THE RESPONSIVENESS OF MATHEMATICS ACHIEVEMENT IN GRADE 8 TO ANXIETY, CONFIDENCE, SEX, AND PRIOR MATHEMATICS ACHIEVEMENT

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The Responsiveness of Mathematics Achievement in Grade 8 to Anxiety, Confidence, Sex, and Prior Mathematics Achievement

by

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ABSTRACT

This is a study of mathematics achievement in Grade 8, and an examination of some of the factors that may influence it. The factors considered were anxiety, confidence, sex, and prior mathematics achievement.

Grade 8 students from six schools located in urban and rural areas participated in the study.

Students were required to answer an Anxiety-Confidence Questionnaire which was adapted from the Fennema-Sherman Mathematics Attitude Scale. They also completed the Concepts, Problem-Solving, and Computation subtests of the Canadian Tests of Basic Skills as measures of current mathematics achievement. Permanent school records were used to determine the same students' scores on corresponding subtests given two years previously.

Sex, mathematics anxiety, and prior mathematics achievement were found to each contribute significantly to current mathematics achievement over and above the other variables, with prior mathematics achievement having the most impact. Current mathematics achievement was found to be negatively affected by anxiety and positively by confidence. Both prior achievement and sex were found to contribute significantly to the variances in anxiety and confidence.

It was found that anxiety and confidence both contributed significantly to the variance in current

achievement in the area of concepts. The influence of sex on achievement was significant over and above the others only in the area of computation.

Path analysis showed that the direct effect of sex on achievement which favoured females was offset by the indirect effects of sex on achievement via anxiety and confidence, both of which worked in favour of males.

In general, females tended to exhibit higher anxiety and males higher confidence even when their performance was the same. However, the separate sex analysis showed that anxiety correlated more highly with current achievement for males whereas confidence correlated more highly with current achievement for females.

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CHAPTER 1

BACKGROUND

Introduction

In recent years there has been considerable discussion of the psychological aspects of mathematics education. Not only is the cognitive area being examined but the contribution of other factors is being considered as well. For example, Aiken (1970) recommended that in researching mathematics achievement, non-intellective variables as well as intellective variables be considered since "only about half the variance in mathematical achievement can be accounted for by differences in abilities" (Aiken, 1971, p. 209).

Aiken (1970), in his review of attitudes towards mathematics, cited Dutton (1968) as reporting that it was the junior high school which seemed to be the critical point in the determination of attitudes towards mathematics. He also cited Brown and Abel (1965) who found that correlates between attitude and achievement were higher for arithmetic than for spelling, reading, or language. Schofield (1982), in contrast, examined the relationship between the mathematics attitude of elementary school children and their achievement and found no significant relationship between them. He cited Riedesel and Burns (1973) who reviewed the teaching of elementary school mathematics and contended that although it would seem that attitudes to and achievement in mathematics should be positively and substantially related, at that time there was no body of research to support such a relationship.

In Newfoundland and Labrador, mathematics achievement is below the national average as measured by the Canadian Tests of Basic Skills (Blagdon 1986). It is imperative that this low achievement be investigated, possible reasons postulated and solutions formulated.

Since attitudinal factors may influence present performance in mathematics, another related problem was also considered. That is, the problem of keeping students enrolled in higher level mathematics courses. Because secondary school mathematics is required as a prerequisite for many professions today, the continuation of its study should be encouraged among our young people. Sherman (1982) suggested a relationship between a lack of confidence in oneself as a mathematics learner and the discontinuation of the study of mathematics. Stanic and Reyes (1986) stated that confidence in learning mathematics is one of the strongest attitudinal predictors of mathematics course-taking. Aside from its possible effect on mathematics performance then, lack of mathematics confidence may indicate that mathematics courses will be dropped at the earliest opportunity.

An analysis of sex differences in mathematics achievement was also investigated in this study. If sex differences do exist then it would be helpful to know whether or not they are related to, or perhaps mediated by, such affective variables as mathematics anxiety and confidence in mathematics. Since sex differences begin to appear at the junior high level when sex-typed interests are beginning to emerge (Hilton & Berglund, 1974), this is an appropriate age-group on which to focus.

Finally, in examining this relationship it should be kept in mind that not only may attitude affect performance but performance may affect attitude formation as well. Aiken, cited in Hilton and Berglund (1974), suggested that there is a dynamic interaction between attitude and performance. Therefore this study also looked at previous mathematics achievement and its relationship to the affective variables of mathematics anxiety and confidence in mathematics.

Purpose of the Study

The purpose of this research was to determine whether or not certain affective variables contribute significantly to mathematics achievement in Grade 8. In particular, anxiety and confidence in mathematics were measured and the researcher tried to determine whether these factors contribute significantly to the overall variance in mathematics achievement over and above the effect of prior achievement.

With respect to sex differences in mathematics, the objective of this research was to show that the relationship between sex and mathematics achievement is attenuated in the presence of confidence and anxiety.

The following are the specific questions which this research investigated:

1. What is the relationship between prior achievement in mathematics as measured by Canadian Tests of Basic Skills, Grade 6 (CTBS 6) and present achievement in mathematics as measured by Canadian Tests of Basic Skills, Grade 8 (CTBS 8)?
2. What is the relationship between anxiety in mathematics and mathematics achievement in Grade 8?
3. What is the relationship between confidence in mathematics and mathematics achievement in Grade 8?
4. Is anxiety in mathematics related to the sex of the subject?
5. Is confidence in mathematics related to the sex of the subject?
6. Is confidence in mathematics related to prior achievement?

7. Is anxiety related to prior achievement?
8. Are there significant differences between the sexes in mathematics achievement?
9. Are sex differences in mathematics achievement more pronounced in Grade 8 than in Grade 6?
10. Are anxiety and confidence significantly related to each other?

Theoretical Significance

The results of many studies regarding sex differences in mathematics achievement have been rather ambiguous. There is no conclusive evidence regarding the magnitude of the differences found, the kinds of mathematics affected, or the age at which males begin to outperform females. However, there is some evidence to indicate that this phenomenon may occur around adolescence (Maccoby, 1974) - the junior high school level.

It has been shown that anxiety is negatively related to achievement in that highly anxious students have lower achievement than low anxious students (Aiken, 1970; Richardson and Suinn, 1972). Consequently, anxiety can be debilitating. However, a certain minimal amount of anxiety may be necessary to motivate one to perform. Some low anxious students may have already given up in mathematics and therefore exhibit low performance. This could indicate that this may not be a linear relationship. The present study tried to clarify this relationship.

Although both anxiety and confidence in mathematics have been shown to be related to achievement (Stanic & Reyes, 1986), as well as to sex (Reyes, 1984), it is not known how sex differences in achievement may be related to the sex differences in these particular variables. Maccoby (1966) concluded that anxiety plays a different role for the two sexes, in that "correlations between measures of anxiety and measures of aptitude or achievement are substantially negative for girls and women, while the correlations are either low negative, zero or positive for boys and men" (p. 30). This study investigated whether or not sex differences in achievement are attenuated in the presence of either of the variables of mathematics anxiety or confidence in mathematics.

In most studies using the Fennema-Sherman Mathematics Attitude Scale, eight of the nine attitude constructs have been considered. In this research only two of these, anxiety and confidence in mathematics were examined, but their effects on current mathematics achievement were estimated only after taking the effect of prior achievement into account.

This research adds to present evidence relating to achievement in the field of mathematics education by identifying the strengths of the relationships between anxiety and achievement as well as between confidence and achievement at the junior high level, and by establishing whether or not these variables contribute significantly to the variation in mathematics achievement when prior mathematics achievement is controlled.

Social Significance

It is vital to consider the affective variables which relate to mathematics performance. Payne (1982) stated:

> Many educators feel that the treatment of affective concerns should be pursued not only because they influence learning but also because they influence an individual's ability to participate effectively in a democratic society, are necessary for a healthy life, and interact with occupational and vocational satisfaction. (p. 1185)

The affective variables of mathematics anxiety and confidence in mathematics may be considered opposites with respect to the feelings elicited when mathematics is encountered. Many adults struggle with a strong aversion to anything mathematical - a condition which has been dubbed mathophobia. One of the consequences of such feelings is mathematics avoidance, which was found to be more prevalent among females than males (Sells, 1978). Whether low enrollment of females in professional areas such as engineering, which require a good mathematics background, is directly related to mathematics anxiety on the part of females, is not definitely established. If continued participation in mathematics is a goal, however, it is imperative that students feel confident in this area. Johnson (1984) stated, "By the time students reach college, it may be entirely too late to cause basic changes in attitude" (p. 1369). In fact, it may be reasonable to suggest that early negative attitudes may result in fewer females enrolling in mathematics at the college level. Johnson (1984) further suggested that "female deficiency in mathematics aptitude at the college level may be fossilized remains of transient attitude differences occurring during early adolescence" (p. 1369). Reyes (1984) pointed out that "affective variables have been found to be related to the underrepresentation of these groups (i.e. females, minorities, low-SES students) in mathematics classrooms and careers requiring mathematics knowledge" (p. 559).

Hilton and Berglund (1974) reported that their "data indicated there is a close relationship between a student's perception of mathematics and his performance in it" (p. 237). If there exists such a relationship, and if it can be shown that anxiety is significantly correlated with mathematics achievement, then corrective measures should be taken to alleviate anxiety and therefore boost achievement.

It is important to note that teachers can be a tremendous influence on student mathematics confidence (Beauvais, 1985). The type of feedback which a student receives is vital to his or her performance. If anxiety is shown to be related to the sex of the subject, then males and females may have to be treated differently in mathematics classrooms. In light of the fact that Becker (1981) reported that teachers already treat males and females differently perhaps attributing to male dominance in this area, it is necessary to rethink what is happening.

It is important that every student be provided with an equal opportunity to become mathematically literate. If alleviating anxiety and trying to build confidence in mathematics is a step toward this goal, then it is necessary to establish this with evidence from research.

Research Framework

The sex factor in mathematics achievement has been studied from many different perspectives in the past, and this study takes another look at sex differences in mathematics achievement specifically in Grade 8. A proposed model of this study is portrayed in Figure 1.1. From this model other models of the same type were developed and analyzed.

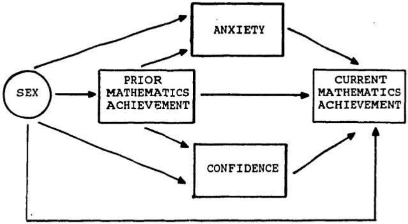


Figure 1.1. Proposed model of mathematics achievement.

It should be noted that the reciprocal relationship between anxiety and confidence was not examined according to this model. In order to have an arrow between these two variables in Figure 1.1, the model would have to be respecified and at the present time there is a lack of consensus as to how such a relationship could be estimated.

The research investigated the effects of four independent variables, sex, prior mathematics achievement, confidence in mathematics, and mathematics anxiety on the dependent variable, current mathematics achievement. When mathematics achievement was viewed as a whole, a total mathematics score was used in comparing prior achievement and current achievement. It seemed likely, however, that the relationships among the variables could become clearer if total achievement were broken down into its various components. They were Concepts, Problem-Solving, and Computation. Therefore each aspect of mathematics achievement was examined using analogous models where the effects of sex, anxiety, confidence, and prior achievement on current achievement was observed in each specific area.

Using these models, the highest correlations would be expected among the achievement variables for two reasons. First, mathematics is inherently hierarchical; and second, there are numerous studies in the literature which demonstrate that current achievement in mathematics is predicted by prior achievement. That is, a student who performs well in Grade 6 will also perform well in Grade 8 and conversely, a child who has low performance in Grade 6 will probably also have low performance in Grade 8. Many studies use prior achievement as a control variable because if a factor accounts for achievement after controlling for prior achievement, then one may be confident that the relationship between the factor and achievement is not spurious.

