The preparation and attitudes of calculus-based Physics 227 and algebra-based Physics 103 students
by Jacqueline Alean Stelzl

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education
Montana State University

Abstract:
The problem of this study was fivefold: (a) to deter- mine sex-related differences in preparation for the study of physics; (b) to determine relationships between preparation for and grades in physics by sex; (c) to determine sex-related differences in attitudes toward physics; (d) to determine relationships between attitudes toward physics and grades in physics by sex; and (e) to compare the attitudes of science and engineering students to those of nonscience and nonengineering students toward phy si cs by sex.

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Each of the following math and science preparation, was found to be correlated to grades in physics for some groups: the number of years of high school math, science, and physics; and the number of quarter hours of college math. The following attitudes were correlated to grades in physics for some groups: positive attitudes toward women in physics; confidence; low anxiety; the perceived usefulness of physics; and the active enjoyment of physics. Some significant differences were found between the math preparation, science preparation, and attitudes of males as compared to those of females. Also, a few significant differences were found between the attitudes of Physics 227 students as compared to those of Physics 103 students.

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by

Jacqueline Alean Stelzl

A thesis submitted in partial fulfillment
of the requirements for the degree

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APPROVAL

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Jacqueline Alean Stelzl

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

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Each of the following math and science preparation was found to be correlated to grades in physics for some groups: the number of years of high school math, science, and physics; and the number of quarter hours of college math. The following attitudes were correlated to grades in physics for some groups: positive attitudes toward women in physics; confidence; low anxiety; the perceived usefulness of physics; and the active enjoyment of physics. Some significant differences were found between the math preparation, science preparation, and attitudes of males as compared to those of females. Also, a few significant differences were found between the attitudes of Physics 227 students as compared to those of Physics 103 students.

It is noteworthy that some attitudes which this study indicated as significantly affecting one's grades in physics were also found to be sex dependent. Thus, instructors should examine their teaching methods to ensure that they are not discouraging capable students from this discipline.

Chapter I

INTRODUCTION

Traditionally, because physics has been considered to be a man's field, more men than women have selected physics as an occupational field and so the great majority of students who choose to major in this discipline today are male.

In 1978-79, for example, only 12.8% of physics bachelor's degrees were awarded to women (AIP Report, 1980). Such a disparate representation of men and women may reflect sex-related differences in ability for, preparation for, or attitudes toward physics. This study examined the latter two of these possibilities. It did not attempt to examine one's innate ability to do physics, although there is some evidence in the research literature to suggest that physiological differences may partially account for sex-related differences.

Since math and science are part of one's preparation for study in physics, how much does this preparation affect physics grades in college? Brasted (1975) found the taking of high school science to affect performance in college chemistry. Certain implications might also arise regarding the sex of the student if females are not equally encouraged with males to take math and science in high school. Research such as that by Haven (1970), shows that male and female students do not always receive the same amount of math and science as part of their high school education. Males may be encouraged to take much more math and science. If women are discouraged from participating in math and science, then lack of knowledge in these areas will affect their lives. According to the report "A Nation at Risk. The Imperative for Educational Reform," (released by the National Commission on Excellence in Education, 1983) people who are lacking in such skills and training will become disenfranchised. Whatever barriers keep women from math related careers must be removed. For example, math anxiety among women can have serious effects. This is also true for men. Math anxiety may cause those who are math-anxious to become math-avoiders (Morris, 1981). Morris goes on to say that math avoidance was tolerable when many jobs required little mathematics, but today, those who avoid math become isolated from full participation in a technological society.

Attitudes toward physics, which may be generally described as one's perceptions of the subject-matter field, are important for study in physics. An individual's perception of himself or herself may also influence the career choices that one makes. Influencing these choices may be: attitudes toward success in physics, the perceived masculinity of physics, attitudes toward one's ability to do physics, the perceived usefulness of physics, feelings of anxiety, and the active enjoyment of physics. Extensive research on sex-related attitudes has been conducted by Fennema and Sherman (1977) and by Fox (1979). Although their work did not pertain to physics directly, it examined a closely related discipline, mathematics, a field which carries many of its principles over into physics.

If women are underrepresented in physics because they lack the preparation necessary to pursue this field, then women should be more strongly advised to take these courses early in their academic studies. Women may be less well prepared than men for study in physics, and their performance in college physics may be greatly hindered by deficient preparation. Similarily, if it appears that certain negative attitudes affect academic performance, then instructional stategies could be used to change some of these attitudes. In short, women should have the same opportunity that men have to pursue their interests in the field.

Statement of the Problem

The problem of this study was fivefold: (a) to determine sex-related differences in preparation for the study of physics; (b) to determine relationships between preparation for and grades in physics by sex; (c) to determine sex-related differences in attitudes toward physics; (d) to determine relationships between attitudes toward physics and grades in physics by sex; and (e) to compare attitudes toward physics by sex of science and engineering students to those of nonscience and nonengineering students enrolled in physics during the 1981 school year.

Application

The results of this study can be used for student advisement and for the improvement of instructional strategies. If it can be determined what preparation is most advantageous for high achievement in physics, then counselors could use the information for student advisement especially at the high school level. With the proper advisement, students could be made aware of their deficiencies prior to enrolling in physics. Curricula could be planned to encourage those attitudes which significantly affect one's success in physics. Instructional strategies could be devised to moderate or correct negative attitudes. As preparation for and attitudes toward physics improve, grades might improve.

General Questions

The following questions were examined:

1. What are the relationships between grades in physics and the following subcategories of preparation for physics:

(a) The number of years of high school math,

(b) The number of years of high school science,

(c) The number of years of high school physics,

(d) The number of quarter hours of college math,

(e) The number of quarter hours of college science,

(f) The number of quarter hours of college physics prior to the present physics course?

2. How does the amount of math and science preparation of males compare to that of females?

3. What are the relationships between grades in physics and the following subcategories of attitudes:

(a) Attitudes toward success in physics,

(b) The perceived masculinity of physics,

(c) Attitudes toward one's own ability to do physics,

(d) The perceived usefulness of physics,

(e) Feelings of anxiety toward physics,

(f) The active enjoyment of physics?

4. How do the attitudes of males compare to those of females?

5. How do attitudes of science and engineering students compare to attitudes of other students?

Several outcomes were predicted.

A. It was expected that the more math and science taken by an individual prior to college physics, the better will be his or her performance in college physics.

B. Males were expected to have a better preparation in math and science than females.

C. Positive attitudes toward success in physics, one's own ability to do physics, the perceived usefulness of physics, and the active enjoyment of physics were expected to have a positive effect on academic performance. Feelings of fear toward physics are expected to negatively affect one's academic performance. The perception of physics as a masculine field was expected to negatively affect the academic performance of females but not of males.

D. The attitudes of males were expected to be different from the attitudes of females.

E. The attitudes of science and engineering students were expected to be more positive than the attitudes of other students.

General Procedure

These research questions were approached in the following manner. A questionnaire was distributed about the second week of the winter quarter of 1981 to all students in Physics 227 (a calculus-based course designed for science and engineering majors) and Physics 103 (an algebra-based course designed for nonscience and nonengineering majors) at MSU. Responses were returned approximately one to two weeks after they had been distributed. The survey was constructed to obtain information about the students' personal backgrounds, prior coursework in math and science, and attitudes toward physics. Grades were obtained from the class role at the end of the quarter. Student signatures on the survey instrument gave me the authority to obtain this information.

Limitations and Delimitations

This study was limited first of all, by the data collected. The survey relies upon the individual as the source of the data. It is assumed that all responses were accurate descriptions of one's background and attitudes. Second, the study was limited by the faculty members who teach Physics 227 and 103. Faculty are assigned to classes by the Department Chairman. Physics 227 was taught by a different instructor from the instructor who taught Physics 103. Since the survey was distributed only about a week and a half into the winter quarter, it is assumed that any influence of the instructor's personality on the student was minimal. Third, the study was limited by the teaching assistants in the laboratory sections of Physics 227. The laboratory sections of Physics 227 were taught by several teaching assistants. Because of the gender-related nature of this survey and the request for personal attitudes of students upon enrollment in physics, it is also assumed that the personalities of the teaching assistants did not affect answers of the respondents.

The study was delimited by the population to be studied. The class of Physics 227 and that of Physics 103 were chosen as the populations to be examined. Also, the study was delimited by the date, winter quarter, 1981. Also, the study was delimited by the geographic location. Montana State University was chosen as the campus on which to conduct this investigation.

Definition of Terms

Academic performance was determined by letter grades. Letter grades were assigned as follows. Students earning 90% or more of all available points for the quarter were assigned the grade A. Students earning 80% to 89% of all points were assigned the grade B, those earning 70% to 79% the grade C, those earning 60% to 69% the grade D, and those earning less than 60% the grade F.

Attitudes were defined as a psychological process encompassing previous experience, such that when one approaches a new situation that previous experience influences his behavior in it (Newcomb, 1966).

Instruction was defined as a situation conducive to learning which need not be limited to teaching.

Summary

It is important that women and men have equal opportunities to pursue their personal and vocational interests. Cited literature suggests that there are sex-related differences in preparation for and attitudes toward physics and that these differences may affect academic performance. This investigation attempted to ascertain if students in Physics 227, a course designed for science and engineering majors, are similar to or different from students in Physics 103, a course constructed for nonscience and nonengineering majors. In addition, the responses of males were compared to the responses of females in these same courses. To investigate this problem, a survey was distributed during the winter quarter of 1981 to students enrolled in these two courses. Information from this study could be used for instructional improvement and student advisement.

Chapter II

THE REVIEW OF LITERATURE

The review of literature is divided into three parts: (a) a general discussion of sex-related differences pertaining to math and science students; (b) the effect of one's preparation on academic performance; and (c) the effect of attitudes on academic performance.

A General Discussion of Sex-Related Differences Pertaining to Math and Science Students

General Information

Many more men than women appear to be attracted to the physical sciences. A greater percentage of men than women receive physics degrees. In 1978-79, the percentages of women awarded the bachelors degree, the masters degree, and the doctorate were 11, 10, and 6 respectively (AIP Report, 1980). The percentage of women who have been awarded the bachelors degree in physics has only slightly increased over the years. Also, the percentage of women in study at the graduate level has not changed much. In

1976-77, 10.5% of the bachelors degrees were awarded to women (AIP Report, 1978), and by 1979, 12.8% were awarded to women (AIP Report, 1980). The percentage had increased to only 11.3% by 1983 (AIP Report, 1984). If advanced study is considered, the percentage of women also remains quite unchanged. The percentages of women in graduate study in 1976-77, 1977-78, and 1978-79 were 9%, 9%, and 8% respectively (AIP Report, 1978; AIP Report, 1979; and AIP Report, 1980). In 1982-83, 11% of those in graduate study were women (AIP Report, 1984).

Beyond the doctorate, women continue to drop out. The umemployment rate among females who hold doctorates was about 5% as compared to less than 1% among males in 1979 to 1980 (Yearbook of Higher Education, 1979). According to Vetter and Babco (1984), while most college teachers in foreign language, English, home economics, and the health specialties are female, less than 5% in physics and engineering are women.

Heredity

Why do more men than women study physics? One's ability for, preparation for, and attitudes toward physics can affect success in physics. Although this study did not investigate one's innate ability to do physics, there is evidence that heredity might play a part. For example, Stafford (1961) suggests that sex differences in ability may occur in a recessive gene located on the X chromosome. Stafford explains that if a gene were sex-linked and recessive, then it could show up more often in males than in females since males have a Y chromosome and only one X chromosome, while females have two X chromosomes. A male would only have to receive one recessive gene located on the X chromosome in order to receive innate mathematical ability, while females would have to receive two such recessive genes if they were to receive an innate ability for math. How would this gene manifest itself? Five research investigations studied this phenomenon. Research by Salkind (1976) supports the claim that boys do better than girls on spatial visualization tests. Bock and Kolakowski (1973) state that parents and offspring exhibit an ability for spatial visualization which matches the pattern expected for a sex-linked recessive gene. Sex differences may be displayed through adrenergic activating and cholinergic inhibitory neural responses (Broverman, Klaiber, Kobayashi, and Vogel, 1968). Adrenergic and cholinergic systems are competitive. One system activates the neuron to fire, while the other system inhibits such firing. The authors just mentioned suggest that these systems are sensitive to sex hormones. Further, the authors hypothesize that alterations of the balance of these two systems affects one's cognitive abilities: an increase in the adrenergic activating system relative to the cholinergic inhibitory system would inhibit one's ability for perceptual restructuring and facilitate one's perceptual-motor ability.

