema & Sherman, 1986). The perception of the mathematician as an eccentric "white male nerd" (Beane, 1990) discourages girls and minorities from joining mathematics classes. Fennema and Sherman (1986) feel attitudes influence the decision to study and learn mathematics. These attitudes, which develop as students progress through their school experiences, are influenced by the messages received from peers, teachers, and parents. Competence in mathematics can lead to careers in aerospace, architecture, chemistry, engineering, environmental science, physics, and computer science, wrote Griffin (1990). Female students often have less opportunity to be involved with mathematics and computers in school than male students (Ascher, 1987), therefore, they lack opportunities to be competitive in mathematics courses and careers.

The precarious status of female representation is revealed in occupational status and statistics. M. Sadker and D. Sadker (1994a) found that women at work are listened to less, spoken to less, promoted less, and paid less. Nussbaum (1994) reveals that the majority of low-pay, low-rank, and low-management jobs are held by women. The numbers show that of the 500% increase in engineers (Campbell, 1986), only 5% are female (1.6% is black). In 1985, Boswell found 2% of the engineers are women and 2.5% have a Ph.D. in physics. Recent information shows only 8% of the engineers are women (M. Sadker & D. Sadker, 1994a). Clark (1983) reports that one third of the MBAs are earned by women, yet females represent only 7% of the business owners and 5% of the business executives. In 1994, Nussbaum found 2% of the business executives were women and only 3% of the executives were women of color. Role models for
female students are lacking in education because 80% of the elementary principals are men, as are 96% of the junior high principals, and 98% of the nation's school superintendents. Women represent 70% of the teachers in America, yet they earn 15% less than male teachers (Nussbaum, 1994). Ernest (1980) states that 7% of the Ph.D.s are earned by women, while 1.6% of the mathematics professors are women. A local university shows 10% of its College of Science professors (mathematics, computer science, and sciences) are women. At the same university, 68 of the 428 graduate engineering students are women (Gordon, 1993). Chipman and Thomas (1985) report a low of 3% of women are involved in mathematics careers. Clark (1983) found females represented 20% of those in medical school, yet no woman headed a medical school. In an occupational report, Silverman (1986) found that females constitute 3% of the dentists, 6% of the engineers, 8% of the architects, 15% of the physicians, 20% of the scientists, and 99% of the secretarial force. Clearly these occupational statistics are discouraging. Although affirmative action initiatives have changed some figures positively, stereotyping of sex roles pushes women of all cultures to select the traditional careers of teaching, nursing, and social work rather than mathematics related careers (Powell 1990). Beane (1988) is convinced that sex stereotyping inhibits minorities and females from pursuing mathematics or mathematics careers. M. Sadker and D. Sadker (1994b) feel "schools should make science and mathematics more female friendly" (p. 9). Evidence abounds that providing successful experiences in mathematics can build self-esteem, interest, and positive mathematics attitudes in mathematics career areas for gifted female students. This study will examine grouping practices which could provide successful experiences for females in the area of mathematics.

**Significance of the Study**

Children begin career aspirations in early elementary school, sometimes as early as kindergarten, where classroom opportunity to role-play different occupations is found.
Fox and Tobin (1988) believe career aspirations begin in kindergarten with males more likely to choose mathematics careers than girls. Females typically get little encouragement to pursue mathematics careers. Brody and Fox (1980) found women pursue mathematics in smaller numbers than men. Women achieve less and work less in mathematics-related careers. Mathematics is vital to professional careers in which women are underrepresented (Campbell, 1986; Fennema & Sherman, 1977). This underrepresentation is evident in the current workforce. Approximately 50% are female, yet only 13% are involved in science, mathematics, or engineering (Reis & Callahan, 1989). This study will examine classroom practices that could encourage women to become interested in mathematics careers and stay interested in mathematics.

This research study is timely in that it is congruent with recent reports of underachievement and underchallenge of gifted students (Ross, 1993), gender bias in classrooms (AAUW, 1992; Lindley & Keithly, 1991; M. Sadker & D. Sadker, 1994a, 1994b), high school students who are inadequately prepared for careers in mathematics and technology (Stokes, 1990), an inadequately prepared mathematics teaching force, a curriculum written for the industrial age (Wheatley, 1983), out of date textbooks focused at the computational level, and emphasis on drill and practice in elementary grades (VanTassel-Baska, 1989). Ross (1993) believes the regular school curriculum is not appropriate for advanced learners, the teaching style is inappropriate, the learning climate is negative, and accommodations are not made for gifted students. Henry (1993) reported that it is wrong for students who are brilliant in mathematics to have to sit around and waste time. The current situation in America's schools does not challenge the gifted student, especially the female mathematically gifted student.

Reports confirm that many students, not just gifted students waste their time in school. The National Excellence report (Ross, 1993) shows that elementary students have mastered 30 - 50% of the year's curriculum before they begin school. Reis (1993) reaffirmed this finding in a national study that shows 60% of the students studied already
knew 80% of the material they would study that year. She found that most teachers make few provisions for the gifted or talented student, primarily because they have no training in providing a differentiated curriculum. School materials provide little challenge for the average student and certainly not for the gifted (Mead, 1991). Gifted students are frequently burned out because they are "rewarded" for working quickly by being given additional boring work (Huang, 1994). Even though reports show most students already know most of the year's curriculum, little is done to accelerate or accommodate gifted students, male or female.

Pre-existing gender-related abilities are sometimes incorrectly cited as the reason for uneven performance in mathematics. Reis and Callahan (1989) found no innate differences in spatial ability in females and males. Females outperform males in the early school years on achievement tests, yet their scores lag on the SAT, especially in science and mathematics (Lindley & Keithley, 1991; M. Sadker & D. Sadker, 1994a). According to Cramer (1989), research is needed at the elementary level, to determine if grouping practices influence mathematics attitudes and achievement. The current focus in classroom activity in Virginia Beach City Public Schools is on homogeneous cooperative learning groups. Males tend to take over speaking roles and leadership roles in cooperative grouping situations (M. Sadker & D. Sadker, 1994a). Therefore, the arrangement of cooperative groups creates a practical problem for every teacher. The research study will examine grouping practices that could influence the success of the feminine half of the school age population.

**The Research Study**

**Research Questions**

There are three main questions this research study attempted to answer: One, will there be a difference in the mathematics achievement level of fourth and fifth grade mathematically gifted females in same-sex cooperative groups from those in mixed-sex cooperative groups? Two, will there be a difference in attitudes towards mathematics in
fourth and fifth grade mathematically gifted females in same-sex cooperative groups from those in mixed-sex groups? Three, will there be any interaction between attitude and achievement in fourth and fifth grade mathematically gifted females in same-sex cooperative groups or in mixed-sex groups?

Research Objectives

The research project studied the impact of certain grouping practices on mathematical achievement and attitudes of fourth and fifth grade females with advanced mathematics ability (academically gifted) who were enrolled in a mathematics pilot program at Old Donation Center, a magnet school in Virginia Beach, Virginia. Grouping practices within ten different classes, representing five different days, chosen randomly, were examined to determine the effect of all female versus male-female grouping on mathematics attitudes and achievement. Attitudes were measured with a pre-post instrument, the Fennema-Sherman mathematics Attitudes Scales (F-S MAS). Achievement was measured on the mathematics computation and concepts portions of the Comprehensive Test of Basic Skills (CTBS).

This study was limited to fourth and fifth grade girls with advanced mathematical ability. The results may have application for females at all grade levels with advanced mathematics or science abilities. The results may also apply to minorities with similar abilities and concerns (Kamii, 1990). In a comprehensive study of the trends and issues in minority education, Ascher (1987) found African-Americans, Hispanics, and Puerto Ricans were severely underrepresented in advanced mathematics and academic tracks. She feels enrollment is low in these areas because these areas are perceived as useless, stereotyped as a white domain, and lacking racial role models for students. Because of all of these factors, Ascher found minorities score below the norm on science and mathematics achievement tests. Nationally, minorities and female represent a significant portion of the population and the future workforce. Consequently, this study will contribute to advancing the knowledge base concerning these populations.
The value of this research will be new information about gender issues in the urban elementary school, especially in a subject area in which females traditionally do not excel. This study's objective is to contribute to knowledge concerning how gender attitudes can influence student attitudes toward a subject area and achievement in that area. This information could influence classroom grouping practices as teachers become aware that at certain times it is more beneficial if females work with females. This classroom change is extremely easy to implement. Benefits to the school system would be the research basis for establishing a magnet school for advanced mathematics and science instruction. This could result in increased mathematics scores and increased opportunities for meeting the unique needs of female students.

The benefits to female students in the urban school setting would be self-esteem gains and positive attitudes towards mathematics which would ensure continued interest, success, and enrollment in advanced mathematics courses and careers. Future impact will be the increased number of women involved in mathematics and mathematics careers as well as increased wage earnings for the 60% of the population that will be working in the 21st century. This study will provide knowledge about attitudes and achievement of elementary students in mathematics. Knowledge that is important to determine appropriate instruction for females that will enable them to learn mathematics more efficiently, enhance their achievement, expectations, and increase their involvement in mathematics careers (Yong 1992). Hollinger (1991) believes this kind of career involvement is essential to insure that society will not lose approximately one-half of the pool of future mathematicians. Reis (1987) feels it is necessary to address the factors in the environment that can be manipulated to help ensure the development of ability and achievement in mathematics and mathematics careers. Mathematically gifted females deserve an environment in which they are encouraged and expected to fully participate; only then can society maximize their personal, academic, and career potential (Phelps 1991). This research study will examine an aspect of the classroom environment to
determine if grouping practices can encourage females to participate more actively. Active participation through same-sex grouping practices is theorized to lead to more positive attitudes toward mathematics and thus to better achievement.

**Definitions**

Terms used in this research study will be operationally defined in the following section. Because opposing views exist in defining some of the terms, a more thorough discussion of the varying opinions will be found in Chapter II.

**Accelerated** - the increase in the speed or rate, in this case of exposure to mathematics ideas, topics, and concepts (Webster, 1979).

**Arithmetic** - the art of computing with numbers (Webster, 1968).

**Attitude** - a manner of acting, feeling, or thinking that shows one's disposition or opinion toward a given topic (Webster, 1968).

**Curriculum** - a specific course of study (VanTassel-Baska, 1992).

**Cooperative work** - small groups of students of two to five working cooperatively to solve a problem, perform an operation, or other classroom activity (VanTassel-Baska, 1992).

**Differentiation and differentiated curriculum** - a course of study that is different from the curriculum to which most of the students are exposed (Borland, 1989).

**Curriculum compacting** - the combined use of enrichment and acceleration to move students through new areas once they have mastered a certain area (Wolffe, 1988).

**Effectance** - a concept pertaining to motivation in mathematics that was developed to measure the effectance or active involvement and enjoyment of mathematics (Fennema & Sherman, 1986).

**Enrichment** - a broadening of the curriculum to include elements not usually present (Southern & Jones, 1991).

**Gifted and Talented** - are those identified by professionally qualified persons who, by virtue of outstanding abilities, are capable of high performance.
These are children who require differentiated educational programs and/or services beyond those normally provided by the regular school program in order to realize their contribution to self and society.

Children capable of high performance include those with demonstrated achievement and/or potential ability in any of the following areas, singly or in combination: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, visual and performing arts, psychomotor ability (Parke, 1989, p. 7)

Higher Order Thinking Skills - application, analysis, synthesis, evaluation, and problem solving (VanTassel-Baska, 1992).

Locus of Control - a sense of the feeling of control over your own life (Tobias, 1976).

Mathematics - the group of sciences (including arithmetic, geometry, algebra, and calculus) dealing with quantities, magnitude, forms, and their relationships, attributes by the use of numbers and symbols (Webster, 1968).

Summary

Recent reports of the neglect of gifted students in America's schools and the inadequate mathematics preparation of high school graduates have made educators aware of a crisis in public education. Mathematics as a curriculum and an occupational area has consistently been underrepresented by females. Advanced mathematics is needed for certain college majors and many careers in which women also have been traditionally underrepresented. Explanations or reasons for this phenomenon point to cultural factors rather than innate abilities. Attitudes and opportunities are believed to be major influences in helping females with mathematics abilities decide to take advanced mathematics courses which would lead to mathematics careers. This research study will examine the effects of class groupings on female attitudes and achievement in a specialized mathematics program.
Chapter II. Review of the Related Literature

The theoretical framework was constructed after a wide range of research and literature concerning factors which could influence a female student's attitudes toward mathematics and achievement in mathematics was examined by this researcher. Related literature was explored concerning internal and external barriers that prevent success in courses and influence different career aspirations for men and women. The influence of teacher and peer attitudes was examined along with the relationship between attitude and achievement. Achievement in mathematics has often been related to "innate" differences in thinking abilities for males and females. These "innate" differences were studied in the literature review. Students with specific abilities are often accelerated in different ways; acceleration and enrichment was examined and defined. Research studies of acceleration practices were also examined to determine problems and possibilities. In addition, identification, socio-emotional, and curriculum issues were reviewed to determine how best to meet the needs of mathematically gifted students. The lack of research at the elementary level is discussed, terms are defined, and recommendations from the literature conclude the theoretical framework.

Related Literature

Barriers to Females

Society imposes restrictions and expectations on females that often become internalized as barriers. Whitmore (1980) discussed internal and external barriers that prevent achievement for gifted students. Internal barriers, she believes, include perfectionism, supersensitivity, and deficiency in social skills. External barriers spring from societal pressure or expectations as well as the lack of appropriate educational provisions. Inappropriate educational provisions exist in non-differentiated curriculum, instructional style, teacher philosophy, and punitive social climate. Boswell (1985) found
three factors that prevent women from participating in mathematics fields. These barriers are external forces such as sex discrimination in education, science, and business; social pressure from parents and peers; and internal barriers from negative attitudes and beliefs.

models of the same sex discourage women and minorities from entering mathematics careers (Beane, 1988; Fox & Tobin, 1988; Fox, Brody, & Tobin, 1985). Sex-role stereotyping affects everyone, wrote Grau (1982), because it hinders personal and professional growth. Sex-role stereotyping limits what males and females believe they can achieve. Negative views of female abilities in relation to their role in society has harmful and limiting effects on the development and nurture of giftedness in girls (Silverman, 1986). These negative perceptions influence the subtle manner in which girls are treated by parents and teachers, thus limiting the development of their full potential.

External barriers are often gender specific, but can be non-gender specific. Reis and Callahan (1989) contend gender specific external barriers exist for adult women such as entry into traditional male occupations, unequal pay for equal work, and sexism. Other non-gender related external barriers exist that include racism and the condition of the job market. Hollinger (1991) believes that of all the barriers that exist for female achievement in mathematics, sex-role socialization is the most pervasive and limiting.

**Sex role socialization**

Sex role socialization begins in infancy when parents begin to encouraging independence and risk-taking in males while encouraging dependency in girls (Clark, 1983; Meece, et al., 1982; Silverman, 1986). Girls are encouraged to exhibit socially related behaviors that are passive, accepting, and nurturing. Males are encouraged to be aggressive, self-confident, impulsive, risk-takers, active, and curious. Males expect to perform better, have higher expectations, and set higher standards for themselves (Clark, 1983). Studies (Meece, et al., 1982) revealed "socializers treat boys and girls differently in a variety of ways that might be linked to mathematics and course selection" (p. 331). Clark (1983) noticed that the kind of help significant others in the environment give to children is different; "others" encourage males to be independent and "others" encourage females to be passive and dependent. Even the toys children play with may prepare them for mathematical activities. Toys for males are often spatial games that are mathematically
oriented (Meece, et al., 1982). These factors combine to deter the efforts of females to pursue advanced mathematics courses and mathematical related careers.

Children begin thinking and role-playing different occupations in early elementary school. The difference in career aspirations begins as early as kindergarten, with males more likely than girls to choose mathematical careers even if the girls are gifted in mathematics (Fox, 1976). Females typically get little encouragement from teachers, parents, or peers to pursue mathematics courses or careers. The message that girls get from their significant others is that mathematics is a male domain (Clark, 1983; Fennema & Sherman, 1977; Fox, 1976; M. Sadker & D. Sadker, 1994a). As a consequence, females are more reluctant to take advanced mathematics courses (Brody & Fox, 1980). If they do take mathematics courses, they tend to be low level courses (Fennema, 1974). Chipman and Thomas (1985) reported that a national study revealed 22% of female students take four years of high school mathematics. Although this figure was an increase from the 9% found in 1960, the authors were not alarmed by their findings. However, 78% of females are not taking four years of high school mathematics. The fourth year of high school is generally the year in which calculus or other advanced mathematics courses would be taken. These advanced mathematics courses serve to gain admittance to certain college majors.

Writers, concerned with the problem of maintaining interest in taking advanced mathematics courses, have suggested methods to ensure that females begin and continue their interest in mathematics. Taffel (1987) and Silverman (1991) believe exposure to a stimulating curriculum at an early age will motivate females to choose advanced mathematics courses that lead to careers requiring mathematics talents. Fox and Tobin (1988) consider mathematics the key to unlock career opportunities available for most intelligent and academically talented students. Mathematics is vital to professional careers in which women are underrepresented. Females number only 13% of those involved in science, mathematics, and engineering (Reis & Callahan, 1989). Mathematical
competency is necessary for a wide range of careers, not only in mathematics, science, business, social sciences, but also with statistics and computers (Brody & Fox, 1980). Mathematical knowledge and concepts learned in advanced mathematics courses is necessary to function effectively in certain occupations, especially highly technical jobs.

Ability and Attitudes

Ability Differences in Females and Males

Differences in ability to perform well with mathematical reasoning has been posited to be the result of differences in "innate" ability. Maccoby and Jacklin are frequently mentioned in literature pertaining to differences that exist between male and female mathematical ability and reasoning. Fox (1977) presented a summary of Maccoby and Jacklins' 1974 research which is often cited to support innate differences in males and females. Maccoby and Jacklin's research found that women and men did not differ on global intelligence, but mathematical differences showed at the end of elementary school when males performed better in geometry and these differences continue at incremental rates. Hyde (1981) conducted a meta-analysis of Maccoby and Jacklin's 1974 research in psychological gender differences to determine if the reported findings of mathematical sex differences were as great as had been reported. "Maccoby and Jacklin concluded that three cognitive gender differences were well-established: girls have greater verbal ability than boys, and boys have better visual-spatial ability and better mathematical ability than girls" (Hyde, 1981, p. 892). Hyde believes the impression of large gender differences is wrongly assumed by the wording of the findings. Her meta-analysis generated "W2" which measured the proportion of the total variance in the population that is accounted for by difference in gender. In verbal ability W2 was .01, therefore gender accounted for 1% of the variance. Quantitative ability W2 was .01, again 1% of the variance. Visual-spatial ability W2 was .043 or 4.3% of the variance. Gender differences in verbal, quantitative, and visual spatial ability were small, accounting for no more than 1% - 5% of the variance.
Hyde felt that Maccoby and Jacklin's research is misused, especially by counselors, when helping students to decide course and career choice. The stereotype of women being unable to understand mathematics prevents others from "pushing" them towards mathematics (Ascher, 1987). Counselors, parents, teachers, and peers frequently advise females not to take mathematics courses or not to be interested in mathematics as a career, because they are conditioned to believe that women cannot perform as well as men.

Because there are many conflicting opinions concerning the differences between males and females in mathematical ability and reasoning, research studies have examined sex differences under controlled conditions. Eccles (1985) reported the reasons males outperform females are that males are better at spatial problem solving; males get more encouragement for advanced courses and careers; mathematics is perceived as a male domain; and males perceive themselves as more competent and confident in learning mathematics. Benbow and Stanley (1982a) found small statistical sex differences in mathematical reasoning ability, attitude, and mathematical performance with students in their Studies of Mathematically Precocious Youth (SMPY) program. When males and females have the same or similar mathematics background there were no differences in achievement on mathematical tests (Eccles, 1985; Fox & Tobin, 1988). In another study of mathematically advanced youth, Biggerstaff (1990) discovered no difference in abilities but did find different approaches among males and females to solving problems. There seem to be no clear conclusions about male and female differences in mathematical ability.

Studies among secondary students have investigated patterns of taking mathematics courses. Fennema (1980) discovered little difference in male and female abilities in a study of secondary mathematics students, but she found great differences in patterns of mathematics course taking as well as the level and type of mathematics courses taken. Chipman and Thomas (1985) reported that a 1979 study shows selection of different courses accounts for all sex differences found in twelfth grade mathematics. The authors concluded that sex differences in mathematics achievement are accounted for by differences
in mathematics course enrollment. Useem (1991) studied twenty-six school districts near Boston and found 16% - 17% of the students were in accelerated mathematics in the eighth grade but only 5% - 6% took calculus in their senior year. The patterns of mathematics course taking and mathematics attitudes are crucial to female mathematics success (Reis & Callahan, 1989). Obviously, patterns of taking mathematics courses vary among males and females. If males and females abilities are similar in elementary school there must be external factors or attitudes that influence the interest women have in pursuing more advanced mathematics courses.

Although there is much research about how different sexes think and perform in mathematics there appear to be no firm conclusions. Fox (1977) stated that in spite of research about the brain, we know too little about the organization and operation of the brain to say if there are specific differences in male and female abilities. It is possible that the research which supports that males are better than females in mathematical activities is flawed because the course taking precedents are different for males and females. Although there is a belief that males have advanced spatial ability which gives them an advantage on standardized tests, no innate differences were found in spatial ability in females and males (Reis & Callahan, 1989). In fact, in one study, thirteen year old females scored better in spatial visualization and computation than males (Chipman & Thomas, 1985). Davis and Rimm (1989) reported results of several research studies: a longitudinal study found no significant sex differences in mathematical or spatial ability on the SAT-M; a Hawaiian study of males and females found female achievement was higher; a 1980 study found no support that any ability is totally and exclusively related to sex. There were no differences in spatial relations, thus no link between spatial ability and achievement. It seems that for each study that "proves" males perform better, one can find one that contradicts the finding.

Fennema and Sherman (1977) conducted an in-depth study of 559 females and 644 males in the ninth through twelfth grade at four high schools. Results showed that males
score higher in spatial visualization (results were significant at two of four schools). Boys score higher in mathematical confidence (three of four schools) and rate mathematics as a male domain; this was significant at all schools. Sex-related differences in performance were found to be small. The data do not support either the expectations that males are invariably superior in mathematics achievement, in spatial visualization, or in more difficult mathematics courses.

A follow-up study using the Fennema-Sherman Mathematics Attitudes Scales was conducted by Fennema and Sherman (1978) with junior high students. They used 1,320 sixth through eighth grade students with equal distribution of white males and females of varied socio-economic levels. Sex differences showed in two affective variables: confidence in learning mathematics and mathematics as a male domain; both were significant for males. Results showed women score higher in computation, males score better in higher cognitive level mathematics, and there is no significant difference in spatial visualization. Fennema and Sherman found no universal sex-related differences in mathematical learning. The authors interest in attitudes males and females have about mathematics led them to develop the mathematics attitudes scales. These authors reflect the opinion of this researcher and many others who believe that attitudes and perceptions about mathematics and mathematical ability may inhibit females from reaching their full potential in mathematics.