With respect to sex differences in performance, it would be expected that since males tend to outperform females in secondary school but not in elementary school (Maccoby and Jacklin, 1966), this research should find a higher correlation between sex and present performance (CTBS 8) than between sex and previous performance (CTBS 6).

As for the relationships of anxiety and confidence to sex of subject, there is reason to believe that sex is correlated negatively with anxiety in mathematics. That is, males tend to have lower scores than females (Fox, Fennema and Sherman, 1977). This may be due to females being more open about reporting anxiety in general. Similarly, males tend to be more confident in mathematics hence a positive correlation between sex and confidence variable could be expected. Anxiety and confidence are related to each other in that if a person has low anxiety, it would be reasonable to assume that he or she has a great deal of confidence in that area. Conversely, low confidence would be correlated with high anxiety.

The effect of prior achievement on anxiety and confidence levels is one which concerns every educator. Since students who have low performance probably experience high anxiety while those with high performance are less anxious, the correlation between prior achievement and anxiety was expected to be negative. Similarly, the relationship between anxiety and current achievement was also expected to be negatively correlated although the relationship may not be linear. Highly anxious students often experience low achievement, and their low achievement then contributes to greater anxiety. Students low in anxiety exhibit higher performance and their high performance enables them to have more confidence in mathematics. However, students with very low anxiety may in fact not have enough anxiety to motivate them to perform at all. In this case low anxiety would correlate with low performance.

On the other hand, confidence and performance should be positively correlated. A person with a high level of confidence should also have a high level of performance. This high performance in turn builds confidence. Therefore both prior achievement and confidence, as well as confidence and current mathematics achievement should exhibit positive correlations.

In this study, the intermediary effects of anxiety and confidence with respect to sex differences were also considered. That is, anxiety and confidence may have obscured whatever sex differences there were in mathematics achievement. In other words, it is the sex difference in these two affective variables which correlated with sex difference in achievement more so than the direct correlation of achievement with sex differences alone.

Limitations

The generalizability of the findings of this study depends on the degree that the sample is representative for the population of Grade 8 students in Newfoundland. With this in mind, it should be noted that this study is restricted to a single grade level as it only investigated Grade 8 students. Also all of the data was collected from students enrolled with the same Board of Education, although both rural and urban students are represented. Thirdly, the sample is limited to those students who were willing to participate in this study and for whom all of the necessary information was available.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter presents a literature review of certain factors proposed in previous studies to affect achievement in mathematics. Each variable proposed in Figure 1.1 (see page 10) is taken in turn and the theory related to each is described.

Sex Differences in Mathematics Achievement

Differences in mathematics achievement between males and females have been observed for many years. Numerous studies have investigated this matter in various ways. Maccoby (1966) reviewed the field of sex differences in the cognitive area and found few differences in mathematics in elementary school. In 1974 Maccoby reported that in quantitative ability:

> the majority of studies on more representative samples show no sex differences up to adolescence and when sex differences were found in the age range 9-13, they tend to favour boys. After this age, boys move ahead; and the sex differences become somewhat more consistent from one study to another. (p. 85)

Aiken (1987) in his review of the literature on sex differences in mathematical ability suggested that any differences were not pronounced before high school. With respect to mathematics achievement, the dependent variable in this study, he stated:

> ...several investigations and reviews of sex differences in mathematical achievement (Armstrong, 1980, Fennema & Carpenter, 1981, Marshall, 1984) have concluded that, at grade six and beyond, boys are somewhat superior to girls in arithmetic reasoning (e.g., story problems) and that girls are somewhat superior to boys in arithmetic fundamentals (e.g., computations). It has also been reported that the factor structure of mathematical abilities becomes more differentiated with age, males showing a greater number and more strongly differentiated factors than females after junior high school. (Dye & Very, 1968, p. 26)

Benbow and Stanley (1982) reported that males were superior in mathematical reasoning. In their Study of Mathematically Precocious Youth (SMPY) between the years of 1972 and 1974, they followed longitudinally the development of 2188 students who were identified as being in the top 5% in mathematical ability in Grades 7 and 8. Unexpectedly, they found substantial sex differences in mathematical reasoning ability which persisted over time. It must be pointed out that they dealt with a specific segment of the population rather than a normal classroom group.

Hilton and Berglund (1974) concluded that sex differences increased with age and that sex-typed interests emerged during adolescence. Because females tended to be more self-conscious at this stage of their development, they may have been reluctant to be seen as mathematically precocious. There has been considerable controversy regarding the existence of sex differences in mathematics. Fennema and Sherman (1977) studied 1233 students in grades 9 to 12. They were tested during four classroom sessions within a two month period and the researchers contended that "the generalized belief that females cannot do well in mathematics is not supported" (p. 69). Benbow and Stanley (1980), on the other hand, suggested that sex differences in mathematics aptitude existed between males and females with the same formal educational experiences. Further they concluded that these differences were due to male superiority.

Maccoby (1966), in a summarization of many studies in this field, reported findings according to various aspects of mathematics. For counting and computation, females outperformed males or no differences were found. In mathematical reasoning, males outperformed females or no differences were found. For spatial visualization and restructuring, males outperformed females. Generally, if sex differences appeared, they favoured males for high level cognitive tasks and females for low-level cognitive tasks. With respect to anxiety in mathematics females tended to be more anxious than males. Johnson (1984) concluded that the male advantages he found in problem-solving were related to spatial and mathematical ability. Hanna (1986) studied "Sex Differences in the Mathematics Achievement of Eighth Graders in Ontario". Her sample consisted of 3523 students who were tested with a pretest and a posttest covering five broad topics in mathematics. She found no statistically significant differences for either algebra, arithmetic or probability and statistics, but males gave more correct responses for geometry and measurement.

Armstrong (1981) cited Fox and Cohn (1980) who found significant sex differences in achievement favouring junior high school males as measured by scores on the Scholastic Aptitude Test in Math (SAT-M). Ethington (1984) concluded that sex had a significant effect on mathematics achievement even when spatial ability, background in mathematics, and interest in mathematics were controlled.

At the eighth grade level, Crosswhite (1985) in the Second International Mathematics Survey of 7000 students in a one year period found no overall patterns of differences in mathematics achievement between males and females. In contrast to this, Sawada, Olson, and Sigurdson (1981), studied over 3000 students from each of Grades 3,6,9, and 12 and found large sex differences in mathematics achievement favoring males. Brandon, Newton, and Hammond (1987) found that, in Hawaii, females performed even better in mathematics than males. They stated that "sex differences in mathematics achievement worldwide vary by ethnicity along a continuum ranging from moderate differences favouring females to large differences favouring males" (p. 454).

In Newfoundland and Labrador, the results of the Canadian Tests of Basic Skills in Grade 8 (Blagdon, 1986) showed that females outperformed males on mathematical skills (i.e. computation) which is consistent with previous findings. However, sex differences in overall mathematics achievement were not found. In a study of Grade 9 students in Newfoundland, Hipditch (1987) found that there were few sex differences in algebra. In the case of geometry he found no differences for coordinate and plane geometry but significant differences in favour of males for transformational geometry.

Mathematics Anxiety and Mathematics Achievement

Aiken (1970) reviewed the literature with respect to attitudes in mathematics and cited Brown and Abel (1965) as clearly demonstrating that "the correlation between pupil attitude and achievement was higher for arithmetic than for spelling, reading or language" (p. 559).

Attitude has many facets and anxiety is only one component of attitude toward mathematics. Richardson and Suinn (1972) defined mathematics anxiety in the following way. "Mathematics anxiety involves the feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). Fennema and Sherman (1976) demonstrated the components of attitude in the Mathematics Attitude Scale, which consists of nine subscales, recognizing that the domains of these subscales intersect. Fennema and Sherman (1978) and Tsai and Walberg (1983) found that attitudes towards mathematics correlate with mathematics achievement in the junior high school.

Attitude and anxiety are very closely related. Aiken (1970) said that "attitudes are affective variables, so some relationships between a measure of attitude and a measure of anxiety toward a particular school subject should not be unexpected" (p. 563). He further cited Alpet et al. (1963), Degnan (1967), Stephens (1960), and Werdelein (1966) as finding significant correlations between performance in mathematics and measures of attitudes and anxiety towards mathematics. Aiken's review (1970) also reported that Reese (1961), who studied 539 fourth and sixth grade students during a one week period, "obtained a correlation of -.25

between scores on the Children's Manifest Anxiety Scale and arithmetic achievement in 4th and 6th grade girls when IQ was partialled out" (p. 563).

Elmore (1985) reported that positive attitudes towards mathematics influenced achievement. Wooley (1982) cited Danills and Hewitt (1978) as finding anxiety to have a highly consistent effect on performance. Gliner (1987) studied 95 students in Grades 9 through 12 and found that higher levels of mathematics anxiety were related to lower levels of mathematics achievement. Clute (1984) said that "studies have shown that high achievement in mathematics is related to low anxiety for students from grade school through college" (p. 50).

There has been much written not only on the relationship between mathematics anxiety and performance, but also on the relationship between anxiety and sex, and then performance. Chansky (1966) studied 23 Grade 9 students and found that anxiety as measured by the Children's Manifest Anxiety Scale was negatively correlated for females but for males anxiety was unrelated to achievement. With this in mind, it was necessary not only to investigate the relationship between anxiety and achievement but also to do so separately for males and females. Although there may not be sex differences in mathematics anxiety (Tsai & Walberg, 1983), and there seems to be no consistent pattern to show that one sex has more positive feelings than the other, Fennema (1974b) stated that "measures of attitudes and anxiety are better predictors of mathematics learning for girls than for boys" (p. 186).

Sherman (1982) reported that "differences in mathematics achievement when found were accompanied by less favorable attitudes towards mathematics on the part of girls" (p. 132). Schofield (1982) also found that "attitude toward mathematics tends to be less positive and less variable in girls than in boys" (cited in Aiken, 1987, p. 30). Contrasting to this, Wooley (1982) found in his study that females had a significantly higher positive attitude toward mathematics but he also cited Sepie and Keeling (1978) and Phillips (1967) who found higher female anxiety. The extent to which anxiety effects the relationship between gender and attitude towards mathematics needs clarification through further study.

Confidence in Mathematics Performance and Mathematics Achievement

Another aspect of attitude toward mathematics is the confidence felt toward the subject. It refers to a person's belief in his or her ability to learn and use mathematics. It is very similar to what is sometimes referred to as academic self-concept. Aiken (1970) cited Berstein (1964) as demonstrating the effects of certain feelings. If a student experiences the same feelings for a time, these feelings will lead to a particular self-image which will influence expectations and in turn influence performance. Stanic and Reyes (1986) in their study of seventh-graders said "confidence in learning mathematics has to do with how sure a student is of her or his ability to learn and perform well in mathematics" (p. 6). They further suggested that confidence in mathematics had a significant positive correlation with mathematics achievement and was one of the strongest predictors of mathematics course taking. Fennema and Reyes (1981), in an extensive observational study of 82 high and low confidence students in Grade 7, found that confidence in mathematics was positively correlated with student achievement.

Although Mevarech (1986) used the term mathematical self-concept, she was measuring the student's perception of his or her math matics aptitude. This is a construct which is very similar to confidence in mathematics. She studied 117 Grade 7 students over a three month period and one of her conclusions was that mathematics achievement and mathematics self-concept were significantly correlated. Padwal (1984), in a Canadian study of 85 junior high school students, found that self-concept and academic achievement were significantly positively correlated. He concluded that "the implication of this finding is that students' academic performance depends not only on how capable they are, but also on how capable they think they are" (p. 7).

Confidence, like anxiety, has been studied with respect to sex differences. Reyes (1984) reported that gender differences in mathematics achievement were usually associated with gender differences in confidence. Matthews (1984) concurred with the view that confidence is important to the understanding of gender-related differences. Webb (1981) found that the females in her study had less confidence in their ability to learn mathematics than males.