Sex-related neural effects were observed in eyelid conditioning experiments (Spence and Spence, 1966). It is interesting that anxiety was also found to be related to neural effects. Witelson (1976) suggests that sex differences in the neural organization of the right and left brain may affect cognitive development. According to Witelson, males can be found to display such right brain socialization by age 13. Kilshaw and Annett (1983) give evidence for superior skill shown in left-handers. A group varying in age from 3 1/2 years to over 50 years was studied. The group was asked to move pegs with their right and left hands. In practically all age groups males were faster than females with their left hands. Females were generally faster with their right hands until 10 years of age. After ten, males equaled and later surpassed females in most of the older groups. Also, left-handers were faster than right-handers; right-mixed-handers were intermediate in speed for moving pegs with the non-preferred hand. The conclusion of this article was that the left hemisphere specialization for language may be achieved by way of a right hemisphere handicap and left handers may be advantaged in that they may have escaped this risk. Thus, left-handers may have a better mathematical abilty as compared tto right-handers.

Benbow and Stanley (1980) suggest that sex differences in math achievement may stem from a greater male aptitude for mathematics. They base this premise on data compiled over eight years by the Study of Mathematically Precocious Youth. Approximately 10,000 males and females took part in the study. They found, for example, that of those scoring above 500 on the Scholastic Aptitude Test in Mathematics, males outnumbered females in a ratio greater than 2 to 1. Thus, heredity may influence one's ability to do physics.

Culture

In addition to hereditary factors, cultural factors may also account for sex differences. Cultural factors are environmental influences. For example, women may choose not to study physics because they are convinced that physics is inappropriate for females. Children may learn at a very early age what behavior is considered sexually appropriate for them. The kinds of toys which parents select for their children may indicate the cultural appropriateness of certain role behaviors (Rheingold and Cook, 1975). In 1972 and 1973, Rheingold and Cook studied the rooms of 48 boys and 48 girls, all under the age of six. The names of the children were primarily obtained from birth censuses at North Carolina Memorial Hospital. The researchers found that boys were given a greater number of vehicles, sports equipment, toy animals, depots, fauna, machines, military toys, and educational art. Girls were given a greater number of doll houses, dolls, and domestic toys. These toys may suggest the kinds of interests which children are expected to manifest as they mature. In addition, certain out-of class experiences might contribute to an appearant male superiority in math (Tomizuka and Tobias, 1981). These authors suggest that males may learn certain math skills by participating in such sports as sailing or such games as billiards. Thus, children's behaviors may be modified by cultural pressures.

If cultural factors have significantly deterred women from this field, then perhaps something can be done. Females should be as strongly encouraged as males to excell in math and science. Perhaps, if females are strongly encouraged to engage in more math and science related activities, they will acquire preparation better suited for advanced study in physics. Also, such encouragement may convince women that physics can be an appropriate field for them. It was once thought that sports were for men. World records in sports show women to be approaching men: this rate of approach has increased in later years (Dyer, 1984). Dyer cites in an article entittled "Catching Up the Men" that while a decade ago women ran 75% as fast as men, top female athletes today are close to 90% the speed of men. Since sports have become acceptable for women, women have become better at sports. If women are convinced that math and science are appropriate fields for women, then perhaps they will be as succesful as men.

Males may develop skills different from those of females. Is spatial visualization hereditary, or is it a skill which is acquired? As Kistiakowsky (1980) states, even if spatial ability is inherited, it may mean only that one of many genes responsible for math performance is sex-linked, and a learned component for the use of these abilities would also influence one's achievement in that subject. Kistiakowsky, as well as Fennema (1979), suggests that educational programs might be planned to better develop this skill. Patricia Blatter (1982) wrote an article that discussed some previous reports on spatial ability. According to the article, the data are conflicting, and, as the author concludes, the environment as well as genetic factors have not been thoroughly researched.

The Effect of Preparation on Academic Performance in Math and Science

General Discussion of Math and Science Preparation for Physics

In general, the math and science preparation of female students appears to be poor compared to that of male students. Haven (1970) found that females were much less likely than males to take math and science in high school. In collaboration with specialists from the Educational Testing Service, a questionnaire was distributed in 1966 to more than 26,000 students. While 84% of the males were found to have studied math during their senior year, only 56% of the females did so. Also, 82% of the males reported that they studied science, while only 60% of the females said the same.

Innate ability does not appear to be the only factor which determines the choice to study a mathematical field. A study by Deboer (1984) found women to take less science and math both in high school and college than males although they performed better than the males. A random sample of 30% of graduates from a liberal arts college during the years 1975, 1977, and 1979 were selected. Although females had a GPA of 3.40 as opposed to a GPA of 3.18 for males in high school science, they took only 3.13

years of science as opposed to 3.46 years for males. Also, while females received a GPA of 3.36 as opposed to 3.10 for males in high school math, females took only 3.51 years of this subject as opposed to 3.77 years for males. In college science women had a GPA of 2.86 as opposed to 2.76 for men, although females took only 2.21 years as opposed to 3.38 years for males. In college math, females had a GPA of 2.80 as opposed to 2.58 for males, although women took only 0.76 years of the subject as opposed to 1.05 years for men.

Mathematics Preparation For Physics

A deficient background in math affects one's performance in physics because physics is generally taught as a mathematically based discipline. The solutions of most physics related problems rely on one's ability to work with numbers. Consequently, it is reasonable to suggest that an individual's background in mathematics is very important for one's performance in the field. Brasted (1957) obtained data from 1400 students who took part in a study begun by the High School Liaison Committee of the Minnesota Section of the American Chemical Society. He also collected information from 1100 more students in a supplementary survey. Students who were enrolled in first quarter college chemistry courses designed for academic majors other than chemistry and chemical engineering were studied. It was found that students who had taken more than two high school math courses tended to receive higher grades in college chemistry. Of those who had taken more than two high school math courses, 13.4% received an A in college chemistry. Of those who had taken two courses or less of high school math, only 8.0% received an A in the course. While 28.6% of students who had taken more than two high school math classes received a B in college chemistry, only 19.4% of those who had taken two courses or less of high school math received a B in the course. If success in college chemistry is dependent upon the amount of mathematics previously taken by the individual, then perhaps success in physics is similarly dependent, for physics like chemistry, is a mathematically based science.

At Montana State University, Laubach (1969) found no significant correlation between the Physics 227 grade and the high school math grade point average. Of the 36 students who took part in the study in 1965, a non-significant correlation of only 0.046 was found. A study by Hudson and Rottmann (1981) suggests that one's performance in introductory college physics is related to math skills obtained prior to physics. Students in introductory, pre-professional physics were separated into those completing and those not completing the course. A grade was assigned to those dropping out of the course based on their achievement at the time of withdrawal. The final grade was found to correlate with achievement on a mathematical skills diagnostic test given prior to the physics course for those who completed the course and those who dropped out (0.418 and 0.232 respectively, $p<0.001$). Hudson and McIntire (1977) found a correlation between math skills and physics performance, but it was quite weak. The study, which was done in 1976 at the University of Houston, was comprised of 205 students enrolled in introductory physics. The researchers found that those who scored low on a math skills pre-test tended to score low in physics. Those who scored high on the math pre-test, however, did not have a corresponding tendency of scoring high in physics. The authors conclude that one's scores on the math pre-test was a better predictor of failure than success in physics. Although a strong math background may not guarantee success in physics, deficient math skills may hinder better than average performance.

Science Preparation For Physics

A strong background in a previous physics course or other sciences may also influence one's performance in physics. The various sciences have become increasingly interrelated; they have grown from separate disciplines into a kind of hybrid (Bernal, 1972). An individual might find the concepts, terms, and skills previously learned in high school physics or other sciences important for understanding physics. Therefore, an individual's science background may affect one's performance in physics.

This argument is not supported by either Laubach (1969) or by Grey, Fullerton, and Yale (1969). Laubauch made a comparison of the Physics 227 grade at MSU to the high school physics grade. In 1965, he studied 49 students who had taken high school physics. The Physics 227 grade and the high school physics grade were found to have a non-significant correlation of 0.014. Similarily, Grey, Fullerton, and Yale were unsuccessful in establishing a relationship between achievement in biology and prior enrollment in 9th grade physical science. However, strong support for the opposite side was found by Brasted (1957). He examined the effect of high school science on college chemistry and found a connection. Those individuals who took high school chemistry and physics had a tendency to receive higher grades than those who did not take these courses in high school. Of students enrolled in first quarter college chemistry, 14.0% of those who had taken high school chemistry received an A in college chemistry. Only 4.4% of those who had not taken high school chemistry received an A in the course. While 27.4% of students who had taken high school chemistry received a B in college chemistry, only 13.6% of those who had not taken high school chemistry received a B in the course. Of students enrolled in the first quarter college chemistry course designed for nonchemistry and nonengineering majors, 13.4% of those who had taken high school physics received an A in college chemistry. Only 7.8% of those who had not taken high school physics received an A in the course. While 22.8% of students who had taken high school physics received a B in college chemistry, only 16.6% of those who had not taken high school physics received a B in the course. Thus, a deficient background in science may contribute to low performance in college physics.

<u>The Effect of Attitudes on Academic Performance</u>

General Discussion of Sex-Related Attitudes Toward Mathematics and Science

That many female students harbor rather negative attitudes toward physics is supported by Norman (1977). This study was designed to investigate whether female students developed more negative attitudes toward math than male students did. The attitudes of 939 male students and 1045 female students were examined in 1974. Students were enrolled in grade two and grades six through ten in the public schools of Albuquerque. Also, included were students enrolled in the introductory psychology courses at the University of New Mexico. The attitude scale used in this study consisted of the following; subject comparisons and practical value statements, word problems, general statements, and work with numbers. Attitudes were found to be similar for male and female students in grades two, six, seven, and eight. At ninth grade, as the author explains, attitudes were no longer similar ($t=2.15$, $p=0.04$) and these differences showed increased significance at the 10th grade and college level (grade 10, $t=3.29$, $p<.01$; college level, $t=3.89$, $p<.001$). Thus female students began developing negative attitudes toward math around 9th grade.

Poor attitudes might be a cause of poor performance in physics. A number of studies have found relationships between attitude and academic achievement. A positive correlation between attitudes toward math and math performance was found by Aiken (1972). In this study a group composed of 85 girls and 97 boys, all eighth graders, from a Greensboro, North Carolina school completed a 90 item attitude inventory. Their attitudes toward math correlated positively with their grades in math and arithmetic. Hough and Piper (1982) found a relationship between science attitudes and science achievement. Weak positive relationships have also been found between attitudes toward chemistry and physics and performance in college chemistry and physics (Rothman, 1968), and similar relationships have been found between science attitudes and science performance (Ward, 1975; Billeh and Zakhariades, 1975).

If female students have poor attitudes toward physics, then perhaps these attitudes should be changed. As attitudes change, grades may be improved. A math study in Kano, Nigeria, by Mukherjee (1978) supports this hypothesis. The investigation consisted of 100 male secondary students. The boys were divided into an experimental group and a control group. The experimental group attended six one-hour sessions at which the importance and enjoyment of math was stressed, encouraging comments were made, and questions were answered. The control group did not attend these sessions. Students were given a pre-test and post-test of math achievement and attitudes. The results, of this study indicate that the attitudes of the control group stayed about the same, while the attitudes of the experimental group improved. The math post-test of attitudes and performance were found to have a correlation of 0.274 ($df=48$, $p<0.05$). Thus, the study concludes that as student attitudes improve, their performance can also improve.

Sex-Related and Performance-Related Attitudes

There are several negative attitudes which might deter women from studying the field of physics and affect their academic performance in this discipline. In their study of math attitudes, Fennema and Sherman (1977) suggested the following as possibly sex-related: attitudes toward one's ability to do math, attitudes toward success in math, the perceived masculinity of math, feelings of anxiety toward math, the perceived usefulness of math and the active enjoyment of math. Their research did suggest that some of these attitudes are sex-related. In 1975, the researchers examined the attitudes and math achievement of 644 male and 589 female students in a Wisconsin city. All students were enrolled in math, grades 9 through 12. The following results were found. In some cases, males rated themselves more confident in their abilities to do math than females did. Also, males regarded math as more of a masculine field than females did. Boys, in three of the four schools, indicated math to be more useful than girls did. Yet, girls in one high school, showed a more positive attitude toward success in math than boys did. Neither males nor females significantly indicated a greater active enjoyment of math. The main study did not make use of the data collected on math anxiety because they were so highly correlated with one's confidence in that subject area in a preliminary sample.