There is an abundance of literature on sex differences in mathematical abilities. Fennema (1980) reported that reviews of mathematics literature before 1974 found no sex differences in mathematical abilities in young children but differences emerge in upper elementary or junior high school. After 1974 conclusions were different. The author compared four major studies: Project TALENT, National Longitudinal Study of Mathematical Abilities (NLSMA), The First National Assessment of Educational Programs (NAEP-1), and The Fennema-Sherman studies. She reached the following conclusions: no sex-related differences were evident in elementary school at any cognitive level, from
computation to problem solving; beyond elementary school differences did not always appear; if differences appeared after seventh grade they tended to favor males, especially in mathematical reasoning; there was evidence that sex-related differences found in high school mathematical learning were not as great in 1978 as in previous years; and ideas reached about male superiority have often been gathered from old data or from data in which the number of prior mathematics courses was not considered. Fennema concluded, when students of similar mathematics background are studied, differences in achievement are small. Fennema and Sherman (1977) felt previous research showing differences in mathematical ability had been conducted with subjects of unequal mathematical background. The authors concluded that opinions about females having less aptitude in mathematics should be changed. In order to change prevailing attitudes concerning female performance education must begin early in all students’ lives. The attitudes of males as well as females must be changed if females are to be encouraged to excel.

Patterns of differences in mathematical achievement, spatial visualization, and affective variables point to the influence of socio-cultural factors. Meece, et al. (1982) in a literature review of mathematics, females, and careers, found achievement differences that favored boys are not large or always found in senior high students. The authors said expectations of performance because of sex are not universally found but if they were found they favored boys. Silverman (1986) concluded if there are no or only slight differences between abilities of males and females, then the environment must exert powerful influences. The environment in which students learn should be studied in order to determine what is the best method to help females reach their full potential in mathematics.

Boys are not innately superior, in fact, females outperform males in the early school years. In a comprehensive research review of various aged students, Fennema (1974) and Stokes (1990) found no significant differences in mathematical abilities in pre-school or elementary age students. Girls occasionally outperform boys on computational skills.
(Meece, et al., 1982). If there were differences in fourth through ninth grade, they favored boys for higher level thinking (Fennema, 1974; Stokes, 1990). Sex differences showed up at junior high level where boys performed better than girls in all levels of mathematics cognitive thinking (Benbow & Stanley, 1982b; Raymond & Benbow, 1986; M. Sadker & D. Sadker, 1994a). Conner and Serbin (1985) studied 335 seventh and tenth grade male and female students; results found males did not show better performance than females until the tenth grade. If females do not take higher level mathematics courses, naturally their scores after tenth grade would not be as high as boys who tend to take more advanced mathematics courses.

Students gifted in mathematics, who have participated in special programs, have been compared to determine performance differences. A junior high male and female Study of Mathematically Precocious Youth (SMPY) found the boys' mean score on the SAT-M was significantly higher than the girls' (Fennema, 1980). There may have been a problem in this study because the students volunteered to participate. Only a few of the females volunteered for the study, indicating that perhaps they were not confident of their ability in mathematics. Fox and Cohn (1980) also conducted a thorough study of SMPY results from 1972-1979. Results revealed the boys' mean score on the SAT-M was 31 points higher than the girls' score. Although the percentage of boys who scored higher than the top scoring females has declined since 1972 when the study began, Fox and Cohn posit the theory that differences could be related to environmental factors. These environmental factors could be the complications of conflicting adolescent female roles (Brown & Gilligan, 1992; Silverman, 1986). It is interesting to this researcher that Brown and Gilligan, as well as, Silverman found almost identical problems that are experienced by women, even though their approach to studying women is different and from a different perspective.

Female Abilities, Attitudes, and Mathematics Study

Females tend to underestimate their performance and abilities, especially in the area
of mathematics. Girls become vulnerable during early adolescence when their self-esteem and confidence in mathematics drops. Consequently, Campbell (1986) concludes, they have less expectations of success in mathematics and mathematical courses. Females use social interactions to determine their personal quality and acceptance of achievement. Gifted girls have trouble reconciling high achievement with femininity and may choose not to be high achievers because they perceive this to be unfeminine (Freeman, 1985; M. Sadker & D. Sadker, 1994a). They compare themselves with others to determine their self-worth (Reis & Callahan, 1989) and often view themselves as less competent (Meece, et al., 1982). The perception of a young female as less competent coupled with underestimation of performance and abilities prevents her from achieving or pursuing mathematics courses or careers.

Although girls are stronger than males in mathematics fundamentals, the decline in self-esteem and self-confidence in early adolescence coupled with negative attitudes of female giftedness contribute to the decline of mathematics achievement and taking courses at the secondary level. Ascher (1987) found that females in high school lack interest in mathematics as a result of socialization and lack of early achievement. Minority females had a high interest in mathematics, yet, few choose to take advanced mathematics courses. S. Anderson (1990) believes cultural pressures which push students toward or away from mathematics begin in the sixth grade. Therefore, intervention to counteract cultural pressure is needed before the students arrive at the sixth grade level.

National studies have examined differences and similarities in male and female performance in mathematics. A National Assessment of Educational Progress (NAEP) report showed no differences in males or females on a wide range of mathematics skills (Stokes, 1990). Conversely, Armstrong (1985) found males outperform females at every level of mathematical courses on problem solving. Males and females show equal ability on arithmetic tests in elementary school; yet, females exhibit lower mathematics and science scores on the Scholastic Aptitude Test (Fennema, 1974; Fox, 1980; Lindley &
Keithley, 1991). Borland (1986) wrote that there are strong societal forces that negatively affect cognitive development. It is necessary to address the forces in our environment that can be manipulated to help ensure the development and encouragement of mathematical ability and achievement in young females (Reis and Callahan, 1989). Females do not suddenly become untalented or ungifted in mathematics in the time span between elementary school and middle school. The female brain does not suddenly stop developing after girls leave the fifth grade. Something must happen socially and environmentally that causes these differences to develop and to be so inconsistent.

Girls do not choose to take advanced mathematics courses in large numbers. Casserly and Rock (1985) reported a 1978 women in mathematics survey which found that 7.2% enrolled in calculus were females. The numbers in certain mathematics courses were significant at the .05 level (Armstrong, 1985). Numbers showed the percentage of total twelfth grade students enrollment in certain mathematics courses. These courses included probability and statistics (9.5% males and 4.9% females), algebra (53.7% males and 42.2% females), accounting (32.6% males and 40.5% females), and business mathematics (32.6% males and 40.5% females). These figures indicate that female enrollment is low in every advanced mathematics course. Fox (1980) emphasized that the difference in male and female patterns of taking mathematics courses and in pursuing mathematical careers goes beyond ability and was related directly to attitudes that exist and become compounded during the middle school years. It is important to address these attitudes in early elementary school during the formation stage.

Students have the freedom to choose advanced mathematics but do not do so because of the lack of information and the lack of social support from peers, parents, and teachers (Sells, 1980). A 1978 Study for Mathematically Precocious Youth (SMPY) showed girls less likely to prefer mathematics courses, less likely to like or find mathematics useful, and more likely to say mathematics is difficult (Brush, 1985). Negative attitudes such as these will prevent females from being interested in mathematics.
because they have a perception of themselves as incapable of performing well in mathematics. If students at the middle school level have perceptions of themselves as capable of doing mathematics, this will influence their decision to stay in mathematics courses (Griffin, 1990). Brush (1985) discovered two predictors of student course preference were feelings about mathematics and gender. These findings were significant at the .001 level. A successful mathematics program can help give students a more positive perception of having mathematics ability which will help develop more positive feelings about mathematics.

**Relationship between Attitudes and Achievement**

Attitudes gained from a child's society, environment, and culture play an important role in the success that a student experiences with mathematics. Webster (1968) defined attitude as a "manner of acting, feeling, or thinking that shows one's disposition or opinion" toward a given topic. Teacher attitudes are important, especially to female students, because teachers expect more from and interact more with males in mathematics classes (AAUW, 1992; Fox & Tobin, 1988; Meece, et al., 1982; M. Sadker & D. Sadker, 1994a; Stanus, 1993). White males are the most likely to get teacher attention; black girls are the least likely to receive teacher attention (M. Sadker & D. Sadker, 1994a). Teacher attention is important in developing self-esteem and achievement. The difference in teacher interaction begins in second grade (Meece, et al., 1982; M. Sadker & D. Sadker, 1994a) when boys get more and different quality feedback from the teachers. Boys are criticized for neatness while girls are criticized for correctness. Teacher attitudes which encourage or discourage are critical to the development of interest and persistence in mathematics courses (Fox, 1980). Fox believes teacher attitudes and expectations have been found to deny classroom opportunities to females thus raising equal opportunity issues. Teachers can provide important opportunities in mathematics class for girls to participate on an equal basis with boys.

Young gifted females are influenced by the attitudes from their male peers. These
male attitudes may be factors influencing how females participate or perform in mathematics (Cramer, 1989). Lindley and Keithley (1991) believe that children form attitudes based on messages they receive from others. These messages from peer groups appear to play increasingly important roles as students advance in age and grade (Boswell, 1985). Coleman and Fults (1982) found students determine their capabilities on the basis of comparisons with others in their environment through the messages they receive from others. Evidence has been found that males begin sending messages as early as fourth grade concerning the inadequacy of female mathematics ability and aptitude (Yong, 1992). These messages contribute to gifted girls considering themselves unfeminine if they are high achievers (Freeman, 1983; M. Sadker & D. Sadker, 1994a). High achievement in gifted girls seems to conflict with the societal "ideal" of feminity.

Girls begin their school life and progress through elementary school equal to boys on achievement tests but this progress tapers off due to socialization forces during adolescence (Silverman, 1986). It seems that girls are more influenced by peer pressures and peer attitudes than boys, especially concerning mathematics (Evans, 1971). Gifted girls begin underachievement around the sixth grade, when it is believed they have less self confidence and little locus of control (Brown & Gilligan, 1992; Clark, 1983; Gallagher, 1985). The idea of little locus of control (control over your own life) is evidenced by the fact that women attribute success to external factors and failure directly to themselves (Davis & Rimm, 1989; Tobias, 1976). Women often fail to take "credit" for their own ability and excellent work.

Adolescent Complications

Adolescence presents many complications for all students, especially for gifted girls. Brown and Gilligan (1992) explored the complications of adolescence and liken early adolescence to a crossroads for females when they are pulled in several directions when their wishes and desires conflict with society's wishes and desires. They are often in danger of losing their 'self' or their own 'voice' because they allow the other influences
in their lives to dominate. "At adolescence, girls can become more readily disconnected from what they are feeling, distanced from their own desires and pleasures, and ironically more reliant on others to tell them what they want and feel and think and know" (Brown & Gilligan, 1992, p. 169). Adolescent girls do not have the self-confidence to determine their own futures and often allow others to determine their future by telling them what they are capable or are not capable of doing.

Peer attitudes and acceptance are strong motivating forces for adolescents. A change is needed in boys' sexist attitudes to enable them to accept and support females in mathematics roles throughout all levels of school (Fox, 1980; M. Sadker & D. Sadker, 1994a). Problems are exacerbated at middle school level when the social status decreases for intellectually gifted females. In middle school interest in mathematics begins to dwindle; however, girls' interest declines earlier than boys (Meece, et al., 1982). Boys generally rate mathematics more useful than girls rate mathematics. The perception of the usefulness of mathematics is important to its pursuit. The perception of the value of mathematics or mathematics related careers can be a predictor of achievement, future course plans, and career pursuit.

Adolescents perceive mathematically gifted girls more negatively than mathematically gifted boys. Intellectual achievement is viewed as unfeminine (Ernest, 1980; Homer, 1969; M. Sadker & D. Sadker, 1994a). There is much peer pressure against mathematics achievement for girls because mathematics is stereotyped as both a male subject and as a male domain (Austin & Draper, 1981; Benbow & Stanley, 1982a; 1982b; Brody & Fox, 1980; Campbell, 1986; Fox, 1980; Raymond & Benbow, 1986). Fennema and Sherman (1986) feel mathematics underachievement for females reflects larger cultural conditions. Mathematics underachievement is a reflection of societal barriers and attitudes that prevent females from becoming successful.

The attitudes toward a subject can influence how interested the student will be in that subject and possibly how she will achieve in that subject. Mathematics attitudes are as
important as the study of mathematics (Blum-Anderson, 1990). Evans (1971) believes that mathematics attitudes play an important part in learning mathematics. Student attitudes are the source of sex differences in mathematics achievement and course selection (Meece, et al., 1982). Evans reported a 1942 study in which boys liked and achieved better in mathematics than girls. Evans interpreted this finding of mathematics as a male-typed subject as being closely tied to occupational needs of the times. Unfortunately, ideas and times have not changed much. Mathematics attitudes include one's perception of the difficulty, usefulness, and appropriateness of mathematics. Females attribute success or mathematics aptitude to diligence and effort rather than innate ability (Eccles, 1985). Thirteen year olds have higher achievement with mathematics if they did not perceive mathematics as a male domain (Armstrong, 1985). Women typically interpret problems with mathematics understanding or achievement as personal failures, thus reinforcing negative attitudes (Rothman, 1991). Dismuke (1991) believes successful mathematical opportunities will contribute to a healthy self-concept, self-confidence, and positive attitudes toward mathematics which will lead to future interests in mathematics courses and careers. Reis and Callahan (1989) felt that positive attitudes as well as patterns of taking mathematics courses are important in keeping females interested in participating in advanced mathematics courses. This researcher agrees with Reis and Callahan that positive attitudes must be developed early in elementary school to make females feel interested and capable in mathematics.

The relationship between attitudes and achievement in mathematics is cloudy. Evans (1971) found differing opinions on how and if attitudes influence achievement. He reported early studies that found achievement favored students with more positive attitudes to mathematics; however, none of his studies were completed with identified gifted students. Studies of gifted students found generally positive attitudes to learning, especially when grouped for a particular subject (Allan, 1989, 1991; Bracken, 1980; Feldhusen, 1989; J. Kulik & C-L. Kulik, 1982). Positive attitudes toward mathematics
are related to mathematics achievement scores (Boswell, 1985; Davis & Rimm, 1989). A meta-analysis of 52 ability group studies, found that high-ability students performed better if they were grouped with other high-ability students (J. Kulik & C-L. Kulik, 1982). The students had more positive attitudes toward school and themselves because they benefitted significantly from the stimulation of other students and special curricula. Some researchers found the relationship between attitudes and achievement could not clearly be established (Benbow & Stanley, 1982; Reyes & Stanic, 1988; Yong, 1988). The usefulness of mathematics, liking mathematics, and the attitudes of peers and teachers are all correlated with mathematics achievement (Armstrong, 1985). Further research concerning female, male, and male-female groups would certainly contribute to the knowledge base concerning attitudes and achievement.

**Gifted Research**

**Definitions of Giftedness**

Any discussion of gifted programs and gifted students must include a definition of giftedness. The definitions of gifted are as varied as the people who posit such definitions. Congress declared that:

> gifted and talented children are those identified by professionally qualified persons who by virtue of outstanding abilities are capable of high performance. These are children who require differentiated educational programs and services beyond those normally provided by the regular school program in order to realize their contribution to self and society (Gallagher, 1985, p. 5).

Clark (1983) writes that the gifted and talented are students who show "evidence of high performance capability in areas such as intellectual, creative, artistic, leadership capacity, or specific academic fields" (p. 5). They need services not usually provided by the school in order to develop their potential.

Silverman (1986) defined the gifted as those who are developmentally advanced in one or more areas and need a differentiated program in order to develop at their own pace.
The gifted have advanced brain development that can be seen in outstanding cognitive ability, academic aptitude, creative behavior, leadership ability, or ability in the visual and performing arts (Clark, 1983).

The Javits Gifted and Talented Education Act says:

Children and youth with outstanding talent perform or show the potential for performing at remarkably high levels of accomplishment when compared with others of their age, experience, or environment. These children and youth exhibit high performance capability in intellectual, creative and/or artistic areas, possess an unusual leadership capacity, or excel in specific academic fields. They require services or activities not ordinarily provided by the schools. Outstanding talents are present in children and youth from all cultural groups, across all economic strata, and in all areas of human endeavor (Ross, 1993, p. 3).

The state of Virginia declared:

Gifted and talented children are those identified by professionally qualified persons who, by virtue of outstanding abilities, are capable of high performance. These are children who require differentiated educational programs and/or services beyond those normally provided by the regular school program in order to realize their contribution to self and society.

Children capable of high performance include those with demonstrated achievement and/or potential ability in any of the following areas, singly or in combination: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, visual and performing arts, psychomotor ability (Parke, 1989, p. 7).

Although the Javits definition has influenced recent thinking about gifted education, for this study the Virginia definition will be the reference point, especially those students capable of high performance in a specific academic aptitude, i.e. mathematics.

Gifted Programs and Opportunities

No matter how gifted is defined, boys are more likely to be referred and selected for gifted programs (Freeman, 1983). Gifted boys, rather than gifted girls, are often more accepted by the teacher (Richardson & Benbow, 1990). A comprehensive three year study of fourth, sixth, and eighth grade students found boys were more demanding and often received more and better kinds of attention (M. Sadker, D. Sadker, & Stulberg, 1993). The imbalance of attention shows up more visibly in mathematics and science classrooms.
It follows that if boys are more accepted and are allowed to dominate classrooms; they get more praise and encouragement than girls. They participate more actively because they are called on more often than girls (AAUW, 1992; Reis & Callahan, 1989). Ketcham and Snyder (1977) found no clear conclusion about how the teacher and the environment influence attitudes, but Reis and Callahan (1989) felt the effect of environment was more influential for positive mathematics attitudes in males. Teacher attitude and environment could reinforce gender specific perceived inadequacies and negative attitudes in females. This study will examine the relationship between classroom environment and attitudes of peers and individual students at the elementary level.

The Commonwealth of Virginia has mandated specialized educational opportunities for students identified as gifted. Wolfle (1988) stated that opportunities for gifted students in mathematics can be provided in a variety of ways: by promotion, peer tutoring, regrouping students, and learning centers. While these ideas have merit, they also have problems. The author found that promoting to the next grade is not always a solution because often the pacing is too slow for the gifted students. Utilizing a gifted student as a peer tutor is often misused and does not develop the gifted student's potential. Testing and regrouping in the regular classroom works only if the teacher is well-trained in gifted education. Learning centers, while effective and self-directed, are extremely time consuming to create.

Controversy surrounds the benefit or harm of the acceleration of students. Accelerated students of all ages from elementary school to secondary school in several subject areas were found to be as well-adjusted as students not accelerated (Allan, 1991; Austin & Draper, 1981; Janos, Fung, and Robinson, 1985; J. Kulik & C-L.Kulik, 1984; Richardson & Benbow, 1990; Richardson & Janos, 1986; Solano, 1987; Southern, Jones, & Fiscus, 1989; Swiatek, 1992; Swiatek & Benbow, 1991a, 1991b). Gifted students of various ages were compared with regular students and were found to have more positive socio-emotional adjustment, more positive self-esteem, more mature interactions, and
better inter-personal relations (Lehman & Erdwins, 1981). The benefits of acceleration for the student include: more interest and enthusiasm in school, early completion of professional training, better attitude and motivation, reduction in college drop-outs, reduction in educational costs for parents, better preparation, and positive self-esteem (Stanley & Benbow, 1986; Southern & Jones, 1991; VanTassel-Baska, 1986). Acceleration can provide appropriate educational opportunities for interaction with other students of similar interests and abilities. Acceleration is an inexpensive way to effectively meet students' needs and sustain interest in a variety of educational settings (Bartkovich & Mezynski, 1981; Brody & Fox, 1980; Proctor, Feldhusen, & Black, 1988; Southern, et al., 1989). Although there are advantages and disadvantages to acceleration, benefits to the students and their parents seem to outweigh any disadvantages.

Grouping students for certain activities, such as mathematics instruction, has been argued to have a negative impact because it will remove "top" role models from the classroom. However, removing the mathematically gifted student from the classroom does not remove the role models because students of low and average abilities model their behavior and coping skills on students with similar ability, not on gifted students who were far superior to them (Allan, 1991; Schneider, Clegg, Byrne, Ledinghan, & Crombie, 1989). Burke (1993) found that children choose as leaders and friends people not 'too much brighter' than they.

Administrators are reluctant to endorse acceleration because it removes the best students from the school setting. Removing specific ability students from the regular classroom will allow other students to 'shine' and provide opportunities for teachers to work more efficiently with the other students (Belcastro, 1987). Regular classroom teachers often are able to make only minimal changes for gifted students unless they are trained in gifted education and curriculum development (Gallagher, Greeman, Karnes, & King, 1960). Special programs for mathematics can have positive results because the students interact with others of their own cognitive ability level (Wolfle, 1986). J. Kulik
and C-L. Kulik's (1982) meta-analysis of 52 ability group studies, found high ability students benefitted significantly from the stimulation of other students and a specific curricula. Benefits include higher achievement and more positive attitude toward the subject, self, and school. Ross and Parker (1980) found that grouping students for special programs provided opportunities to share concerns and to develop a supportive environment that encourages risk taking and re-examining of self. The mathematics program at Old Donation Center (ODC) provides a supportive environment in which students are grouped to meet their educational needs. This supportive environment encourages risk-taking and cooperative learning activities needed to help females succeed in mathematics.

Mathematics Programs

An accelerated mathematics program for students with advanced mathematics ability, such as the program at Old Donation Center (ODC), is designed to provide opportunities to successfully meet the needs of mathematically gifted students. The pilot mathematics program was implemented initially to serve students whose parents had requested advanced mathematics opportunities for their mathematically gifted children who were experiencing problems in regular elementary schools. Problems exist in the regular elementary schools because texts are too easy (Reis, Burns, & Renzulli, 1992), too watered down (Cohen, 1993), too repetitious (Freeman, 1983; Reis, et al., 1992; Wheatley, 1987), too oriented to computation (Hershberger & Wheatley, 1980), and inappropriate for gifted students (Wheatley, 1987). The teaching style, learning environment, and curriculum is not often appropriate for students with advanced ability (Freeman, 1983). As a result, students develop poor work habits because they are not challenged; they become bored, idle, and apathetic (Gallagher, 1992; Stanley & Benbow, 1986). A special mathematics program can increase interest and ability, enhance self-esteem and self-confidence, and improve academic and social skills (Moore & Wood, 1988). This is the type of intervention that is necessary to enable females to interact with
their "true" peers on a social and intellectual level.

A study of fourth grade students found 60% already knew 80% of the fourth grade mathematics in September (Reis, 1993; Reis, et al., 1992). In spite of this finding, often the whole class is taught at the same level from the same book (Rosenbloom, 1986). This situation presents frustrations for mathematically gifted students. Students should not have to repeat what they already know; this practice promotes apathy and poor attitudes to learning (Reis, et al., 1992; Renzulli, 1992). Mathematics is a subject that is especially vulnerable for gifted students because they can be discouraged easily (Wolfle, 1986). A specific abilities mathematics program, such as the Old Donation Center mathematics program, is a positive alternative to vertical acceleration (skipping grades) and the regular classroom. Students can profit from a fast-paced, accelerated mathematics curriculum (Wheatley, 1983). Fast-paced accelerated classes provide challenging mathematics instruction and a supportive peer group for girls (Brody & Fox, 1980).