Fennema and Sherman (1977) concluded that while females do not have less aptitude for mathematics, certain socio-cultural factors contribute to the apparent deficiency in female achievements in mathematics and mathematically-related professions. They contended that different sex-role perceptions and experiences with mathematics contributed to a lack of confidence in mathematics on the part of females. Fennema and Sherman (1977) cited Dornbusch (1974) as showing females to be "less confident of their mathematical intellectual abilities" (p. 53). This means that females do not think they can achieve as well as males do in mathematics even if their performance shows otherwise. Perhaps this is why Schofield (1982) found that females' attitudes towards mathematics did not predict their performance as well as males' attitudes predicted theirs.

Holloway (1986) cited Fox, Fennema and Sherman (1977) and stated that "sex differences have also been found on affective and motivational variables such as anxiety, self-confidence, and valuing of mathematics" (p. 232).

Mura (1987) cited Robitaille (1977) who reported that "girls in grades 5-8 showed less confidence than boys in their ability to perform arithmetic calculation, while they actually performed better than boys" (p. 16). Robitaille (1977), who studied 5440 students in Grades 5 through 8, stated that "despite the fact that the girls consistently outperform the boys as regards achievement in only 3 out of the 20 cases is the girls' mean self-confidence score greater than that of the boys" (p. 20). In that study achievement was measured only in terms of computation. It should be noted however that Benbow and Stanley (1982) did not find sex differences in attitudes towards mathematics even though they found sex differences in achievement at the seventh-grade level.

With respect to the interrelatedness of the two affective variables under investigation, Clute (1984) cited Fennema and Sherman (1976) as showing that "mathematics anxiety is strongly but negatively correlated to mathematics confidence" (p. 50). This seems very logical in that a person who feels confident toward his or her ability to do mathematics would also experience low anxiety about it.

Prior Mathematics Achievement and Current Mathematics Achievement

Generally speaking, in education the best predictor of academic achievement is previous academic achievement. In developing the concept of mastery learning, Bloom (1978) contended that the pattern of achievement is so predetermined by early encounters of success or failure that after primary school the relative ranking of students in a class remains almost perfectly fixed. Inherent in his theory is also the idea that how one views one's ability in a certain area, that is, one's self-concept of ability, is largely influenced by previous achievement. In this study, the construct confidence in mathematics was viewed as being very similar to self-concept of ability in mathematics, and so the relationship between previous achievement and confidence was considered as well. Similarly, experiences help determine how anxious one feels about mathematics. Therefore, the relationship between prior achievement and anxiety was examined. Since students were unaware of CTBS results, it was necessary to assume that these scores reflected the school grades which, when given to the students, influenced their positive or negative attitudes. Aiken (1971) stated:

> It is a truism that one of the best predictors of an individual's future behaviour is what he has done in the past. Barnes and Asher (1962) found that the best single predictor of 9th grade algebra mark was the 8th grade algebra mark. (p. 205)

Howe (1982) concluded that entering mathematics and reading scores were the best predictors of final grade.

Padwal (1984) found that intelligence and academic achievement were significantly positively correlated. Alexander (1983) reported that the best predictor of later test performance was earlier test performance.

It was expected then to find a high correlation between CTBS 6 scores and CTBS 8 scores in this study, although the cognitive variables are not the only ones considered here. Aiken (1970) cautioned that investigations of mathematics achievement should include non-intellective variables since differences in abilities do not account for most of the variance in mathematics achievement.

Although the idea that non-intellective variables contribute to our understanding of mathematics achievement is not a new one, few studies specifically address the impact of such variables when taking the cognitive ones into account. One study which clearly did this was that of Padwal (1984), who studied 85 students in Grades 7 and 8. He investigated the relationship of self-concept to intelligence, anxiety and academic achievement. As previously explained, self-concept is similar to confidence in mathematics, and although Padwal used a combination of IQ, CTBS scores and first term marks as a measure of intelligence rather than only CTBS which this researcher used as an indicator of previous achievement, his results can be referred to in relation to this study. He found a positive correlation between self-concept and achievement with and without intelligence partialled out.

Conclusion and Hypotheses

This study helps clarify whether or not sex differences exist in mathematics achievement at the Grade 8 level. More than that, it tried to show whether sex differences in achievement, if they exist, may be attributable to sex differences in anxiety and confidence. By separate sex analysis it examined where the differences do exist. The results of this study showed that affective variables such as anxiety and confidence are important predictors of achievement even when the impact of prior achievement is controlled.

By examining the separate components of the CTBS mathematics section, in conjunction with separate sex analysis, it is even more clearly seen that differences occur which are specific to a particular area of mathematics, whether it be concepts, problem-solving, or computation. The aspects of mathematics which are affected by anxiety or confidence in either males or females were clarified. After examining the results of this study, more direction is possible for future research.

Based on the review of the literature the researcher proposed the following null hypotheses in this study:

1. There will be no significant relationship between CTBS 6 and CTBS 8.
2. There will be no significant relationship between mathematics anxiety and mathematics achievement in Grade 8.

3. There will be no significant relationship between confidence in mathematics and mathematics achievement in Grade 8.
4. There will be no significant relationship between anxiety and sex of the subject.
5. There will be no significant relationship between confidence and sex of the subject.
6. There will be no significant relationship between prior mathematics achievement and confidence.
7. There will be no significant relationship between prior mathematics achievement and anxiety.
8. There will be no significant differences between the sexes in mathematics achievement in either Grade 6 or Grade 8.
9. There will be no significant relationship between mathematics anxiety and confidence in mathematics in Grade 8.

Each achievement variable was examined on four constructs. They were Concepts, Problem-Solving, Computation, and Total Mathematics (a composite score derived from the other three).

CHAPTER 3

RESEARCH PLANS AND METHODOLOGY

In this chapter the various procedures involved in completing this study are described. First there is the description of the sample and test instruments. Following this the procedure of the study is given as well as the proposed analysis of the model. Finally, there is a section on the pilot study which was undertaken prior to the collection of the main data.

Sample

The sample used for this study consisted of Grade 8 students from six different schools in various regions of Newfoundland with both the urban and rural areas being represented. The subjects were all enrolled in schools operated by a single Board of Education. The total number of subjects for whom all the necessary information was available was 150, 76 males and 74 females. The data was personally collected by the researcher. These were all Grade 8 students assigned to the same mathematics course (the regular Grade 8 curriculum) and so comprised a relatively homogeneous group. Because of the nature of this research separate analyses were done for males and females.

The co-operation of the Board Superintendent, as well as the principals, teachers, parents, and students was acquired. A parental consent form, as well as a letter explaining the study, was sent home with each child, and returned to the homeroom teacher (See Appendix A). Anonymity was ensured by having the co-operating teachers transcribe the necessary CTBS 6 scores from the students' permanent records, and then assigning each of them an identification number. This number was then used to identify him or her on the various tests.

Research Instruments

Mathematics Achievement

Mathematics achievement in this study was measured by the mathematics sections of the Canadian Tests of Basic Skills for Grade 8. This is the Level 14 section of the test. The three components of the mathematics section are Mathematics Concepts, Mathematics Problem-solving, and Mathematics Computation. The test called Mathematics Concepts examines how well students understand the number system and the terms and operations used in mathematics. The second test entitled Mathematics Problem-Solving examines the skill of the student in solving mathematics problems. The third is a test of mathematics computation which tests proficiency in working with the operations in mathematics. These instruments have reported internal consistency reliability coefficients ranging from 0.87 to 0.96.

Mathematics Anxiety

Anxiety is only one component of attitude towards mathematics. The Mathematics Attitude Scale developed by Fennema and Sherman (1976) is composed of nine subscales and anxiety is one such subscale. The complete Fennema-Sherman Mathematics Attitude Scale has a split-half reliability ranging from 0.87 to 0.93 (Sherman 1982) but the reliability measures for all of the subscales are not given separately. However, they have been used and analyzed separately in previous studies (Fennema-Reyes 1981). Fennema and Sherman (1976) defined the anxiety subscale as follows:

> The Mathematics Anxiety Scale (A) is intended to measure feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimensions range from feeling at ease to feeling distinct anxiety. The scale is not intended to measure confidence in, or enjoyment of, mathematics. (p. 326)

Since only seven items appear on this subscale, three more were added by the researcher. The subjects provided answers in one of four categories. They are Strongly Agree, Agree, Disagree, or Strongly Disagree. Because there are only four choices, students did not have the opportunity to choose a middle, uncertain category. The pilot test results revealed an alpha reliability measure of internal consistency for this Mathematics Anxiety Scale of 0.90 (See Pilot Study).

Confidence in Mathematics

This construct is also a component of mathematics attitude and is based on a subscale of the Mathematics Attitude Scale (Fennema-Sherman 1976). Their research defined the confidence subscale as follows:

> The Confidence in Learning Mathematics Scale (C) is intended to measure confidence in one's ability to learn and to perform well on mathematical tasks. The dimension ranges from distinct lack of confidence to definite confidence. The scale is not intended to measure anxiety or mental confusion, interest, enjoyment, or zest in problem-solving. (p. 326)

The split-half reliability for each scale on the MAS (Mathematics Attitude Scale) is given in the literature as > 0.89, but because the researcher added four more items, a pilot test was conducted and analyzed to determine reliability. This being done, an alpha reliability of 0.92 was found (See Pilot Study).

Prior Mathematics Achievement

Prior achievement was measured by CTBS 6 whose scores are part of each student's permanent record. There are three components as well as a total mathematics score recorded on the CTBS results. They are M-1 Concepts, M-2 Problems, and M-3 Computation. The percentile ranks of each of these as well as the percentile ranks of the total mathematics scores were compared with the corresponding results gathered in this study for each component of CTBS 8.

Procedure

Both the Mathematics Anxiety Scale and the Confidence in Mathematics Scale were included on the same questionnaire (See Appendix B). This questionnaire was piloted with a small group before the main study was carried out.

Over a two week period in May 1988, the researcher administered the Anxiety-Confidence Questionnaire and the three subtests of CTBS 8 to 200 Grade 8 students in six schools. The co-operation of homeroom teachers was acquired for supervision purposes but all instructions were read aloud by the researcher. The tests were strictly timed, given in a consistent order, and took about three class periods to complete. They were administered and hand-scored by the researcher in accordance with the CTBS Manual guidelines.

The raw scores for each item on the Anxiety-Confidence Questionnaire were entered on the data file. The raw scores of each CTBS subtest were converted to percentile ranks before being entered into the computer. For the Total Mathematics measure, the grade equivalents of each subtest were averaged and the resultant grade equivalent then converted to percentile rank for comparison purposes.

The CTBS 6 scores for each subtest in the mathematics section as well as the total mathematics score in percentile rank were acquired from students' permanent school records.

Analysis

Each hypothesis proposed in Chapter 2 was examined using Pearson product-moment correlations, and then each model proposed was subjected to a multiple regression analysis. This procedure was then parallelled for each sex separately. The existence of a non-linear relationship and the possible presence of interactions was examined, and finally, path analysis was undertaken.

Correlations

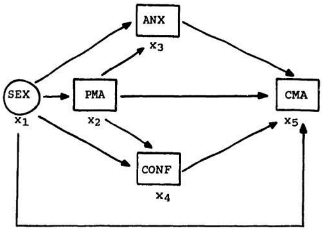
In this study the relationships between variables was analyzed using the Pearson product-moment correlation coefficient. Borg and Gall (1983) stated that "the correlational method allows the researcher to analyze how several variables, either singly or in combination, might affect a particular pattern of behavior" (p. 575).

Here the scores for CTBS 6 and CTBS 8 were compared in order to find out the degree of their relationship. Anxiety and confidence scores were each compared with CTBS 8. Previous mathematics achievement as measured by CTBS 6 was correlated with each of present anxiety and confidence scores. The variable sex was compared with each of anxiety, confidence, CTBS 6 and CTBS 8. In all cases each component of the mathematics section of CTBS 6 and CTBS 8 was examined. The 0.05 level of probability was accepted as evidence of a significant relationship. The SPSS-X program was used to perform the necessary statistics on the computer.