Fox (1979) found similar results. In this study, which took place from 1977 to 1979, the Fennema-Sherman Mathematics Attitudes Scales were sent to mathematically gifted 7th and 8th graders. These individuals were identified by the Study of Mathematically Precocious Youth (Johns Hopkins study). Responses were received by 189 males and 148 females. As in the Fennema and Sherman study, males tended to rate math as more of a male field than females. Also, males rated themselves more confident in their mathematical ability than did females.

A relationship appears to exist between these attitudes and one's grades. Fennema and Sherman (1977) found that in those schools in which math performance was found to be sex-related, five or six prominent sex-related attitudes were also found.

Confidence

A study by Simmons, Brown, Bush, and Blyth (1978) of black and white adolescents suggests that girls of both races are lower in self-esteem than boys. If females have less self-esteem than males, then perhaps their scholastic performance could be affected by this attitude. Doran and Seller (1978) developed a self concept scale which they distributed their survey instrument to 320 high school biology students in New York in 1972-73. The self concept was found to correlate with performance in biology with a coefficient of 0.28. Maqsud (1983) found math achievement to be related to self-esteem ($t=2.07$, $p<0.05$).

Ernest (1976) found sex differerences in one's self concept. The study was designed to measure the perceived ability of male and female students in various subjects. In 1973, 1324 questionnaires were distributed to children in grades two through twelve. Most of the schools examined were located in southern California, but a few schools were selected from the East Coast. Students were asked whether they thought girls or boys did better in the subjects of math, English, science, and social science. In the lower grades, boys thought that boys did better in the subject-matter fields, whereas girls thought that girls did better. The results were different at the high school level, wherein 506 high school students, grades nine through twelve, were examined separately (see Table 1). When students were asked who they thought did better in math, 52% indicated no difference between the sexes, while 32% indicated that boys did better. Only 16% stated that girls did better. When students were asked whom they thought did better in science, 48% indicated no difference between the sexes, while 47% indicated that boys did better, but only 5% said that girls did better.

If boys are expected to do better than girls in these subjects, the chances are that boys will perform better than girls will. Is this a self-fulfilling prophecy?

Ott (1978) also found a sex difference in one's perceived ability to succeed academically. In this study,

TABLE 1

A Comparison of the Attitudes of Males and Females Toward the Field of Math, English, Science, and Social Studies

(Whom do students think do better in the following subjects?)

	Math	English	Science	Social Studies
Boys do better	32%	4%	47%	21%
girls do better	16%	52%	5%	15%
no difference	52%	44%	48%	64%

(Ernest, 1976, p. 598)

16 institutions, which enrolled 30 or more female engineering freshmen were examined. All of the women as well as 10% of the men in these engineering programs were selected for this study. Although women had received higher grades in high school, as evidenced from their grades and class standing, a smaller percentage of women than men expected to earn an A average and to rank in the upper 10% of their class. Ott concludes that males may feel more confident than females to study a math or science discipline. Berg and Ferber (1983) found females to lack confidence and maternal support as opposed to males in biological and physical sciences. Rea and Strange (1983) surveyed students at a midwestern university. Majors were classified as male mostly if 2/3 of students within that discipline were male, and female mostly if 2/3 were female. Of 186 usable responses, the authors reported that more women in disciplines categorized as 'male mostly' indicated that they expected to encounter difficulty proving their capabilities in that field than females in 'female mostly' disciplines ($t=2.78$, $p<0.01$).

Attitudes Toward Success

Although one might reasonably suggest that attitudes toward successful achievement in math or science may influence one's grades in that subject, the research literature in this area has mixed findings. Males appear to have more realistic expectations than females toward success in this field (Crandall, Kathovosky, and Preston, 1962). A group of 20 girls and 20 boys of early grade school age took part in this study. Boys' expectations correlated positively to their intellectual competence as measured by the Stanford Binet Intellectual Test (correlation coefficient = 0.62). The relationship between girls' expectations and competence was negatively correlated at -0.42 (0.05 level). Success was not so easily predicted for girls as it was for boys. Dawkins (1980) found that black female high school seniors expected to pursue traditionally female occupations more often than black males, while males more likely expected to have such jobs as managers or owners. In 1970 Berman and Haug (1975) found that sex differences emerged in goal setting for persons having high occupational aspirations (executives and major professionals). The experimental group consisted of students at two large campuses in a midwestern city. As shown in Table 2, a higher percentage of females than males showed a discrepency between their occupational aspirations and expectations. That is, these females showed a difference between the careers they wished to pursue and those that they expected to pursue more than males did.

TABLE 2

Discrepancies Between Occupational Aspirations and Expectaions, by Sex (Controlling on level of Occupational Aspirations)

High Occupational Aspirations*		
	Sex	
Occupational Discrepancy	Male	Female
Some	33%	53%
None	67	47
Total Percent	100	100
N	(133)	(47)
	$X = 5.97$, $df = 1$, $p < 0.05$	

* High Aspirations= major professional, executive (Hollingshead Level 1)

(Berman and Haug, 1975, p. 173)

Perceived Masculinity

The perceived masculinity of math and science may also be important for academic success in the sense that women may feel that math and science are inappropriate fields for them. Houts and Entwisle (1968) found that when competitive behavior was perceived as appropriate for women, a relationship existed between females' attitudes and their school grades. However, if competition was perceived as inappropriate, this relationship did not exist.

Graf and Riddell (1972) found sex differences in problem solving ability when the problem context was masculine, but found no such differences when the same problem was domestically worded. A math problem was given to 34 males and 34 females at San Diego State College. Half of these college students were asked to solve a problem involving stock purchases. The other half were asked to solve a problem related to the purchase of fabric. Females took an average of 69.5 seconds to solve the yardage problem, while males took 67.5 seconds to do so. The time difference was much larger, however, for the solution to the masculine problem. While males took 70.4 seconds to work the stock problem, females took 96.25 seconds to do so. Similarily, Preece (1979) found that boys did better than girls on problem solving tests unless the problems were overtly domestic in context.

Ehindero (1982) studied a group of 70 randomly selected high school students in Nigeria of which 35 was females and 35 were males. Each were given a test regarding the sex-related contextual nature of problems. Males did better than females on male-related problems ($t=7.50$, $p<0.01$). Females did better than males on female-related problems ($t=6.32$, $p<0.01$). No significant difference was found on problems that were fairly content-free ($t=1.16$, $p<0.10$). The author concludes that there is a need to design problems that are nonsex biased.

Thus, females may perform poorly if they perceive their behavior to be inconsistent with the traditionally perceived feminine role. Marshal (1983) suggests that males and females might approach problems differently. An article by Clay (1982) discusses the achievement of women as compared to men in physics. For example, since the ratio of women to men is small, women that are in this field should be more highly selected and therefore perform better. The article suggests however, that this is not the case because students might pace themselves with their peers, only doing what is needed to stay in step with them. The article also suggests that females may learn differently than men and thus physics as it is designed today may not be suitable for females.

Some research indicates that sex appropriate attitudes affect math and science achievement. Bright (1983) suggests that men are interested in job pay while women are interested in their personal relationships. An article by Henriques (1984) discusses women as an untapped resource in technology. The author believes that stereotypes of women keep them from many top jobs. Dwyer (1974) designed a study to see whether perceived sex role standards would correspond to achievement test scores. A group of 385 children in northern California completed a sex role standards and individual sex role preference survey. These children, second, fourth, sixth, and eighth graders, took the Stanford Achievement Test, while tenth and twelth graders, took the Iowa Tests of Educational Development. The author concludes that sex differences in arithmetic test scores may be more related to childrens' perceptions of a field rather than biologically determined factors, individual preference for the topic, or personal preferences for sex roles.

Brush (1980) compared the self-perceptions of males and females to their perceptions of a mathematician. Juniors and seniors from New England high schools were asked to respond to a questionnaire in which they rated themselves on several objectives. In addition, they rated several characterstics that they felt a mathematician might possess. Of the 239 males and 271 females that responded to the survey, the self-ratings of males were found to more closely correspond to their perceptions of a mathematician than those of females.

Hawly (1971) found that women might be influenced by men's views. In this research investigation 86 women were asked to complete an attitude questionnaire. Women who were engaged in traditionally female occupations such as homemaking tended to believe that men perceived female behavior in a sex based way. Women, who were not engaged in traditionally feminine careers, however, did not believe that men viewed their behavior in this way. Fitzpatrick (1978) also found evidence that women's roles affect math achievement (0.05 level). Females who were high achievers had more liberal attitudes toward the role of women.

Feelings of Fear

Anxiety is another factor that may affect academic performance. Sepie and Keeling (1978) examined the effect of math anxiety on performance. A group of 246 eleven and twelve year olds were divided into three groups; overachievers, achievers, and underachievers in math. Math anxiety was found to be associated with underachievement. Aiken and Dregger (1961) found a correlation between attitudes such as fear, irritation, and impatience with math achievement ($t=3.16$, $p<0.01$). Seminars and clinics, such as those initiated by Tobias (Donady and Tobias, 1977), have been initiated on several campuses to help women deal with math anxiety.

Perceived Usefulness

Whether math and science are perceived as useful may affect one's grades. During 1971 and 1972, a general attitude survey was distributed to 760 students enrolled in a physical science course at Southern Illinois University (Baldwin and Boedeker, 1975). Each student was asked why she or he did not choose physics as an elective. About 22% (164) of the students indicated that physics did not seem relevant to them. An even larger percentage said that it was not interesting, too difficult, too mathematical, or that their backgrounds were deficient. In 1971, Brown and Elliott (1973) surveyed 1108 physics students at California Polytech State University. A relatively large percentage of them (37%) rated physics as low in personal usefulness.

Active Enjoyment

Active enjoyment of math and science might affect academic performance. Although significant sex differences were not found in the Fennema and Sherman Mathematics Effectance Motivation Scale, males did show a greater tendency than females to become involved in math activities outside of school (Fennema and Sherman, 1977). In two of the four schools in this investigation, this difference was significant.

Summary

According to the research literature, it would appear that good preparation and a positive attitude are important for successful performance in math and science. There is evidence to suggest that females as compared to males have a deficient preparation in these fields. Also, there appears to be a number of sex-related attitudes toward math and science. Poor attitudes seem to predict correspondingly poor achievement. As methods are found to correct some of these conditions, research suggests that grades will improve.

Chapter III

PROCEDURE

The problem of this study was fivefold: (a) to determine sex-related differences in preparation for the study of physics; (b) to determine relationships between preparation for and grades in physics by sex; (c) to determine sex-related differences in attitudes toward physics; (d) to determine relationships between attitudes toward and grades in physics by sex; and (e) to compare attitudes toward physics by sex of science and engineering students to nonscience and nonengineering students taking physics at MSU during the 1980-81 school year. This chapter will provide a description of the population, the categories to be investigated, the method of data collection, the method of organizing data, statistical hypotheses, the methodology of data analysis, and accuracy precautions.

Population Description

The population of this study was composed of all students enrolled in Physics 227 and 103 at MSU during the winter quarter of 1981. The Physics 227 class was comprised of students who desire a strong concentration in physics. Students who take this course are undergraduates and generally major in physics, engineering, or chemistry. About 83% of the students are male and 17% are female. For most, this course was a requirement. Mathematics was well integrated into the course curriculum, and calculus was a prerequisite.

The Physics 103 class was mostly comprised of students who are seeking a more limited approach to physics. Students who enroll in this course are undergraduates and are generally nonscience majors. Approximately 73% of the students are male and 27% are female. The course was not required in any curriculum, but does fulfill part of the general education requirements. The course work is descriptive with very little mathematics used.

As the study examined the entire population of Physics 227 and 103 students no sampling procedures were followed. There were 302 students in Physics 227 and 102 students in Physics 103.

Investigative Categories

The responses of males and females were compared within each of the following categories: (a) math and science preparation for physics; (b) attitudes toward physics; and (c) a comparison of the attitudes of Physics 227 students to those of Physics 103 students; and (d) a discriminant analysis.