The mathematically gifted student performs two to five levels beyond grade level (Hershberger & Wheatley, 1980). Because of this phenomenon, acceleration is frequently utilized to meet the student's educational needs by grouping students with their "true academic" and intellectual peers (McDaniel, 1990; Moore & Wood, 1988). Clark (1983) found that students favored acceleration, while teachers and administrators were against acceleration. Slavin (1991), who generally opposes ability grouping and acceleration, felt that acceleration is justified in mathematics instruction because it benefits mathematically gifted students. Belcastro (1990) stressed that acceleration is based on the philosophy that education should develop students to their fullest potential. Acceleration is an effective and efficient means of meeting students' needs (Swiatek, 1992). Fast-paced enriched mathematics classes lead to time saved, boredom and frustration avoided, and increased productivity for gifted students (Bartkovich & Mezynski, 1981; Clark, 1983; Keating & Stanley, 1972). Students who need acceleration because of advanced ability can become frustrated, rebellious, apathetic, show offs, or excessively submissive (Keating & Stanley,
Females and Mathematics

Fox and Tobin (1988) found that girls perform better with a female teacher in a predominantly female class because females are less confident of their mathematical ability, especially in a mixed-gender class. Fennema and Sherman's (1986) research did not confirm the importance of same-sex teacher but found that teacher encouragement or non-encouragement was a factor influencing performance. A Study of Mathematics for Precocious Youth (SMPY) summer program for all girls at Johns Hopkins University was compared with a similar SMPY mixed-sex program. Results of the study showed that gifted girls have more interest in mathematics courses and keep pace with the number of courses taken by the boys; whereas usually girls do not keep pace with boys. Success of the program was attributed to the all-girl nature of the class (Brody & Fox, 1980). Fox (1981) found that in all-girl programs, girls are more willing to take risks and explore feelings and concerns than they would be in a mixed-sex class situation. The opportunity to explore feelings and concerns without censure from male peers may contribute to the success of all-girl programs.

Gwizdala and Steinback (1990) studied an all female and all male secondary school before and after a merger. The authors developed an instrument to measure the students' attitudes toward and about mathematics before and after the merger. Results showed the girls had more positive attitudes to mathematics before the merger. Participants from the all-girl school viewed males as having negative effects on the mathematics classes because the girls felt less comfortable asking questions. One-fourth of the girls said males and females were treated differently in class because the teachers act as though they think boys are smarter. In the mixed-sex groups both males and females perceive males as being smarter than when the students were in same-sex groups. VanTassel-Baska (1989a) found evidence that female-only classes have a positive effect on attitudes. She suggests the alternative of all-girl groups to help females discover their strengths before society
confuses them into hiding them. Single-sex schools foster higher self-esteem, more interest in non-traditional subject, less stereotyping of jobs and careers, more female role models, better achievement, and more opportunities for development of leadership skills (M. Sadker & D. Sadker, 1994a). Same-sex groups can have a positive influence on individual student's perceptions of their own abilities and capabilities in a particular subject area.

Across the United States, different areas are utilizing same-gender classes. An all-girl mathematics class in Ventura, California was formed to empower the students because they indicated a lack of confidence in mathematics and felt intimidated by boys. Males in their classes had been found to be very competitive and would block out the girl's ideas. The curriculum, which utilized small study groups, non-competitive classes, and activities (legally open to males), was found to raise the self-esteem of females in mathematics (Michaels, 1993). Fennema (1980) does not advocate all-girl classes because she felt societal expectations would not allow equitable opportunities and offerings.

Students in grades four to six prefer to work with same-gender groups. Students self-select in segregated gender groups (M. Sadker & D. Sadker, 1994a). These preferences coupled with sex-role stereotyping and attitude complications become a viable argument for same-gender classes. Federal anti-sex discrimination regulations, such as Title IX, discourages a public school system from having single-sex classes. An alternative grouping option is to plan same-sex groups for mathematics instruction and activities within classrooms at the elementary level as a means of fostering better attitudes and achievement in females. Fox (1980) said there was a need occasionally to group girls with girls so that feelings can be explored and reassurance can be given that girls are not unfeminine or odd because they like mathematics.

According to Graham (Personal correspondence, November 1993), grouping activities in the advanced mathematics program typically occupy 60% to 80% of mathematics class instruction time, a significant amount of time for female students.
Cooperative grouping is especially productive in learning mathematics and mathematics concepts (VanTassel-Baska, 1992). This research study of grouping practices in the mathematics pilot program should contribute to knowledge about gender attitudes and male-female interactions at the elementary school level in the urban setting.

The research study will focus on mathematically gifted females in the urban setting but its implications are not limited to this group. For example, 85% of the workers in the year 2000 will be minorities, immigrants, and women, all of whom are considered "at risk" for not achieving their full potential in mathematics (Kamii, 1990). Females with low self-esteem, low self-confidence, and low expectations in mathematics have similar problems to minorities and African-Americans (B. Anderson, 1990). Results from this research study may have implications for minorities, immigrants, and African-Americans. Information generated from this study may also have application in the area of science, where only 5% are female and 1.5% are black.

Linda Silverman is familiar with the area of female underachievement. Silverman (1991) believes it is necessary to identify gifted girls in the primary grades before they have been conditioned into hiding their talents. The security and the safety of other gifted females can help young gifted girls appreciate their talents. Female peers can help or hinder the development of gifted girls. Unfortunately, sometimes female peers will reject a girl who appears too smart or too successful (Silverman, 1986). The possibility of rejection creates a strong need for gifted girls to hide their talents in order to be accepted. Conformity and underachievement sometimes become prized and encouraged by parents, teachers, and peers.

Underachievement in mathematics does not seem to be a problem for boys. Boys are more likely to accelerate themselves through course selection (Brody & Fox, 1980). Males tend to take more mathematics classes at more advanced levels (Campbell, 1986). Retention of females in mathematics courses is a continuing problem despite special programs that have increased the number of degrees in engineering, mathematics, and
Early intervention in elementary school can help increase the number of females enrolled in mathematics courses because girls tend to remain in special programs once they have started (Reis & Callahan, 1989). Females represent 50% of our future and a specialized mathematics program can help change the underrepresentation of women in mathematics careers and mathematics courses (Campbell, 1986). Research with gifted females can also provide new information since much of the information in gifted education has been the result of research with males (Reis & Callahan, 1989). This study will generate information about the performance of gifted females in different school grouping situations that could lead to increased involvement in mathematical careers.

According to Wolfle (1986) one of the fastest ways to turn off bright children to the excitement of learning is to bore them with endless repetition of skills they have already mastered. Gifted students' needs in mathematics cannot be met in the regular classroom or by putting the student ahead a grade or two because the older students are not as advanced in pacing (VanTassel-Baska, 1989a). Fox (1980) pointed to the need for additional research with the mathematically gifted student, especially at the elementary level. This research study will examine mathematically gifted females at the elementary level to determine if certain grouping practices influence attitudes and achievement.

**The Need for Early Intervention**

Children enter school with perceptions of attitudes and expectations based on gender concerns (Lindley & Keithley, 1991). Children as early as four begin to define the world in terms of their perceived roles of male and female people (Grau, 1983). Fennema (1980) found that gender stereotyping began in early elementary school. Gender stereotyping combined with early development of attitudes toward mathematics ability form the antecedents for female underachievement. These antecedents are present as early as fourth grade when males feel they are more likely to succeed than girls because they underestimate female ability (Boswell, 1985; Evans, 1971). While Cramer (1989) was conducting research with young gifted students, she found factors are present that
contribute to the development of confidence in mathematics ability. Intervention is needed in early elementary school while personal value orientations and occupational interests are developing, before differences become internalized, and before the decline in interest in mathematics begins (Evans, 1971; Meece, et al., 1982; Wheatley, 1983).

Lack of interest in mathematics and negative attitudes begin sometime between fourth and sixth grade. Early intervention is crucial to avoid the damaging attitudes that prevent willingness to pursue mathematics and mathematics courses (Evans, 1971; Fox, 1980; Hershberger & Wheatley, 1980; Ross, 1993; Silverman, 1991). These damaging attitudes toward mathematics show when students say that mathematics is their least favorite subject in grades three through seven (Evans, 1971). Researchers urged early identification in order to provide females with opportunities appropriate to their abilities, cognitive development, learning styles, and achievement (Hershberger & Wheatley, 1980; Phelps, 1991; Stanus, 1993; Tursman, 1983).

Early identification is needed to provide the optimum classroom opportunities necessary to develop mathematics talent in gifted females. It follows that girls lose interest in mathematics after grade four and tend to become socialized into hiding their mathematical talents (Silverman, 1991). Intervention needs to address the variables that effect participation, which include positive attitudes toward mathematics (enjoyment and confidence in mathematics), perception of the usefulness of mathematics, and the positive influence of significant others such as peers, parents, and teachers (Armstrong, 1985). Beane (1988) and Fox, et al. (1985) suggest early intervention could help create better opportunities for mathematics success. Intervention can help develop attitudes and behavior that can be successful in helping females perceive the value of advanced mathematics study and the pursuit of mathematics careers (Brody & Fox, 1980; Fox, 1980). Elementary school is the most effective place to build positive attitudes, break stereotypical images, and build strong academic self-concepts (Evans, 1971). Schools should recognize mathematics talent early (Luchins & Luchins, 1980; VanTassel-Baska,
After the identification of talent, intervention programs should be implemented that will increase the number of participants in mathematics courses. Programs must involve boys, girls, as well as teachers (Fennema, 1980). Females tend to stay in mathematics courses if they are identified early and to participate in special programs (Casserly, 1980). The specialized nature of programs helps students develop self-confidence and positive attitudes needed to continue studying mathematics courses which could lead to mathematics careers.

The Need for Elementary Research

Little has been found concerning early elementary mathematics research. Studies of mathematics attitudes at varying ages and ability levels have been suggested because there is limited information about attitudes toward various school subjects (Beane, 1988; Yong, 1992). Cramer (1989) found numerous mathematics studies above the elementary school level but felt a new focus was needed at the elementary school age before attitudes and interests toward mathematics and mathematics abilities have been formed. Evans (1971) cited the need for more sophisticated research about attitudes, their relation to mathematics, and how attitudes contribute to student involvement in mathematics. Although some attitude studies have been conducted with older students and limited studies have examined elementary student attitudes, additional study with elementary age students is needed to determine how attitudes influence female mathematics performance.

VanTassel-Baska (1989b) wrote that early access to advanced opportunities, even as early as kindergarten, should be provided for the mathematically gifted student, who has grasped mathematics concepts long before they were presented in the school setting. Reis (1987) recommended research at the elementary level concerning how culture, society, and the environment impact on students and the student's attitude toward self and others. Programs for the mathematically gifted foster high achievement among females, especially if the programs begin in elementary school and involve a sizeable number of females (Fox, 1980). Fox recommended study of mathematically gifted students with different
interventions such as mixed-sex and same-sex programs to determine the impact on students if content and abilities are the same. This study will examine the effect of same-sex grouping vs. mixed-sex grouping on mathematics achievement and attitudes of academically gifted fourth and fifth grade females in the urban classroom.

Urban Focus

This research study will have an urban focus. The research study has an urban focus because Virginia Beach is a city that reflects cultural, racial, and socio-economic diversity such as that found in other urban settings. Figures from the 1990 census (D. Yeatman, personal communication, October 20, 1993) reveal that the total population in Virginia Beach was 393,069. Of this total 316,408 (80.5%) are Caucasian; 54,671 (13.9%) are African-American; 1,384 (0.35%) are American Indian; 17,025 (4.3%) are Asian-Pacific Islander; and 3,581 (0.09%) are Hispanic. Since the target population for this study is drawn from the schools in all residential areas of Virginia Beach, the student sample reflects the variety of socio-economic, cultural, and ethnic groups that reside in the city.

Mathematically Gifted

Characteristics

Silverman (1989) suggests a list of characteristics which could be used in identifying gifted students. These include, good problem-solving abilities, learning rapidly, an extensive vocabulary, a good memory, a long attention span, ability to show compassion, examples of perfectionism, a high energy level, a preference for older companions, a wide range of interests, early or avid reader, good at puzzles, mazes or numbers, mature for age, and showing perseverance in interest areas. Clark (1983) found other characteristics of gifted students include: curiosity, good verbal ability, processes information easily, thinks quickly and flexibly, sees relationships, generates original ideas and solutions, shows unusual sensitivity, exhibits sense of humor, has self-awareness, shows idealism, has inner locus of control, demonstrates intense emotions, has advanced
moral judgment, demonstrates leadership, and often shows discrepancy between physical and intellectual development.

Curriculum

The curriculum for gifted mathematics students should have certain characteristics which will be defined and discussed. Webster (1979) defined curriculum as a specific course of study. This course of study covers all the planned activities that happen in or out of school (Posner & Rudnitsky, 1986). Several mathematics researchers and gifted experts have varied opinions about what the curriculum should contain for gifted mathematics students.

The argument for content based curriculum stems from the fact that the students are identified for the mathematics program because of a specific above average ability in mathematics. Although acceleration in one content area is rarely used in elementary schools, it follows that acceleration in a specific content area is appropriate to meet the needs of students with specific abilities (VanTassel-Baska, 1989). Keating and Stanley (1972) felt that ability in a specific area showed considerable interest in that area, because much of what the student has learned was learned outside of school. A special curriculum designed to meet the needs of mathematically gifted students will focus on accelerated content, because a "gifted curriculum that does not have a strong content base or focus has little richness" (VanTassel-Baska, 1992, p. 179). If a student has shown advanced ability in a special content area, i.e. mathematics, it follows that the mathematically gifted student should be allowed to explore the area in which there exists ability and interest.

The connection between the regular curriculum and gifted curriculum originates with the "Nation at Risk" curriculum reform, which places emphasis on excellence through raising standards. VanTassel-Baska (1989b) has written about how the curriculum reform movement relates to gifted education. Gifted education has played a leadership role in the area of curriculum reform with its focus on mathematics, science, and technology. Gifted
education has also encouraged the early involvement of women and minorities in career tracks. Academy, residential, or magnet schools that focused on science and mathematics were established in response to the curriculum reform movement.

Thinking research and utilizing various thinking skills with students of all ages was first developed in gifted curricula. VanTassel-Baska (1992) found the successful use of high order thinking skills in the curriculum for gifted students precipitated a trend of using higher order thinking skills in the regular school's core curriculum. Strategies and curricular changes initiated in gifted education have filtered into the regular curriculum. Gifted educators can help general education with staff development, curriculum integration, and the infusion of higher order thinking skills. Gifted education bridges the gap between research and theories by determining how to apply and integrate new ideas into the regular curriculum. The gifted arena is an excellent trial ground for new ideas and theories (VanTassel-Baska, 1992).

Stokes (1990) mentioned a crisis in the urban schools because students have a weakness in mathematics and science. This weakness is evident because graduates fail to acquire mathematics knowledge and problem solving skills needed in highly technical careers. Analysis, synthesis, evaluation, and problem solving are excellent higher level thinking skills students need to apply in real life situations.

Gifted curricula must be developed within certain guidelines. Wheatley (1983), a professor of mathematics education at Purdue University, writes that curriculum components should include problem solving skills, geometry and measurement (graphs), facts and computations, mathematics and algebra concepts (terms and equations), computer programming and computer literacy, estimation, mental mathematics and the use of calculators, numeration (place value and number systems), probability and statistics, spatial visualization, and applications of concepts. Willis (1992) on the other hand, feels curriculum should include hands on experiences through instruction in doing rather than knowing. Students should be assessed by how they can apply knowledge to show
evidence of problem solving skills, such as problem finding, solution finding, idea finding, and interpreting results. Wolfle (1988) supports a curriculum that is differentiated, compacted, has sophisticated content, uses different approaches to learning, provides problem solving opportunities, and includes puzzles and games. Gallagher (1985) believes the curriculum content should be modified through acceleration, enrichment, sophistication, and novelty. Novelty of content includes topics not usually included in the regular curriculum, such as probability or statistics. The curriculum for mathematically gifted students features active involvement in problem solving, mathematical concepts, and computer usage through differentiated sophisticated content.

Curriculum compacting is often used with mathematically gifted students. Wolfle (1988) defines curriculum compacting as "using enrichment and acceleration simultaneously to allow students to move on to new areas once they have demonstrated competence" in a certain area (p. 234). Content sophistication is defined as obtaining a higher level of understanding of abstract mathematics principles than normally expected (Gallagher, 1985; Wolfle, 1988). An example would be the use of deductive reasoning processes with elementary students or introducing statistics and problem solving with algebraic concepts.

Enrichment is defined by Gallagher (1985) as activities that broaden the experiential base of the student while keeping the same instruction. Wolfle (1988) said enrichment activities go beyond the materials and thought processes in the regular classroom. Southern and Jones (1991) defined enrichment as a broadening of the curriculum to include elements not usually present. Stanley and Benbow (1986) believe enrichment provides experiences beyond the usual classroom curriculum, while Wolfle (1986) considers enrichment a more detailed, involved, and broad examination of an area. Enriched curriculum in this study is defined as providing more involved experiences not usually found in the classroom curriculum, such as Challenge© Mathematics, computer simulations, logic problems, and independent research concerning mathematics and
mathematicians. Challenge® mathematics is a program developed especially for mathematically gifted students.

A curriculum for gifted mathematics students should not only be differentiated but it should be defensibly differentiated. Borland (1989) defines differentiated curriculum as a course of study that is different from the curriculum to which most of the students are exposed, it is "differentiated in response to the characteristics of gifted children as specified in the program's definition of the target population" (p. 173). The differentiation is based on the exceptionality of the student. A curriculum for gifted mathematics students should provide challenging mathematics instruction through fast-paced accelerated classes, application of mathematics knowledge to real world problems, career-education, and text books without sex role stereotypes (Brody & Fox, 1980; George, 1976; Ross, 1993; VanTassel-Baska, 1989b). Because of the unique nature of mathematically gifted students, a unique curriculum must be developed.

Acceleration is one method to use in meeting the needs of mathematically gifted students. Acceleration is the increase in the speed or rate, in this instance of exposure to mathematics ideas, topics, and concepts (Webster, 1979). Acceleration was alternately defined as early entrance to school, grade skipping, advanced placement in subjects (Feldhusen, 1989), fast-paced courses (Swiatek & Benbow, 1991b; VanTassel-Baska, 1986b), adaptation of advanced curriculum to use with younger children (Richardson & Benbow, 1990), continuous progress, self-paced instruction (VanTassel-Baska, 1986), subject-matter placement (placement in a higher grade for mathematics), non-graded classes, curriculum compacting (VanTassel-Baska, 1986), telescoping curriculum (completing a course in less time), mentorships, extracurricular programs, concurrent enrollment (enrollment in high school and college), advanced placement, credit by examination, and correspondence courses (Southern & Jones, 1991). Acceleration in this study will be defined as a fast-paced course containing advanced and enriched curriculum that is used with elementary students. Curriculum compacting is subsumed in the fast-
paced course definition of acceleration.

Any mathematics program should have certain program goals. The National Council of Teachers of Mathematics (NCTM) established national goals which guide programming for mathematics students. The NCTM goals include problem solving, communicating mathematically, reasoning mathematically, valuing mathematics, and having confidence in one's ability (VanTassel-Baska, 1989). Additionally, a gifted mathematics curriculum should contain: higher level thinking skills (Clark, 1983; Hersberger & Wheatley, 1980; VanTassel-Baska, 1986) advanced topics or content sophistication (Hersberger & Wheatley, 1980; VanTassel-Baska, 1986); development of spatial ability (Hersberger & Wheatley, 1980); development of logical thinking (Hersberger & Wheatley, 1980; VanTassel-Baska, 1989); content acceleration through the introduction of probability and statistics (Borland, 1989); novelty through the use of calculators and computers (Borland, 1989; VanTassel-Baska, 1989; Wolfe, 1988); independent investigations (Borland, 1989); development of computational ability (Hersberger & Wheatley, 1980; Van Tassel-Baska, 1989; Willis, 1992); and the development of a healthy self-concept (Hersberger & Wheatley, 1980). Passow (1982) believes that students need enrichment, as well as acceleration so that they will not be pushed too rapidly through the curriculum. The author said that the consequence of only acceleration will be that students learn facts but not how to apply knowledge because there is not time to create or explore problems or concepts. Freeman (1985) and Wolfe (1986, 1988) suggest the best mathematics gifted program should contain elements of acceleration and enrichment. The mathematics program that best meets the needs of gifted students combines both acceleration and enrichment principles.

Thought must be given to the pace of instruction. Curriculum pacing should be appropriate to the capacities and knowledge of the students, at a challenging level that slightly exceeds the level just mastered (Stanley & Benbow, 1986). Activities should encourage active involvement and interaction of students with other students in small
groups (Hershberger & Wheatley, 1980; VanTassel-Baska, 1989; Willis, 1992). Active involvement and interaction of students will help foster positive attitudes and confidence in the student's ability to perform mathematics functions. Active involvement and interaction can help students become enthusiastic and motivated to take additional mathematics courses. Students are motivated to stay in mathematics courses if exposed to an exciting and stimulating curriculum, (Taffel, 1987). When females successfully and actively participate in mathematics courses, they are likely to choose and remain in mathematics careers.

Summary

Internal and external barriers prevent success for women. Many of these barriers are related to attitudes as well as occupational and cultural expectations (Boswell, 1985; Reis & Callahan, 1989; Whitmore, 1980). Gifted females fail to develop their full potential in mathematics because they fail to stay interested in taking advanced mathematics courses considered "gatekeepers" to many college majors, needed for science, mathematics, engineering, and technological careers. Sex differences ability at various grade levels has been examined in the research literature with conflicting results, especially in relationship to middle and high school level mathematics. Recent gender studies have found no or small differences between males and females in mathematics performance, especially if the number of mathematics courses is held constant (Biggerstaff, 1990; Eccles, 1985; Fennema & Sherman, 1977; Fox & Tobin, 1988; Stokes, 1990). Overall, there appears to be no firm, reliable, conclusive data that proves males perform better than females in mathematical tasks, especially when mathematical background remains constant.

When the question is asked about the differences in attitudes toward mathematics, the answers are clearer. Research results show significant differences in male and female attitudes toward mathematics (Fennema & Sherman, 1977). These attitude differences which begin in early elementary school can influence whether or not a mathematically
A gifted female will take advanced mathematics courses or pursue a mathematical career. The relationship between achievement and attitudes has been studied but yielded no significant results. Students who were grouped for a particular subject generally had more positive attitudes; positive attitudes that are related to achievement (Allan, 1989, 1991; Boswell, 1985; Bracken, 1980; Davis & Rimm, 1989; Feldhusen, 1989; Kulik & Kulik, 1982). When students of like interests and abilities are grouped together, they are challenged by each other's abilities and supported by those abilities.

Special intervention programs are needed for girls in elementary school to counter the negative influences of culture, teachers, parents, and peers. Acceleration and enrichment, along with differentiated curriculum, trained teachers, and specialized teaching strategies, provide mathematically gifted students special opportunities to develop their potential. Cooperative grouping offers many learning opportunities within the gifted classroom. When these grouping practices occupy a major portion of class time it can influence the attitudes the student has to a particular subject. Females exhibit more positive attitudes to mathematics when grouped with the same sex (Brody & Fox, 1980; Fox, 1981; Michaels, 1993). Although same sex classes are not universally advocated same-sex cooperative learning groups could positively influence attitudes and achievement in fourth and fifth grade females in the urban classroom. This study will examine the effects of certain grouping practices on attitudes and achievement of mathematically gifted females in fourth and fifth grade urban classrooms.
Chapter III. Research Methodology

The review of the related literature reveals the lack of research at the elementary level involving females and their attitudes toward mathematics and how these attitudes might influence mathematics achievement. Implications from the literature lead this researcher to conclude that a study should be conducted with mathematically gifted females who are in a special program, to determine if cooperative grouping practices would affect mathematics attitudes and achievement.

Research design

The purpose of this research project is to examine the effect of same-sex grouping versus mixed-sex grouping on mathematics attitudes and achievement in fourth and fifth grade females involved in a mathematically gifted pilot program at Old Donation Center (ODC), a magnet center in Virginia Beach. The research design used in this study is a randomized pre-test, post-test experimental design. The statistical procedure that best examines this problem is the one factor Multivariate Analysis of Variance (MANOVA) with two levels. The MANOVA is appropriate because the method of grouping students is one independent variable and mathematics attitudes and mathematics achievement are two dependent variables.