Regression Analysis

Aiken (1987) recommended that in future research on sex differences in mathematics, particularly those studies which involve both affective and cognitive variables, multivariate techniques should be used to analyze the data. Borg and Gall (1983) defined multiple regression as "a multivariate technique for determining the correlation between a criterion variable and some combination of two or more predictor variables" (p. 596).

The multiple regression analysis in this study is based on Model #1 (See Figure 3.1), which involves both affective and cognitive predictor variables.



Key: x_1 = SEX = Sex of Subject

x_2 = PMA = Prior Mathematics Achievement

x_3 = ANX = Anxiety

x_4 = CONF = Confidence

x_5 = CMA = Current Mathematics Achievement

Figure 3.1. Model #1 with variables.

The relationships shown in Figure 3.1 were tested by using the following equations. The theory suggests that

PMA = f (SEX) or $x_2 = f(x_1)$

ANX = f (PMA, SEX) or $x_3 = f(x_2, x_1)$

CONF = f (PMA, SEX) or $x_4 = f(x_2, x_1)$

CMA = f (SEX, PMA, ANX, CONF) or $x_5 = f(x_4, x_3, x_2, x_1)$

These functional relationships lead to the following equations:

(1) $x_2 = a_0 + b_1x_1 + E_1$

(2) $x_3 = a_0 + b_1x_1 + b_2x_2 + E_2$

(3) $x_4 = a_0 + b_1x_1 + b_2x_2 + E_3$

(4) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + E_4$

Equations 1-4 tested linear relationships.

(5) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4(x_3)(x_3) + b_5x_4 + E_5$

This equation checked to see if anxiety is better defined as a non-linear relationship. In this case, the variable x_3 needed to be standardized as follows:

$$Sx_3 = (x_{x3} - \bar{x}_{x3}) / SD_{x3}$$

(6) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5(x_2)(x_3) + E_6$

(7) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5(x_2)(x_4) + E_7$

Equations 6 and 7 examined the interaction effects between prior achievement and anxiety and confidence. Variables x_2, x_3, and x_4 had to be standardized for these equations.

(8) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5(x_1)(x_3) + E_8$

(9) $x_5 = a_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5(x_1)(x_4) + E_9$

Equations 8 and 9 examined the interaction effects between sex of subject and anxiety and confidence. Variables x_1, x_3, and x_4 had to be standardized for these equations.

Using multiple regression analysis for each model suggested, the coefficient of determination or R^2 for the complete model was derived. This statistic indicates the degree of fit of the model. It shows the proportion of variance in the dependent or criterion variable which is accounted for by the independent or predictor variables. The amount of variance explained by each variable was calculated and the significant contribution of each variable over and above the others was statistically determined. The t-test was used to determine the significance of the contribution of each independent variable.

A separate regression analysis was necessary for each equation suggested. That is, both a non-linear relationship and possible interactions were tested.

Path Analysis

On the basic model (See Figure 3.1), path analysis was conducted. Borg and Gall (1983) stated that "path analysis is a method for testing the validity of a theory about causal relationships between three or more variables that have been studied using a correlational research design" (p. 606).

In order to examine, for example, whether or not previous achievement caused feelings of anxiety or confidence, the path coefficients were determined by statistical analysis. "A path coefficient is a standardized regression coefficient indicating the direct effect of one variable on another in the path analysis" (Borg and Gall, 1983, p.610). In this study sex is the only exogenous variable. That is, it is the only variable in the model which lacks a hypothesized cause. Anxiety, confidence, previous achievement, and current achievement are all endogenous variables with hypothesized causes as shown by the arrows in the model (See Figure 3.1). The path coefficients are the same as the Beta coefficients calculated in the multiple regression. Having determined these path coefficients, it was possible also to calculate indirect effects among the variables. This is particularly true of the paths SEX → ANX → CMA and SEX → CONF → CMA. The paths PMA → ANX → CMA and PMA → CONF → CMA were also examined.

Pilot Study

Objectives

The pilot study was undertaken with several objectives in mind. It was first necessary to ascertain the amount of time it would take to administer the Anxiety-Confidence Questionnaire, and secondly, to determine whether or not it was feasible to read each question orally for more complete understanding. Thirdly, the results of the pilot study would enable the reliabilities of the instruments to be computed as well as a factor analysis to be performed. Since the researcher had added a total of seven items to the original subscales of the Fennema-Sherman Mathematics Attitude Scale, accurate data needed to be obtained before the questionnaire could be used for the main sample.

The Anxiety-Confidence Questionnaire was piloted with 45 subjects from Grade 7. These were not part of the final data collection.

Results

It was determined that the questionnaire took about 15 minutes to complete and that reading the questions orally, in the opinion of the researcher, facilitated understanding. The alpha reliability for the Mathematics Anxiety Scale derived from the pilot study was 0.90 and the alpha reliability for the Confidence in Mathematics Scale derived from the pilot was 0.92.

Tables 3.1 to 3.4 record the factor analysis results of the pilot study for the Anxiety-Confidence Questionnaire. From the high correlations among the items of each scale, it was concluded that no items needed to be deleted, but that all were appropriate to use in the main study.

Table 3.1

Anxiety Correlation Matrix (Pilot Study)

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	$\bar{X}$	SD
A1	1.000										2.578	.812
A2	.356	1.000									2.511	1.079
A3	.492	.509	1.000								2.089	.949
A4	.557	.635	.672	1.000							2.111	.910
A5	.542	.163	.332	.374	1.000						2.111	.831
A6	.483	.480	.714	.689	.349	1.000					1.956	.878
A7	.474	.334	.415	.479	.312	.534	1.000				2.333	.905
A8	.310	.821	.339	.460	.212	.407	.439	1.000			2.600	1.031
A9	.448	.634	.592	.550	.342	.601	.527	.581	1.000		2.289	.843
A10	.541	.490	.474	.575	.318	.510	.620	.572	.614	1.000	2.156	.878

Determinant of correlation matrix = .0015

Kaiser-Meyer-Olkin measure of sampling adequacy = .8259

[a] See Appendix B for the questionnaire items corresponding to A1-A10

Table 3.2

Confidence Correlation Matrix (Pilot Study)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	$\bar{X}$	SD
C1	1.000										3.044	.952
C2	.584	1.000									2.978	.941
C3	.530	.235	1.000								3.244	.743
C4	.493	.211	.759	1.000							3.022	.917
C5	.595	.397	.253	.419	1.000						2.778	1.020
C6	.245	.225	.446	.521	.143	1.000					3.444	.693
C7	.675	.311	.793	.672	.412	.418	1.000				2.911	.925
C8	.440	.288	.585	.636	.512	.391	.653	1.000			3.156	.852
C9	.743	.455	.687	.583	.614	.348	.812	.690	1.000		2.800	.944
C10	.858	.525	.523	.590	.669	.359	.706	.630	.760	1.000	2.533	.944

Determinant of correlation matrix = .0003

Kaiser-Meyer-Olkin measure of sampling adequacy = .8492

* See Appendix B for the questionnaire items corresponding to C1-C10

Table 3.3

Factor Analysis Results: Anxiety Model (Pilot Study)

	Factor Loadings	Eigenvalue	Factor Score Coefficients
A1	.696	5.442	.128
A2	.750	1.201	.138
A3	.763	.824	.140
A4	.825	.711	.152
A5	.503	.481	.092
A6	.795	.395	.146
A7	.696	.329	.128
A8	.703	.264	.129
A9	.810	.259	.149
A10	.783	.095	.144

Alpha reliability = 0.90

Table 3.4

Factor Analysis Results: Confidence Model (Pilot Study)

	Factor Loadings	Eigenvalue	Factor Score Coefficients
C1	.825	5.833	.141
C2	.533	1.319	.091
C3	.781	.783	.134
C4	.782	.639	.134
C5	.662	.441	.113
C6	.509	.362	.087
C7	.872	.270	.149
C8	.775	.143	.133
C9	.899	.122	.154
C10	.883	.088	.151

Alpha reliability = 0.92

CHAPTER 4

RESULTS

Introduction

The purpose of this study was to examine the relationships among sex, anxiety, confidence, prior mathematics achievement, and current mathematics achievement in Grade 8. The sample consisted of 150 students for whom data was available on each of the variables mentioned. In this chapter the results of the factor analysis of the Anxiety-Confidence Questionnaire are given. Each research question stated in Chapter 3 is answered and the corresponding hypotheses accepted or rejected. Following this, the results of the analyses of possible interactions of variables is discussed. Results of the path analysis are recorded in Section 5. Finally, the separate sex analysis is described and the results given.

Through factor analysis, the appropriate weights for each item on the two parts of the Anxiety-Confidence Questionnaire were determined. On the basis of these weights, scores for anxiety and confidence were computed for each subject. Each subtest of the CTBS 8, mathematics section, was personally hand-scored. They were Concepts (CP), Problem-Solving (PS), and Computation (CM). The raw scores were converted to grade equivalents and then to percentile ranks, as percentile ranks have nearly the same characteristics as an interval scale. The total mathematics score was derived by averaging the grade equivalents and then converting to percentile ranks. The prior achievement scores were simply copied from the student's permanent school record. In this study female was coded (2) and male was coded (1) so that positive correlations favour females.

Factor-Analysis of the Anxiety-Confidence Questionnaire

From the pilot test results, it was expected that the reliabilities of both the Anxiety and Confidence sections of the questionnaire would be very high. Based on the results of the total sample, the alpha reliability for Mathematics Anxiety was 0.90 and the alpha reliability for Confidence in Mathematics was 0.94.

Tables 4.1 and 4.2 show the matrices for Anxiety and Confidence respectively. They tell how well each item on the questionnaire correlates with each other item. All questions on each scale were shown to be highly related to one another and so accurately measured the construct.

Figures 4.1 and 4.2 show the measurement models for the constructs Anxiety and Confidence respectively. The factor loadings indicate how well each item correlates with the construct. The residuals on each item were calculated by using the formula $(1-h^2)^{1/2}$ where h^2 represents the communality.

Table 4.1

Anxiety Correlation Matrix

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	$\bar{X}$	SD
A1	1.000										2.472	.786
A2	.398	1.000									2.196	.815
A3	.560	.542	1.000								1.918	.879
A4	.437	.495	.690	1.000							1.900	.894
A5	.457	.534	.552	.555	1.000						1.836	.833
A6	.348	.455	.503	.442	.327	1.000					1.829	.756
A7	.265	.415	.265	.285	.361	.354	1.000				2.272	.785
A8	.421	.538	.497	.547	.500	.394	.380	1.000			2.285	.949
A9	.475	.593	.626	.549	.521	.608	.428	.574	1.000		2.291	.766
A10	.506	.489	.531	.581	.523	.410	.513	.552	.568	1.000	2.241	.799

Determinant of correlation matrix = .0070

Kaiser-Meyer-Olkin measure of sampling adequacy= .9147

* See Appendix B for the questionnaire items corresponding to A1 - A10

Table 4.2

Confidence Correlation Matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	$\bar{X}$	SD
C1	1.000										3.006	.897
C2	.617	1.000									3.164	.856
C3	.719	.629	1.000								3.057	.923
C4	.521	.446	.540	1.000							2.943	.705
C5	.698	.577	.680	.467	1.000						2.962	1.011
C6	.623	.517	.637	.513	.557	1.000					3.497	.674
C7	.700	.663	.794	.609	.678	.591	1.000				2.764	.880
C8	.491	.467	.595	.633	.576	.521	.613	1.000			3.075	.776
C9	.781	.706	.800	.601	.650	.647	.816	.593	1.000		2.856	.878
C10	.705	.579	.691	.557	.659	.565	.709	.532	.753	1.000	2.759	.964

Determinant of correlation matrix = .0004

Kaiser-Meyer-Olkin measure of sampling adequacy= .9435

* See Appendix B for the questionnaire items corresponding to C1 - C10

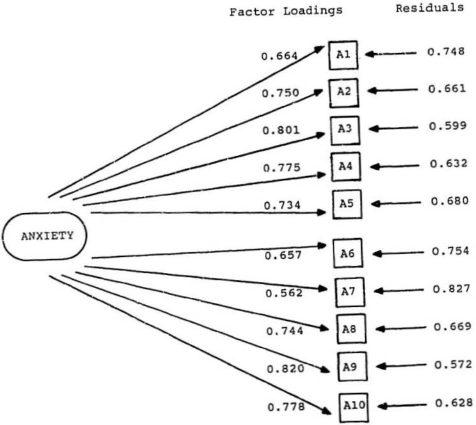


Figure 4.1 Measurement model: Anxiety

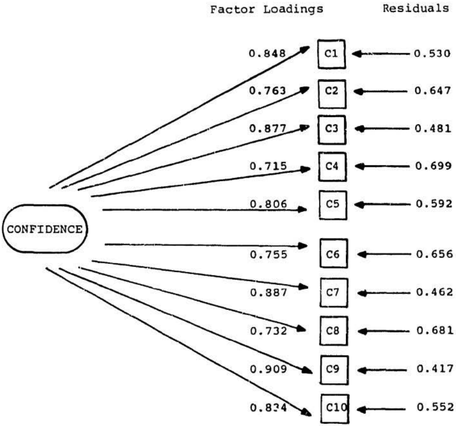


Figure 4.2 Measurement model: Confidence

Tables 4.3 and 4.4 show the factor analysis results for Anxiety and Confidence, from which the following compute statements were derived.