Method of Data Collection

Data were gathered from a survey questionnaire. The first part of the survey instrument gathered background information on each individual student. Questions in this section of the survey instrument pertained to the individual's sex, age group, quarter hours of college math, quarter hours of college science, quarter hours of previous college physics courses, years of high school math, years of high school science, and years of high school physics. The individual was also asked whether or not the physics course was required for his or her major. The second part of the survey instrument was comprised of six of the Fennema-Sherman Attitudes Scales.* The following attitudes were investigated: attitudes toward success in physics, attitudes toward one's own ability to do physics, the perceived masculinity of physics, feelings of anxiety toward physics, and the active enjoyment of physics. These

* Permission to use and modify the Fennema-Sherman Mathematics Attitudes Scales was given by the authors.

scales were modified to pertain to the study of physics rather than mathematics. In addition, some of the questions were reworded or modified in content from that of the original questionnaire.

Answers to the attitudes section of the survey instrument were made on the following Likert scale.

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

Responses were scored in the same manner as that of Fennema and Sherman. Each scale was composed of 6 positively worded and 6 negatively worded statements. As the authors explain, the responses are then assigned scores from 1 to 5: a score of 5 is assigned to that response thought to bring about the learning of math in a positive manner. The Male Domain Scale is the exception to this rule: a score of 5 is assigned to the response which indicates that the individual did not stereotype mathematics as a field for men.

Thus 5 points were awarded to the strongly agree response of positively worded statements which indicated confidence, perceived success, the perceived usefulness of physics, and the active enjoyment of physics. On the other hand, 5 points were awarded to the strongly disagree response of negatively worded statements of these same attitudes. Also, 5 points were awarded to the strongly agree response of positively worded statements which indicated a lack of anxiety and that physics was not perceived as masculine, whereas 5 points would also be awarded to the strongly disagree response of negatively worded statements of these same attitudes (see Table 3).

The questionnaire was distributed during class sessions in both courses within the first two weeks of the winter quarter of 1981. Responses were collected approximately one to two weeks later during a following lab period in Physics 227 and during a following class period in Physics 103. At the end of the quarter, student grades were obtained from the class roles. Student names are not disclosed in this report.

Reliability

Fennema and Sherman found split half reliabilities of the success, male domain, confidence, usefulness, anxiety, and effectance motivation scales to be 0.87, 0.87, 0.93, 0.88, 0.89, and 0.87, respectively. Split half reliabilities were also calculated in this study. Questions were divided into their respective scales. Items were numbered. Responses of odd numbered items were correlated to responses of even numbered items. From this half test coefficient r_{hh}, the reliability of the scale was

TABLE 3

Method of Scoring Survey Responses

Attitude		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Confidence	Positively worded statement	5	4	3	2	1
	Negatively worded statement	1	2	3	4	5
Perceived	Positively worded statement	5	4	3	2	1
Success	Negatively worded statement	1	2	3	4	5
Perceived	Positively worded statement	5	4	3	2	1
Usefulness	Negatively worded statement	1	2	3	4	5
Active	Positively worded statement	5	4	3	2	1
Enjoyment	Negatively worded statement	1	2	3	4	5
Anxiety	Positively worded statement	5	4	3	2	1
	Negatively worded statement	1	2	3	4	5
Perceived	Positively worded statement	5	4	3	2	1
Masculinity	Negatively worded statement	1	2	3	4	5

determined. The Spearman-Brown formula for the reliability coefficient is

$$r = \frac{2}{1 + r_{hh}}$$

where r_{hh} is the reliability of the half test and thus, r estimates the reliability of the whole test (Ferguson, 1976).

Validity

The validity of the Fennema-Sherman Mathematics Attitudes Scales were determined by the researchers themselves. Both authors independently wrote several items which were to compose the attitude scales and judged the other author's items for validity. The validity of the modified attitude scales which were used for this study, were determined by selected faculty persons who are knowledgeable about the subject matter area and testing procedures. Faculty members from Physics, Chemistry, and Biology at MSU, because of their expertise in science were asked to comment on the substance of the survey. Faculty members from Education, because of their expertise in testing procedures, commented on the face validity of items on the survey instrument.

Method of Organizing Data

The results of the study are organized in the following tables:

Table 4: Description of students

Tables 5-10: Correlations of the amount of math and science preparation for physics to grades received in physics by sex

Table 11-16: Comparisons of the amount of math and science preparation for physics for males and females

Table 17: Means for each item of the modified Fennema-Sherman attitudes scales by sex

Tables 18-23: Correlations of mean responses of attitudes toward physics to grades received in physics by sex

Tables 24-29: Comparisons of mean attitude responses toward physics of females and males

Tables 30-35: Comparison of mean attitude responses of Physics 227 students to those of Physics 103 students (females and males)

Statistical Hypotheses

The statistical hypotheses will now be presented. The null hypotheses were examined with the onetail test at the .05 level of significance. The alternative hypotheses predicted the following:

1A. There would be a positive correlation between the number of years of high school math and grades in physics.

1B. There would be a positive correlation between the number of years of high school science and grades in physics.

1C. There would be a positive correlation between the number of years of high school physics and grades in the present physics course.

1D. There would be a positive correlation between the number of quarter hours of college math and grades in physics.

1E. There would be a positive correlation between the number of quarter hours of college science and grades in physics.

1F. There would be a positive correlation between the number of quarter hours of college physics and grades in physics.

2A. Males would have taken significantly more math than females.

2B. Males would have taken significantly more science than females.

3A. There would be a positive correlation between attitudes toward success in physics and grades in physics.

A higher correlation will be found for males than for females.

3B. There would be a correlation between positive attitudes toward women in the field of physics and grades in physics. This would be a positive correlation for females and a negative correlation for males.

3C. There would be a positive correlation between attitudes toward one's own ability for physics and grades in physics.

3D. There would be a positive correlation between the perceived usefulness of physics and grades in physics.

3E. There would be a positive correlation between low anxiety toward physics and grades in physics.

3F. There would be a positive correlation between the active enjoyment of physics and grades in physics.

4A. Males would rate themselves higher in confidence than females.

4B. Males would indicate that physics is more of a masculine field than would females.

4C. Males would rate physics as more useful than females would.

4D. Males would indicate a greater active enjoyment of physics than females would.

4E. On the other hand, girls would rate themselves higher in anxiety than males.

4F. Also, girls would have more positive attitudes toward success than males.

5A. Physics 227 students would rate themselves higher in confidence than Physics 103 students.

5B. Physics 227 females would indicate that physics was a more acceptable field for women than Physics 103 females.

5C. Physics 227 students would rate physics as more useful than Physics 103 students.

5D. Physics 227 students would indicate a greater active enjoyment of physics than Physics 103 students.

5E. Physics 103 students would rate themselves higher in anxiety toward physics than Physics 227 students.

5F. Physics 227 students have more positive attitudes toward success in physics than Physics 103 students.

Data Analysis

Data were analyzed statistically. Hypotheses 1(A-F) and 3(A-F) were tested by the Pearson-product-moment correlation coefficient. The formula for the correlation coefficient is

$$r = \frac{\sum_{i=1}^{N}(X_i-\overline{X})(Y_i-\overline{Y})}{\sqrt{\sum_{i=1}^{N}(X_i-\overline{X})^2\ (Y_i-\overline{Y})^2}} = \frac{\sum_{i=1}^{N} x_i y_i}{\sqrt{\sum_{i=1}^{N} x_i^2 \sum_{i=1}^{N} y_i^2}}$$

where $\overline{X}$ is the mean of one variable,

$\overline{Y}$ is the mean of a second variable,

X_i is a specific data score of the first variable,

Y_i is a specific data score of the second variable,

x_i is the deviation of scores from X, and

y_i is the deviation of scores from Y (Ferguson, 1976).

The correlation coefficient indicates how closely the scores of one variable correspond to the scores of a second variable. A high correlation implies that a close linear relationship exists between two variables. As Ferguson explains, a correlation coeficient of +1 describes the maximum positive relationship between two variables, while a correlation coefficient of -1 describes the maximum negative relationship between two variables: a correlation coefficient of 0 indicates that there is no relationship between the variables. The 0.05 level of significance was chosen for testing the null hypotheses. This level of significance means that one has a 5% chance of rejecting a null hypothesis when it as actually true. A correlation coefficient greater than or equal to the critical value of r for the one-tailed test will result in rejection of the null and acceptance of the alternative hypotheses.

Hypotheses 2(A-B), 4(A-F), and 5(A-F) were tested by a t test of significance between the means. The formula is given by

$$t = \frac{(\overline{X} - \overline{Y})}{\sqrt{S_{\overline{X}}{}^2 + S_{\overline{X}}{}^2}}$$

(Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975)

where the degrees of freedom are approximated by

$$df = \frac{[(S_{\overline{X}})^2 + (S_{\overline{y}})^2]}{\sqrt{\frac{[S_{\overline{X}}{}^2]^2}{N_1 - 1} + \frac{[S_y{}^2]^2}{N_2 - 1}}}$$

(Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975)

where $s_{\overline{X}}$ is the standard error of sample 1

$$s_{\overline{x}} = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})^2}{N_1 (N_1 - 1)}}$$

(Cochran and Cox, 1957)

and $s_{\overline{y}}$ is the standard error of sample 2

$$s_{\overline{y}} = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})^2}{N_2 (N_2 - 1)}}$$

$\overline{X}$ is the mean of scores in sample 1,

$\overline{Y}$ is the mean of scores in sample 2,

X_i is a specific score in group 1,

Y_i is a specific score in group 2,

N_1 is the number of items in sample 1, and

N_2 is the number of items in sample 2.

The degrees of freedom were approximated as a correction for the large differences in the variances of one group as compared to the variances of another group. The standard 't' table used for the determination of rejection or retention of the null hypotheses assumes that the variances of the groups to be compared are similar. In this study, however, the variances of the groups were in many cases significantly different as compared to the variances in other groups.

The 0.05 level of significance was chosen for rejection of the null hypotheses. A t greater than or equal to the critical value of t for the one-tailed test would result in rejection of the null and acceptance of the alternative hypotheses.

Precautions for Accuracy

Statistical analyses were made by a computer at the Computer Center at Montana State University using the "Statistical Package for the Social Sciences" (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975). Programming help was obtained from specialists at the Computer Center. The assumption was made that the computer was accurate and running properly. Key punch errors were rechecked for added accuracy.

Summary

The problem of this study was investigated by distributing a questionnaire to all students in Physics 227 and 103 at MSU during winter quarter of 1981. The survey instrument obtained information about students' preparation for and attitudes toward physics, along with personal background data. Students' grades in these physics classes were obtained at the end of the quarter from the roll sheets.

The responses of males and females were compared. The study investigated sex-related differences in preparation for and attitudes toward physics. The effect on grades of preparation for and attitudes toward physics were also examined for males and females.

Data were grouped in tables. Statistical analyses were performed by a computer. The 0.05 level of significance was chosen for testing the null hypotheses.

Chapter IV

RESULTS

The problem of this study was fivefold: (a) to determine sex-related differences in preparation for the study of physics; (b) to determine relationships between preparation for and grades in physics by sex; (c) to determine sex-related differences in attitudes toward physics; (d) to determine relationships between attitudes toward physics and grades in physics by sex; and (e) to compare attitudes toward physics by sex of science and engineering students to those of nonscience and nonengineering students enrolled in physics during the 1981 school year. The population of this study was composed of all Montana State University students enrolled in Physics 227 and 103 during the winter quarter of 1981. All students were given the opportunity to respond.

The results are divided into three parts: (a) math and science preparation for physics; (b) attitudes toward physics; and (c) a comparison of the attitudes of Physics 227 students to those of Physics 103 students. The

Pearson-product-moment correlation coefficient was used to analyze relationships among the variables of this study. A t test of significance between the means was used to determine how closely the mean score of one group compared to the mean score of a second group. Hypotheses were examined at the 0.05 level of significance.

The reader should be cautioned that results were not obtained from the entire population. While all students in Physics 227 and 103 were given the opportunity to respond to the survey, some chose not to respond. The number and percentage of Physics 227 males, 227 females, 103 males, and 103 females responding to the survey are shown in Table 4. The number of those responding the survey who received a grade of A, B, C, D, or F are shown in Table 5. The large majority of Physics 227 respondants indicated that they were science or engineering majors and 18 to 22 years of age. The majority of Physics 103 respondents indicated that they were not science or engineering majors and that they were 18 to 22 years of age.