The dependent variables are the scores on a mathematics attitudes scale and an achievement test that were administered at the beginning and termination of the treatment. Mathematics attitudes were measured quantitatively on the Fennema-Sherman Mathematics Attitudes Scales. Achievement was measured quantitatively on an out of grade level, Comprehensive Test of Basic Skills (CTBS, Level 15 and 16). Out-of-grade-level tests are recommended for gifted students because the ceiling effect of a within-grade level test
Random selection of individual students is not possible for this experimental design because the students are selected by selection matrix (See Appendix A) and should have the opportunity to participate if they qualify. It is not possible, therefore, to choose or not choose a student to participate in the study on a truly random basis. Practically, random selection is not possible because the students attend Old Donation Center one day of the week based on which school they attend the other four days. The students are provided public transportation by the school system; consequently; they cannot be individually randomly assigned to a control or experimental group because this would present a transportation hardship for the parents. In this design the classrooms were randomly assigned because the students could not be randomly selected. Random assignment means each class has an equal chance to be assigned to receive the treatment (Borg & Gall, 1989).

**Hypotheses**

Null: Ho1 There will be no interaction between attitudes and achievement in fourth or fifth grade mathematically gifted females in same-sex cooperative groups or mixed-sex cooperative groups.

Null: Ho2 There will be no difference in the mathematics achievement level of fourth and fifth grade mathematically gifted females in same-sex cooperative groups or mixed-sex cooperative groups.

Null: Ho3 There will be no difference in attitudes towards mathematics in fourth and fifth grade mathematically gifted females in same-sex cooperative groups or mixed-sex groups.

Alternate hypotheses:

Ho1 There will be some interaction between attitudes and achievement in fourth or fifth grade mathematically gifted females in same-sex cooperative groups or mixed-sex cooperative groups.

Ho2 There will be a difference in the mathematics achievement level of fourth and
fifth grade mathematically gifted females in same-sex cooperative groups from females in mixed-sex cooperative groups.

Ho3 There will a difference in attitudes towards mathematics in fourth and fifth grade mathematically gifted females in same-sex cooperative groups from females in mixed-sex groups.

Research Setting

Community. The research study has an urban focus because Virginia Beach is a city that reflects cultural, racial, and socio-economic diversity such as that found in other urban settings. Figures from the 1990 census (D. Yeatman, personal communication, October 20, 1993) reveal that the total population in Virginia Beach was 393,069. Of this total 316,408 (80.5%) are Caucasian; 54,671 (13.9%) are African-American; 1,384 (0.35%) are American Indian; 17,025 (4.3%) are Asian-Pacific Islander; and 3,581 (0.09%) are Hispanic. The total 1992 population figure for Virginia Beach was estimated at 410,607 (D. Yeatman, personal communication, October 20, 1993). The target population for this study was drawn from all the schools in Virginia Beach, the student sample should reflect the variety of socio-economic, cultural, ethnic, and racial groups that reside in the city.

School. The setting for the research study is Old Donation Center for the Gifted and Talented in Virginia Beach, Virginia. Old Donation Center serves as a magnet center for elementary and middle school students who have been identified as gifted and/or talented. Students generally attend the center one day per week and attend a regular or base school the other four days. Schools whose students attend the center on a given day are generally grouped to include those that have high and low socio-economic and high and low population of gifted students; this enhances the variety of cultural backgrounds and the diversity of the classes. Belcastro (1987) defines this arrangement as a pull-out program because the students are placed in a special grouping for instruction. A pull-out program is an administrative arrangement in which gifted students are placed in
heterogeneous classrooms for most of their instruction but are pulled out for specific classes in a different setting part of the week (Vaughan, Feldhusen, & Asher, 1991).

Mathematics Program

The mathematics educational program is based on the philosophy that gifted students require the following opportunities:

- To interact with all students,
- To interact with other gifted students,
- To pursue their particular interests and to share the results of these pursuits.

The mathematics program is designed to;

1. Challenge students of superior ability in mathematics with advanced in-depth experiences
2. Provide differentiated instruction which addresses the varied learning styles of students who are gifted in mathematics
3. Achieve excellence through continuous, developmentally appropriate opportunities in specially equipped facilities.

The Virginia Beach City Public School System provides programs for students in grades four and five who are gifted in mathematics. Acceptance into these programs is based on the following:

- Base school and/or Old Donation Center teacher recommendations,
- Scores from standardized achievement tests and aptitude tests,
- Interest inventories,
- Student performance in laboratory situations.

Students from the elementary schools in Virginia Beach City Public Schools who have demonstrated superior potential in mathematics are identified in the spring of third grade to attend Old Donation Center one day per week in a two year program beginning in fourth grade. At Old Donation Center the students receive differentiated, enriched and accelerated instruction in mathematics designed to meet their educational needs from qualified mathematics instructors trained in gifted education strategies. The mathematics curriculum integrates basic knowledge, skills and complex concepts. The mathematics program is implemented in addition to the standard curriculum. Quarterly mathematics grades are assigned by the instructors at Old Donation Center. (Program for Academically Gifted in Mathematics and Science: Grades Four and Five, 1993, p. 3).

Curriculum. The discussion of a curriculum and the needs of mathematically gifted students found in the review of related literature serve as the rationale for the formation of the mathematics program at Old Donation Center. The students receive instruction that is differentiated, enriched, and accelerated to meet their educational needs. Teachers are qualified in mathematics and gifted education strategies. Acceleration of
curriculum is one method to meet the needs of mathematically gifted students. Acceleration of student learning is accomplished in a variety of ways that were discussed in the review of related literature. Acceleration in this study is defined as a fast-paced course containing advanced and enriched curriculum.

The mathematics program goals and the curriculum are shaped by The National Council of Teachers of Mathematics (NCTM). These goals include problem solving, communicating mathematically, reasoning mathematically, valuing mathematics, and having confidence in one's ability (House, 1987; NCTM, 1989). Additionally, gifted mathematics curriculum should contain higher level thinking skills, advanced topics or content sophistication, use of logical thinking, content acceleration and novelty through the use of calculators and computers, independent investigations, activities to develop computational ability, and activities to develop a healthy self-concept (Borland, 1989; Hersberger & Wheatley, 1980; VanTassel-Baska, 1986, 1989b; Willis, 1992; Wolfle, 1988; ). The best mathematics program for gifted students should contain elements of acceleration and enrichment so the students have opportunities to practice what they know (Freeman, 1985; Wolfle, 1986; 1988). The mathematics program at Old Donation Center combines both acceleration and enrichment principles.

The curriculum includes a variety of concepts, topics, and processes while emphasizing the development of critical, logical, and creative thinking skills. VanTassel-Baska (1989b) reinforces the logic of developing higher level thinking skills. The mathematics curriculum for gifted students integrates problem solving and applications throughout all topics of study. Major emphasis is given to the use of calculators as problem solving tools. The use of calculators was advocated by VanTassel-Baska as well as Hersberger and Wheatley (1980).

Teachers. Educational qualifications for teachers of the gifted have been adopted by the Commonwealth of Virginia but they were not in effect when the mathematics teachers were chosen to teach at Old Donation Center (ODC). Those qualifications include
courses or experience in the following areas of gifted education: curriculum development, socio-emotional needs and characteristics, instructional strategies, creativity, counseling, practicum, and educational needs. Wolfle (1986) contends that the teacher must be trained to work with gifted students. Both of the mathematics teachers taught in the intellectually gifted program at ODC. For one year they received training and practical experience in curriculum and instructional strategies before they taught in the academically gifted program for mathematics.

A synthesis of research concerning desirable characteristics of gifted and talented teachers generates the following list: sympathetic to and identification with the problems of the gifted, creative, highly intelligent, flexible (in ways of thinking), variety of interests, love of learning, innovative, ability to communicate, well-organized, emotionally mature, non-authoritarian style, and possessing a sense of humor (Tompkins, 1990). Teachers of mathematically gifted students must be bright and dynamic (George, 1976). Moore and Wood (1988) desire teachers with strong personal characteristics and backgrounds in mathematics. Both teachers have demonstrated the dynamic characteristics desired in teachers of gifted and talented students and they have successfully completed and were currently enrolled in courses needed to become endorsed in gifted education.

Certain teacher strategies are found helpful in fostering more positive attitudes toward mathematics. Blum-Anderson (1990) suggests the following ten teacher strategies to foster good attitudes toward mathematics:

1. Help students understand that frustration is a normal part of learning.
2. Choose vocabulary carefully.
3. Acknowledge that test anxiety exists.
4. Relate mathematical topics to occupations and personal uses whenever possible.
5. Form flexible study groups composed of three to four students.
7. Use cooperative learning and group or individual projects as the dominant instructional method.

8. Create a mathematical assistance area.

9. Be cognizant of the fact that students' confidence in mathematics is not stable.

10. Advertise mathematics courses.

Ascher (1987) recommends that teachers should be good role models, make mathematics relevant, utilize special learning techniques, eliminate the stress of competition and reduce mathematics anxiety. Specially trained teachers can provide more information about the value of mathematics as a career, help females attribute success in mathematics to ability and interest, encourage females to pursue mathematics, and petition for four years of high school mathematics (Beauvais et al., 1985). The administrator of ODC chose the teachers for the academically gifted program because they had demonstrated the attitudes, competences, characteristics, qualities, experience, and knowledge necessary to be successful teachers of children who are gifted in mathematics. Each teacher is capable of utilizing both gifted knowledge and mathematical knowledge to create curriculum and educational experiences that effectively meet the needs of gifted students.

Research population

Elementary Population Demographics, 1991. The target population was selected from approximately 12,000 third grade students in Virginia Beach City Public Schools. Those selected are significantly above grade level in mathematics and mathematical concepts as indicated by their scores on a variety of measures. The ethnic membership (see Figure 1) of all elementary schools in Virginia Beach on September 30, 1991, revealed 31,768 or 73.9% Caucasian; 8,398 or 19.5% African-American; 36 or 0.1% American Indian; 2,016 or 4.7% Asian-Pacific Islander; 766 or 1.8% Hispanic; and 2 or 0.0% other (S. Vaughn, personal communication, October 21, 1993).
Third Grade Demographics, 1991. The 1991-1992 third grade students served as the target population for the current fifth grade students. The ethnic membership (see Figure 2) of all third grade students shows 4,383 or 74.6% are Caucasian; 1,121 or 19.1% are African-American; 7 or 0.1% are American Indian; 267 or 4.5% are Asian-Pacific Islander; and 96 or 1.6% are Hispanic (A. Woody, personal correspondence, 1993).
Fifth grade mathematics students. An analysis of the fifth grade mathematics students at Old Donation Center (see Figure 3) indicate that 3 or 4.35% are African-American, 54 or 78.3% are Caucasian, 0 is Hispanic, 1 or 1.4% is American Indian, and 16 or 15.9 are Asian-Pacific Islander (D. Russo, personal communication, October, 1993). A comparison of demographics of mathematics students with general elementary students reveals a low representation of African-American students and a high representation of Asian-Pacific Islander students. Other racial percentages parallel school population demographics.

**Fifth Grade Math Demographics**

[Diagram showing racial demographics]

Figure 3 Demographics of Fifth Grade Mathematics Students at ODC

**Elementary population demographics, 1992.** The September 30, 1992, ethnic membership in all elementary schools was: 29,657 (73.5%) Caucasian; 8,099 (20.0%) African-American; 33 (0.1%) American Indian; 1,795 (4.4%) Asian-Pacific Islander; 826 (2.0%) Hispanic; for a total of 40,410 (S. Vaughn, personal communication, October 21, 1993). The 1992 elementary school population (see Figure 4) was the target group for the current fourth grade students.
Third grade demographics, 1992. The 1992-1993 third grade students were the target group for the current fourth grade mathematics students. A. Woody (personal correspondence, 1993) reported the 1992-1993 ethnic membership of all third grade students (see Figure 5) showed 4,495 or 73.2% are Caucasian; 1,219 or 19.9% are African-American; 3 or 0.0% are American Indian; 286 or 4.7% are Asian-Pacific Islander; and 138 or 2.3% are Hispanic.

Total Third Grade 92-93

Figure 5 Virginia Beach Third Grade Student Demographics, 1992-1993
Fourth grade mathematics students. A demographic analysis of the current fourth grade mathematics students at Old Donation Center (see Figure 6) indicates 9 or 11.3% are African American, 65 or 81.3% are Caucasian, 1 or 1.25% is Hispanic, 0 are American Indian and 5 or 6.3% are Asian-Pacific Islander (D. Russo, personal communication, October, 1993).

Fourth Grade Math Demographics

![Pie chart showing demographics]

- Caucasian 81.3%
- African-American 11.3%
- Asian-Pacific Isl. 6.3%
- Hispanic 1.3%

Figure 6 Demographics of Fourth Grade Mathematics Students at ODC

Total numbers of mathematics students at Old Donation Center reveal that 12 or 8.05% are African-American, 119 or 79.86% are Caucasian, 1 or .0671% is Hispanic, 1 or .0671% is American Indian and 16 or 10.73% are Asian-Pacific Islander (D. Russo, personal communication, October, 1993). A comparison of the 1991 and 1992 elementary school figures indicates that the proportion of minorities is increasing and the Caucasian population is decreasing, thus reflecting demographic trends found in many urban areas.
Research Sample

Sample.

The research sample of 54 females, aged 9.3 - 11.3, was drawn from the 180 students currently participating in the mathematics pilot program in the fourth and fifth grade at Old Donation Center. Analysis revealed that 54 or 32% of the students are female and 124 or 68% of the students are male. Ethnic numbers of the control group show that 0 is African-American, 14 are Caucasian, 0 is Hispanic, 1 is Native American, and 5 are Asian-Pacific Islander. The analysis of the experimental group shows 5 are African-American, 26 are Caucasian, 0 is Hispanic, 0 is Native American, and 3 are Asian-Pacific Islander. Sample totals show 5 students are African-American, 40 are Caucasian, 0 are Hispanic, 1 is native American, and 8 are Asian-Pacific Islander. Figure 7 shows demographics percentages for the total sample. All schools in Virginia Beach are not exactly alike socioeconomically and academically, hence the sample contained a representative mix of racial, ethnic and socio-economic groups.

Research Sample Demographics

Caucasian 74.1%
African-American 9.3%
American Indian 1.9%
Asian-Pacific Isl. 14.8%

Figure 7 Total Research Sample Demographics
Demographic analysis of the female sample reveals that racial distributions in the classes show a high representation Asian-Pacific Islanders and a low representation of Hispanics and African-Americans. The numbers for Caucasian and American Indian membership parallel population demographics.

Sample Selection

Referral guidelines concerning characteristics of academically gifted students (Appendix B) were established to determine if students exhibit mathematical ability so they could be referred for further consideration. The literature reveals information from gifted researchers as well as mathematics researchers. Wolfle (1986) writes that exceptional mathematics students exhibit the following characteristics:

1. See a problem quickly and solve it.
2. Read rapidly and retain what is read and recall in detail.
3. Are reluctant to practice skills already mastered.
5. Have a keen sense of humor, appreciate verbal puns, cartoons, jokes, satire.
6. Are persistent in task completion, set high personal goals, are perfectionists.
7. Are keen and alert observers, note details and are quick to see similarities, differences and anomalies.
8. Move from concrete to abstract concepts and synthesis quickly.
9. Are unwilling to accept statements without examination of whys and hows.
10. Listen to only part of the explanation and appear to lack concentration or interest, but know what is going on and usually know the answer.
11. Show rapid insight.
12. Are not willing to do busy work just to get a "grade."
13. Are perfectionists and show frustration with imperfection.

A general list of behavioral characteristics of mathematically gifted students, developed by authorities in the field of gifted and mathematics education, was used by third grade teachers, parents, gifted resource teachers, gifted program teachers, and counselors in referring students to the advanced mathematics program. Information from

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academic records, standardized tests, teacher evaluation, observations, and percentile ranks on standardized test scores was included on referral sheets (Appendix C). Students whose scores were above the 85th percentile on standardized tests were referred. Moore and Wood (1988) generally consider students who scored on the 97th, 98th, and 99th percentile on a standardized mathematics achievement test for their Centers for Talented Youth (CTY) program. The referral process clearly utilized a variety of identifiers.

Student identification includes a variety of assessment measures, observations, and interest inventories as recommended in the research literature (Clark, 1983; Fox, 1981; Frasier, 1987; Reis, 1987; Silverman, 1989; Wolfe, 1988). An IQ test is not an appropriate measure to identify a student for an academically gifted program in mathematics because it is a global measure; therefore, an achievement test is recommended to predict success in mathematics (Fox, 1981; Stanley and Benbow, 1986). Tests with high ceilings or out of grade level tests of specific aptitude and achievement are suggested, such as the Iowa Test of Basic Skills (ITBS) and the California Achievement Text (CAT) (Clark, 1983; Fox, 1981; George, 1976; Moore & Wood, 1988). All referred students are evaluated with various instruments: Otis-Lennon IQ Test, Comprehensive Test of Basic Skills (CTBS - math concepts and computation portions), interest inventory (Appendix D), and performance testing (Appendix E). Students are selected if they accumulate 15 - 25 points on a selection matrix (See Appendix A). Some of the selected students are identified as intellectually gifted (IQ of 130 or above on the Otis-Lennon), while all of the selected students are identified as academically gifted in mathematics (above average mathematics scores on the CTBS).

Operational Procedures

In order to conduct research in Virginia Beach, approval for the study must first be obtained from the Educational Planning Center of the school system, the building principal, and the teachers involved in the study. Forms (Appendix F) were submitted to an
assessment specialist in Educational Planning to be forwarded to the superintendent and school board for approval. Approval for the research study was obtained from the superintendent, school board, building principal, and the teachers involved in the study (See Appendix G). The mathematics teachers were interested in cooperating with this study because they had observed that girls seemed to "wimp" out when they were in groups with boys (Tompkins, 1992). The experiment did not interrupt classroom processes because the only instructional change was the way the students were grouped for cooperative mathematics activities. It was not necessary to obtain permission for a child to participate in this study (S. Vaughn, personal communication, October 21, 1993) but parents were made aware of the study and the administration of the attitude survey by letter (Appendix H) in order to give them an opportunity to withdraw their child from the study. No parent withdrew their child. Approval was also obtained from the human subjects committee at Old Dominion University (see Appendix I).

References to students are by group scores only. Students were given an identification number for the attitude scale and the achievement measure to enable comparisons to be made while preserving anonymity. Classrooms and teachers are identified by day and grade level to maintain anonymity.

**Experimental Treatment and Procedure**

**Experimental versus Control Groups**

Each day of the week a different group of students attends the mathematics program. For this study, six classes (students on Tuesday, Wednesday, and Thursday) were chosen randomly at fourth and at fifth grades to be the experimental group and four classes (Monday and Friday) at fourth and at fifth grades were the control group. The experimental groups were decided randomly by the mathematics teachers and by this researcher through the method of choosing cards. Essentially, there were no differences between the experimental and control groups because the school population on each day of
the week contains a mixture of socio-economic groups and cultural diversity. The experimental and the control groups are represented in Table 1.

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
<tr>
<td>Control Group</td>
<td>Experimental Group</td>
<td>Experimental Group</td>
<td>Experimental Group</td>
<td>Control Group</td>
</tr>
</tbody>
</table>

Table 1
Distribution of Experimental versus Control Groups in the Mathematics Research Study by Days of Attendance

Experimental Design

The experimental classroom utilized 34 females being grouped with females (same-sex groups) for all cooperative group work. Cooperative group work is defined as those activities that require small groups of students of two to five working cooperatively to solve a problem, perform an operation, or any other classroom activity (Graham, 1993; VanTassel-Baska, 1992). Since cooperative group work occupies approximately 60% of the advanced mathematics program's instructional practices, this was expected to show a difference in mathematics attitudes and achievement in the experimental (same-sex groups) versus the control (mixed-sex groups) subjects. The experimental treatment grouped students in same-sex groups for all cooperative group work. Females in the experimental classrooms always were grouped with other females for all cooperative work, yet this arrangement did not require a classroom of all girls or all boys. The experiment lasted for five months from January to May. The groups were arranged by choosing a card from a specific pile of all-boy cards or all-girl cards.

The control group of 20 females had mixed-sex (regular) groups for all cooperative group work. The mixed-sex groups were arranged by various random means (i.e. pick a
card, pick a color). Females in the control group were grouped in random mixed-sex groups for all cooperative group work. All other instruction, requirements, teaching styles, and other classroom activities remained the same. Two teachers, one at fourth and one at fifth grade, taught both the control and experimental groups. The numbers in the groups varied because the number of females in classes varied. The smallest number of females in a group in a class was three and the largest was eight.

Data Collection

The study utilizes achievement data measured with the Comprehensive Test of Basic Skills (CTBS) administered in January and during the third week of May. A mathematics attitudes scale (Fennema-Sherman Mathematics Attitudes Scales) was administered prior to treatment (December) and during the third week of May. Treatment began during the first week of January when the students returned from winter holidays. An end-of-treatment qualitative assessment (Appendix J) was conducted in May using DiBono's PMI (Pluses, Minuses, and Interesting) to determine male and female student reactions to the grouping arrangement. Specific dates and events are recorded on a timeline (Appendix K).

Research objectives were to utilize data available on mathematics achievement and mathematics attitudes in determining the effects of same-sex groups versus mixed-sex groups on mathematically gifted females in grades four and five. Data examined from the CTBS (Levels 15 and 16) include mathematics concepts and computation scores. The CTBS measured if there was a difference in the achievement of the females who had been in same-sex groups compared with those who had been in mixed-sex cooperative learning groups. Attitude data were gathered from the pre-test and post-test administration of the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS). The F-S MAS was used to determine if there was a difference in the attitudes towards mathematics in females who had been in same-sex versus mixed-sex cooperative groups. Program monitoring of classroom activities was achieved through a self-report checklist and lesson plans.
Information concerning gender and ethnic classification of the students was provided by either the classroom teacher making the student referral, the mathematics teacher, an ODC teacher, or the individual student.

**Instruments**

As a result of the review of related literature two instruments were selected that met the research objectives of measuring mathematics achievement and mathematics attitudes: The California Test of Basic Skills (CTBS) and the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS).

**Comprehensive Tests of Basic Skills (CTBS) - achievement measure.** The Comprehensive Tests of Basic Skills Fourth Edition (CTBS/4) "is a test series designed to measure achievement in basic skills commonly taught in schools" (CTBS, 1989, p.1). The mathematics computation and mathematics concepts sections of the CTBS were used to measure mathematics achievement. Mathematics computation measures the ability to compute numbers, decimals and fractions, and use algebraic expressions, exponents, and percents. The mathematics concepts portion measures how well the student can apply mathematics knowledge to numbers, number theory, algebra, data interpretation, geometry and measurement, or to use problem-solving skills.

The research objective is to utilize data available on mathematics achievement measures to determine if there is any difference between female mathematics achievement in same-sex groups versus mixed-sex cooperative group arrangements. Results from the Comprehensive Test of Basic Skills (CTBS) Levels 15 and 16, at fourth and fifth grade, respectively, will be compared statistically to determine if any differences are statistically significant. Level 15 is considered to be a fifth grade level test and can be used with grades 4.6 - 6.2. Level 16 is considered to be a sixth grade level test and can be used with 5.6 - 7.2 (M. Powell, personal communication, March 1, 1994). "Out of grade level" tests are administered because the ceiling effect, found with accelerated groups, often does not show gains (Beggs, Mouw, & Barton, 1989). Currently the Comprehensive Tests of
Basic Skills represent the most valid and reliable instrument to assess how well students apply mathematical knowledge to number, number theories, and problem-solving skills (E. Davis, personal communication, November, 1993; M. Powell, personal communication, June, 1994).