ANX (Anxiety) = $fsc(a_1 - \bar{a}_1/SD_{a1}) + fsc(a_2 - \bar{a}_2/SD_{a2})$ $+ \ldots + fsc(a_{10}-\bar{a}_{10}/SDa_{10})$ where a_1 to a_{10} refer to each item of the anxiety scale, and fsc is the factor score coefficient for each item.

Similarly CONF (confidence) = $fsc(c_1 - \bar{c}_1 / SD_{c1}) +$ $fsc(c_2-\bar{c}_2/SDc_2) + \ldots + fsc(c_{10}-\bar{c}_{10}/SD_{c10})$ where c_1 to c_{10} refer to each item of the confidence scale, and fsc is the factor score coefficient for each item.

Prior to discussing the research questions, the models used for the multiple regression analyses are listed in Figures 4.3 and 4.4 and the basic correlation matrix for all the variables used in this study is given in Table 4.5.

Table 4.3

Factor Analysis Results: Anxiety Model

	Factor Loadings	Eigenvalue	Factor Score Coefficients
A1	.664	5.363	.124
A2	.750	.890	.140
A3	.801	.756	.149
A4	.775	.629	.145
A5	.734	.530	.137
A6	.657	.503	.123
A7	.562	.403	.105
A8	.744	.346	.139
A9	.820	.330	.153
A10	.778	.251	.145

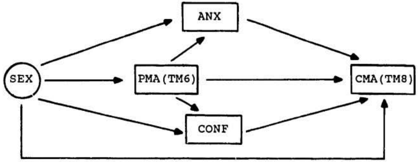
Alpha Reliability = 0.90

Table 4.4

Factor Analysis Results: Confidence Model

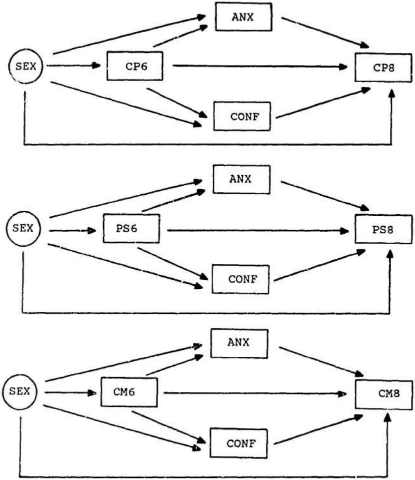
	Factor Loadings	Eigenvalue	Factor Score Coefficients
C1	.848	6.642	.128
C2	.763	.731	.119
C3	.877	.491	.132
C4	.715	.464	.108
C5	.806	.436	.121
C6	.755	.347	.114
C7	.887	.294	.134
C8	.732	.258	.110
C9	.909	.191	.137
C10	.834	.144	.126

Alpha Reliability = 0.94



Key: ANX = Mathematics Anxiety
CONF = Confidence in Mathematics
PMA(TM6) = Prior Mathematics Achievement (Total mathematics score, grade 6)
CMA(TM8) = Current Mathematics Achievement (Total mathematics score, grade 8)

Figure 4.3. Model #1: Total mathematics achievement.



Key: ANX = Mathematics Anxiety
CONF = Confidence in Mathematics
CP6 = Concepts (Grade 6)
CP8 = Concepts (Grade 8)
PS6 = Problem-Solving (Grade 6)
PS8 = Problem-Solving (Grade 8)
CM6 = Computation (Grade 6)
CM8 = Computation (Grade 8)

Figure 4.4. Analogous models using concepts, problem-solving, and computation respectively.

Table 4.5

Zero-Order Relationships, Means and Standard Deviations for all Variables in the Mathematics Achievement Study

	CP6	PS6	CM6	TM6	SEX	ANX	CONF	CP8	PS8	CM8	TM8	$\bar{X}$	SD
CP6	1.000											64.213	24.387
PS6	0.628**	1.000										59.180	25.372
CM6	0.486**	0.529**	1.000									51.540	28.710
TM6	0.844**	0.844**	0.798**	1.000								56.767	24.965
SEX	-0.021	0.053	0.088	0.039	1.000							1.493	0.502
ANX	-0.395**	-0.373**	-0.383**	-0.467**	0.282**	1.000						-0.128	1.104
CONF	0.421**	0.372**	0.416**	0.496**	-0.249**	-0.842**	1.000					0.011	1.019
CP8	0.531**	0.518**	0.432**	0.604**	-0.015**	-0.538**	0.552**	1.000				40.780	24.108
PS8	0.547**	0.602**	0.504**	0.655**	0.039	-0.424**	0.424**	0.641**	1.000			33.420	23.380
CM8	0.419**	0.455**	0.492**	0.553**	0.140*	-0.379**	0.377**	0.583**	0.540*	1.000		24.873	21.018
TM8	0.591**	0.605**	0.562**	0.709**	0.057	-0.517**	0.518**	0.855**	0.856**	0.829**	1.000	30.833	22.776

Number of cases = 150

* significance < 0.05

** significance < 0.001

Key: CP6 = Concepts Grade 6, PS6 = Problem-Solving Grade 6, CM6 = Computation Grade 6, TM6 = Total Mathematics Grade 5, SEX = Sex of Subject, ANX = Mathematics Anxiety, CONF = Confidence in Mathematics, CP8 = Concepts Grade 8, PS* = Problem-Solving Grade 8, CM8 = Computation Grade 8, TM8 = Total mathematics Grade 8.

Results Relating to Hypotheses

Question 1

What is the relationship between prior achievement in mathematics as measured by CTBS 6, and present achievement in mathematics as measured by CTBS 8?

Hypothesis: There is no significant relationship between CTBS 6 and CTBS 8.

The Canadian Tests of Basic Skills, mathematics section, is composed of three parts. These are mathematics concepts (CP), problem-solving (PS), and computation (CM). The total mathematics score is designated in the tables as TM.

There is a significant relationship between previous achievement in mathematics and present mathematics achievement. (See Table 4.5) Each subtest in Grade 6 showed a significant relationship to each subtest in Grade 8, the highest correlations being between corresponding subtests. For example, the correlation between CP6 and CP8 is higher than the correlations between CP6 and PS8 or CP6 and CM8. The null hypothesis for this relationship must be rejected.

In order to examine the strength of this relationship in the presence of other variables hypothesized to also affect present mathematics achievement, Model #1 (See Figure 4.3) was proposed and tested. The results of the multiple regression for this model are recorded in Table 4.6.

Analogous models (See Figure 4.4) using the separate components of CTBS 6 and CTBS 8 yielded results as recorded in Table 4.7 and Table 4.8.

Model #1, using total mathematics as a measure of prior and present achievement in the presence of sex and confidence, explains 56% of the variance in present mathematics achievement (R-square = .56), whereas the models using CP, PS, and CM are less powerful. Similarly, although all of the prior achievement-present achievement relationships are significant, the total mathematics relationship is the strongest one. TM6 alone accounts for approximately 31% ($beta^2$) of the variance in TM8. It should be noted that in this study the variables are not orthogonal in that they exhibit correlations with each other which are greater than zero. Therefore the statistic $beta^2$ is an underestimate of the variance explained by each variable so that the percentages quoted here are not as accurate as they would be had all of the variables been truly independent of each other. Keeping this in mind, CP6 alone accounts for approximately 12% of the variance in CP8, PS6 alone accounts for approximately 24 % of the variance in PS8, and CM6 alone accounts for approximately 12% of the variance in CM8. Of the three subtests, prior achievement, is the strongest

Table 4.6

Regression Analysis Results for Model #1.

Independent Variables	CMA (TM8)				
	B	SEB	Beta	T	Sign t
SEX	5.340	2.665	0.118	2.004	0.047
PMA (TM6)	0.511	0.059	0.560	8.595	0.000
ANX	-4.789	2.337	-0.213	-2.049	0.042
CONF	2.009	2.344	0.090	0.857	0.393
Multiple R	0.74				
R-Square	0.56				

Table 4.7

Regression Analysis Results for Concepts and Problem-Solving

Independent Variables	CP8					PS8				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
SEX	5.689	3.139	0.118	1.813	0.072	4.213	3.124	0.090	1.349	0.180
ANX	-5.575	2.787	-0.234	-2.000	0.047	-3.577	2.760	-0.155	-1.296	0.197
CONF	5.689	2.782	0.240	2.045	0.043	3.061	2.714	0.133	1.128	0.261
CP6	0.336	0.069	0.340	4.904	0.000					
PS6						0.451	0.064	0.489	7.014	0.000

Multiple R = 0.66   Multiple R = 0.65

R-Square = 0.44   R-Square = 0.42

Table 4.8

Regression Analysis Results for Computation

Independent Variables	CM8 B	SEB	Beta	T	Sign t
SEX	8.158	3.075	0.195	2.653	0.009
ANX	-4.572	2.674	-0.221	-1.710	0.090
CONF	1.916	2.678	0.093	0.716	0.475
TM6	0.258	0.057	0.352	4.538	0.000

Multiple R = 0.56

R-Square = 0.32

predictor of present achievement in the area of problem-solving.

Of the variables included in Model #1, TM6 had the greatest impact on the variance in TM8. (See Table 4.8)

Question 2

What is the relationship between anxiety in mathematics and achievement in Grade 8?

Hypothesis: There is no significant relationship between anxiety in mathematics and achievement in Grade 8.

There are significant relationships between anxiety and each of CP8, PS8, CM8, and TM8. Anxiety and achievement are correlated strongly and negatively. If a student has low anxiety, he or she has high achievement, whereas a highly anxious person has low achievement and vice-versa (See Table 4.9).

Model #1 was again used to determine the strength of the anxiety-achievement relationship in the presence of other predictor variables. Table 4.6 indicates that anxiety is a moderately powerful predictor of achievement in Grade 8. In fact, this variable helps explain the variance in mathematics achievement over and above the effects of prior

Table 4.9

Pearson Correlations between Anxiety and Mathematics Achievement in Grade 8.

	Anxiety	
Dependent Variables	r	significance
CP8 (concepts)	−0.538	0.000
PS8 (problem-solving)	−0.424	0.000
CM8 (computations)	−0.379	0.000
TM8 (total mathematics)	−0.517	0.000

achievement, sex, and confidence. Anxiety alone explains approximately 5% ($beta^2$) of the variance in present mathematics achievement. Therefore it can be stated that the way one feels about mathematics significantly influences performance over and above the powerful influence of prior achievement, as well as over and above the moderate, but significant, influence of sex on achievement.