TABLE 4

Percent of Students Who Responded

Group	Total Number of Respondents (N)	Percent of Those Responding to the Survey
Physics 227 males	105	42%
Physics 227 females	29	56%
Physics 103 males	38	51%
Physics 103 females	21	75%

TABLE 5

Description of Students

	Grades				
Group	A	B	C	D	F
Physics 227 males	56	27	14	1	7
Physics 227 females	11	10	6	2	0
Physics 103 males	15	15	5	3	0
Physics 103 females	7	5	7	2	0

Math and Science Preparation for Physics

HYPOTHESIS 1A: There is a positive correlation between the number of years of high school math and grades in physics.

A positive correlation between the number of years of high school math and grades in physics was found for Physics 103 females ($r=0.468$, $p=0.02$). This relationship is significant at the 0.05 level. Thus, the null hypothesis is rejected, and the alternative accepted for Physics 103 females. In the other cases involving males and females the null hypothesis is retained since significance was not found at the prescribed level. Table 6 shows the correlation coefficients found for each of the various groups.

HYPOTHESIS 1B: There is a positive correlation between the number of years of high school science and grades in physics.

A positive correlation was found between the number of years of high school science and grades in physics for Physics 227 males ($r=0.183$, $p=0.03$) and Physics 103 females ($r=0.420$, $p= 0.03$). This relationship is significant at the 0.05 level. Thus, the null hypothesis is rejected for Physics 227 males and Physics 103 females. In the other cases involving males and females the null hypothesis is

TABLE 6

Correlations of the Amount of High School Math Preparation for Physics to Grades Received in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
Physics 227					
males	3.80	0.765	105	0.0810	0.2
females	3.89	0.567	28	0.0240	0.5
Physics 103					
males	2.81	1.13	37	0.229	0.09
females	3.05	1.16	21	0.467	0.02*

*Significant at the 0.05 level

retained since no significant relationships were found at the prescribed level. The results are shown in Table 7.

HYPOTHESIS 1C: There is a positive correlation between the number of years of high school physics and grades in physics.

A positive correlation was found between the number of years of high school physics and grades in physics for Physics 227 males ($r=0.214$, $p=0.01$). This relationship is significant at the 0.05 level. Thus, the null hypothesis is rejected for Physics 227 males but is retained for Physics 227 females, Physics 103 males, and Physics 103 females since no other significant relationships were found at the prescribed level. The results are shown in Table 8.

HYPOTHESIS 1D: There is a positive correlation between the amount of college math taken by an individual and grades in physics.

At the 0.05 level, a positive correlation was found to be significant between the number of quarter hours of college math and grades in physics for Physics 227 females ($r=0.375$, $p=0.04$). No other significant correlations were found. Therefore, the null hypothesis is rejected for Physics 227 females, but is retained for Physics 227 males, Physics 103 males, and Physics 103 females. The results are shown in Table 9.

TABLE 7

Correlations of the Amount of High School Science Preparation for Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	3.28	1.19	104	0.183	0.03*
females	3.52	0.79	28	-0.0302	0.4
<u>Physics 103</u>					
males	2.43	1.13	38	-0.162	0.2
females	2.43	1.12	21	0.420	0.03*

* Significant at the 0.05 level

TABLE 8

Correlations of the Amount of High School Physics Preparation to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	0.881	0.586	105	0.214	0.01*
females	0.828	0.449	29	0.225	0.1
<u>Physics 103</u>					
males	0.382	0.538	38	-0.0014	0.5
females	0.300	0.733	20	-0.145	0.3

*Significant at the 0.05 level

TABLE 9

Correlations of the Number of Quarter Hours of College Math to Grades in Physics.

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
male	9.73	9.56	95	-0.130	0.1
females	7.83	7.89	23	0.375	0.04*
<u>Physics 103</u>					
males	5.94	5.10	33	0.0348	0.4
females	6.20	8.00	20	-0.142	0.3

*Significant at the 0.05 level

HYPOTHESIS 1E: There is a positive correlation between the amount of college science taken by an individual and grades in physics.

At the 0.05 level, no correlation was found between the number of quarter hours of college science and grades in physics. Thus, the null hypothesis is retained. Results are found in Table 10.

HYPOTHESIS 1F: There is a positive correlation between the amount of college physics taken by an individual and grades in physics.

At the 0.05 level, no positive correlations were found between the number of quarter hours of college physics and grades in physics. Thus, the null hypothesis is retained. The results are found in Table 11.

HYPOTHESIS 2A: Males will have taken significantly more math than females.

A t test of significance between the means did not show a significant difference for the number of years of high school math taken by males as compared to that taken by females. Thus, the null hypothesis regarding high school math is retained.

Also, a significant difference was not found for the number of quarter hours of college math taken by males as compared to that taken by females. Thus, the null hypothesis regarding college math is retained. The results are shown in Tables 12 and 13.

TABLE 10

Correlations of the Number of Quarter Hours of College Science to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	11.4	19.8	96	-0.0064	0.5
females	5.96	3.48	23	0.150	0.2
<u>Physics 103</u>					
males	5.47	5.93	36	0.0681	0.3
females	5.45	4.35	20	0.342	0.07

*Significant at the 0.05 level

TABLE 11

Correlations of the Number of Quarter Hours of College Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
Physics 227					
males	1.17	2.66	97	0.120	0.1
females	0.120	0.600	25	0.208	0.2
Physics 103					
males	0.568	1.41	37	-0.0578	0.4
females	1.76	3.06	21	0.349	0.06

TABLE 12

A t Test of Significance Between the Means for the Number of Years of High School Math Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	3.80	0.765	105		
				-0.71	0.2
females	3.90	0.567	28		
<u>Physics 103</u>					
males	2.81	1.13	37		
				-0.75	0.2
females	3.05	1.16	21		

TABLE 13

A t Test of Significance Between the Means for the Number of Quarter Hours of College Math Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
males	9.73	9.56	95		
				0.99	0.2
females	7.83	7.89	23		
Physics 103					
males	5.94	5.10	33		
				-0.13	0.4
females	6.20	8.00	20		

HYPOTHESIS 2B: Males will have taken significantly more science than females.

A t test of significance between the means did not show a significant difference for the number of years of high school science taken by males as compared to that taken by females. Thus the null hypothesis regarding high school science is retained.

A significant difference was found at the 0.05 level of the number of quarter hours of college science taken by males as compared to females. Physics 227 males had taken more college science than had Physics 227 females ($t=2.55$, $p=0.006$). No significant difference was found between the amount of college science taken by Physics 103 males as compared to Physics 103 females. Thus, the null hypotheses is rejected for Physics 227 males and females but is retained for Physics 103 males and females. The results are shown in Tables 14 and 15.

HYPOTHESIS 2C: Males will have taken significantly more physics than females.

A t test of significance between the means did not show a significant difference between the amount of high school physics taken by males as compared to females. Thus the null hypothesis regarding high school physics is retained.

A significant difference was found at the 0.05 level of the amount of college physics taken by males as compared

TABLE 14

A t Test of Significance Between the Means for the Number of Years of High School Science Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	3.28	1.19	104		
				-1.24	0.1
females	3.52	0.79	28		
<u>Physics 103</u>					
males	2.43	1.13	38		
				0.02	0.5
females	2.43	1.12	21		

TABLE 15

A t Test of Significance Between the Means for the Number of Quarter Hours of College Science Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
males	11.4	19.8	96		
				2.55	0.006*
females	5.96	3.48	23		
Physics 103					
males	5.47	5.93	36		
				0.02	0.5
females	5.45	4.35	20		

*Significant at the 0.05 level

to that taken by females in Physics 227. Males indicated that they had taken significantly more college physics prior to Physics 227 than females had ($t=3.55$, $p=0.001$). A fairly large negative t was found for Physics 103 students ($t=-1.69$, $p=0.05$). Therefore, the null hypothesis regarding previous college physics courses is rejected for Physics 227 students and is retained for Physics 103 students. The results are shown in Tables 16 and 17.

Attitudes Toward Physics

The results of the modified Fennema-Sherman Attitudes Scales are shown in Tables 18, 19, 20, 21, 22, and 23. Each scale is composed of 6 positively worded statements and 6 negatively worded statements (Fennema and Sherman, 1976). As the authors explain, the responses are assigned scores from 1 to 5: a score of 5 is assigned to that response thought to effect the learning of math in the most positive mannor. The authors go on to say that the Male Domain Scale was the exception to this rule: a score of 5 was assigned to the response which indicated that the individual did not stereotype mathematics as a field for men. Refer to the discussion on page 42 and Table 3 for the method of scoring data.

TABLE 16

A t Test of Significance Between the Means for the Number of Years of High School Physics Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	0.881	0.586	105		
				0.53	0.3
females	0.828	0.449	29		
<u>Physics 103</u>					
males	0.382	0.538	38		
				0.44	0.3
females	0.300	0.733	20		

TABLE 17

A t Test of Significance Between the Means for the Number of Quarter Hours of College Physics Taken by Males as Compared to that Taken by Females

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	1.17	2.66	97		
				3.55	0.001*
females	0.120	0.600	28		
<u>Physics 103</u>					
males	0.568	1.41	37		
				-1.69	0.05
females	1.76	3.06	21		

*Significant at the 0.05 level

TABLE 18

The Modified Success Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ It would make me happy to be recognized as an excellent student in physics.	4.20	4.28	3.95	3.95
2.+ I'd be proud to be the outstanding student in physics.	4.30	4.17	4.05	4.10
3.+ I'd be happy to get top grades in physics.	4.41	4.48	4.27	4.43
4.+ It would be really greatto win a prize in physics.	3.90	3.76	3.79	3.71
5.+ Being first in a physics competition would make me pleased.	4.12	3.79	3.79	4.14
6.+ Being regarded as smart in physics would be a great thing.	3.90	3.86	3.55	4.14

TABLE 18-Continued

7.- Winning a prize in physics would make me feel unpleasantly conspicuous.	4.10	4.03	4.08	4.24
8.- People would think that I was an egghead if I got A's in physics.	4.26	4.21	4.27	4.33
9.- If I had good grades in physics, I would try to hide it.	4.07	4.17	3.95	4.50
10.- If I got the highest grade in physics I'd prefer no one knew.	3.59	3.48	3.47	4.29
11.- It would make people like me less if I were a really good physics student.	4.08	4.40	4.05	4.15
12.- I don't like people to think I'm smart in physics.	4.17	4.17	4.14	4.62
N=	105	29	38	21

TABLE 19

The Modified Male Domain Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ Females are as good as males in physics.	4.02	4.38	4.18	4.25
2.+ Studying physics is just as appropriate for women as for men.	4.46	4.90	4.39	4.62
3.+ I would trust a woman just as much as I would trust a man to figure out important calculations.	4.16	4.66	4.32	4.38
4.+ Girls can do just as well as boys in physics.	4.19	4.66	4.24	4.57
5.+ Males are not naturally better than females in physics.	3.82	4.28	3.50	4.20
6.+ Women certainly are logical enough to do well in physics.	4.12	4.52	4.16	4.48

TABLE 19-Continued

7.- It's hard to believe a female could be a genius in physics.	4.39	4.72	4.35	4.70
8.- When a woman has to solve a physics problem, it is feminine to ask a man for help.	4.16	4.38	3.95	4.05
9.- I would have more faith in the answer for a physics problem solved by a man than a woman.	4.10	4.59	4.08	4.33
10.- Girls who enjoy studying physics are a bit peculiar.	4.28	4.72	4.21	4.57
11.- Physics is for men.	4.39	4.86	4.32	4.67
12.- I would expect a woman mathematician to be a masculine type of person.	4.15	4.34	4.16	4.48
N=	105	29	38	21

TABLE 20

The Modified confidence Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ Generally I have felt secure about attempting physics.	3.95	3.62	3.55	3.19
2.+ I am sure I could do advanced work in physics.	3.90	3.66	3.34	2.75
3.+ I am sure that I can learn physics.	4.34	4.28	4.18	4.10
4.+ I think I could handle more difficult physics.	3.97	3.59	3.34	3.15
5.+ I can get good grades in physics.	4.11	4.10	4.03	3.86
6.+I have a lot of self-confidence when it comes to physics.	3.67	3.17	3.13	2.48