**Fennema-Sherman Mathematics Attitudes Scales (F-S MAS) - attitude measure.**

The Fennema-Sherman Mathematics Attitudes Scales are described in the testing manual as nine, domain specific, Likert-type scales. Each scale measures an attitude the researchers believed to be related to mathematics learning.

The scales can be used as a total package to assess a variety of attitudes toward the learning of mathematics, or the scales can be used individually. Each scale assesses an attitude that has been hypothesized to be related to the study and/or learning of mathematics by males and females. The scales include (a) confidence in learning mathematics; (b) father, mother, and teacher scales measuring perceptions of attitudes toward one as a learner of mathematics; (c) effective motivation in mathematics; (d) attitude toward success in mathematics; (e) mathematics as a male domain; (f) usefulness of mathematics; and (g) mathematics anxiety scale. Included are item statistics as well as scale statistics that were obtained by testing two high-school-age populations (N = 1600). (Fennema and Sherman, 1986, p 1.)

The Fennema-Sherman Mathematics Attitudes Scales were developed by Elizabeth Fennema, a Professor of Curriculum and Instruction at the University of Wisconsin-Madison, and Julia Sherman of Madison Psychiatric Associates, Ltd. Fennema specializes in research on staff development, teaching, and mathematics education, and has conducted research to determine how students process mathematics concepts. The authors felt there were affective variables that could cause differences between the sexes in mathematics achievement or the selection of mathematics courses.

In determining which instrument to use to measure attitudes, concern was given to an efficient and accurate method. Worthen and Sanders (1987) maintain that a testing instrument should be evaluated according to several concerns: the administrative concerns of cost, time needed to administer and score, special facilities and equipment required, qualifications needed for the assessment person, currency of the test, validity for the
intended use, reliability, and the sampling procedures used in developing the instrument. These ideas suggested by Worthen and Sanders guided this researcher in locating an attitude instrument that met these qualifications while still accurately reflecting the attitudes of the respondents.

Evans (1971) found that attitudes could be measured by self-report methods such as a questionnaire or scales. The mathematics attitudes of fourth and sixth grade students were examined in his study using four attitude measures. He reported that the information from attitude scales accurately represented real feelings and how that individual would behave toward that subject (object). The scales examined by Evans were the Dutton-Thurston Attitude Scale (1957), The Dutton-Likert Attitude Scale (1968), The Attonen-Revised Hoyt Attitude Scale (1967), and the Semantic Differential Attitude Scale (1957). Though the names imply mathematics, the scales (copies were available to this researcher) measured attitudes towards various subcomponents of arithmetic not attitudes towards global mathematics ideas. Few of the statements related to confidence in mathematics, usefulness of mathematics, or attitudes of significant others. Some of the mathematics scales had no gradation of feelings, utilizing a yes/no response. Only a few items were found on the scales (n < 25) and these attitude scales presented information with only one score. This researcher felt that the low number of items on other attitudes scales examined would not reflect the different factors that work together to influence mathematics attitudes and achievement.

A thorough examination of Mental Measurements Yearbooks (Buros, 1978, 1985, 1991; Mitchell, 1983), and the Directory of Unpublished Experimental Mental Measures (Goldman & Busch, 1978), reveals no comprehensive instruments to measure a variety of attitudes concerning mathematics. Some mathematics attitudes instruments were listed but the limited number of items did not present a clear picture of the factors that this researcher believed might be barriers to success for women in mathematics.

The Fennema-Sherman Mathematics Attitudes Scales were chosen because they
were more effective, easier to administer, less disruptive, less intrusive, and less time consuming. The scales appeared in several mathematics attitude research studies conducted in the field of gifted or mathematics education (Brush, 1985; Malancon, Thomson & Bacnal, 1993; O'Neal, Ernest, McLean & Templeton, 1983). The attitude scales were developed by researchers knowledgeable about mathematics, thus, they reflect attitude concerns other researchers considered important to success in mathematics. They were up-to-date and would not require a large amount of instructional time to administer. The use of these scales would not prove an economic burden for this researcher to administer to a large group of students because the scales could be copied rather than purchased. The Fennema-Sherman Mathematics Attitudes Scales are a non-intrusive, self-report measure that did not interfere with the daily curriculum or instruction as suggested by Rossi and Freeman (1989). The tests did not need to be administered by a trained assessment specialist and they could be scored by computer.

Validity of the F-S MAS was established through several research studies. Fennema and Sherman defined dimensions that the mathematics attitudes scales would measure and wrote items independently which were judged for content validity. Content validity had been established through extensive factor analysis and content analysis (Fennema & Sherman, 1986). Items agreed upon were selected so that half were worded positively and half were worded negatively. Scales were administered on a "pilot" basis to secondary students in rural-urban Madison, Wisconsin. The number participating in the pilot was 367 (180 males and 187 females) and the number participating in the final instrument development was 1,233 (589 females and 644 males). There was no specific information available on the ethnicity of the participants although it is believed that a majority of the population was Caucasian (E. Fennema, personal communication, November 11, 1993). Split-half reliability for each scale is > .89. Item means, student deviations, correlations, and intercorrelations were obtained by administering the scales to two testing groups of ninth through twelfth grade students. Norms were not established,
but percentile ratings for each of the scales was determined by the distribution of the scores on each of the scales.

Validity of the F-S MAS was established with a variety of grade levels from elementary to secondary using a varied ethnic population. Thompson, Malancon, and Bacnal (1993) conducted a study of 174 elementary school teachers (97.1% female) to examine the validity of the F-S MAS. A factor analysis was used to explore measurement integrity. Results of the factor analysis found the scores "reasonably valid." Rathbone (1989) used the F-S MAS to determine difference in attitudes toward mathematics of fifth grade students who were low-achievers and high-achievers in mathematics. A "true random sample" of 200 was chosen from a sample of 5,229 in an urban setting. The sample was approximately equal in high and low achieving students and males and females in each group. There was no mention of fifth grade students (even the low-achieving students) having trouble reading the test. The author found confidence levels were related to attitudes. High-achieving students were more likely to perceive mathematics as a male domain and had more positive attitudes to mathematics than low-achieving students. The difference was statistically significant.

Reliabilities of the F-S MAS were investigated at different grade levels and with the question format. In administering the test to 1,600 secondary students, reliabilities with the positive-negative question format ranged from .86 to .93, indicating high reliability. F values of grade by sex Analysis of Variance (ANOVA) indicated most of the subscale F values were significant at the .01 and .05 level. The scales, which were developed with a grant from the National Science Foundation, show a high degree of reliability and validity.

Reliabilities of the F-S MAS were further confirmed at the middle school level in a test-retest reliability study by Yong (1992) who used the scales with 117 (45 males and 72 females) gifted African-American students. The reliabilities of the study used with these sixth, seventh, and eight graders showed a reliability level of .86. F-S MAS was used successfully with a middle school population in a 1978 Study for Mathematically
Precocious Youth (SMPY) study. In this study, Brush (1985) reports the use of F-S MAS with 816 sixth graders. The group was about equally divided between boys and girls, including an 8% ethnic minority. F-S MAS yielded similar results with those found in the high school group, thus demonstrating successful use with a lower age group.

Another study to measure the reliabilities of F-S MAS was conducted by Melancon et al., (1993). There were 623 sixth through twelfth grade male and female students of varied ethnic backgrounds in an urban school system who were involved in the study. The sample included 58.3% Caucasian, 27.6% African-American, and 7.4% Hispanic students. Of these, 51% were females. In the statistical analysis, measurement integrity of the scores from the attitudes scales was computed using alpha coefficients of the scores from the attitudes scales. Alpha coefficients on the six scales ranged from .80 for Usefulness and Anxiety to .70 for Male Domain. Teacher attitude had a score of .45 and Confidence was low at .05. Instrumentation may have been a problem in this study because the test was changed to a yes-no format. The authors concluded the tests were sufficiently reliable when used with a varied population.

The F-S MAS was used again to assess fifth grade male and female student attitudes towards mathematics after computer experiences with Logo (O'Neal et al., 1988). Four subscales were used with 59 males and 84 females aged 10.1-13.0. There was no mention in this study of the students reporting difficulties reading or understanding the attitude scales.

When Gwizdala and Steinback (1990) conducted research to measure mathematics attitudes in same-sex schools which merged into mixed-sex schools, they developed an instrument which included items concerning the like or dislike of mathematics, usefulness of mathematics, self-esteem in mathematics, identification of who encourages one to pursue mathematics, perceptions of who excells in mathematics, how males and females are treated, and impact of male participation in classes. Their scales reflect the same
concerns of the Fennema and Sherman scales.

Many of the mathematics attitude scales investigated by this researcher were written for high school students. The Fennema-Sherman Mathematics Attitudes Scales were originally piloted and tested on high school populations. Consideration was given to the effectiveness of using this instrument with fourth and fifth grade students. Fennema (1974) found a high correlation between verbal ability and mathematics ability. Reis (1987) stated that an elementary gifted students' reading level can be at middle or secondary level since gifted students read several years beyond their grade level. It is therefore believed that mathematically gifted students would have the verbal capacity to perform effectively with this instrument. Often, a gifted student at fourth or fifth grade will be able to read effectively at the ninth grade level (W. Pindur, personal communication, November 21, 1993; Reis, 1987). A review of the instrument with the teachers involved in this study supported the beliefs by this researcher that the students would have no trouble understanding the wording of the instrument. This was the best measure available to measure the factors that influence mathematics attitudes (E. Fennema, personal communication, November 11, 1993).

Qualitative Measure. A qualitative instrument was developed to assess the students' perceptions of the two grouping arrangements. The students had asked questions about the grouping arrangement and the teachers and this researcher believed an assessment of their perceptions would be beneficial to educational practitioners. A technique developed by DiBono called PMI (Pluses, Minuses, and Interestings) was utilized because it is open-ended and will cause more reflective feedback. The students are asked to evaluate a situation by listing the pluses or positives, minuses or negatives, and interestings of the situation.

Administration of Instruments

All of the instruments were administered by the mathematics teachers. This was not an unusual procedure because the same process had been used previously to assess
students' achievement. Instructions for the tests were read by the teachers and the students completed the measures individually. Confidentiality on all measures was assured by the use of identification numbers or no identification.

Attitude statements were randomly distributed in one instrument as suggested by Fennema and Sherman (1986). All the attitude scales in the F-S MAS, except the "Father and Mother Scale," were administered to the students for both pre-test and post-test. Occasionally, colloquial words were changed to reflect current usage. Questions concerning the meaning of certain words were answered by the teachers in an unemotional manner using standard dictionary definitions. A copy of the document administered to the students is included in the Appendix.

Students placed their answers on a computer scanning sheet that had been designed by this researcher with assistance from an assessment specialist with Virginia Beach City Public Schools. Each student was assigned an identification number. The pre-test was administered during the first complete week in December before the treatment began in January.

CTBS was scored with "score-eze" sheets in January and with copies of scoring sheets in June. The teachers indicated that they do not know the contents of the CTBS.

The qualitative measure (PMI) was distributed during the third week of May just before the grouping situation ended. Students were not asked to sign their name, but were asked to indicate grade level and gender.

**Program Monitoring**

A checklist was developed as a means of monitoring the implementation of lesson plans, the amount of time that the teachers spent in cooperative groups, and any interfering factors that prevented cooperative grouping. A copy of the program monitoring checklist is found in Appendix L. The checklist was developed by this researcher to validate what was being taught and how, while not intruding on the time and classroom environment. Rossi and Freeman (1989) say that monitoring should be kept as simple as possible. This
simple unobtrusive measure (checklist) was agreed on by this researcher and the two teachers involved in this study and was completed daily. The use of the questionnaire/checklist was suggested as a non-threatening and quick method to monitor implementation of the program (W. Findur, personal communication, November, 21, 1993).

The program was also monitored with an examination of curriculum and lesson plans which Worthen and Sanders (1987) advocate as another method of data gathering. Observation methods should not be obtrusive or create a disadvantage because they are time-consuming and require extensive training. Rossi and Freeman (1989) suggest four methods of program monitoring: "direct observation by the evaluator, service records, data from service providers and information from program participants" (p. 205). Service records exist in the daily lesson plans that were utilized by this researcher as part of the data gathered in program monitoring. The data gathered from lesson plans and the teacher questionnaire/checklist exist as a valid and reliable confirmation of the continuity between the program description and the program delivery.

**Limitations**

The external validity problem of novelty did not apply because the students had been in the program for either four months or for a year and four months before the treatment began. They were used to being grouped for problem solving activities. The students may or may not have been in same-sex cooperative groups in their base schools, depending on the philosophy of their classroom teacher or building principal.

Differential selection was not an internal validity issue because all the students were chosen by the same selection matrix (Appendix F). The students exhibit varying ranges of ability such as those found within any gifted classroom. Some students have abilities in the gifted range (IQ of 130+) as measured on the Otis-Lennon IQ test; while other students have high mathematics abilities as measured by the CTBS. Internal validity considerations from instrumentation were not a problem because the time lapse between the pre-test and post-test was five months.
Attrition can be a problem in any form of research but with an experimental subject pool of 28 fourth graders and 28 fifth graders this was not a problem. Parents and base school teachers encourage the students to stay involved in the program. One student dropped out of the mathematics program last year. One student moved in January. All others remained in the program. Compensatory rivalry by the control group was not a validity problem because the students did not usually interact with each other since they attend Old Donation Center (ODC) on different days and are enrolled in different base schools. Rivalry within classrooms between boys and girls was also not a problem because cooperative problem solving is emphasized.

Threats to external validity would probably result more from interaction of selection and treatment than interaction of testing and treatment because the students were selected for their high scores. Results could be generalized to a similar population so this is not a threat to external validity. Another external validity threat could be a reactive (unusual) arrangement but teacher training and qualifications along with curriculum were specific enough that this problem was eliminated. The use of the experimental design and information from pre-test measures lessened the possibility of group differences before treatment.

External validity could be threatened by experimenter bias because the experimenter is emotionally involved in conducting the experiment. The researcher was not involved in the administration of the attitude or achievement measure; therefore, this researcher is able to maintain an objective attitude in the collection and examination of existing and new data.

This study acknowledges the complication of teacher attitudes but did not focus on teacher attitudes. The mathematics teachers had become sensitized to gender issues through special programs on television, workshops, classes, inservices, and resource books emphasizing gender issues. The two teachers in this study are trained to work with gifted students. The same teachers taught both the control and experimental groups
in the same manner; the only difference was that in the experimental classes, girls were always grouped with girls after the treatment had begun. Having the same teacher for the experimental and control groups lessened internal validity problems.

Studies with academically advanced students who are grouped for instruction in a subject area have found that they have a more positive attitude towards that subject area (Allen, 1991; Bracken, 1980; Feldhusen, 1989; J. Kulik & C-L. Kulik, 1982). This researcher acknowledges that the students may already possess a positive attitude towards mathematics and the research study may find only minute changes in their attitudes towards mathematics.

Consideration was given to referral and selection because teachers pay less attention to girls and ask less demanding questions (Hershberger & Wheatley, 1980). A limitation of this study could be that girls who have mathematics capabilities were not referred. The selection process could be confounded by regular classroom teacher attitudes, questions, and interpretation of characteristics that indicate specific ability. Inservice sessions for base school third grade teachers on characteristics of gifted mathematics students have addressed this problem. Bias selection was further lessened because the assessment specialists from Old Donation Center scanned student records at all regular elementary schools for potential candidates and gifted resource teachers in the regular elementary schools referred students who indicate specific ability in the mathematics area.

The students who were selected for the program had to choose or volunteer to participate in the program. George (1976) feels students should be able to volunteer to participate in this type of program because this creates self-motivation. This researcher acknowledges that volunteerism could be a confounding threat to the validity of the study. However, in any special program for which students are chosen, they must make the choice as to whether or not they will participate. Results could still be generalized to students who are selected to participate in a special program.
Data Analysis

Computers and calculators were used to analyze the data generated by this study. Computer graphics and spread sheets were utilized to generate tables, charts, and other visual aids. Based on these results and the research previously discussed concerning attitudes and achievement, this researcher expected to find that the attitudes and achievement in the classes with same-sex groups would be higher than the attitudes and achievement in the classes with mixed-sex groups. Results of data collection and analysis are reported in Chapter IV.
Chapter IV. Data Analysis and Findings

This section contains the results of the statistical analyses that were completed to test the three Null hypotheses related to this research study. This section presents the hypotheses, scoring techniques, computer software used in data analysis, statistical analyses, tables of results, means and standard deviations.

**Hypotheses**

Null: Ho1 There will be no interaction between attitudes and achievement in fourth or fifth grade mathematically gifted females in same-sex cooperative groups or those in mixed-sex cooperative groups.

Null: Ho2 There will be no difference in the mathematics achievement level of fourth and fifth grade mathematically gifted females in same-sex cooperative groups from those in mixed-sex cooperative groups.

Null: Ho3 There will be no difference in attitudes towards mathematics in fourth and fifth grade mathematically gifted females in same-sex cooperative groups from those in mixed-sex groups.

**Statistical Analysis**

Several statistical methods were used to test the null hypotheses: Multivariate Analysis of Variance (MANOVA), Analysis of Variance (ANOVA), Regression Analysis, and Fisher's Exact Test (a variation of Chi-square). SPSS for MS WINDOWS Release 6.0 was used to analyze the results of the Fennema-Sherman Mathematics Attitudes Scales. SAS Proprietary Software Release (6.08) was used to analyze all additional data. Because
the design was unbalanced (unequal numbers in the experimental and control groups) the General Linear Model was used (C. Philput, personal communication, June 26, 1994).

Scoring Methodology

**Attitudes.** Information from the Fennema-Sherman Mathematics Attitudes Scales was processed after scoring sheets were scanned by a computer. All answers for the scales were standardized so that very negative and very positive answers equaled 1.0. Therefore, the closer a score is to 1.0, the more positive the attitude.

**Achievement.** The Comprehensive Tests of Basic Skills (CTBS) were hand scored by this researcher and results were interpreted using the winter and spring norms books. The number of correct responses was converted to a scale score, percentile rank, stanine, and normal curve equivalent (NCE). NCE scores from the CTBS were used in the achievement analysis because this score allows comparison between different groups. NCEs are "similar to percentile ranks but have the additional advantage of being based on an equal-interval scale" (CTBS, 1990, p. 6).

**Program Monitoring.** The teacher checklists were examined and compared against the daily lesson plans. The amount of time spent in cooperative groups was calculated.

**Qualitative Measure.** An analysis of the qualitative measure (PMI) was made using a tally sheet. Items that were semantically similar were grouped together. Responses from experimental and control groups (see Tables 2 and 3) are displayed in rank order by number of responses, frequency of responses, and the number of responses per student. The "Positive" responses for the experimental group were 1.94 per student while positive responses from the control group were 1.45 per student. The "Minuses" for the experimental group were 0.82 per student and 1.8 minuses per student for the control group. Response to " interesting" was 0.88 per student with the experimental group and 0.95 per student in the control group.

The experimental group found the following items most positive: "sitting with friends and other girls," "working with other girls because they agreed more," "being more
comfortable with girls," "obtaining more encouragement from girls because they don't criticize," "it was easier to think and relate," "it was easier to talk and share ideas," "you were more involved and treated more equally." The control group found the following items more positive: "making new and different friends," "learning about others," "sitting with friends," and "seeing a different point of view."

The disadvantages (Minuses) found with the experimental group were: "girls argue and are talkative," "you don't get different points of view or thinking," "work with the same people" (number of girls in some classes are small). The control group listed the following minuses: "boys are annoying and talkative," "there are always more boys and girls are ignored," "you don't get to be with friends," and "girls want to be separate" (from the boys). Analysis of "Interestings" showed that the experimental (same-sex) group felt the following: "learn other girls ideas/feelings about mathematics," "see differences in thinking," "get to know others well because you communicate and share," "don't like it all the time," and "I'm more comfortable because people make me feel welcome." The control group reported interestings as: "learn to cooperate with different people," "get different opinions," "see how boys think," "learn more new things together," and "two boys are always in groups" (so they always have same-sex partners). The control (mixed-sex groups) report of small numbers of females in classes coincides with low numbers of females referred to gifted or mathematics classes found by Freeman (1983).

The qualitative measure was ambiguously worded with no verbal cues to prompt comments. Comments made by the students in both groups coincide with the findings of M. Sadker and D. Sadker (1994a) that girls wanted to be separate, boys ignored girls, boys demanded more attention, and boys took over. The experimental group (same-sex) felt more encouragement to talk, to explore feelings, and to share concerns. These findings reflect the strengths of same-sex groups or schools previously reported (Brody & Fox, 1980; Fox, 1981). Concern has been expressed that boys often ignore girls, block out their ideas, and prevent them from actively being involved in the learning process (AAUW,
Females in the experimental (same-sex groups) report they feel they were more actively involved in the learning process. The specialized advanced mathematics program can ease the concerns of educators that boys ignore girls and keep them from being actively involved in learning mathematics. The specialized mathematics program provides females opportunities to actively participate in problem-solving activities and mathematics learning in cooperative groups.
Table 2 Responses to Pluses, Minuses, Interettings from the Experimental Group

<table>
<thead>
<tr>
<th>Pluses</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier to think/relate/talk/share</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Sit with friends/other girls</td>
<td>7</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Work better with girls, agree more</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>More comfortable with girls</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Girls encourage more, don't criticize</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Improve problem solving</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Better involved/boys can't leave you out</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Fun</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Get treated more equal</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Learn more about what girls think</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Don't have to listen to boys</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>42</td>
<td>24</td>
<td>66</td>
</tr>
<tr>
<td># Responses per student</td>
<td>1.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minuses</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls argue/are talkative</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Don't get different point of view/thinking</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Don't know others/work w same people</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Some people not your friend</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Not feel comfortable</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Can't settle boy/girl differences</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Boys help you solve problems</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Its weird</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Like to hear disgusting things</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Girls don't understand assignment</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>20</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td># Responses per student</td>
<td>.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interesting</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn other girls ideas/feelings about math</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>See differences in thinking</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Get to know others well/communicate/share</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Don't like it all the time</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>More comfortable/people make me feel welcome</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Like it, agree more</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Learn more</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Can express self more freely/good for shy girls</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Find boys/girls think same</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Work better with girls than boys</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Get answers quickly if work together</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Girls usually sit with girls</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Responses</strong></td>
<td>22</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td># Responses per student</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Table 3: Responses to Pluses, Minuses and Interesting of the Control Group

<table>
<thead>
<tr>
<th>Pluses controls</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make new friends/work w different people</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Sit with friends</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Learn about others</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>See different perceptions/viewpoints</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>No fight about who sits with who</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Show boys that girls are smart</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pay more attention</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>All participate</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Get to sit with boys</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>12</strong></td>
<td><strong>17</strong></td>
<td><strong>29</strong></td>
</tr>
<tr>
<td><strong># responses per student</strong></td>
<td><strong>1.45</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minuses Controls</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grps don't get along: mean, bossy, dislike</td>
<td>3</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Boys are annoying and talkative</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>More boys, if only 1 girl she's ignored</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Don't get with friends</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Girls want to be separated from boys</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Don't have same interests</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Boys joke girls</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Become boy crazy</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Boys talk only to boys</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total responses</strong></td>
<td><strong>15</strong></td>
<td><strong>21</strong></td>
<td><strong>36</strong></td>
</tr>
<tr>
<td><strong># responses per student</strong></td>
<td><strong>1.8</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interesting</th>
<th>4th</th>
<th>5th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn to cooperate with different people</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Get different opinions, see how boys think</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Learn more new things together</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2 boys are always in groups</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>If 2 boys/2/girls, they sit together/not mixed</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>See how people react</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Some people don't mind</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>8</strong></td>
<td><strong>11</strong></td>
<td><strong>19</strong></td>
</tr>
<tr>
<td><strong># Responses per student</strong></td>
<td><strong>0.88</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Statistical Results

Pre-Test

T-tests were conducted on the pre-test attitudes scales using SPSS computer software. The T-tests showed the experimental and control group means and the standard deviation were not significantly different on the Fennema-Sherman Mathematics Attitudes Scales pre-test (see Figure 8). The groups began the study with similarly positive attitudes (not statistically different). Overall, students have very positive attitudes on each of the subscales. Students show more positive attitudes toward Attitude for Success with Mathematics (1.36, standard deviation is 0.34) and Usefulness of Mathematics (1.19, the standard deviation is 0.17). Students show slightly less positive attitudes on Teacher Attitudes (1.53, the standard deviation is 0.34) and Effectance in Mathematics (1.53, the standard deviation is 0.68). Mathematics anxiety on the pre-test is also high (1.53, the standard deviation is 0.68). The lowest attitude (1.19, the standard deviation is 0.68) is on mathematics as a male domain which means females do not perceive mathematics as a male domain. The students had been in the program for four months or a year and four months before the treatment began. It is possible that the students had previously developed positive attitudes before the study began.
Attitude Means Experimental vs Controls

Figure 8 Pre-Test Attitudes on the Fennema-Sherman Mathematics Attitudes Scales: Means and Standard Deviations of Control versus Experimental Groups

Note. AS = Attitude toward success with mathematics, MD = mathematics as a male domain, TA = teacher attitude, CL = confidence toward learning mathematics, MA = anxiety towards mathematics, EM = effectance in mathematics, UM = usefulness of mathematics. Attitude mean scores are the upper numbers that are plotted. The lower numbers plotted are the standard deviations for each attitude.