When sex, confidence, and prior achievement were controlled, separate subtest analysis (See Table 4.7) showed that the relationship between anxiety and mathematics achievement was significant only for the subtest of Concepts.

The null hypothesis for the relationship between mathematics anxiety and current mathematics achievement in Grade 8 must be rejected.

Question 3

What is the relationship between confidence in mathematics and mathematics achievement in Grade 8?

Hypothesis: There is no significant relationship between confidence and mathematics achievement in Grade 8.

Table 4.5 shows that confidence-achievement is a significant relationship in each subtest examined as well as in total mathematics. Of the three subtests, confidence showed the highest correlation with Concepts 8, and the lowest correlation with Computations 8.

In examining the strength of this relationship in the presence of sex, anxiety, and prior achievement, it was found that the confidence-achievement relationship was not significant (See Table 4.6). Since anxiety and confidence are highly correlated, it appears that in the presence of anxiety, the effect of confidence is severely attenuated. In this case anxiety is behaving as a suppressor variable, in whose presence the full impact of confidence on achievement is not felt. Model #2 was constructed to check whether or not confidence alone had a significant relationship to TM8 over and above the effects of sex and prior achievement.

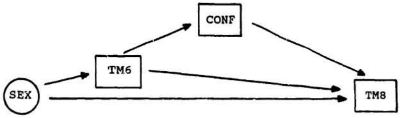


Figure 4.5. Model #2: Revised mathematics achievement model.

Without the suppressing effect of anxiety in the multiple regression equation, confidence showed a significant relationship to TM8, over and above the effects of SEX and TM6 (See Table 4.10).

Interestingly, Table 4.7 reveals that for the subtest of Concepts, confidence does have a significant relationship to achievement even in the presence of anxiety. Therefore, although it would seem from the analysis using Total Mathematics as the achievement variable (See Table 4.6) that anxiety and confidence are measuring nearly the same thing, the separate subtest analysis showed that the constructs behave differently.

The null hypothesis for the relationship between confidence in mathematics and current mathematics achievement in Grade 8 must be rejected.

Question 4

Is anxiety in mathematics significantly related to the sex of the subject?

Hypothesis: There is no significant relationship between anxiety and sex of the subject.

Table 4.10

Regression Analysis Results for Model #2.

Independent Variables	CMA (TM8)				
	B	SEB	Beta	T	Sign t
SEX	4.509	2.616	0.099	1.723	0.087
TM6	0.540	0.058	0.594	9.332	0.000
CONF	5.578	1.487	0.246	3.750	0.000

Multiple R = 0.75

R-Square = 0.56

Table 4.5 records the basic correlation matrix of all the variables used in this study. The Pearson correlation coefficient is 0.282 and the zero-order relationship between sex and anxiety is significant. Given, however, the very great influence which prior achievement could have on anxiety, a regression analysis using Model #3 (See Figure 4.6) clarified the strength of each relationship.

The relationship between sex and anxiety is significant over and above the powerful influence of prior achievement (See Table 4.11). Analogous models were tested for Concepts, Problem-Solving, and Computation which showed that the relationship between sex and anxiety is significant in each case in the presence of prior achievement in each subtest (See Tables 4.12, 4.13, 4.14). Sex is correlated most highly with anxiety when Computation 6 is held constant (beta = 0.318). Sex correlates least with anxiety when Concepts 6 is held constant (beta = 0.273).

Question 5

Is confidence in mathematics significantly related to the sex of the subject?

Hypothesis: There is no significant relationship between confidence and the sex of the subject.

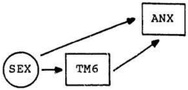


Figure 4.6. Model #3: Anxiety Model.

Table 4.11

Regression Analysis Results for Anxiety and Confidence Models

Independent Variables	ANX					CONF				
	[illegible]	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
SEX	0.607	0.139	0.300	4.374	0.000	-0.547	0.138	-0.269	-3.953	0.000
PMA (TM6)	-0.019	0.003	-0.478	-6.966	0.000	0.021	0.003	0.507	7.438	0.000

Multiple R = 0.55

R-Square = 0.31

Multiple R = 0.56

R-Square = 0.32

Table 4.12

Regression Analysis Results for Anxiety and Confidence with Sex and Concepts

Independent Variables	ANX					CONF				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
Sex	0.552	0.146	0.273	3.777	0.000	-0.489	0.147	-0.241	-3.335	0.001
CP6	-0.016	0.003	-0.389	-5.380	0.000	0.017	0.003	0.416	5.772	0.000

Multiple R = 0.48
R-Square = 0.23

Multiple R = 0.49
R-Square = 0.24

Table 4.13

Regression Analysis Results for Anxiety and Confidence with Sex and Problem-Solving

Independent Variables	ANX					CONF				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
Sex	0.611	0.146	0.302	4.170	0.000	-0.548	0.149	-0.270	-3.680	0.000
PS6	-0.016	0.003	-0.389	-5.367	0.000	0.016	0.003	0.386	5.268	0.000

ANX	CONF
Multiple R = 0.48	Multiple R = 0.46
R-Square = 0.23	R-Square = 0.21

Table 4.14

Regression Analysis Results for Anxiety and Confidence with Sex and Computation

Independent Variables	ANX					CONF				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
Sex	0.642	0.145	0.318	4.418	0.000	-0.585	0.145	-0.288	-4.033	0.000
CM6	-0.014	0.003	-0.410	-5.710	0.000	0.016	0.003	0.442	6.181	0.000
Multiple R = 0.50						Multiple R = 0.51				
R-Square = 0.25						R-Square = 0.26				

The zero-order relationship between sex of subject and confidence in mathematics is -0.249 and is significant (See Table 4.5). The negative sign on the coefficient means that males score high on confidence in mathematics while females have low scores on confidence, and vice-versa. As in the case with anxiety, this relationship was tested in the presence of TM6 and was significant over and above the powerful influence of prior achievement on current mathematics achievement. Model #4 was used to estimate this relationship. The results of this analysis are recorded in Table 4.11. The same is true for each subtest of Mathematics as shown Tables 4.12, 4.13 and 4.14. Of the three subtest analyses, sex correlates most with confidence when Computations 6 is held constant (beta = -0.288) and least when Concepts is held constant (beta = -0.241).

The null hypothesis for the relationship of confidence and sex of the subject must be rejected.

Question 6

(a) Is confidence significantly related to prior achievement?

(b) Is anxiety significantly related to prior achievement?

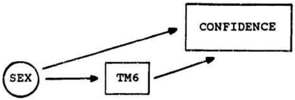


Figure 4.7. Model #4: Confidence Model.

Hypotheses: (a) There is no significant relationship between prior achievement and confidence in mathematics.

(b) There is no significant relationship between prior achievement and mathematics anxiety.

The zero-order relationship for prior achievement and confidence as well as the zero-order relationship for prior achievement and anxiety were both significant (See Table 4.5). Both relationships were tested in the presence of sex in the multiple regression analyses (See Tables 4.11 - 4.14). Prior achievement contributes significantly to the variance in both anxiety and confidence over and above the influence of sex for each subtest, as well as when total mathematics is used as the measure of prior achievement. In each case also, prior achievement is a better predictor of anxiety and confidence than is sex.

When total mathematics is used as the measure of prior achievement, this variable alone contributes at least 23% ($beta^2$) to the variance in anxiety and 26% ($beta^2$) in confidence. The null hypothesis for this relationship must be rejected.

Question 7

(a) Are there significant differences between the sexes in mathematics achievement?

(b) Are sex differences in mathematics achievement more pronounced in Grade 8 than in Grade 6?

Hypothesis: There are no significant differences between the sexes in mathematics achievement in either Grade 6 or Grade 8.

The zero-order relationships for sex with mathematics achievement in Grade 6 and Grade 8 are not significant (See Table 4.5). For all subtests except Concepts in both grades, as well as for total mathematics achievement, the sign on the relationship is positive indicating that high achievement favours females in these areas.

Table 4.6 shows that when the sex-achievement relationship is tested while controlling for the effects of anxiety, confidence, and prior achievement, it is a significant relationship, and it favours females. Table 4.6 records the model which has total mathematics as the measure of achievement. By using this type of analysis, it is possible to statistically control for factors which undoubtedly confound the true relationship of sex with achievement. This means that if it were possible to get two groups, one of males, and the other of females, with exactly corresponding anxiety, confidence, and prior achievement levels, the females would outperform the males. Sex alone, however, accounts for only 1% of the variance in total mathematics in Grade 8.

Tables 4.7 and 4.8 show the effect of sex on achievement for each of the subtests of CTBS 8. It is in the area of Computations only that females show a significantly better performance than males although the direction of the relationship favours females in all cases when the variables of anxiety, confidence, and prior achievement are controlled.

The relationship between sex and mathematics achievement in Grade 6 is not significant, and in Grade 8 it is significant only when the affective variables are controlled. The null hypothesis for this relationship must be accepted for Grade 6, but rejected for Grade 8.

Question 8

Are anxiety and confidence significantly related to each other?

Hypothesis: There is no significant relationship between mathematics anxiety and confidence in mathematics in Grade 8.

Table 4.5 shows that the anxiety-confidence relationship has a Pearson r of -0.842 and is significant. The negative sign means that high anxiety correlates with low confidence and that low anxiety correlates with high confidence. Because of the high covariance between these two variables, confidence can be regarded as a suppressor variable when used in the same equation with anxiety. Consequently, the effect of anxiety is attenuated in the presence of confidence and vice-versa. The regression analyses revealed that they do in fact act as suppressor variables of each other when they are present in the same regression equation. For example, the relationship between confidence and anxiety is not significant in the presence of anxiety (See Table 4.6) whereas it is significant when anxiety is not present in the equation (See Table 4.10). The null hypothesis for this relationship must be rejected.

Analysis of Interactions and Non-linear Relationships

As proposed in Chapter 3, a functional equation was examined to see if the relationship between anxiety and achievement is a non-linear one. If, for example, both low and high anxiety correspond to high achievement, then the polynomial expression in the multiple regression analysis should capture a significant amount of the variance in total mathematics achievement. This equation is as follows:

$$x_5 = f(x_1, x_2, x_3, (x_3)^2, x_4)$$

where x_5 = total mathematics achievement in grade 8

x_1 = sex

x_2 = prior mathematics achievement

x_3 = anxiety

x_4 = confidence

It appears that the polynomial term, $(\text{anxiety})^2$, does not contribute significantly to the variance in mathematics achievement in Grade 8 (See Table 4.15). Anxiety alone, however, is significantly correlated with achievement (beta = - 0.216). Therefore, it can be concluded that anxiety and achievement are linearly correlated in a negative direction.

It was also suggested in the functional equations in Chapter 3 that there was a possibility that prior achievement could be interacting with anxiety or confidence influencing mathematics achievement. The two equations which follow were proposed to investigate these possibilities.

Table 4.15

Regression Analysis Results for Model #1 including the Polynomial Expression.

Independent Variables	CMA (TM8)				
	B	SEB	Beta	T	Sign t
SEX	5.335	2.674	0.117	1.995	0.048
ANX	-4.845	2.405	-0.216	-2.014	0.046
$(ANX)^2$	0.112	1.070	0.006	0.105	0.917
CONF	2.029	2.360	0.091	0.860	0.391
PMA	0.509	0.062	0.558	8.199	0.000
Multiple R	0.75				
R-Square	0.56				

$x_5 = f\ (x_1, x_2, x_3, x_2x_3, x_4)$

and $x_5 = f\ (x_1, x_2, x_3, x_2x_4, x_4)$

where x_5 = TM8 (total mathematics achievement-8)

x_1 = sex

x_2 = prior achievement (TM6)

x_3 = anxiety

x^4 = confidence

x_2x_3= interaction 1 (TM6 * ANX;

x_2x_4= interaction 2 (TM6 * CONF)

The variables involved in the interactions were standardized before the interaction scores were computed.