TABLE 20-Continued

7.- I am no good in physics.	4.17	4.10	3.82	3.55
8.- I don't think I could do advanced physics.	4.25	3.93	3.45	2.57
9.-I'm not the type to do well in physics.	4.29	4.00	3.79	3.19
10.- For some reason even though I study, physics seems unusually hard for me.	3.85	3.72	3.66	3.29
11.- Most subjects I can handle O.K., but I have a knack for flubbing up physics.	3.99	3.79	3.79	3.57
12.-Physics has been my worst subject.	4.10	3.96	4.03	3.71
N=	105	29	38	21

TABLE 21

The Modified Usefulness Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ I'll need physics for my future work.	4.47	4.21	3.29	2.90
2.+ I study physics because I know how useful it is.	4.02	3.90	3.55	3.38
3.+ Knowing physics will help me earn a living.	4.28	4.21	3.21	2.80
4.+ Physics is a worthwhile and necessary subject.	4.39	4.24	3.92	4.14
5.+ I will need a firm mastery of physics for my future work.	4.27	4.10	2.92	2.10
6.+ I will use physics in many ways as an adult.	3.93	3.69	3.61	3.29
7.- Physics is of no relevance to my life.	4.51	4.28	4.29	4.00

TABLE 21-Continued

8.- Physics will not be important to me in my life's work.	4.39	4.48	3.66	3.60
9.- I see physics as a subject I will rarely use in my daily life as an adult.	4.26	4.24	3.71	3.43
10.- Taking physics is a waste of time.	4.63	4.59	4.39	4.38
11.-In terms of my adult life it is not important for me to do well in physics.	4.52	4.21	4.13	3.95
12.- I expect to have little use for physics when I get out of school.	4.56	4.34	3.76	3.14
N=	105	29	38	21

TABLE 22

The Modified Anxiety Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ Physics doesn't scare me at all.	3.33	2.90	3.50	3.05
2.+ It wouldn't bother me at all to take more physics.	4.16	4.14	3.66	3.48
3.+ I haven't usually worried about being able to solve physics problems.	3.37	3.14	3.26	3.43
4.+ I almost never have gotten shook up during a physics test.	2.82	2.45	3.08	3.05
5.+ I usually have been at ease during physics tests.	3.28	3.04	3.32	3.15
6.+ I usually have been at ease in physics classes.	3.91	3.69	3.66	3.45

TABLE 22-Continued

7.- Physics usually makes me feel uncomfortable and nervous.	4.04	3.76	3.97	3.62
8.- Phyics makes me feel uncomfortable, restless, irritable, and impatient.	4.03	4.07	4.03	3.86
9.- I get a sinking feeling when I think of trying hard physics problems.	3.77	3.43	3.53	3.14
10.- My mind goes blank and I am unable to think clearly when working physics.	3.81	3.59	3.84	3.71
11.- A physics test scares me.	3.43	2.86	3.47	2.95
12.- Physics makes me feel uneasy and confused.	3.92	3.76	3.97	3.62
N=	105	29	38	21

TABLE 23

The Modified Effectance Motivation Scale

Statement	Physics 227 Male	Physics 227 Female	Physics 103 Male	Physics 103 Female
1.+ I like physics related puzzles.	3.68	3.79	3.55	3.10
2.+ Physics is enjoyable and stimulating to me.	3.89	3.86	3.84	3.71
3.+ When a physics problem arises that I can't immediately solve, I stick with it until I have the solution.	3.79	3.48	3.55	3.52
4.+ Once I start trying to work on a physics puzzle, I find it hard to stop.	3.42	3.41	3.32	3.45
5.+ When a question is left unanswered in physics class, I continue to think about it afterward.	3.68	3.79	3.68	3.52

TABLE 23-Continued

6.+ I am challenged by physics problems I can't understand immediately.	3.94	3.86	3.61	3.76
7.- Figuring out physics problems does not appeal to me.	3.96	4.10	3.82	3.85
8.- The challenge of physics problems does not appeal to me.	4.06	4.21	3.87	3.60
9.- Physics related puzzles are boring.	3.83	4.03	3.68	3.80
10.- I don't understand how some people can spend so much time on physics and seem to enjoy it.	4.00	4.10	3.89	4.05
11.- I would rather have someone give me the solution to a difficult physics problem than to have to work it out for myself.	4.06	4.14	3.97	4.05
12.- I do as little work in physics as possible.	3.88	3.97	3.95	4.05
N=	105	29	38	21

HYPOTHESIS 3A: There will be a positive correlation between attitudes toward success in physics and grades in physics.

At the 0.05 level, no significant correlation was found between attitudes toward success in physics and grades in physics. Thus, the null hypothesis is retained. The results are shown in Table 24.

HYPOTHESIS 3B: There will be a correlation between positive attitudes toward women in the field of physics and grades in physics. There will be a positive correlation for women and a negative correlation for men.

At the 0.05 level, no significant correlation was found between the perceived masculinity of physics and grades in physics for Physics 227 males, 227 females, and 103 males. A positive correlation coefficient for Physics 103 females was significant at this level ($r=0.551$, $p=0.005$). The more positive the attitudes of Physics 103 females toward women in the field of physics, the higher the grade achieved in that course tended to be. A large positive correlation coefficient was found for Physics 103 males, but this was not significant with the one-tailed test as hypothesized. The results are shown in Table 25.

HYPOTHESIS 3C: There will be a positive correlation between attitudes toward one's own ability to do physics and grades in physics.

TABLE 24

Correlations of Attitudes Toward Success in Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	4.09	0.504	105	0.0773	0.2
females	4.07	0.395	29	0.0095	0.5
<u>Physics 103</u>					
males	3.95	0.498	38	0.131	0.2
females	4.22	0.438	21	-0.0667	0.4

TABLE 25

Correlations of the Perceived Masculinity of Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
Physics 227					
males	4.19	0.586	105	0.0647	0.3
females	4.58	0.396	29	0.0637	0.4
Physics 103					
males	4.15	0.493	38	0.329	0.02
females	4.45	0.459	21	0.551	0.005*

*Significant at the 0.05 level

High positive correlations, which were significant at the 0.05 level, were found between attitudes toward one's own ability to do physics and grades in physics for Physics 227 males (r=0.351, p=0.000), for Physics 103 males (0.407, p=0.006), and for Physics 103 females (r=0.656, p=0.001). No other correlation was found to be significant at the prescribed level. Thus, the null hypothesis is rejected for Physics 227 males, Physics 103 males, and Physics 103 females, but is retained for Physics 227 females (see Table 26).

HYPOTHESIS 3D: There will be a positive correlation between the perceived usefulness of physics and grades in physics.

At the 0.05 level, a significant correlation was found only for Physics 103 females (r=0.367, p=0.05). Thus, the null hypothesis is retained for other cases involving males and females (see Table 27).

HYPOTHESIS 3E: There will be a positive correlation between low anxiety toward physics and grades in physics.

High correlations, significant at the 0.05 level, were found between feelings of fear toward physics and grades in physics for Physics 227 males (r=0.382, p=0.000), Physics 103 males (r=0.518, p=0.000), and for Physics 103 females (r=0.539, p=0.006). The more fear expressed by Physics 227 males, Physics 103 males, and Physics 103 females, the lower their achievement in physics tended to

TABLE 26

Correlations of Attitudes Toward One's Own Ability to Do Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	4.05	0.510	105	0.351	0.000*
females	3.83	0.492	29	-0.156	0.2
<u>Physics 103</u>					
males	3.68	0.624	38	0.407	0.006*
females	3.29	0.727	21	0.656	0.001*

*Significant at the 0.05 level

TABLE 27

Correlations of the Perceived Usefulness of Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
Physics 227					
males	4.35	0.451	105	0.108	0.1
females	4.21	0.578	29	-0.0135	0.5
Physics 103					
males	3.70	0.611	38	0.260	0.06
females	3.42	0.666	21	0.367	0.05*

*Significant at the 0.05 level

be. No significant correlation was found for Physics 227 females. Thus, the null hypothesis is rejected for Physics 227 males, Physics 103 males, and Physics 103 females but is retained for Physics 227 females. The results are shown in Table 28.

HYPOTHESIS 3F: There will be a positive correlation between the active enjoyment of physics and grades in physics.

High correlations, significant at the 0.05 level, were found between the active enjoyment of physics and grades in physics for Physics 227 males (r=0.261, p=0.004), Physics 103 males (r=0.282, p=0.04), and Physics 103 females (r=0.626, p=0.001). No correlation was found for Physics 227 females. Thus, the null hypothesis is rejected for Physics 227 males, Physics 103 males, and Physics 103 females but is retained for Physics 227 females (see Table 29).

HYPOTHESIS 4A: Males will rate themselves higher in confidence than females.

A t, significant at the 0.05 level, was found for Physics 227 and 103 students. Physics 227 males did rate themselves higher in confidence than Physics 227 females did (t=2.11, p=0.02). Also, Physics 103 males rated themselves more confident than Physics 103 females did (t=2.09, P=0.02). Thus, the null hypothesis is rejected

TABLE 28

Correlations of Fear Toward Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	3.66	0.599	105	0.382	0.000*
females	3.40	0.650	29	-0.261	0.09
<u>Physics 103</u>					
males	3.61	0.577	38	0.518	0.000*
females	3.39	0.829	21	0.539	0.006*

*Significant at the 0.05 level

TABLE 29

Correlations of the Active Enjoyment of Physics to Grades in Physics

Group	Mean	Standard Deviation	No. (N)	Correlation Coefficient	Level of Significance
<u>Physics 227</u>					
males	3.85	0.476	105	0.261	0.004*
females	3.89	0.446	29	-0.199	0.2
<u>Physics 103</u>					
males	3.73	0.511	38	0.282	0.04*
females	3.70	0.677	21	0.626	0.001*

*Significant at the 0.05 level

for Physics 227 and 103 students. The results are shown in Table 30.

HYPOTHESIS 4B: Males will indicate that physics is more of a male field than will females.

A t, significant at the 0.05 level was found for Physics 227 and 103 students. Physics 227 males did indicate that physics was a masculine discipline more than Physics 227 females did ($t=-4.22$, $p=0.000$) as did Physics 103 males compared to Physics 103 females ($t=2.29$, $p=0.01$). Thus, the null hypothesis is rejected for Physics 227 and 103 students, (see Table 31).

HYPOTHESIS 4C: Males will rate physics as more useful than females will.

At the 0.05 level, males did not significantly rate physics as more useful than females did. Thus, the null hypothesis is retained for Physics 227 and 103 students (see Table 32).

HYPOTHESIS 4D: Males will indicate a greater active enjoyment of physics than females will.

At the 0.05 level, males did not significantly indicate a greater active enjoyment of physics than females did. Thus, the null hypothesis is retained for Physics 227 and 103 students (see Table 33).

HYPOTHESIS 4E: Females will rate themselves higher in anxiety than males will.

TABLE 30

A t Test of Significance Between the Means for Attitudes Toward One's Own Ability to do Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	4.05	0.510	105		
				2.11	0.02*
females	3.83	0.492	29		
<u>Physics 103</u>					
males	3.68	0.624	38		
				2.09	0.02*
females	3.29	0.727	21		

*Significant at the 0.05 level

TABLE 31

A t Test of Significance Between the Means for Attitudes Toward Women in the Field of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
male	4.19	0.586	105	-4.22	0.000*
female	4.58	0.396	29		
Physics 103					
male	4.15	0.493	38	-2.29	0.01*
female	4.45	0.459	21		

*Significant at the 0.05 level

TABLE 32

A t Test of Significance between the Means for the Perceived Usefulness of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Physics 227</u>					
males	4.35	0.451	105		
				1.25	0.1
females	4.21	0.578	29		
<u>Physics 103</u>					
males	3.70	0.611	38		
				1.59	0.06
females	3.42	0.666	21		

TABLE 33

A t Test of Significance Between the Means for the Active Enjoyment of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
males	3.85	0.476	105		
				-0.49	0.3
females	3.89	0.446	29		
Physics 103					
males	3.73	0.511	38		
				0.14	0.4
females	3.70	0.677	21		

A t, significant at the 0.05 level was found for Physics 227 students but not for Physics 103 students. Physics 227 females indicated a greater fear of physics than did Physics 227 males ($t=1.96$, $p=0.03$). Thus, the null hypothesis is rejected for Physics 227 students but is retained for Physics 103 students. The results are shown in Table 34.

HYPOTHESIS 4F: Females will indicate that they have more positive attitudes toward success than males will.