Control Tot = control totals, Exper Tot - experimental group totals.

MANOVA Analysis

Two Multivariate Analyses of Variance (MANOVA) were required to analyze the data: attitude MANOVA and achievement MANOVA (Borg & Gall, 1989; Huck, Cornier, & Bounds, 1974; Kachigan, 1986). MANOVAs and suggested follow-up
analyses were conducted: Pillai's Trace, Hotelling-Lawley Trace, Roy's Greatest Root statistic and Tukey's Post Hoc test.

The MANOVA for both attitude and achievement (see Table 4) reported main overall effects, interaction effects, Lambda values, and p-values. Wilks' Lambda values (Λ) and p-values for the attitude MANOVA show no significance for group (Λ = 0.94175132, p = 0.5645) or test (Λ = 0.92005495, p = 0.3293). Results should equal or exceed the .05 level in order to be significant. There is an almost significant Lambda-value and p-value (Λ = 0.87886959, p = 0.0866) for grade and attitudes (see Table 4). The MANOVA analysis was performed by looking at grade, either fourth or fifth, by groups, either experimental or control, or by test, either the pre-test or the post-test. There were no significant interaction Lambda-values or p-values reported in the attitude MANOVA for grade by group (Λ = 0.94558080, p = 0.6115), group by test (Λ = 0.96425331, p = 0.8340), grade by test (Λ = 0.92325610, p = 0.3596), or grade by group by test (Λ = 0.94290556, p = 0.5786).

The achievement MANOVA (see Table 4) reported no significant Lambda values or p-values for either experimental or control group (Λ = 0.99908760, p = 0.9558), fourth or fifth grade (Λ = 0.96370906, p = 0.1604), or pre-test and post-test (Λ = 0.96683663, p = 0.1884). There were no significant interaction Λ-values or p-values reported in the achievement MANOVA for grade by group (Λ = 0.96987435, p = 0.2200), group by test (Λ = 0.96605459, p = 0.8223), grade by test (Λ = 0.95905938, p = 0.1263), or grade by group by test (Λ = 0.99665689, p = 0.8472). The MANOVAs tested the three null hypotheses to determine if there were statistically significant differences between the
centriods of the experimental and control groups. Table 4 shows Lambda Values and p-values for main overall effects and interaction in both achievement and attitude scores as a result of the two MANOVA analyses. There were no overall main effects or interactions from the achievement or attitude analyses that were statistically significant because they did not equal or exceed the .05 level of significance. The null hypotheses could not be rejected based on the statistical analysis.

All the subjects in this study are in the gifted range (academically or intellectually), thus, they already score high on the achievement measures. The students' scores on the achievement measure represent the upper quarter of all possible scores. The students in this study are grouped together because they have ability in an academic area. Gifted students generally have more positive attitudes toward school, especially when grouped for a particular subject (Allan, 1989, 1991; Bracken, 1980; Feldhusen, 1989; Kulik, J.A. & Kulik, C-L.C., 1982). The attitude scores at the beginning of the study were very high as were the achievement scores. The students in this study represent the top one-quarter range in ability and achievement. The scores represent the upper quarter of all possible scores. This phenomena is called "restriction of range" of all actual scores to all possible scores (C. Philput, personal communication, June 26, 1994). Restriction of range restricts the possibility of finding results that are statistically significant.

Borg and Gall (1989) caution that the total number of subjects should be at least two times as large as the number of dependent variables. The number of main dependent variables was two, the number of levels of dependent variables was 9 or 18 for pre-and post-test. The total subject pool was 54 with 108 observations. The number of observations seems adequate but may have been too few when there is also restriction of range.
Table 4  
Results of Multivariate Analysis of Variance of Attitudes on the Fennema-Sherman Mathematics Attitudes Scales and CTBS Achievement: Overall Main Effects and Interaction Results by Group, Grade, and Test

<table>
<thead>
<tr>
<th></th>
<th>Attitude</th>
<th>Achievemen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A-Value</td>
<td>p-value</td>
</tr>
<tr>
<td>Groups</td>
<td>0.9417</td>
<td>0.5645</td>
</tr>
<tr>
<td>Grade</td>
<td>0.8789</td>
<td>0.0866d</td>
</tr>
<tr>
<td>Test</td>
<td>0.9200</td>
<td>0.3293</td>
</tr>
</tbody>
</table>

Interaction

|                     | A-Value | p-value    | A-Value | p-value |
|---------------------|----------|------------|
| Grade*Group         | 0.9456  | 0.6115     | 0.9698  | 0.2200  |
| Group*Test          | 0.9642  | 0.8340     | 0.9660  | 0.8223  |
| Grade*Test          | 0.9233  | 0.3596     | 0.9590  | 0.1263  |
| Group*Grade*Test    | 0.9429  | 0.5786     | 0.9966  | 0.8472  |

Note. Attitudes are measured by the Fennema-Sherman Mathematics Attitudes Scales and Achievement is measured by Comprehensive Test of Basic Skills (CTBS), Mathematics computation and concepts portions.

a A-value = Lambda value  
b Group means experimental (N=34) vs. control (N=20).  
c Grade is fourth or fifth  
d Almost significant  
e Test is pre-test or post-test
Post Hoc Analysis. Two Multivariate Analyses of Variance (MANOVA) analyzed the attitude and achievement data and found no overall main effects or interactions from the achievement or attitude analyses that were statistically significant. Tukey's Post Hoc tests (see Table 5) were used to further analyze this data. Each attitude was run as a dependent variable against group, grade, group by grade, test, group by test, grade by test, and group by grade by test.

Results of two of these analyses were interesting. When the attitude for success with mathematics (AS) was examined by group, grade and test, the p-value for grade showed almost significant results (p=0.0539). The mean score of the subscale attitude AS is 1.5138 at fourth and 1.37037 at fifth. While the results were not statistically significant, numbers for Attitude for Success (AS) with mathematics are almost statistically significant and may be showing a trend found as students get older (C. Philput, personal communication, June 26, 1994). Evidence of a very positive attitude for success with mathematics could be a result of the special program. The review of the literature found that females generally had a more positive attitude toward success with mathematics if they had been grouped together in a special program (Fox, 1988; Reis, 1987; Wheatley, 1983).
Table 5

Results of Tukey's Post Hoc Analysis of the Subscale: Attitude for Success with Mathematics (AS) by Group, Grade, and Test

<table>
<thead>
<tr>
<th></th>
<th>F-Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group(^a)</td>
<td>0.38</td>
<td>0.5387</td>
</tr>
<tr>
<td>Grade(^b)</td>
<td>3.80</td>
<td>0.0539(^c)</td>
</tr>
<tr>
<td>Test(^d)</td>
<td>2.01</td>
<td>0.1598</td>
</tr>
<tr>
<td>Grade*Group</td>
<td>0.26</td>
<td>0.6099</td>
</tr>
<tr>
<td>Group*Test</td>
<td>0.00</td>
<td>0.9931</td>
</tr>
<tr>
<td>Grade*Test</td>
<td>5.14</td>
<td>0.0255</td>
</tr>
<tr>
<td>Group<em>Grade</em>Test</td>
<td>1.11</td>
<td>0.2946</td>
</tr>
</tbody>
</table>

Note. Attitudes measured on the Fennema-Sherman Mathematics Attitudes Scales

Mean scores of AS showed:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth</td>
<td>1.51389</td>
</tr>
<tr>
<td>Fifth</td>
<td>1.37037</td>
</tr>
</tbody>
</table>

\(^a\) Group means experimental (N=43) versus control (N=20).
\(^b\) Grade is either fourth (N=27) or fifth (N=27)
\(^c\) Almost significant
\(^d\) Test is pre-test or post-test

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The Post hoc test conducted using the variable (attitude), mathematics as a male domain (MD) yielded mean scores for both fourth and fifth grade that are interesting. Mean score for fourth grade females was $1.30556$ and mean score for fifth grade females was $1.266998$. These scores are interesting because they may be showing a trend (C. Philput, personal communication July 18, 1994). Researchers found MD associated with success for females in mathematics (Austin & Draper, 1981; Campbell, 1986; Fennema, 1977; Fennema & Sherman, 1978; Fox, 1980; Raymond & Benbow, 1986; Stanley & Benbow, 1982a). Follow-up study is suggested to determine if this trend is evident at the end of sixth grade and if this attitude is associated with achievement.

The Tukey's post hoc analysis examined grade by group, group by test, group by test and group by grade by test and found no other statistical numbers important.

**Regression Analyses Results**

Regression analyses utilizing the General Linear Model were used to determine if there was a relationship between attitudes and achievement. The relationship was examined in several ways while the computer had access to the students' data. There were six regressions for main effects, nine regressions for 2-way interactions, twenty-four regressions for 3-way interactions. Regression analysis found no statistically significant relationship between attitude and achievement ($> .05$). The findings showing no clear relationship between attitude and achievement support previous research (Evans, 1971; Fox, 1980; Meece, et al., 1982; M. Sadker & D. Sadker, 1994a). The regression analysis showing no clear relationship between attitude and achievement does not support other research that found a positive relationship between attitudes and achievement (Boswell, 1985; Davis & Rimm, 1989; Elmore, 1992).

Of the approximately 40 regressions that were calculated, two regressions were
found to be interesting: (see Tables 6 and 7) the relationship between mathematics concept score and three attitude variables and the relationship between achievement and attitude by group and test time. A significant relationship was found (see Table 6) in the relationship between achievement and attitude at the fourth grade level on the concepts portion of the pre-test CTBS. The adjusted R-square for the relationship between achievement and attitude at fourth grade level on the pre-test is 0.4319. This means that 43% of the variance in mathematics concept scores for fourth grade on the pre-test measure is accounted for by three attitudes: Attitude for Success with Mathematics (AS), Teachers Attitude (TA), and Usefulness of Mathematics (UM). The data show: 1) the higher the attitude on AS, the lower the concept score; 2) the more positive the attitude on TA, the higher the concept score; and 3) the higher the attitude on UM, the lower the concept score. It is logical that a more positive perception of teacher attitude would be related to a higher concept score. A higher score on attitude of success with mathematics and the usefulness of mathematics indicates a less positive attitude and could easily be related to a lower concepts score. If females do not believe they will succeed with mathematics and do not perceive mathematics as useful, they will probably not have a very positive attitudes toward mathematics, therefore their understanding of mathematic concepts will be lower.
Table 6

Results of Regression Analysis of the Relationship Between Achievement and Attitude by Grade Level and Test Time at Grade 4 on the Pre-Test CTBS, Concepts Portion. (N=27)

| Variable | DF | Prob > |T| |
|----------|----|--------|
| AS       | 1  | 0.0018a|
| MD       | 1  | 0.8442 |
| TA       | 1  | 0.0006a|
| CL       | 1  | 0.0660 |
| MA       | 1  | 0.5301 |
| UM       | 1  | 0.0151a|
| EM       | 1  | 0.8787 |

Adjusted R-square = 0.4319

p = 0.0093

Note. Variables: AS = Attitude of Success with Mathematics, MD = Mathematics as a Male Domain, TA = Teachers Attitude, CL = Confidence in Learning Mathematics, MA = Mathematics Anxiety, UM = Usefulness of Mathematics, and EM= Effectance in Mathematics.

a These three attitudes account for 43% of the variance in mathematics concepts on the pre-test CTBS.
The second finding is that there is a relationship between achievement and attitude and group and test time. An analysis of the relationship between achievement on the computation portion of the post-test CTBS and attitude with the control group revealed a significant relationship (see Table 7). The adjusted R-square for the relationship between achievement on mathematics computation and attitude and attitude on the post-test is 0.9389 (p = 0.0468). The relationship shows all the attitudes are related to performance on the computations portion of the CTBS on the post-test, they account for 93% of the variance. It is possible that these findings are significant due to chance alone; a phenomena called experiment-wise error rate. There are too few observations to develop a stable correlation matrix. (C. Philput, personal communication, June 16, 1994). A study with a larger sample would yield more observations which would lead to more stable statistical analysis.
Table 7

Results of Regression Analysis of the Relationship Between Achievement on Computation Portion of CTBS and Attitude by Control Group (N = 20) and Post-Test

| Variable | DF | Prob > |t| |
|----------|----|---------|
| AS       | 1  | 0.0138  |
| MD       | 1  | 0.0839  |
| TA       | 1  | 0.0243  |
| CL       | 1  | 0.6679  |
| MA       | 1  | 0.0167  |
| UM       | 1  | 0.3314  |
| EM       | 1  | 0.0221  |

Adjusted R-square = 0.9389

p = 0.0468

Note. Variables: AS = Attitude of Success with Mathematics, MD = Mathematics as a Male Domain, TA = Teachers Attitude, CL = Confidence in Learning Mathematics, MA = Mathematics Anxiety, UM = Usefulness of Mathematics, and EM = Effectance in Mathematics.

Program Monitoring

It was predicted that the amount of time spent in cooperative grouping would be between 60% and 80%. Results of the analysis of the checklists completed weekly by the two mathematics teachers revealed that 53.59% of the total instructional time in fourth and fifth grade is spent in cooperative grouping arrangements. The percentage of instructional
time spent in cooperative grouping arrangements at fourth is 49.17% and at fifth it is 58%.
The time spent per instructional day was generally consistent. A careful comparison of
lesson plans with the checklist information shows that the majority of time is spent in
cooporative group work of some kind. It is possible that a greater percentage of time is
spent in cooperative work than was reported.

Qualitative Analysis Results

Fisher's Exact Test (a version of the Chi-square test) was used to analyze the
frequency of student responses to the qualitative measure (see Table 8). This particular
test was used because it is more conservative and is recommended for small sample sizes
(C. Philput, personal communication, June 26, 1994). The "Positive" responses for the
experimental group were 1.94 per student while responses from the control group were
1.45 per student. The "Minuses" for the experimental group were 0.82 per student and
1.8 per student for the control group. Responses to " Interesting" was 0.88 per student in
the experimental group and 0.95 per student from the control group. Two conclusions can
be made: there are significantly more minuses and significantly fewer pluses for the control
group; there are significantly more pluses and significantly fewer minuses for experimental
group. The level of significance would have to equal or exceed .05 in order to be
statistically significant. The number of responses for each group is significant at the .005
level. The more numerous positive responses from the same-sex group support other
findings in same sex classes or schools (Brody & Fox, 1980; Fennema & Sherman, 1977,
1978; Fox, 1981; Gwidzala & Steinback, 1990; Michaels, 1993; Van-Tassel Baska,
1989a).

The qualitative measure revealed the most statistically important findings. When
students were asked to examine and think about the grouping arrangement, the frequency
of their responses was statistically significant. Results show there are significantly more
minuses for the control group (mixed-sex), and significantly fewer pluses; there are
significantly more pluses for experimental group (same-sex) and significantly fewer minuses. Students' comments support findings in the literature that students prefer to work with same-sex friends (M. Sadker & D. Sadker 1994a; Silverman, 1991). Students feel more support from other females to take risks, to become actively involved, and to share feelings about mathematics in same-sex groups. This supports previous findings of the positives of same-sex groups (AAUW, 1992; Fox, 1980; Reis & Callahan, 1989; Sadker, M. & Sadker, D., 1994a).

Table 8

Statistical Analysis of Frequency Responses to Qualitative measure, PMI for Group* x Answer response.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>DF</th>
<th>Value</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>2</td>
<td>10.579</td>
<td>0.005</td>
</tr>
<tr>
<td>Likelihood Ratio Chi-Square</td>
<td>2</td>
<td>10.552</td>
<td>0.005</td>
</tr>
<tr>
<td>Mantel-Haenszel Chi-Square</td>
<td>1</td>
<td>2.272</td>
<td>0.132</td>
</tr>
<tr>
<td>Fisher's Exact Test (2-tail)</td>
<td></td>
<td></td>
<td>5.47E-03***</td>
</tr>
<tr>
<td>Phi Coefficient</td>
<td></td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>Contingency Coefficient</td>
<td></td>
<td>0.220</td>
<td></td>
</tr>
<tr>
<td>Cramer's V</td>
<td></td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>Sample Size = 208</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** p=.005

Note. PMI means the Pluses, Minuses and Interesting about a situation.

a Group means experimental (N = 34) versus control (N = 20).
Means and Standard Deviations

The statistical analysis generated information about the means and standard deviations of the groups on the achievement and attitudes measures (see Tables 9, 10, and 11). The overall means and standard deviations as well as the control and experimental means and standard deviations can be seen in Table 9. Overall scores for all students on the CTBS are high for computation (84.06, standard deviation is 11.09) and concepts (86.81, standard deviation is 10.59). The control group's scores are high on computation (84.75, standard deviation is 11.11) and concepts (87.85, standard deviation is 10.63). The experimental group scores were also high on computation (83.66, standard deviation is 11.13) and concepts (86.19, standard deviation is 10.60). Overall attitudes toward mathematics as measured by the Fennema-Sherman Mathematics Attitudes Scales were high (1.0 = perfect positive attitudes). The attitude means ranged from the most positive for usefulness of mathematics (UM) at 1.31 (standard deviation is 0.350) to effectance with mathematics (EM) at 1.67 (standard deviation is 0.582).

Mean scores for the experimental group on every attitude scale were positive. Attitude for success with mathematics (AS) is 1.4227941 (standard deviation is 0.4567342). Mathematics as a male domain (MD) shows 1.2965686 (standard deviation is 0.3287566). Teacher attitude (TA) is 1.6924020 (standard deviation is 0.604923). Confidence in learning mathematics (CL) is 1.416667 (standard deviation is 0.4345658). Mathematics anxiety (MA) is 1.6164216 (standard deviation is 0.6887120). Usefulness of mathematics (UM) is 1.3590688 (standard deviation is 0.3951555). Effectance in mathematics (EM) is 1.6960784 (standard deviation is 0.6633569).

The attitude scores in the control group are also found in Table 9. The control group's mean attitude scores on effectance with mathematics (EM) is 1.62 (standard deviation is 0.415). Usefulness of mathematics (UM) is 1.239 (standard deviation is 0.242). Mathematics as a male domain (MD) is 1.2687500 (standard deviation is 0.2705167). Attitude toward success with mathematics (AS) is 1.475 (standard deviation
is 0.40130). Teachers attitude (TA) is 1.613 (standard deviation is 0.361). Confidence in learning mathematics (CL) is 1.329 (standard deviation is 0.287). Mathematics anxiety (MA) is 1.573 (standard deviation is 0.4394163). Usefulness of mathematics (UM) is 1.240 (standard deviation is 0.242). Again the mean scores on the attitude measure indicate very positive attitudes toward mathematics. The differences between the attitude means on each of the different attitudes ranged from 0.03 -0.09. These differences were not statistically significant. Although there are no statistically significant differences in the two groups on the attitude measure, the very positive attitudes exhibited by the gifted students support research that found gifted students generally have more positive attitudes toward school, especially when grouped for a particular subject (Allan, 1989, 1991; Feldhusen, 1989; Kulik, J.A. & Kulik, C-L. C; 1982).

Overall the group NCE scores on an out-of-grade level CTBS are above the upper one-quarter of all possible scores (84.06 on computation, 86.81 on concepts). The control groups scored slightly higher on computation (84.75) than the experimental (83.66). The control group also scored slightly higher on concepts (87.85) than the experimental group (86.19). The differences are very slight and are not statistically significant.

Both achievement and attitude scores are very high for the two groups, so the range of scores is limited. This phenomena is called "restriction of range" of all actual scores to all possible scores (C. Philput, personal communication, June 26, 1994). Restriction of range increases the difficulty of finding statistically significant differences between the two groups.
Table 9.
Means and Standard Deviations of Achievement and Attitudes: Overall Post-Test Scores and Control versus Experimental Groups.

<table>
<thead>
<tr>
<th>Overall Group</th>
<th>Control (N=20)</th>
<th>Experimental (N=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td>Comp</td>
<td>84.0648148</td>
<td>11.0852880</td>
</tr>
<tr>
<td>Conc</td>
<td>86.8055556</td>
<td>10.5904721</td>
</tr>
</tbody>
</table>

CTBS NCE Scores

| Attitudes (measured by the Fennema-Sherman Mathematics Attitudes Scales) |
|--------------------------|----------------|----------------|----------------|----------------|----------------|
| AS                       | 1.4421296      | 0.4358450      | 1.4750000      | 0.4012978      | 1.4227941      | 0.4567342          |
| MD                       | 1.2862654      | 0.3074603      | 1.2687500      | 0.2705167      | 1.2965686      | 0.3287566          |
| TA                       | 1.6628086      | 0.5273398      | 1.6125000      | 0.3608069      | 1.6924020      | 0.6049234          |
| CL                       | 1.3842593      | 0.3875050      | 1.3291667      | 0.2874079      | 1.416667      | 0.4345658          |
| MA                       | 1.6003086      | 0.6064896      | 1.5729067      | 0.4394163      | 1.614216      | 0.6887120          |
| UM                       | 1.3148148      | 0.3497391      | 1.2395833      | 0.2419710      | 1.3590688      | 0.3951555          |
| EM                       | 1.6682099      | 0.5828304      | 1.6208333      | 0.4151468      | 1.6960784      | 0.6633569          |

Note. CTBS NCE scores are used to measure achievement. Comp = mathematics computation, Conc = mathematics concepts, NCE = Normal Curve Equivalent scores. Attitudes: AS = Attitude of Success with Mathematics, MD = Mathematics as a Male Domain, TA = Teachers Attitude, CL = Confidence in learning Mathematics, MA = Mathematics Anxiety, UM = Usefulness of Mathematics, and EM= Effectance in Mathematics.
Means and standard deviations of post-test achievement on the CTBS and attitudes on the Fennema-Sherman Mathematics Attitudes Scales by grade levels is shown in Table 10. All scores favor the fifth grade females. Normal curve equivalent (NCE) scores for computation and concepts portion of the CTBS show fifth grade scores were 85.89 for computation, (the standard deviation is 11.985) and 88.02 for concepts (the standard deviation is 9.184). Fourth grade scores are 82.24 for computation (the standard deviation is 9.882) and 85.59 for concepts (the standard deviation is 11.793). The fifth grade females scored higher on mathematics computation (85.89) than the fourth grade females (82.24). The fifth grade scores on the CTBS are higher in mathematics concepts (88.02) than the fourth grade scores (85.59). The differences range from 2.43 - 3.65 which are not statistically significant.