Neither of the interactions improves the model of mathematics achievement significantly. For example, without the variable INT 1, Model #1 explains 56 % of the variance in TM8,and with this variable added, the model explains 56.5% (See Table 4.16). This small amount of increase in explanatory power does not warrant the inclusion of the Interaction 1 variable. The same is true for Interaction 2. Also, neither the relationship of Interaction 1 and mathematics achievement nor the relationship of Interaction 2 with mathematics achievement is statistically significant.

4.16

Regression Analysis Results for Model #1 with Interactions 1 & 2.

Independent Variables	CMA (TM8)					CMA (TM8)				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
Sex	5.253	2.661	0.116	1.974	0.050	5.339	2.660	0.118	2.008	0.047
Anx	-0.838	3.972	-0.037	-0.211	0.833	-4.040	2.408	-0.180	-1.677	0.096
Conf	2.225	2.347	0.100	0.948	0.345	-0.853	3.277	-0.038	-0.260	0.795
Int 1 (TM6xANX)	-0.066	0.054	-0.179	-1.229	0.221					
Int 2 (TM6xCONF)						0.067	0.054	0.170	1.248	0.214
PMA(TM6)	0.515	0.059	0.564	8.662	0.000	0.514	0.059	0.563	8.652	0.000
Multiple R = 0.75						Multiple R = 0.75				
R-Square = 0.57						R-Square = 0.57				

Similarly, two equations were tested which included the possible interactions of sex with anxiety, and sex with confidence. These were

$$x_5 = f\ (x_1, x_2, x_3, x_1x_3, x_4)$$

and $$x_5 = f\ (x_1, x_2, x_3, x_4, x_1x_4)$$

where x_5 = TM8 (total mathematics 8)

x_1 = sex

x_2 = TM6 (total mathematics 6)

x_3 = anxiety

x_4 = confidence

x_1x_3= Interaction 3 (sex * anx)

x_1x_4= Interaction 4 (sex * conf)

Again the variables involved in the interactions were standardized before the interaction score was computed.

As with the previous interactions, the overall explanatory power of the model was not improved as a result of their inclusion (See Table 4.17). The R^2 for the models with interactions 3 or 4 added is still 56%. Also neither the relationship between Interaction 3 and mathematics achievement nor the relationship between Interaction 4 and mathematics achievement is statistically significant.

Table 4.17

Regression Analysis Results for Model #1 with Interactions 3 & 4.

Independent Variables	CMA (TM8)					CMA (TM8)				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
Sex	5.433	2.685	0.120	2.024	0.045	5.311	2.682	0.117	1.980	0.050
Anx	-3.477	4.289	-0.155	-0.811	0.419	-4.750	2.360	-2.114	-2.013	0.046
Conf	2.034	2.352	0.091	0.865	0.389	2.558	4.436	0.114	0.576	0.565
Int 3	0.980	2.683	0.063	0.365	0.716					
Int 4						0.381	2.616	0.025	0.146	0.885
PMA (TM6)	0.508	0.060	0.557	8.418	0.000	0.512	0.060	0.562	8.513	0.000
Multiple R = 0.75						Multiple R = 0.75				
R-Square = 0.56						R-Square = 0.56				

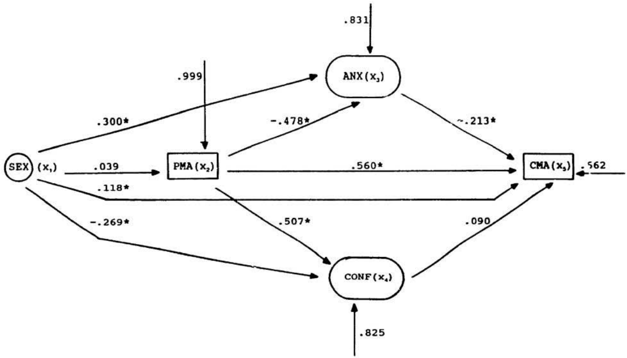
Path Analysis Results

From the low path coefficient of $path_{21}$ and the high residual on the variable PMA (prior mathematics achievement), it can be concluded that sex explains almost none of the variance in mathematics achievement in Grade 6 (See Figure 4.8).

For the endogenous variable anxiety (x_3), both sex and prior achievement show statistically significant relationships to it, although the residual (0.831) indicates that most of the variance in this variable is still coming from outside the ones included here. Sex and prior achievement explain 31% of the variance in mathematics anxiety.

Similarly for confidence in mathematics, both sex and prior achievement (total mathematics-grade 6) show statistically significant relationships to it, but the residual (0.825) also indicates that most of the variance in this variable is coming from outside the model. Sex and prior achievement in mathematics explains 32% of the variance in confidence.

The main endogenous variable, current mathematics achievement (x_5), as measured by total mathematics-8 has a lower residual than any of the other variables in the model. Less than half of the variance in current achievement comes from outside the model. Anxiety, prior achievement, and sex all have significant relationships to current achievement.



x_1 = SEX = Sex of Subject
x_2 = PMA = Prior Mathematics Achievement
x_3 = ANX = Mathematics Anxiety
x_4 = CONF = Confidence in Mathematics
x_5 = CMA = Current Mathematics Achievement

Figure 4.8. Model #1 with path coefficients

* significance < 0.05

The influence of confidence is not significant in the presence of the other variables. 56% of the variance in current mathematics achievement is explained by the variables in the model.

The relationship of sex to current mathematics achievement consists of a direct effect and three main indirect effects in this model. One indirect effect of sex on achievement is via anxiety, another via prior achievement, and a third via confidence. These were investigated and the results are shown in Table 4.18.

Although the direct effect of sex on current achievement is statistically significant, its total effect is negligible. It appears that the effects of anxiety and confidence both work against the females in suppressing the influence of sex on current mathematics achievement.

The relationship of prior achievement to current achievement has a direct effect and two indirect effects in this model. One indirect effect is via anxiety and the other via confidence (See Table 4.19).

Prior mathematics achievement is a most powerful predictor of current mathematics achievement. Its direct effect is quite high in itself but its total effect mediated by each of anxiety and confidence is even higher at 0.714 compared to 0.560. Therefore it can be concluded that anxiety and confidence are both important in influencing current mathematics achievement.

Table 4.18

Path Analysis Results for the Effect of Sex on Current Achievement

	CMA (TM8)		
Independent Variables	Direct Effect	Indirect Effect	Total Effect
Sex	0.118		0.052
Sex → Anx		-0.064	
Sex → TM6		-0.024	
Sex → Conf		0.022	

Table 4.19

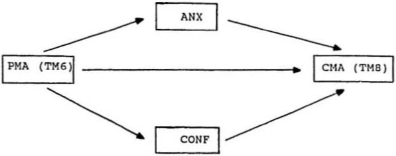
Path Analysis Results for the Effect of Prior Mathematics Achievement on Current Mathematics Achievement

	CMA (TM8)		
Independent Variables	Direct Effect	Indirect Effect	Total Effect
PMA (TM6)	0.560		0.714
PMA → Anx		0.102	
PMA → Conf		0.046	

Separate Sex Analysis

In order to find out where actual sex differences lay and how the sexes behaved differently particularly with reference to anxiety and confidence, the complete multiple regression analyses were performed first for males, and then for females, using the models shown in Figures 4.9 and 4.10.

All prior achievement scores are significantly correlated with current achievement scores for all subtests for both males and females, but a close examination of the Pearson r's show that there are different trends for males and females (see Tables 4.20 - 4.23). For example, the correlation coefficient of concepts-6 with concepts-8 is much greater for males than for females while in the areas of problem-solving and computation, prior achievement is more highly correlated with current achievement for females than for males. For the relationship of prior achievement with anxiety, the Pearson r is larger for males than females in all subtest areas except computation. In the concepts subtest, the correlation coefficient for males is -0.591 but for females it is only -0.270. Again, in the similar relationship of prior achievement with confidence, the Pearson r is greater for males than females in all areas except computation. Proficiency in computation correlates more highly with confidence for females ($r = 0.513$) than for males ($r = 0.397$).



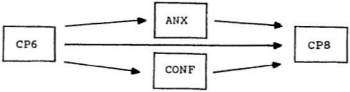
ANX = Mathematics Anxiety

PMA (TM6) = Prior Mathematics Achievement (Total Mathematics, Grade 6)

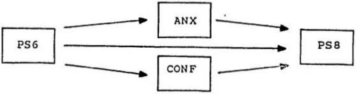
CONF = Confidence in Mathematics

CMA (TM8) = Current Mathematics Achievement (Total Mathematics Achievement, Grade 8)

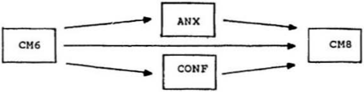
Figure 4.9. Model #5: Total mathematics achievement model for separate sex.



CP = Concepts



PS = Problem-Solving



CM = Computation

Figure 4.10. Analogous models using concepts, problem-solving, and computation respectively for separate sex analysis.

Table 4.20

Zero-Order Relationships, Means and Standard Deviations for Total Mathematics in the Separate Sex Analysis

	TM6	ANX	CONF	TM8	$\bar{X}$(males)	SD(males)	$\bar{X}$(females)	SD(females)
TM6		-0.451*	0.486*	0.702*	55.803	25.491	57.757	24.547
ANX	-0.566*		-0.852*	-0.543*	-0.409	0.853	0.160	1.088
CONF	0.570*	-0.802*		0.568*	0.261	0.901	-0.246	1.073
TM8	0.715*	-0.584*	0.537*		29.553	22.960	32.149	22.667

a -- females above diagonal, males below diagonal

* Significance $<$ 0.001

No. of cases: females 74
males 76

Table 4.21

Zero-Order Relationships, Means and Standard Deviations for Concepts in the Separate Sex Analysis

	CP6	ANX	CONF	CP8	$\bar{X}$(males)	SD(males)	$\bar{X}$(females)	SD(females)
CP6		-0.270*	0.302**	0.395***	64.724	23.478	63.689	25.436
ANX	-0.591***		-0.852***	-0.497***	-0.409	0.853	0.160	1.088
CONF	0.592***	-0.802***		0.522***	0.261	0.901	-0.246	1.073
CP8	0.676***	-0.639***	0.622***		41.132	24.105	40.419	24.270

a -- females above diagonal, males below diagonal

* significance < 0.05
** significance < 0.01
*** significance < 0.001

No. of cases: females 74
males 76

Table 4.22

Zero-Order Relationships, Means and Standard Deviations for Problem-Solving in the Separate Sex Analysis

	PS6	ANX	CONF	PS8	$\bar{X}$(males)	SD(males)	$\bar{X}$(females)	SD(females)
PS6		-0.378**	0.341*	0.641**	57.855	24.191	60.541	26.626
ANX	-0.444**		-0.852**	-0.485**	-0.409	0.853	0.160	1.088
CONF	0.473**	-0.802**		0.452**	0.261	0.901	-0.246	1.073
PS8	0.565**	-0.431**	0.451**		32.513	24.217	34.351	22.615

a -- females above diagonal, males below diagonal

* significance < 0.01
** significance < 0.001

No. of cases: females 74
males 76

Table 4.23

Zero-Order Relationships, Means and Standard Deviations for Computations in the Separate Sex Analysis

	CM6	ANX	CONF	CM8	$\bar{X}$(males)	SD(males)	$\bar{X}$(females)	SD(females)
CM6		-0.443**	0.513**	0.565**	49.066	29.563	54.081	27.778
ANX	-0.416**		-0.852**	-0.423**	-0.409	0.853	0.160	1.088
CONF	0.397**	-0.802**		0.489**	0.261	0.901	-0.246	1.073
CM8	0.408**	-0.466**	0.344*		21.974	18.677	27.851	22.926

a -- females above diagonal, males below diagonal

* significance < 0.01
** significance < 0.001

No. of cases: females 74
males 76

In examining the relationship between anxiety and current mathematics achievement, it is observed that the Pearson r is larger for males than for females in all areas except problem-solving. In the area of concepts, anxiety correlates much more highly in a negative direction with current achievement for males (r = -0.639) than for females (r = -0.497).