A t, significant at the 0.05 level, was found for Physics 103 students ($t=-2.17$, $p=0.02$), but not for Physics 227 students. Physics 103 females indicted more positive attitudes toward success than males did. Thus, the null hypothesis is rejected for Physics 103 students, but is retained for Physics 227 students (see Table 35).

A Comparison of the Attitudes of Physics 227 Students to Those of Physics 103 Students

HYPOTHESIS 5A: Physics 227 students will indicate that they have significantly more positive attitudes toward their ability to do physics than Physics 103 students will.

A t, significant at the 0.05 level, was found for Physics 227 males and females. Physics 227 males indicated more positive attitudes toward their ability to do physics than Physics 103 males did ($t=3.23$, $p=0.001$). Also,

TABLE 34

A t Test of Significance Between the Means for Anxiety of Physics.

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
males	3.66	0.599	105		
				1.96	0.03*
females	3.40	0.650	29		
Physics 103					
males	3.61	0.577	38		
				1.09	0.1
females	3.38	0.829	21		

*Significant at the 0.05 level

Table 35

A t Test of Significance Between the Means for Attitudes Toward Success in Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Physics 227					
males	4.09	0.504	105		
				0.28	0.4
females	4.07	0.395	29		
Physics 103					
males	3.95	0.498	38		
				-2.17	0.02*
females	4.22	0.438	21		

*Significant at the 0.05 level

Physics 227 females indicated more positive attitudes toward their ability to do physics than Physics 103 females did (t=2.95, p=0.003). Thus, the null hypothesis is rejected for male and female students (see Table 36).

Hypothesis 5B: Physics 227 females will have significantly more positive attitudes toward women in the field of physics than Physics 103 females will.

At the 0.05 level, Physics 227 females did not indicate more positive attitudes toward women in the field of physics than Physics 103 females did. Earlier in this study, it was found that males in both Physics 227 and 103 rated physics as a more masculine discipline than did females in these same courses. Since Physics 227 is designed for study toward a physics related field, it was predicted that Physics 227 females would indicate more positive attitudes than Physics 103 females toward women in physics. No difference was found. Also, Physics 227 males did not indicate physics to be a more masculine field than did Physics 103 males. Thus, the null hypothesis is retained for male and female students (see Table 37).

HYPOTHESIS 5C: Physics 227 students will indicate physics to be more useful than Physics 103 students will.

Significant relationships were found at the 0.05 level for Physics 227 and 103 students. Physics 227 males indicated physics to be more useful than did Physics 103 males (t=5.97, p=0.000). Also, Physics 227 females

TABLE 36

A t Test of Significance Between the Means for Attitudes Toward One's Own Ability to do Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Males					
Physics 227	4.05	0.510	105	3.23	0.001*
Physics 103	3.68	0.624	38		
Females					
Physics 227	3.83	0.492	29	2.95	0.003*
Physics 103	3.29	0.727	21		

*Significant at the 0.05 level

TABLE 37

A t Test of Significance Between the Means for Attitudes Toward Women in the Field of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Males					
Physics 227	4.19	0.586	105	-0.36	0.4
Physics 103	4.15	0.493	38		
Females					
Physics 227	4.58	0.396	29	-1.09	0.1
Physics 103	4.45	0.459	21		

indicated physics to be more useful than did Physics 103 females ($t=4.39$, $p=0.000$). Thus, the null hypothesis is rejected for male and female students (see Table 38).

HYPOTHESIS 5D: Physics 227 students will indicate a greater active enjoyment of physics than will Physics 103 students.

No relationships were found to be significant at the 0.05 level. Physics 227 males did not indicate a greater active enjoyment of physics than Physics 103 males did and neither did Physics 227 females as compared to Physics 103 females. Thus, the null hypothesis is retained for males and females (see Table 39).

HYPOTHESIS 5E: Physics 227 students will indicate less fear of physics than will Physics 103 students.

No relationships were found to be significant at the 0.05 level. Physics 227 males did not indicate significantly less fear of physics than Physics 103 males did and neither did Physics 227 females as compared to Physics 103 females. Thus, the null hypothesis is retained for males and females. The results are shown in Table 40.

HYPOTHESIS 5F: Physics 227 students will indicate more positive attitudes toward success than Physics 103 students will.

No significant relationships were found at the 0.05 level. Physics 227 males did not indicate more positive attitudes toward success than Physics 103 males did and

TABLE 38

A t Test of Significance Between the Means for the Perceived Usefulness of Physics.

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Males					
Physics 227	4.35	0.451	105		
				5.97	0.000*
Physics 103	3.70	0.611	38		
Females					
Physics 227	4.21	0.578	29		
				4.33	0.000*
Physics 103	3.42	0.666	21		

*Significant at the 0.05 level

TABLE 39

A t Test of Significance Between the Means for the Active Enjoyment of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
<u>Males</u>					
Physics 227	3.85	0.476	105		
				1.26	0.1
Physics 103	3.73	0.511	38		
<u>Females</u>					
Physics 227	3.89	0.446	29		
				1.12	0.1
Physics 103	3.70	0.677	21		

TABLE 40

A t Test of Significance Between the Means for a Fear of Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Males					
Physics 227	3.66	0.599	105		
				0.48	0.3
Physics 103	3.61	0.577	38		
Females					
Physics 227	3.40	0.650	29		
				0.05	0.5
Physics 103	3.38	0.829	21		

neither did Physics 227 females as compared to Physics 103 females. Thus, the null hypothesis is retained for males and females (see Table 41).

Summary

This research investigation found some relationships of one's preparation and attitudes toward physics with one's grades in physics. It also found some differences between the preparation and attitudes of males as compared with that of females. Also, some differences were found between the attitudes of science and engineering majors as compared to those of nonscience and nonengineering majors.

A few relationships were found to exist between math and science preparation and grades in physics. The following were found to be positively correlated to grades in physics: (a) the number of years of high school math for Physics 103 females; (b) the number of years of high school science for Physics 227 males and Physics 103 females; (c) the number of years of high school physics for Physics 227 males; and (d) the number of quarter hours of college math for Physics 227 females.

No significant difference was found for the amount of math and science taken by males as compared to that taken by females with two exceptions. Physics 227 males

TABLE 41

A t Test of Significance Between the Means for Attitudes Toward Success in Physics

Group	Mean	Standard Deviation	No. (N)	t Value	Level of Significance
Males					
Physics 227	4.09	0.504	105		
				1.55	0.06
Physics 103	3.95	0.498	38		
Females					
Physics 227	4.07	0.395	29		
				-1.24	0.1
Physics 103	4.22	0.438	21		

indicated that they had taken more college science and physics than Physics 227 females have.

Some relationships were also found to exist between attitudes toward physics and grades in physics. The following attitudes seem to be positively correlated to grades in physics: (a) positive attitudes toward women in physics for Physics 103 females: (b) positive attitudes toward one's own ability to do physics for Physics 227 males, Physics 103 males, and Physics 103 females; (c) lack of fear toward physics for Physics 227 males, Physics 103 males, and Physics 103 females, and (d) the perceived usefulness of physics for Physics 103 females; and (e) the active enjoyment of physics for Physics 227 males, Physics 103 males, and Physics 103 females. No correlations were found for Physics 227 females.

Some significant differences were found between the attitudes of males and females. Both groups of males rated themselves higher in confidence than females. Both groups of males indicated that physics was a more masculine discipline than did females. Also, Physics 227 females rated themselves higher in anxiety than Physics 227 females did.

Also, a few significant differences were found between the attitudes of Physics 227 and 103 students. Both males and females in Physics 227 rated themselves higher in confidence than did males and females in Physics

103. Both males and females in Physics 227 indicated a greater perceived usefulness for physics than did Physics 103 males and females.

Chapter V

CONCLUSIONS

The conclusions from this research paper are divided into three parts: (a) math and science preparation for physics by sex; (b) attitudes toward physics by sex; and (c) a comparison of the attitudes of Physics 227 students to those of Physics 103 students by sex.

Math and Science Preparation for Physics by Sex

Math and Grades in Physics

A positive correlation between the number of years of high school math and grades in physics was found for Physics 103 females. Also, a significant correlation was found between the number of quarter hours of college math and grades in physics for Physics 227 females.

Physics 227 requires calculus for solving physics problems. While in high school, Physics 227 males and females had been preparing for a college major in science or engineering, and thus, they had probably received the necessary basic mathematics in high school. The amount of math taken by males and females in high school was similar. A significant correlation, though was found between the number of quarter hours of college math and grades in physics for Physics 227 females. Formal college mathematics learning appears to be more closely related to grades for females than males.

On the other hand, Physics 103 requires only a basic knowledge of mathematics. High school math courses are designed to offer a basic knowledge of math. A significant positive correlation was found between the amount of high school math and grades in Physics 103 for females. Perhaps women should be particularily aware of the necessity of learning math skills for physics related careers, since math was positively correlated to achievement in physics for females in both courses. In fact, the correlation of math to grades was the only significant correlation found in this study for Physics 227 females. Formal math learning may be a limiting factor for females in a mathematical field.

Science and Grades in Physics

A positive correlation was found between the number of years of high school science and grades in physics for Physics 227 males and Physics 103 females.

Thus, learning physics may be related to elementary concepts and terms previously learned in other sciences and science courses in high school. Just as Brasted (1957) found that taking high school physics may affect one's performance in college chemistry, so in like manner, the learning of college physics may be influenced by learning gained from other high school sciences.

Previous Physics Courses and Grades in Physics

A positive correlation was found between the number of years of high school physics and grades in physics for Physics 227 males.

The knowledge and principles learned in high school physics may affect one's grades in Physics 227. A study carried out by Brasted (1957) suggests that students who took high school chemistry had a tendency to receive higher grades in college chemistry than those who had not. In like manner, high school physics may be helpful for studying Physics 227. Most high school physics courses are taught as a mathematical discipline. Although Physics 227 is much more advanced than a high school physics course, it also is taught as a mathematical science. Math skills learned in high school physics may help in Physics 227. Thus, if an individual first takes high school physics, that person may have an advantage in learning the subject matter of Physics 227 since the learning methodology is similar.

On the other hand, Physics 103 relies on the use of very little mathematics for problem solving. The math methods learned in high school physics may not be very important for success in Physics 103.

The methodology for learning the subject matter of Physics 227 and 103, both introductory level physics courses, may be different enough from any other previous college physics classes that such previous courses may not necessarily be of much help in learning the subject matter. The lack of a relationship between previous college physics and Physics 103 might be questioned for females. Although a significant correlation was not found, a relatively large positive correlation coefficient was found ($r=0.349$, $p=0.06$).

Math Preparation of Males as Compared to that of Females

No significant difference was found between the amount of math taken by males as compared to that taken by females. No data were obtained as to the quality of math courses taken. This study does not show whether females took the same level of math as males did.

Science Preparation of Males as Compared to that of Females

Physics 227 males however, were found to have taken more college science than Physics 227 females. No data were obtained as to the quality of the courses taken. This study does not show whether females took the same level of science courses as males did.

Physics Preparation of Males as Compared to that of Females

Males indicated that they had taken significantly more college physics prior to Physics 227 than females did. No significant difference was found for Physics 103 students, although a large negative 't' was found. If physics is thought to be a field better designed for men, then males may be more likely to take more physics than females.

Attitudes Toward Physics by Sex

Attitude Toward Success in Physics

Physics 103 females indicated more positive attitudes toward success in physics than Physics 103 males did. This agrees with the data of Fennema and Sherman (1977), who found females in one school out of four to have indicated a significantly more positive attitude toward success than males.

The Perceived Masculinity of Physics

There was a significant correlation between positive attitudes toward women in physics and grades in physics for Physics 103 females. The more positive the attitudes of Physics 103 females toward women in the field of physics, the higher the grade achieved in that course. Surprisingly, a large positive correlation coefficient was also found for Physics 103 males.

Physics 227 and 103 males indicated that physics was a more masculine discipline than did females. Since physics is a mathematical discipline this study can be compared to that of Fennema and Sherman (1977). They found that males regarded math as more of a masculine field than females did.

Whether a person perceived physics as being exclusively for men of not, that person's performance was relatively unaffected in Physics 227 (mostly science and engineering majors). The positive correlation found for Physics 103 females (mainly nonscience majors) could be the result of perceived sex role standards. The results for Physics 103 females would agree with the research of Hawley (1971), Dwyer (1974), and Fitzpatrick (1979). As Hawley suggests, women's performance in physics may be related to men's views of their roles. In this study, women who were engaged in traditional female occupations tended to believe that men perceived female behavior in a sex based way. Women, who were not engaged in traditionally feminine careers, did not believe that men viewed them this way. This line of reasoning may explain the relationship between the perceived masculinity of physics and grades in physics for Physics 103 females and the lack of such a relationship for Physics 227 females. Research by Dwyer showed sex role standards to affect arithmetic test scores. Similarily, Fitzpatrick's research suggests that women's roles do affect math achievement.