Attitude scores favor the fifth grade girls with slightly more positive scores on most attitudes. Attitude scores are expressed so that the most perfectly positive attitude is 1.00. Attitude to success with mathematics (AS) is 1.37 (standard deviation is 0.358) at fifth and 1.51 at fourth (standard deviation is 0.497). Mathematics as a male domain (MD) at fifth is 1.27 (standard deviation is 0.268) and 1.31 at fourth (standard deviation is 0.343). Teachers attitude (TA) at fifth grade is 1.59 (standard deviation is 0.367) at fifth and at fourth is 1.74 (standard deviation is 0.644). Confidence in learning mathematics (CL) is 1.34 (standard deviation is 0.291) and fourth it is 1.43 (standard deviation is 0.463). At fifth grade usefulness of mathematics (UM) is 1.25 (standard deviation is 0.234) and at fourth grade it is 1.38 (standard deviation is 0.429). Fourth grade scored slightly more positive in mathematics anxiety (MA) at 1.56 (standard deviation is 0.684) and in fifth grade it is 1.64 (standard deviation is 0.520). In fourth grade effectance in mathematics (EM) is 1.62 (standard deviation is 0.690) while it is 1.71 (standard deviation is 0.453) at fifth.

The more positive attitudes at fifth grade support research of Fox (1980) who found females had more positive attitudes in when they had been involved in specialized
programs. Overall attitudes have not begun the downward spiral predicted by researchers (Brown & Gilligan, 1992; Clark, 1983; Gallagher, 1985; Silverman, 1986). If attitudes continue to remain positive, this program will support the success of intervention before students get to middle school when mathematics attitudes begin to decline. Successful intervention was recommended by Fox (1977) and Reis and Callahan (1989). At this point successful intervention appears to have had a positive effect on attitudes and achievement.
Table 10

**Means and Standard Deviations of Mathematics Achievement on the Post-Test and Attitudes by Grade Levels on the Post-Test.**

<table>
<thead>
<tr>
<th></th>
<th>Grade 4 (N=27)</th>
<th></th>
<th>Grade 5 (N=27)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td><strong>CTBS NCE Scores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp</td>
<td>82.2407407</td>
<td>9.8822028</td>
<td>85.8888889</td>
<td>11.9853160</td>
</tr>
<tr>
<td>Conc</td>
<td>85.5925926</td>
<td>11.7930560</td>
<td>88.0185185</td>
<td>9.1846688</td>
</tr>
<tr>
<td><strong>Attitudes on the Fennema-Sherman Mathematics Attitudes Scales (F-S MAS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AS</td>
<td>1.5138889</td>
<td>0.4976649</td>
<td>1.3703704</td>
<td>0.3582169</td>
</tr>
<tr>
<td>MD</td>
<td>1.3055556</td>
<td>0.3437828</td>
<td>1.2669753</td>
<td>0.2681463</td>
</tr>
<tr>
<td>TA</td>
<td>1.7391975</td>
<td>0.6440842</td>
<td>1.5864198</td>
<td>0.3669963</td>
</tr>
<tr>
<td>CL</td>
<td>1.4305556</td>
<td>0.4629202</td>
<td>1.3379630</td>
<td>0.2906729</td>
</tr>
<tr>
<td>MA</td>
<td>1.5596420</td>
<td>0.6846302</td>
<td>1.6419753</td>
<td>0.5199454</td>
</tr>
<tr>
<td>UM</td>
<td>1.3780864</td>
<td>0.4291260</td>
<td>1.2515432</td>
<td>0.2337433</td>
</tr>
<tr>
<td>EM</td>
<td>1.6219136</td>
<td>0.6901738</td>
<td>1.7145062</td>
<td>0.4528624</td>
</tr>
</tbody>
</table>

**Note.** CTBS NCE (Normal Curve Equivalent) scores are used to measure achievement. Comp = mathematics computation, Conc = mathematics concepts, Attitudes on the F-S MAS: AS = Attitude of Success with Mathematics, MD = Mathematics as a Male Domain, TA = Teachers Attitude, CL = Confidence in learning Mathematics, MA = Mathematics Anxiety, UM = Usefulness of Mathematics, and EM = Effectance in Mathematics. The most positive attitude is 1.0
Means and standard deviations for the post-tests on the achievement measure and attitudes measure for the control and experimental group are reported in Table 11. The means on the achievement measure (CTBS) for both the control and experimental group are high. The control group's scores are slightly higher on computations (86.55, standard deviation is 10.650) and concepts (87.90, standard deviation is 12.226) than the experimental group's scores on computation (84.65, standard deviation is 11.364) and concepts (84.32, standard deviation is 11.097). Generally attitudes of all the females are very positive toward mathematics. The control group shows slightly more positive attitudes than the experimental group on some attitudes. Teacher attitude (TA) is 1.59 for control group and 1.82 for the experimental group (standard deviation is 0.356 for control and 0.662 for experimental). Confidence in learning (CL) mathematics for the control group is 1.30 (standard deviation is 0.250) and for the experimental group it is 1.44 (standard deviation is 0.484). Mathematics anxiety (MA) shows 1.63 for the control group (standard deviation is 0.489) and 1.68 for the experimental (standard deviation is 0.714). Usefulness of mathematics (UM) is 1.26 for the control group (standard deviation is 0.278) and 1.39 for the experimental (standard deviation is 0.301). Effectance in mathematics (EM) is 1.68 for the control group (standard deviation is 0.456) and 1.83 for the experimental (standard deviation is 0.68). The experimental group shows more positive attitudes than the control for attitude to success with mathematics (AS) of 1.48 for the experimental (standard deviation is 0.440) and 1.53 for the control (standard deviation is 0.395). Mathematics as a male domain (MD) is 1.32 for the experimental group (standard deviation is 0.269) and 1.28 for the control (standard deviation is 0.262).

Further statistical information concerning results of additional tests can be obtained from the researcher.
Table 11

Means and Standard Deviations on Mathematics Achievement and Attitudes for Control Post-Test and Experimental Post-Test.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control (N = 20)</th>
<th>Experimental (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Dev</td>
</tr>
<tr>
<td>CTBS NCE Scores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp</td>
<td>86.5500000</td>
<td>10.6498085</td>
</tr>
<tr>
<td>Conc</td>
<td>87.9000000</td>
<td>12.2255126</td>
</tr>
<tr>
<td>Attitudes on the Fennema-Sherman Mathematics Attitudes Scales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AS</td>
<td>1.5333333</td>
<td>0.3949610</td>
</tr>
<tr>
<td>MD</td>
<td>1.2750000</td>
<td>0.2622719</td>
</tr>
<tr>
<td>TA</td>
<td>1.5916667</td>
<td>0.3565388</td>
</tr>
<tr>
<td>CL</td>
<td>1.2958333</td>
<td>0.2499634</td>
</tr>
<tr>
<td>MA</td>
<td>1.6291667</td>
<td>0.4885095</td>
</tr>
<tr>
<td>UM</td>
<td>1.2583333</td>
<td>0.2782306</td>
</tr>
<tr>
<td>EM</td>
<td>1.6750000</td>
<td>0.4555538</td>
</tr>
</tbody>
</table>

Note. CTBS NCE (Normal Curve Equivalent) scores are used to measure achievement. Comp = mathematics computation, Conc = mathematics concepts.

Attitudes: AS = Attitude of Success with Mathematics, MD = Mathematics as a Male Domain, TA = Teachers Attitude, CL = Confidence in Learning Mathematics, MA = Mathematics Anxiety, UM = Usefulness of Mathematics, and EM= Effectance in Mathematics.
Summary of Results

Extensive statistical analyses were completed to examine each hypothesis. An attitude Multivariate Analysis of Variance (MANOVA) and an achievement MANOVA showed no main overall effects and no interaction when compared by grade (fourth or fifth), group (experimental of control), or test (pre-test or post). The null hypotheses could not be rejected based on the results of this particular study because there were no statistically significant differences in attitude and achievement in mixed-sex versus same-sex groups. Tukey's Post Hoc follow up analysis revealed two interesting findings. At fifth grade the attitude for success with mathematics (AS) is almost significant and may be showing a trend found in the literature that females develop less favorable attitudes toward success with mathematics as they get older (S. Anderson, 1990; Campbell, 1986). Mean scores of mathematics as a male domain seems to show a trend which could be related to achievement. The importance of the attitude of mathematics as a male domain is supported in other findings (Clark, 1983; Cramer, 1989; Fennema & Sherman, 1977; M. Sadker & D. Sadker, 1994a).

A regression analysis investigated the relationship between attitudes and achievement. No clear statistically significant relationship was established between attitudes and achievement. This supports previous studies that failed to establish a clear relationship between attitudes and achievement (Benbow & Stanley, 1982; Reyes and Stanic 1988; Yong, 1988). The finding is counter to reports of a positive relationship between attitudes and achievement (Boswell, 1985; Davis and Rimm, 1989).

Two relationships are statistically interesting: the relationship between the mathematics concepts score and three attitude variables and the relationship between achievement and attitude by group and test time. Forty-three percent of the variance in mathematics concept scores for fourth grade females on the pre-test achievement measure is accounted for by three attitudes: Success with mathematics (AS), Teachers Attitude (TA), and Usefulness of Mathematics (UM). Interpretations are as follows: 1) the more
positive the attitude on AS, the lower the concept score; 2) the more positive the attitude on TA, the higher the concept score; and 3) the more positive the attitude on UM, the lower the concept score. The second finding is that there is a relationship between all attitudes of the control group and the computation score on the CTBS on the post-test. Significant regression results could have been due to chance alone; a phenomenon called experiment-wise error rate. There are too few observations to develop a stable correlation matrix (C. Philput, personal communication, June 16, 1994).

Program monitoring through the checklist revealed a 7.01% lower amount of time spent in cooperative groups (53.59%) than have been predicted. Comparison of lesson plans and checklists showed students were engaged in cooperative work during most of their instructional time. It is possible that the students are more often performing cooperative activities than had been reported.

The qualitative measure revealed the most statistically significant findings. When students were asked to examine and think about the grouping arrangement without verbal cues, the responses as well as the frequency of their responses was statistically significant at the .005 level. Results show there are significantly more minuses for the control group (mixed-sex), and significantly fewer pluses; there are significantly more pluses for experimental group (same-sex) and significantly fewer minuses. Students' comments support findings in the literature that students prefer to work with same-sex friends (M. Sadker & D. Sadker 1994a; Silverman, 1991). Students feel more support from other females to take risks, to become actively involved, and to share feelings about mathematics in same-sex groups. This supports previous findings that females feel more confident to take risks in same-sex groups (AAUW, 1992; Fox, 1980; Reis & Callahan, 1989; Sadker, M. & Sadker, D., 1994a).

Conclusions about the study will be discussed in Chapter V along with implications and suggestions for future research.
Chapter V. Summary, Conclusions, and Future Implications

Underrepresentation of females in mathematics programs and mathematics courses has created a lack of females in mathematics related careers. Researchers believe that interest in mathematics can be developed through manipulation of the educational environment so that positive attitudes toward mathematics are developed (Reis & Callahan, 1989). More positive attitudes toward mathematics lead to achievement in mathematics, interest in advanced mathematics courses, and involvement in mathematics careers (Brush, 1985; Casserly, 1980; Evans, 1971; Griffin, 1990; Meece et al., 1982; Reis & Callahan, 1989; Silverman, 1991; Taffel, 1987; Yong, 1992).

Mathematical ability, knowledge, and talent are viewed as the building blocks upon which advanced technological careers are built. Mathematics is viewed as the key to mathematical careers in which females are underrepresented (Brody & Fox, 1980, Fox & Tobin, 1985; Reis & Callahan, 1989). Positive attitudes toward mathematics and successful school experiences can create an environment in which mathematics achievement and ability is nourished and strengthened. The purpose of this study was to examine how grouping practices could strengthen or nourish female attitudes and achievement in mathematics. Grouping practices that could strengthen the mathematical foundation for young female students by developing positive attitudes toward mathematics were examined. Hypotheses of the study are that there would be no interaction between attitudes and achievement; no difference in the mathematics achievement level; and no difference in attitudes towards mathematics between fourth and fifth grade mathematically gifted females in same-sex groups or mixed-sex groups.
Two cooperative grouping arrangements (single-sex and mixed-sex) of mathematically gifted females at fourth and fifth grades were examined to determine the effects of grouping on attitude and achievement. Although no statistically significant differences were found in attitude or achievement and no statistically significant relationships were found between attitudes and achievement, significant results were found in the frequency of student responses to the grouping arrangement. Students in the same-sex groups report significantly more positive comments and significantly less negative comments about the grouping arrangements. Students in the mixed-sex groups report significantly less positive comments and significantly more negative comments about the grouping arrangement. This finding was significant at the .005 level and supports the need to have same-sex grouping for females in mathematics classes. The social needs of students must be met as a part of meeting their educational needs. The more positive responses to the same-sex arrangement support the use of same-sex groups in classes.

Conclusions

Mathematics attitudes are important to the study of mathematics, perhaps as important as the study of mathematics itself (Blum-Anderson, 1990; Evans, 1971; Reis & Callahan, 1989). Females in both the experimental and control groups have very positive attitudes to mathematics (1.2315432 to 1.7391975) on the pre-test and post-test attitudes scales (see Figure 7 and Table 4). The very positive attitudes found in this study support previous findings that gifted students generally have positive attitudes, especially when grouped for a particular subject (Allan, 1989; Bracken, 1980; Feldhusen, 1989; Fox, 1980; J. Kulik & C-L. Kulik, 1982; Silverman, 1991; Taffel, 1987). If attitudes continue to remain positive, this program will support intervention programs before students get to middle school when mathematics attitudes begin to decline. Successful intervention was recommended by Fox (1977) and Reis and Callahan (1989). Overall attitudes have not begun the downward spiral predicted by researchers (Brown & Gilligan, 1992; Clark,
1983; Gallagher, 1985; Silverman, 1986). If positive attitudes are crucial to success with mathematics, then these young females should be successful.

The mathematics program provides females with the opportunity to succeed in a cooperative group setting. The students' very positive scores on the attitude measure and high scores on the achievement measure provide evidence that the mathematics program is meeting the educational needs of mathematically gifted students in a positive learning climate through appropriately challenging curriculum at an early age. The teachers appear to maintain rigorous standards that are evident in the high achievement scores. The females have high NCE (Normal Curve Equivalent) scores on mathematics computation and mathematics concepts on out-of-grade level CTBS tests. The scores support other findings of high achievement when gifted students are grouped for special subjects, are challenged with appropriate instructional strategies, and are exposed to a fast-paced, differentiated curriculum (Brody & Fox, 1980; J. Kulik & C-L. Kulik, 1982; Wheatley, 1983).

This study provides evidence that abilities can be detected early so student's abilities and positive attitudes can be nurtured before negative attitudes begin. Several different instruments were used effectively to select students who have performed successfully in the advanced mathematics program. Successful opportunities have helped females develop positive attitudes which are exhibited by the students on the attitudes measure. Researchers feel positive attitudes toward mathematics are evidence of successful opportunities in mathematics (Dismuke, 1977; Reis & Callahan, 1989). Research was suggested at the elementary level particularly with females since much of previous gifted research was completed with males (Beane, 1988; Cramer, 1989; Hershberger & Wheatley, 1980; Phelps, 1991; Yong, 1992). Information about mathematically gifted females at the elementary level is now available and accessible.

The relationship between achievement and attitudes has been again been studied but has yielded no significant results. Other researchers have studied the relationship between attitudes and achievement but have not been able to statistically link positive attitudes with
high achievement (Allan, 1989, 1991; Boswell, 1985; Bracken, 1980; Davis & Rimm, 1989; Feldhusen, 1989; Kulik & Kulik, 1982). When students of like interests and abilities are grouped together, they are challenged by each other's abilities and supported by those abilities. The high achievement and attitudes are evidence that students perform well and challenge each other.

The percentages of cooperative group work is lower than expected, but review of the lesson plans reveals that the majority of work is conducted in groups of some sort. It is possible that the teachers spend a great deal more time in cooperative activities than they reported. A classroom atmosphere of cooperation, rather than competition is encouraged.

**Future Implications**

**Implications for Teachers**

When students are gifted and grouped for a particular subject it is not essential to have same-sex classrooms but it is essential to have same-sex groups for cooperative work. It is not practical to have same-sex classrooms, particularly when female enrollment is low as it often is in mathematics classes (Fox, 1980; Richardson & Benbow, 1990). A disparity between the numbers of boys and girls in mathematics programs and in mathematics classes still exists. The ratio of boys to girls in the mathematics program at ODC is about 2:1. This supports other sources that found boys are more often referred and more accepted in gifted classes (Freeman, 1983; Richardson & Benbow, 1990).

Teachers need inservice training in characteristics that indicate giftedness. Teachers must actively involve females in more opportunities which allow them to show characteristics of mathematical giftedness. This will enable more females to be referred for advanced programs. Teachers need to monitor their interactions, their questions, and their feedback to provide equal encouragement and opportunity for females to excel. In mathematics classes, females should be grouped with other females for cooperative group work. The student responses on the PMI lend support that females need the support from
the peer group and males need to be encouraged to accept females in mathematics roles (Brody & Fox, 1980; Fox, 1980; Ross & Parker, 1980; M. Sadker, & D. Sadker, 1994a).

Teachers cannot monitor all interactions between males and females at any age. Males underestimate girls' abilities as early as third or fourth grade (Evans 1971). Therefore, it is necessary for teachers to begin same-sex grouping very early in elementary school, before males begin sending messages about the inadequacy of female abilities. Females and males need to practice problem-solving activities separately but share problem solving ideas cooperatively to begin to change perceptions about each other and their capabilities.

Same-sex groups are needed in mathematics classes especially if the majority of students in the class are boys. Boys are more numerous and were found more demanding than girls (M. Sadker, D. Sadker, & Stulberg, 1993). The PMI (Pluses, Minuses, and Interestings) showed that females felt that boys ignored girls and were more annoying and talkative. The students stated there are always more boys and the girls are ignored. Being the only girl in a group poses a real disadvantage for girls, therefore it is imperative that at least two females be in each cooperative group. Although attitudes and achievement were not affected by the grouping arrangement, the social needs of the girls are served better in same-sex groups.

Teachers need training in developing differentiated, high-level mathematics curricula. Consultants, gifted experts, and resource teachers can help classroom teachers develop differentiated and enriched curriculum. Counselors and teachers must become aware of subtle gender bias that may be present in teaching, counseling, textbooks, or in the environment. Evidence that teachers still need training exists in an incident that happened to one of the students. One of the fifth grade girls who scored in the 99+ percentile was not referred for a sixth grade advanced mathematics class by her regular school teacher. She had been in the mathematics pilot program for two years and her
scores had been consistently high.

**Implications for Educators**

The same problems with mathematics do not exist for boys because they are more likely to accelerate themselves through course selection (Richardson & Benbow, 1990). Boys do not have the same social implications and problems with mathematics as females (Brody & Fox, 1980; Campbell, 1986; M. Sadker & D. Sadker, 1994a). Girls are more influenced by peer pressure and peer attitudes (Evans, 1971). Problems reported in this study do exist for minorities, immigrants, African-Americans, and females in science fields (Ascher, 1987; Gordon, 1993; Kamii, 1990). This study has generated information concerning how females can experience success with mathematics. The success of special grouping arrangements, special instructional techniques, and a special curriculum can be adapted to create success for minorities, immigrants, African-Americans and females in other subject areas.

**Implications for Policy Makers**

The mathematics program exists only in the fourth and fifth grade at this time. There will be advanced mathematics opportunities for all students in middle and secondary school. At this writing middle school opportunities are undecided. Policy makers must support and provide opportunities for continuing accelerated mathematics opportunities.

The school system must offer more advanced mathematics classes at the middle school level. Algebra should be offered in seventh grade, geometry and other advanced mathematics classes should be made available at the middle school level. Sometimes these provisions could be made at an adjacent high school but students proficient in advanced mathematics ability should not have to provide their own transportation to participate in the advanced mathematics classes. Teachers could travel from one school to another in order to accommodate students with advanced mathematics ability.
Providing more advanced mathematics at the middle and secondary level will mean that students will be ready to take college mathematics courses when they are in high school. The continuation of advanced placement courses and dual-enrollment in college courses should be encouraged. Local institutions of higher education can participate in the development of mathematics abilities by offering special classes after regular school hours or on Saturday.

Implications for Administrators

The implications to administrators of the success of the advanced mathematics program in elementary school is that the program must continue and accommodations should be available at the middle school level for advanced mathematics students. Once the students have been accelerated in mathematics, they should not have to revert to a lower level of mathematics learning. This wastes both the student's time and talents.

Administrators must adopt the philosophy that specialized classes which meet the educational needs of students are not elitist education. Special classes for specific ability students are essential to maintain and develop future potential for society. Grouping does not remove role models because the students model their behavior after successful students of like ability (Allen, 1989, 1991; Burke, 1993; Schneider et al., 1989).

At the middle school level it is important for students to work in same-sex groups. This is the age at which girls begin to feel less secure about their self-concept and their abilities in mathematics (Brown & Gilligan, 1992; Fox, 1976; Silverman, 1993). It is vital for administrators to encourage teachers to have same-sex grouping in their classes for cooperative group work. Administrators must monitor instructional planning and time to ensure that high quality work challenges these students. Administrators must provide time for teachers to meet with mathematics and gifted experts to develop differentiated, accelerated, and enriched curriculum.

The mathematics program has proved that it can effectively accelerate students.
beyond their current grade level by at least one year. The program helps develop very positive attitudes toward mathematics and very high achievement through a combination of teacher attitudes, special curricula, cooperative activities, challenging instruction, and special grouping arrangements.

Administrators, policy makers, teachers, and parents must work to provide opportunities for females to actively participate in special programs, develop positive attitudes to mathematics, and to excel in mathematics. Excelling in mathematics can be enhanced through same-sex groups for students. The success of same-sex groups for females is supported by the positive attitudes and high achievement levels shown in this study. The factors in the environment that cause females to lack equal opportunities can be manipulated. The mathematics program and the same-sex groups have provided an environment in which females have been challenged to actively participate and excel. The program has provided females opportunities appropriate to their abilities, cognitive development, learning style, and achievement. Positive attitudes and high achievement scores provide evidence that the advanced mathematics program for mathematically gifted females has successfully addressed factors in the environment that can affect participation in mathematics, enjoyment of mathematics, and confidence in learning mathematics.

Suggestions for Future Research

A follow-up study of the students who were in the research study should be conducted to measure their attitudes and achievement at the end of each successive year to determine if predicted trends of lower attitudes and achievement in mathematics are evident.

A longitudinal study should compare the mathematics program female students with gifted girls who were not in a mathematics program to determine if there are differences in choices in mathematics courses and/or careers. It is predicted that the students who participated in the mathematics program would take more advanced mathematics courses and be more likely to choose mathematics related careers, if their exposure to mathematics
continues to be positive. Several researchers found this to be true (Brush, 1985; Casserly, 1980; Evans, 1971; Griffin, 1990; Meece et al., 1982; Reis & Callahan, 1989; Silverman, 1991; Taffel, 1987).

Attitudes of incoming fourth grade students should be measured before they have any experience with the mathematics program. These attitudes should be compared with attitudes at the end of a school year. Logically one assumes that the more positive the attitude one has to school or a subject, the better the performance will be in that subject area. A study should be conducted with a larger sample of mathematics students to more clearly establish a relationship between positive attitudes toward mathematics and mathematics achievement at the elementary level.

A larger sample with broader ability range should be studied to obtain a larger range of subjects and abilities. A greater number of observations might yield statistically significant differences. If a control group of mathematically gifted females at fourth and fifth grade could be found who were not in a special mathematics program, then a study could be undertaken to compare the two groups.

Ultimately, this research study supports recent research by Sadker and Sadker (1994) that teachers must utilize the most effective means to work with all students to effectively meet their needs. Teachers must employ different arrangements within classrooms to encourage females to develop their full potential in mathematics and mathematics careers.
REFERENCES


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Virginia Beach City Public Schools, Old Donation Center. Program for academically gifted in mathematics and science: grades four and five (1993). Virginia Beach, Virginia.


BIBLIOGRAPHY


### Appendix A

#### Selection Matrix

**Math Program Matrix (June 1993)**

<table>
<thead>
<tr>
<th>Interest Inventory Range 1 - 10</th>
<th>Otis-Lennon</th>
<th>CTBS</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 15</td>
<td>1 - 10</td>
<td></td>
<td>1 - 5</td>
</tr>
<tr>
<td>130 + = 10</td>
<td>99 - 95 = 15</td>
<td></td>
<td>take lab</td>
</tr>
<tr>
<td>90+ = 5</td>
<td>120 - 129 = 5</td>
<td>90 - 94 = 10</td>
<td>score and</td>
</tr>
<tr>
<td>70 - 89 = 3</td>
<td>&lt; 120 = 0</td>
<td>&lt; 85 = 0</td>
<td>multiply by 2</td>
</tr>
<tr>
<td>50 - 69 = 1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 50 = 0</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

*Source: Em Davis, Principal, Old Donation Center*
Appendix B

Characteristics of Mathematically Gifted Students

Learning Characteristics:
Possesses a large storehouse of information about a variety of science or math related topics;
Has quick mastery and recall of factual information in science or math related areas;
Has rapid insight into cause-effect relationships; tries to discover the how and why of things; asks many provocative questions (as distinct from informational or factual questions); wants to know what makes things (or people) "tick";
Is a keen and alert observer; usually "sees more" or gets more out of science or math related demonstrations, stories, films, etc...

Motivational Characteristics:
Becomes absorbed and truly involved in math or science related topics or problems; is persistent in seeking task completion in areas of interest;
Is easily bored with routine tasks;
Needs little external motivation to follow through in work that initially excites her/him;
Prefers to work independently in areas of interest; requires little direction from teachers when excited about an assignment.

Creativity Characteristics:
Displays a great deal of curiosity about many things in the world of physical and natural science or math; is constantly asking questions about anything and everything;
Generates a large number of ideas or solutions to problems and questions; often offers unusually, unique and clever responses;
Is a high risk taker; is adventurous and speculative;
Often speculates, "What if ....?"

Planning Characteristics:
Grasps the relationship of individual steps to whole mathematical problems or scientific processes;
Recognizes the various alternative methods for accomplishing a mathematical or scientific goal;
Takes into account details and plans all the specific steps necessary to accomplish a mathematical or scientific goal;

Appendix C

Student Referral Sheet

VIRGINIA BEACH CITY PUBLIC SCHOOL
OLD DONATION CENTER
ACADEMIC REFERRAL FOR MATH/SCIENCE (CIRCLE ONE)

Student's Legal name ________________________ Birth Date ___________ Sex ___

Teacher's Name _____________________ School_____________ Grade ____ Date____

Ethnic Code: (Circle One) 1: African-American 2: Caucasian 3: Hispanic
4: Native American 5: Asian/Pacific Islander

Parent's/ Guardian's Name_________________________Telephone (H) _________

Street Address____________________________________Telephone (W) _________

Standardized Tests

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<tr>
<th>Date</th>
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<th>Quantitative</th>
<th>Non-Verbal</th>
<th>Age %</th>
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</thead>
<tbody>
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<td>ITBS</td>
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<td>_____</td>
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<td>ITBS</td>
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<td>_____</td>
<td>RCMP</td>
<td>LTOT</td>
<td>MTOT</td>
<td>BTOT</td>
</tr>
</tbody>
</table>

How would this student benefit from an accelerated program in math/science?

________________________________________________________________________

Please rate the following characteristics as they describe this student.
5= Always, 4= Almost Always, 3= Sometimes, 2= Almost Never, 1= Never

1. Works well independently
2. Assumes responsibility for actions
3. Organizes thoughts and ideas
4. Works well in cooperative learning groups
5. Learns new skills rapidly
6. Applies concepts to new knowledge
7. Seeks challenging situations

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</tbody>
</table>

Comments:________________________________________________________________________

________________________________________________________________________

Teacher's Signature_________________________________________________________Date__________

Please have the student write a paper in class on the following topic and attach to the referral.
"If I could spend one day per week studying anything at all, what would it be and why?"
Appendix D

Student Interest Inventory

LOOKING AT YOURSELF * (reduced copy)

Name _____________________________________________________________

(Last) (First) (Middle)

School ___________________ Grade: ________________________________

Age_____________________ Date of Birth:____________________________

Please show whether you agree or disagree with each statement by circling a number.

4 = Strongly Agree 3 = Agree 2 = Disagree 1 = Strongly Disagree

1. I am a good athlete.
2. I am easy to get along with.
3. I enjoy learning basic math facts.
4. I enjoy working with machines and scientific things.
5. I like to study subjects that are challenging or difficult.
6. I enjoy trying to figure out unusual problems.
7. I like to take charge in planning a project.
8. I enjoy discussing an idea.
9. I like "real life" problems like budgets, savings on sale items, best buys in the grocery store, etc.
10. I don't mind being different from other people.
11. I like to know why and how things work.
12. I like to read science books.
13. I like to cook.
15. I enjoy "word problems."
16. I am interested in NASA and the space program.
17. I like to measure things
18. I like to try to solve difficult problems.
19. I am interested in the environment and problems with pollution litter and the Chesapeake Bay.
20. I work with my family to recycle.
21. I live to work with computers.
22. I am an animal lover.
23. I like number puzzles and problems.
24. I enjoy problems with shapes.
25. My work is often quite original.
26. I like to build things.
27. I like to read.

II. Number the 5 subjects below from 1 - 5 with 1 being your favorite, 2 being your second best, etc.

English Science
Physical Education Mathematics
Social Studies

III

1. My Hobbies are: ________________________________________________.
2. Special activities I have taken part in: ____________________________.
3. Favorite TV programs: ________________________________________.
4. Favorite Magazines: ________________________________________.
5. Best books I have read this year: (two) ____________________________.
6. Clubs or organizations I have taken part in: ________________________.
7. How would you like to spend a day of free time ____________________.
8. If you had to pick any topic you wanted to study, what would it be?__________.

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Appendix E

MATH LAB EVALUATION FOR FOURTH GRADE TASKS

1. Build it: 1 and 2
Pass out bags to groups of students. Students distribute clues in bags. Students share clues by reading them to others in the group. Students must build a structure by correctly piecing together the clues.
Solution for #1:  
red or yellow (top)  yellow  
blue-green-blue  red  
red  blue  
green  blue  
yellow
Solution for #2

2. Cubes in a Bag
Ten cubes are in a bag (7 black, 3 orange)
The instructor takes out 1 cube at a time, replacing the cube each time until 1 cube has been taken out 10 times. Students record results. Students decide if they know how many of each color are in the bag. Write this as a prediction. (P= _____ orange ______ black). Take out 1 cube ten more times have students write another prediction.

3. Riddles with Color Tiles: 1 and 2
Pass out containers with 60 tiles, (15 of each color).
Activity 1: Reveal clues one at a time on an overhead. Students manipulate tiles as each clue is shown. When the fourth clue is revealed, ask the group if they can name all the possible arrangements. Record on transparency as they are given.:
Blue       Yellow  
8          4  
6          3  
4          2  
2          1  
Reveal fifth clue. Solution : 6 blue and 3 yellow

Activity 2: Reveal the first four clues, one at a time. Ask for all possible arrangements:
Red  Green  Blue  
8          1          1  
6          2          2  
4          3          3  
2          4          4  
Read fifth clue and ask which possibilities can be eliminated: (2,4,4)  
Reveal sixth clue.  
Solution: 4 red, 3 green, 3 blue.

4. 0 - 99 Chart
Pass out clues to students. One clue is selected, read, and directions are given in coloring a number chart. Directions are completed before selecting the next clue. All of the group members should agree before doing any coloring. Remind students to use a different color for each clue.

5. Survey and writing activity. Students complete interest inventory if time allows.
Appendix F

Application to Conduct Research

VIRGINIA BEACH CITY PUBLIC SCHOOLS
Educational Planning Center

APPLICATION TO CONDUCT RESEARCH

I. Identifying Information

Name ________________________

Work Location ___________________ Position ________________

Work Address ______________________ Telephone ______________

Home Address ______________________ Telephone ______________

II. Introduction to the Project

A. Title of Project _______________________________________

B. Why are you conducting the study?
   Independent Research ______ Graduate Course Requirement ______
   College/University __________ Professor ______

III. Sampling Information

A. Type of Population
   ______ Elementary ______ Intermediate ______ Jr. High
   ______ Sr. High ______ Other

B. Grade Level(s) ____________________________

C. Subject(s) ____________________________

D. Name of School(s) ____________________________

E. Special Characteristics (if any) of Population ______

<table>
<thead>
<tr>
<th>Group</th>
<th>Number Needed</th>
<th>Time (in minutes) Required for Each Person to Complete Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F. Dates of Data Collection

1. Preferred ______

2. Alternate ______

IV. Attachments

A. Provide a detailed description of your purpose, the review of literature, research design, sampling, data collection, data analysis, time line, and value to the school system.

B. Attach a copy of the data collection instrument(s) you plan to use (surveys, tests, questionnaires).

I understand that acceptance of this request for approval of a research proposal in no way obligates the Virginia Beach City Public Schools to participate in this research. I also understand that approval does not constitute commitment of resources or endorsement of the study or its findings by the school system or by the School Board.

I acknowledge that participation in research studies by students, parents, and school staff is voluntary. I will preserve the anonymity of all participants in all reporting of this study. I will not reveal the identity or include identifiable characteristics of schools or the school system unless authorized by the director of the Educational Planning Center.

If approval is granted, I will abide by all the Virginia Beach City Public School's policies and regulations and will conduct this research within the stipulations accompanying any letter of approval. At the completion of the study, I will provide the Virginia Beach City Public Schools with a copy of the results.

Applicant's Signature ____________________ Date ______

Professor or Faculty Advisor's Signature ____________________ Date ______
Appendix G.

Form for Research Approval

To Whom It May Concern:

I am familiar with the research study proposed by Martha J. Tompkins, that will investigate the effect of grouping arrangements of the fifth and fourth grade females in the mathematically gifted classes at Old Donation Center. I understand that this study complies with rules and regulations set for research in Virginia Beach City Public Schools. I give my approval for this study to be conducted at Old Donation Center. The results of this study can be used as a means to evaluate the mathematically gifted program.

Martha J. Tompkins, Researcher

Em Davis, Principal

Cheryl Graham, Teacher
Parent Letter

November 1993

Dear Parent,

Your child will have an opportunity to take part in a special math study because of her participation in the pilot math project. I am one of the teachers at Old Donation Center, and I am completing a research project for Old Dominion University to investigate how students feel about math. The student's attitudes about math will be determined through a math attitudes scale which will take only a few minutes to complete. For this project, each student will be identified by a number so that none of the students will be identified by name. The math attitude scale will be used in December and in May. If you do not wish your child to participate in this study or if you have any questions, please contact Martha Tompkins at 473-5043.

Thank you for your cooperation.

Sincerely yours,

Martha J. Tompkins
Appendix I

Human Subject Approval

FORM I

DISSERTATION PROSPECTUS ACCEPTANCE

This is to certify that the Dissertation Prospectus entitled:

The Effect of Same Sex Grouping vs. Mixed Sex Grouping on Math Achievement and Attitudes of Academically Gifted Fourth and Fifth Grade Females in the Urban Classroom

presented by Martha J. Tompkins, ss# 231-50-9410,

in the Education Concentration, was accepted by the student's Dissertation Committee on 10-26-93.

(date)

Approved by Human Subjects Committee:  Yes  No

Chairperson Human Subjects Committee

Dissertation Committee:

Chair  10/25/93

Member  10/25/93

Member  10/26/93

Approved:

Concentration Area Director

Dean (Education only)

Return to Concentration Area Director with copy to Student Records Office.

Form I 88/89

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Appendix J

Qualitative Measure - Plus, Minus, Interesting

Dear Student,

Your class has been participating in a special cooperative grouping arrangement. In order to determine your opinion about this arrangement, I am asking you to evaluate the new arrangement using a method called P.M.I. P means plus or the positive things about this arrangement. M means the minuses or bad things about this arrangement. I means the interesting things you have noticed about yourself, your feelings and how others react to this arrangement. It is not necessary to sign your name to this evaluation but I would like you to indicate if you are a male or female and your grade level. This will not affect your math grade in any way.

Thank you for your cooperation,

Grade 4 ____
Grade 5 ____
Male ______
Female _____

<table>
<thead>
<tr>
<th>Plus (Positive things)</th>
<th>Minus (Not so good)</th>
<th>Interesting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix K

Time Line for Research Study

September 1993 - August 1994

September - October: Research plan was discussed with math teachers and the building principal, a research plan was submitted to Dr. Sid Vaughn (Educational Planning Center) requesting permission to conduct a research study.

September - January: ongoing activity - read, information, review, update literature review, read APA and bibliography.

October: Met with assessment personal to get information on CTBS, interest inventory and math tasks. Got print-out of all math students and scores by days and grade level. Meet with stats person and dissertation committee for prospectus review and changes. The attitude scales were typed into the computer by this researcher for coding, randomization of statements, and a print-out was sent to Sid Vaughn for advise in setting up the questions in a computer scanning format. Discussion was held with Sid Vaughn about how to inform or get permission of parents for the research study. Met with math teachers to set up dates for attitude survey and achievement test.

November. A letter, approved by the building principal, was sent to the parents of the female students informing them of the study. Submitted prospectus to ODU committee.

November/ December: Attitude tests were administered during the first week of December.

January: The math teachers and this researcher agreed that the treatment would begin during the first week of January after winter holidays. CTBS was administered during the second week of January. Finalize literature review and update paper.

February: The CTBS was hand-scored by this researcher. Attitude surveys were submitted to Sid Vaughn for computer analysis. The delay in scoring both measures was caused by missing student information, snow days, and other school priorities.

January - April: Score CTBS and report statistical analysis to math teachers and administrator. More data analysis and input into computer.

May: End treatment. The post-test attitude survey was administered during the third week of May and the post-test achievement test was administered during the fourth week of May. Complete qualitative measure (PMI). Post test of attitudes and achievement. Get and analyze data. Discuss results

May - August: Obtain statistics, revise and rewrite and finalize dissertation.

August - Defend dissertation GRADUATE!!!!!!!!!
## Program Monitoring Checklist

### CHECKLIST FOR MATH PROGRAM

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TEACHER</th>
<th>WEEK</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WEDNESDAY</th>
<th>THURSDAY</th>
<th>FRIDAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson plans were followed as planned?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If not, why?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of time for Independent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of time for Group work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If time is less than 50% explain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unusual activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How groups were selected?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix M

Personal Correspondence

Davis, E., Interviews on September 22, October 22, December 2, 1992, at Old Donation Center.


Michaels, C., C.N.N. Headline news. C.N.N. (Channel 26), November 27, 1993, 9:00 p.m.

Pindur, W., Ph. D., Old Dominion University, Discussion of program monitoring and reliability of Attitudes Scales with young students, November 22, 1993.


Powell, M., CTB, Request to send technical manual, validity and reliability of CTBS, June 24, 1994

Russo, D., ODC. Information about student's names, ethnic groups. October, 1993.


Vaughn, E.S., Ph.D., Educational Planning Center, Update on status of Post-Attitudes Scales, June 10, 1994.

Vaughn, E.S., Ph.D., Educational Planning Center, Inquiry about parent permission, October 21, 1993.

Yeatman, D., Public Information Office, Census information, October 21, 1993.
Autobiographical Statement

Martha J. Tompkins
B.S. May 1961, James Madison University
M.S. May 1980, Old Dominion University
C.A.S. August 1991, Old Dominion University

Martha J. Tompkins was born in Newport News, Virginia. She has worked with the Virginia Beach schools for twenty years. In Virginia Beach she has worked as a teacher of gifted students at Old Donation Center for twelve years, as administrative assistant at Old Donation Center for three years, and as a kindergarten teacher for eight years. Her career experience has ranged from teaching kindergarten through college in Norfolk, Hampton, Charlottesville and in Virginia Beach.

Honors include: Old Donation Center Teacher of the Year and a finalist for Virginia Beach Teacher of the Year, Outstanding Young Woman of America, Who's Who in American Education, 1993 Presidential Environmental Youth Award, 1993 McDonald's Friend of the Planet Award and the Howard M. Soule dissertation award from Phi Delta Kappan. She is a member of Phi Delta Kappan and serves as the association's treasurer. She is a member of Kappa Delta Pi and Phi Kappa Phi, honorary societies. She has served on the Board of Directors for the Virginia Beach Education Association and Teaching and Computers, Inc., a national magazine. The mayor of Virginia Beach appointed her to the Clean Community Commission and the Virginia Beach Tomorrow Task Force. Various civic responsibilities are her other interests.

Publications include:

Teaching and Computers magazine

Virginia Education Journal

Photographs and articles in Virginia Beach Beacon, February, June, 1994
Photographs and articles in Richmond Times Dispatch, April, 1994
Various articles in Virginia Beach Beacon
FENNEMA-SHERMAN MATHEMATICS ATTITUDES SCALES

INSTRUMENTS DESIGNED TO MEASURE ATTITUDES TOWARD THE LEARNING
OF MATHEMATICS BY FEMALES AND MALES

by

ELIZABETH FENNEMA
Department of Curriculum and Instruction-Madison

and

JULIA A. SHERMAN
Madison Psychiatric Associates, Ltd.

Wisconsin Center for Education Research
School of Education
University of Wisconsin-Madison

Reprinted March 1986

Originally published in JSAS Catalog of Selected Documents in
Psychology, 1976, 6, 31. (Ms. No. 1225)
Directions for students

FENNEMA-SHERMAN MATHEMATICS ATTITUDE SCALES
By Elizabeth Fennema and Julia A. Sherman
University of Wisconsin-Madison

On the following pages is a series of statements. They have been set up in a way which permits you to indicate the extent to which you agree or disagree with the ideas expressed. Suppose the statement is:

Example 1. I like mathematics.

As you read the statement, you will know whether you agree or disagree. If you strongly agree, blacken circle A opposite Number 1 on your answer sheet. If you agree but with reservations, that is, you do not fully agree, blacken circle B. If you disagree with the ideas, indicate the extent to which you disagree by blackening circle D for disagree or circle E if you strongly disagree. But if you neither agree nor disagree, that is, you are not certain, blacken circle C for undecided. Also, if you cannot answer a question, blacken circle C. Now mark your answer sheet. Do the same for example No. 2.

Example 2. Math is very interesting to me.

Do not spend much time with any statement, but be sure to answer every statement. Work carefully.

There are no "right" or "wrong" answers. The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice. Do not mark on the booklet.

THIS INVENTORY IS BEING USED FOR RESEARCH PURPOSES ONLY AND NO ONE WILL KNOW WHAT YOUR RESPONSES ARE.
1. Generally I have felt secure about attempting mathematics.

2. I see mathematics as a subject I will rarely use in my daily life as an adult.

3. When it comes to anything serious I have felt ignored when talking to math teachers.

4. I think I could handle more difficult mathematics.

5. I do as little work in math as possible.

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

7. I'm no good in math.

8. I would talk to my math teachers about a career which uses math.

9. Mathematics will not be important to me in my life's work.

10. Being first in a mathematics competition would make me pleased.

11. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

12. My math teachers have been interested in my progress in mathematics.

13. The challenge of math problems does not appeal to me.

14. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.

15. I usually have been at ease in math classes.

16. Taking mathematics is a waste of time.

17. My teachers have encouraged me to study more mathematics.
18. If I had good grades in math, I would try to hide it.
19. I'll need a firm mastery of mathematics for my future work.
20. I have found it hard to win the respect of math teachers.
21. I usually have been at ease during math tests.
22. Most subjects I can handle O.K., but I have a knack for flubbing up math.
23. Mathematics is enjoyable and stimulating to me.
24. Math has been my worst subject.
25. It would make me happy to be recognized as an excellent student in mathematics.
26. I don't think I could do advanced mathematics.
27. I haven't usually worried about being able to solve math problems.
28. Math puzzles are boring.
29. Winning a prize in mathematics would make me feel unpleasantly conspicuous.
30. I will use mathematics in many ways as an adult.
31. People would think I was some kind of nerd if I got A's in math.
32. When a woman has to solve a math problem, it is feminine to ask a man for help.
33. I am sure that I can learn mathematics.
34. If I got the highest grade in math I'd prefer no one knew.
35. I am sure I could do advanced work in mathematics.
36. I don’t understand how some people can spend so much time on math and seem to enjoy it.

37. I study mathematics because I know how useful it is.

38. My teachers think advanced math is a waste of time for me.

39. I’d be happy to get top grades in mathematics.

40. Getting a mathematics teacher to take me seriously has usually been a problem.

41. Females are as good as males in geometry.

42. Mathematics usually makes me feel uncomfortable and nervous.

43. I have a lot of self-confidence when it comes to math.

44. It’s hard to believe a female could be a genius in mathematics.

45. It would make people like me less if I were a really good math student.

46. Girls can do just as well as boys in mathematics.

47. I don’t like people to think I’m smart in math.

48. Mathematics is for men; arithmetic is for women.

49. I’ll need mathematics for my future work.

50. It would be really great to win a prize in mathematics.

51. I would expect a woman mathematician to be a unfeminine type of person.

52. Figuring out mathematical problems does not appeal to me.

53. Mathematics is a worthwhile and necessary subject.
54. For some reason even though I study, math seems unusually hard for me.

55. I would have more faith in the answer for a math problem solved by a man than a woman.

56. I'm not the type to do well in math.

57. I am challenged by math problems I can't understand immediately.

58. In terms of my adult life it is not important for me to do well in mathematics in high school.

59. Being regarded as smart in mathematics would be a great thing.

60. Girls who enjoy studying math are a bit peculiar.

61. I can get good grades in mathematics.

62. Males are not naturally better than females in mathematics.

63. I expect to have little use for mathematics when I get out of school.

64. Math doesn't scare me at all.

65. My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.

66. It wouldn't bother me at all to take more math courses.

67. Studying mathematics is just as appropriate for women as for men.

68. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

69. Knowing mathematics will help me earn a living.

70. A math test would scare me.
71. My teachers think I'm the kind of person who could do well in mathematics.

72. My mind goes blank and I am unable to think clearly when working mathematics.

73. When a question is left unanswered in math class, I continue to think about it afterward.

74. Math teachers have made me feel I have the ability to go on in mathematics.

75. Mathematics makes me feel uneasy and confused.

76. I have had a hard time getting teachers to talk seriously with me about mathematics.

77. I like math puzzles.

78. Mathematics is of no relevance to my life.

79. I almost never have gotten nervous during a math test.

80. Once I start trying to work on a math problem, I find it hard to stop.

81. My math teachers would encourage me to take all the math I can.

82. I get a sinking feeling when I think of trying to work hard math problems.

83. I'd be proud to be the most outstanding student in math.

84. I would trust a woman just as much as I would trust a man to figure out important calculations.