Confidence in One's Ability to do Physics

A positive correlation was found between attitude toward one's own ability to do physics and grades in physics for Physics 227 males, Physics 103 males, and Physics 103 females.

Both groups of males indicated more confidence in their abilities to do physics than females did. These data agree with the research of Fennema and Sherman (1977) and of Fox (1979). Both studies found that in most cases males rated themselves more confident in their abilities to do math than females.

Other research investigations indicate similar results. As was suggested by the research of Simmons, Brown, Bush, and Blyth (1978), females may have a lower self-esteem than males. And as Ott's (1978) research shows, women may not expect to do as well as men. Although the women in their study were found to have higher grades in high school as compared with the men, a smaller percentage of them expected to earn an A. Women may have particularily low confidence in a highly mathematical physics course.

The Perceived Usefulness of Physics

At the 0.05 level, a significant correlation was found between the perceived usefulness of physics and grades in physics for Physics 103 females.

Thus, the perceived usefulness of physics does not appear to influence scholastic performance by males or females. Physics 227 males and Physics 227 females, because they are mostly science and engineering majors. These students probably recognize the importance of physics for their fields of study. Therefore, regardless of whether they were high or low achievers in physics, they may have felt that physics was needed for their future work and life.

The attitudes of Physics 103 males and females, however, may have influenced their own performance in the course. The lower the perceived usefulness of physics, the less effort Physics 103 males and females may have put into the course.

Fear of Physics

Positive correlations were found between low anxiety toward physics and grades in physics for Physics 227 males and Physics 103 males and females. Also, Physics 227 females indicated more anxiety toward physics than Physics 227 males did. Teaching strategies might alleviate some of this anxiety. Decreased anxiety could result in better grades.

The Active Enjoyment of Physics

Significant positive correlations were found between the active enjoyment of physics and grades in physics for Physics 227 males, and Physics 103 males and females. The more one likes doing physics, the more constructive time one may spend doing physics, and thus the better that person may do in the course. Also, no significant differeences were found between the active enjoyment of physics of males as compared to that of females. Women appear to enjoy doing physics related activities as much as men do.

A Comparison of the Attitudes of Physics 227 Students to those of Physics 103 Students by Sex

Confidence

Physics 227 males indicated more positive attitudes toward their ability to do physics than did Physics 103 males. Also, Physics 227 females indicated more positive attitudes toward their ability to do physics than Physics 103 females did.

The way one feels about one's abilities may affect her or his choice of college study. If an individual does not feel that he or she is capable of doing physics, then that person may be less apt to study a physics related discipline. If this be the case, then there are more serious implications regarding sex bias. Physics 227 males felt significantly more confident about their abilities to do physics than did Physics 227 females. If females are influenced to feel that they are less able to do physics than males, then they may be less apt to study a discipline which is related to physics and less apt to do well.

Masculinity

Physics 227 females did not indicate more positive attitudes toward women in the field of physics than did Physics 103 females. Also, Physics 227 males did not indicate physics to be significantly more of a masculine field than did Physics 103 males. Thus, attitudes of Physics 227 students appear to be similar to the attitudes of Physics 103 students in this respect.

Usefulness

Physics 227 males indicated physics to be more useful than did Physics 103 males. Also, Physics 227 females indicated physics to be more useful than did Physics 103 females.

Physics 103 students might perceive physics as being less useful than Physics 227 students because of the non-science related nature of their majors. Physics may more directly relate to a science or engineering major than to other non-science majors. Thus, the less a person's major directly relates to physics, the less useful a person may perceive physics to be. Also, the way an individual feels about the usefulness of physics for one's future work or life may affect her or his choice of college study. The less useful a person perceives physics to be, the less apt that person may be to study a physics related discipline.

Active Enjoyment

Physics 227 students did not indicate more positive attitudes toward the active enjoyment of physics than did Physics 103 students. Thus, attitudes toward the active enjoyment of physics of Physics 103 students appears to be similar to the attitudes of Physics 227 students.

Fear of Physics

At the 0.05 level, Physics 227 students did not indicate less fear of physics than did Physics 103 students. Thus, anxiety toward physics of Physics 103 students appears to be similar to that of Physics 227 students.

Success in Physics

Physics 227 students did not indicate more positive attitudes toward success in physics than did Physics 103 students. Thus, attitudes toward success in physics of Physics 103 students appears to be similar to the attitudes of Physics 227 students.

Recommendations

Based on the conclusions of this paper, the following recommendations are made:

1. It is recommended that high school as well as college advisors discuss with their students the advantages of selected math and science courses. Those students having interest in physics should be advised that a strong math and science preparation is important for learning the subject matter of introductory physics. Formal math learning may be particularily important for women. The only correlation between the number of years of high school math and grades in physics was found for Physics 103 females. Also, the only correlation between the number of quarter hours of college math and grades in physics was found for Physics 227 females. In fact, this correlateion for Physics 227 females was the only correlation found in this study for Physics 227 females.

2. It is recommended that instructors particularily develop in their students a sense of confidence in their abilities to do physics, encourage positive attitudes toward women in physics, encourage the active enjoyment of physics, and try to lessen high levels of anxiety. Confidence in one's ability to do physics appears to have a positive effect on some individuals' performance in physics. Also, positive attitudes toward women in physics

and the active enjoyment appear to have a positive affect on some students' grades. On the other hand, fear seems to negatively affect one's performance in this field. Thus, if one's attitudes toward physics could be improved, then perhaps one's performance in that field might also be improved.

3. Lastly, it is recommended that instructors promote such positive attitudes without regard to the students' sex. Some of the same attitudes which this research paper indicated as significantly affecting one's performance in physics, were also found to be sex dependent. Males were found to have some significantly more positive attitudes than females toward the field of physics. Thus, if positive attitudes were developed equally in females and males, then perhaps the performance and participation of female students would improve. Improved attitudes might then encourage more women to pursue a career in physics.

Summary

It is hoped that the results of this research paper can be used for student advisement and for planning instructional strategies. Certain preparation and attitudes were found to be correlated to either the Physics 227 or 103 grade. Thus, if a student is made aware of the quality of background conducive to high achievement in physics, then that person may have a better chance for success in his or her chosen field of study. Also, instruction could be planned to cultivate those positive attitudes which are most conducive to high academic achievement.

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APPENDIX

Letter and Survey Instrument

Dear Student:

This survey is being conducted to learn something about the relationship between attitudes and achievement of students in the field of physics. I hope that you will agree to help me in this study by completing the following questionnaire.

The first part of the study consists of general information. Please indicate your response to each question in the space provided.

The second part of the survey consists of several statements. Please indicate your response to each statement in the box provided to its right. The choices for response are the following: strongly agree, agree, neutral, disagree, and strongly disagree.

THE RESULTS OF THIS SURVEY WILL BE USED FOR RESEARCH PURPOSES ONLY. ALL RESPONSES WILL BE HELD IN CONFIDENCE.

My signature designates that I am a willing participant in this research project. Signature:________________________

GENERAL INFORMATION

1. What is your major?________________________________

2. Is this a required course for your major?______________

3. Sex: Male____ Female____

4. In which age group do you fall?
   17 and under___ 18-22___ 23 and over___

5. While in college, how many <u>quarter</u> <u>hours</u> of mathematics have you taken?____________________

6. While in college, how many <u>quarter</u> <u>hours</u> of science have you taken?______________________

7. While in college, how many <u>quarter</u> <u>hours</u> of physics have you taken prior to this course?____________________________

8. While in high school, how many <u>years</u> of mathematics have you taken?______________________

9. While in high school, how many <u>years</u> of science have you taken?______________________

10. While in high school, how many <u>years</u> of physics have you taken?______________________

11. What is your lecture seat number?__________________

12. At what time do you attend the physics lecture?________

THE MODIFIED FENNEMA-SHERMAN ATTITUDES SCALE

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I am challenged by physics problems I can't understand immediately.					
2. I expect to have little use for physics when I get out of school.					
3. I see physics as a subject I will rarely use in my daily life as an adult.					
4. I don't think I could do advanced physics.					
5. I'm not the type to do well in physics.					
6. Physics is of no relevance to my life.					
7. When a question is left unanswered in phyiscs class, I continue to think about it afterward.					
8. In terms of my adult life it is not important for me to do well in physics.					
9. I get a sinking feeling when I think of trying hard physics problems.					
10. Physics makes me feel uneasy and confused.					
11. I will use physics in many ways as an adult.					
12. Being first in a physics competition would make me pleased.					
13. Studying physics is just as appropriate for women as for men.					
14. Physics is for men.					
15. I am no good in physics.					
16. Physics usually makes me feel uncomfortable and nervous.					

THE MODIFIED FENNEMA-SHERMAN ATTITUDES SCALE-Continued

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
17. I haven't usually worried about being able to solve physics problems.					
18. For some reason, even though I study, physics seems unusually hard for me.					
19. I do as little work in physics as possible.					
20. It wouldn't bother me at all to take more physics courses.					
21. Most subjects I can handle okay, but I have a knack for flubbing up physics.					
22. Knowing physics will help me earn a living.					
23. I'll need physics for my future work.					
24. Physics has been my worst subject.					
25. It would make me happy to be recognized as an excellent student in phyiscs.					
26. When a physics problem arises that I can't immediately solve, I stick with it until I have the solution.					
27. Girls who enjoy studying physics are a bit peculiar.					
28. I'd be proud to be the outstanding student in physics.					
29. Physics is enjoyable and stimulating to me.					
30. Taking physics is a waste of time.					
31. Physics will not be important to me in my life's work.					
32. I don't understand how some people can spend so much time on physics and seem to enjoy it.					

THE MODIFIED FENNEMA-SHERMAN ATTITUDES SCALE-Continued

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
33. I think I could handle more difficult physics.					
34. It's hard to believe a female could be a genius in physics.					
35. I am sure that I can learn physics.					
36. Women certainly are logical enough to do well in physics.					
37. Females are as good as males in physics.					
38. I usually have been at ease during physics tests.					
39. It would make people like me less if I were a really good student.					
40. I would have more faith in the answer for a physics problem solved by a man than a woman.					
41. When a woman has to solve a physics problem, it is feminine to ask a man for help.					
42. Males are not naturally better than females in physics.					
43. People would think that I was an egghead if I got I A's in physics.					
44. I don't like people to think I'm smart in physics.					
45. Winning a prize in physics would make me feel unpleasantly conspicuous.					
46. I like physics related puzzles.					
47. I will need a firm mastery of physics for my future.					
48. I have a lot of self-confidence when it comes to physics.					

THE MODIFIED FENNEMA-SHERMEN ATTITUDES SCALE-Continued

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
49. If I got the highest grade in physics I'd prefer no one knew.					
50. I study physics because I know how useful it is.					
51. I almost never have gotten shook-up during a physics test.					
52. My mind goes blank and I am unable to think clearly when working physics.					
53. Figuring out physics problems does not appeal to me.					
54. I would rather have someone give me the answer to a difficult physics problem than to work it out for myself.					
55. Physics related puzzles are boring.					
56. I am sure I could do advanced work in physics.					
57. It would be really great to win a prize in physics.					
58. Girls can do just as well as boys in physics.					
59. The challenge of physics problems does not appeal to me.					
60. Physics makes me feel uncomfortable, restless, irritable, and impatient.					
61. I can get good grades in physics.					
62. Being regarded as smart in physics would be a great thing.					
63. Generally I have felt secure about attempting physics.					
64. Physics is a worthwhile and necessary subject.					

THE MODIFIED FENNEMA SHERMAN ATTITUDES SCALE-Continued

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
65. I would trust a woman just as much as I would trust a man to figure out important calculations.					
66. Once I start trying to work on a puzzling physics problem, I find it hard to stop.					
67. If I had good grades in physics, I would try to hide it.					
68. I would expect a woman physicist to be a masculine type of person.					
69. I'd be happy to get top grades in physics.					
70. I usually have been at ease in physics classes.					
71. A physics test scares me.					
72. Physics doesn't scare me at all.					