Similarly, the relationship between confidence and current achievement was examined. In this case it was found that the Pearson r was larger for females than for males in all areas except that of concepts. In concepts, confidence correlates with achievement more highly for males (r = 0.622) than for females (r = 0.522), but in computation, confidence correlates with achievement more highly for females (r = 0.489) than for males (r = 0.344). The results of the regression analyses for males and females separately were sometimes different from the main analysis although in many ways the same trends appeared. When using total mathematics as the achievement variable in the model, there does not appear to be much difference in the explanatory power of the model for males versus females. However, when the separate subtests are considered, it can be seen that the model which uses concepts as the achievement variable is much more powerful for males than for females. In contrast to this, the models which use problem-solving and computation as the measures of mathematics achievement in the model along with anxiety and confidence are more powerful for females than for males (See Table 4.24).

In all regression analyses except for that of one of the analogous models where computation is the achievement measure (See Figure 4.10), the only significant relationships were between achievement variables. One of the reasons for this may have been that when the separate analyses were done the sample size was reduced to half the original size. The results of the separate sex analysis for the subtest of computation show that for males, anxiety is an even more powerful predictor of achievement in computation than is prior achievement (See Table 4.25). In this case, anxiety alone explains approximately 21% of the variance in achievement as compared with approximately 7% for prior achievement alone. For females, only prior achievement in computation is significant, explaining approximately 18% of the variance in current achievement in computation.

Table 4.24

Comparison of R-Squares in Separate Sex Analysis

Achievement Test	R^2 (males)	R^2 (females)
Concepts	0.55463	0.34323
Problem-Solving	0.36734	0.48207
Computation	0.27837	0.37310
Total Mathematics	0.55874	0.56496

Table 4.25

Separate Sex Analysis for Computations-8

Independent Variables	CM8 (females)					CM8 (males)				
	B	SEB	Beta	T	Sign t	B	SEB	Beta	T	Sign t
ANX	-0.297	3.805	-0.014	-0.078	0.938	-10.017	3.727	-0.457	-2.688	0.009
CONF	5.525	4.028	0.259	1.372	0.175	-2.668	3.493	-0.129	-0.764	0.447
CM6	0.352	0.091	0.426	3.864	0.000	0.169	0.070	0.268	2.422	0.018

Multiple R = 0.61
R-Square = 0.37

Multiple R = 0.53
R-Square = 0.28

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

This chapter consists of four sections. First there is a summary of the study, then conclusions, implications, and finally, recommendations for further research.

This study proposed a model to explain mathematics achievement in Grade 8 by using the variables sex, mathematics anxiety, confidence in mathematics, and prior mathematics achievement. It was found to be a powerful model, explaining 56% of the variance in mathematics achievement. Most of the explanatory power came from prior achievement, but sex and anxiety also contributed significantly to the variance observed. The effect of confidence was found to be suppressed in the presence of anxiety so that its influence was not detected over and above the influence of anxiety.

The subtests of Concepts, Problem-Solving, and Computation were also examined using analogous models. Problem-Solving was found to be the only subtest in which neither affective variables nor sex made a significant contribution to the variance in achievement. In Concepts, on the other hand, anxiety and confidence each contributed significantly to the variance in current mathematics achievement in that area. Analysis of the subtest of

Computations revealed that sex contributed significantly to the variance in current achievement here.

Interactions and a polynomial term were examined yielding no statistically significant results. The polynomial term results showed that anxiety and achievement were not non-linearly related. Interactions among variables which were tested indicated that their influence was not compounded by their interactions with one another. Path analysis showed that the direct effect of sex on achievement which favours females is offset by the indirect effects of sex on achievement via anxiety and confidence, both of which work in favour of the males. Higher levels of anxiety and lower confidence on the part of females negatively influence their mathematics performance. Path analysis also confirmed that the effect of prior achievement is increased when indirect paths via anxiety and confidence are considered. That is, not only is prior achievement an important predictor of achievement, but its effect in determining anxiety and confidence further increases its prediction power.

Separate sex analysis revealed generally that prior achievement correlated more highly with current achievement for females than for males, but prior achievement correlated more highly with anxiety and confidence for males. Anxiety generally correlated more highly with current achievement for males whereas confidence generally correlated more highly with current achievement for females. The area of Computations seemed to be the female strong-point whereas Concepts provided a more powerful achievement model for males.

Multiple regression analyses for separate sex in the different subtests revealed one major finding in that anxiety is the most powerful predictor of achievement for males in the area of Computation.

Conclusions

When observing the differences in means on CTBS 6 and CTBS 8, as measured by percentile rank, it can be seen that there is a considerable drop between the grades. It may be worth noting that this finding is not unique to this study. In 1986, the Newfoundland and Labrador Department of Education reported a drop of 34 in percentile rank between Grade 6 and Grade 8 in the total mathematics score. The differences in the mean scores in this study showed a drop of 26 points. There seems then to be a real problem in mathematics in the junior high grades if students are scoring lower when compared to their Canadian counterparts in Grade 8 than in Grade 6. Much effort is presently being made to help improve this area of education.

Prior achievement in mathematics is generally the most powerful predictor of current achievement in mathematics, but the affective variables of anxiety and confidence as well as the sex factor, are also very important considerations. This study found that anxiety and confidence were both significantly related to achievement in mathematics. This fact is not only statistically significant but also educationally significant in that environmental factors such as a teacher's attitude, may be influential in increasing or decreasing anxiety on the part of a student. Since anxiety was shown to negatively affect achievement, it can be concluded that if the anxiety level were reduced, there may well be some improvement in achievement. Similarly, since confidence is shown to positively influence achievement, helping students gain confidence in mathematics is a worthy educational goal. It is not sufficient to merely focus on the cognitive realm when these other aspects of students' psychological make-up also impact on their performance in mathematics.

Although sex differences do not explain much of the variance in mathematics achievement in comparison to the other variables in this study, it is important to note that the effects of anxiety and confidence both work against the females in their effects on achievement. This may indicate that females should be treated differently in the classroom so that, for example, females do not feel threatened when answering a question. The area which shows the greatest female superiority is in Computations. As the grades get higher however, this particular aspect of mathematics gets increasingly less important, with Concepts and Problem-Solving becoming the major focus. Therefore it would be expected that any sex differences which favour females in Grade 8 may be reversed later. Similarly, as society becomes more and more technological, proficiency in computation becomes less and less important. It is becoming increasingly necessary, then, to concentrate on helping each student increase achievement in the other areas.

Prior achievement is more important in determining anxiety and confidence levels than is sex. It should be noted that females generally exhibit higher anxiety and males generally exhibit higher confidence even when their performance is the same. Low achievers would probably experience high anxiety and low confidence, both of which will negatively influence achievement for them. It is imperative therefore that the chain reaction be broken at some point. It would be desirable for all students to experience success rather than failure no matter how long it may take them to accomplish a task.

Separate subtest analyses revealed that anxiety and confidence were both significantly related to current achievement in the subtest of Concepts. It appears that when a student is confronting a new concept or introductory material anxiety and confidence play an important role in their grasping of that idea. Teachers should be aware that when explaining concepts, students need to be made to feel comfortable, and must be encouraged to acquire a complete understanding of that material before going on.

It should be noted however that any generalizations from this study are valid only insofar as the population studied is representative of Grade 8 students in Newfoundland.

Implications

If prior achievement is such a powerful predictor of current achievement in mathematics, then by all means efforts must be made to keep the achievement levels in the elementary school as high as possible. Since prior achievement also influences anxiety and confidence, which in turn influence achievement, teachers must ensure that those students who may score poorly on achievement tests are encouraged to continue to try and to not react negatively to mathematics in general.

Since females tend to underestimate their abilities and males to overestimate theirs, care must be taken to help females in particular to be more confident in mathematics. They need to be reassured of their abilities by teachers and others. Although males may be more confident with less achievement, this confidence does not adversely affect them. High confidence correlates significantly with high achievement in all cases studied here.

Since anxiety negatively affects achievement and confidence positively affects achievement, teachers must concentrate on helping to decrease anxiety and to increase student confidence. If students felt better about mathematics, their achievement should improve.

Although there are no significant sex differences in the raw correlations between sex and achievement in this study, the path analysis revealed that it was the variables of anxiety and confidence which prevented the full impact of sex on achievement in favour of females to be felt. This means that females in particular need to be encouraged in mathematics in the educational setting. If females could have as low anxiety as males and as high confidence as males, it would appear that they could make gains in mathematics and possibly make their presence felt in mathematically oriented professions presently dominated by males.

Since anxiety and confidence affect the area of concepts more than any other area, teachers should take great care when introducing new material. Since this effect may accumulate as the concepts continue to build on one another in mathematics, it would be expected that the strong relationship between such variables and mathematics achievement may continue to adversely affect it.

Recommendations for Further Research

It is becoming increasingly important to investigate the factors which influence mathematics achievement. If mathematics performance is to improve and if more young people are to be encouraged in this field, educators should be made aware of the significant predictors of mathematics achievement. Further research is needed to achieve educational goals in the field of mathematics and to help ensure success among students. Therefore the following recommendations are suggested.

1. The sex of the teacher may also be an important variable which could impact on anxiety and confidence levels of males and females, so this variable should be in another study.
2. The sample could be divid. . into a low anxiety group and a high anxiety group so that the impact of anxiety would be more clearly seen in the various subtests. In this case it would be desirable to double the size of the present study. This would ensure having sufficient numbers to avoid sampling fluctuations; hence, spurious results.
3. A longitudinal study involving the measuring of mathematics anxiety in different grades along with its effect on achievement would help clarify

whether or not this is a problem which has a cumulative effect.

4. A similar study could be conducted using other areas of achievement to see if the anxiety factor is unique to the field of mathematics.
5. This study could be replicated at a higher grade level. Research tends to imply that at higher grade levels males increasingly outperform females in mathematics, so that a study conducted at the senior high level would be in order.
6. Factors which could possibly influence anxiety should be studied. Teacher behaviors in the classroom may be one such factor.

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APPENDICES

Appendix A

Correspondence with Superintendent, Principals, and Parents

This is a sample letter to the superintendent of the Board of Education with which the researcher was working. In order to ensure anonymity, any references which would identify the board or individual schools has been deleted.

30 Tobin Cres.
St. John's, NF
April 21, 1988

Superintendent Board of Education

Dear Sir:

Christian Greetings.

As you know I am in the process of completing the M.Ed. program in Curriculum and Instruction (Mathematics Education) at Memorial University of Newfoundland. I am doing my thesis on "The Affective Variables of Anxiety and Confidence in Mathematics and their Effects on Mathematics Achievement in Grade Eight". In this connection, I hope to collect data from Grade Eight students in our board sometime during the month of May. I will be conducting this research personally and hope to be in your area before May 10. Regarding this I would like to ask permission to borrow 35 CTBS booklets to be returned by the end of the month. Also I would like to know if there is a Board Policy regarding the use of CTBS 6 scores which are on the students' permanent records. That is, do I need to get parents' permission in advance?

Enclosed is a copy of the objectives of the research and a list of questions I want to answer. If the study goes well, there may indeed be some important implications for our Mathematics teachers.

My plan is to use the following schools in the study.

Thank-you in advance for your help in this endeavor.

Sincerely,

Sharon Whitt

This is a sample of the first letter sent to the principals. Again, in order to ensure anonymity, any references to the specific board or schools has been deleted.

30 Tobin Cres.
St. John's, NF
April 21, 1988

Principal

Dear Sir:

Christian Greetings.

As you may know I am in the process of completing the M.Ed. program in Curriculum and Instruction (Mathematics Education) at Memorial University of Newfoundland. I am doing my thesis on "The Affective Variables of Anxiety and Confidence in Mathematics and their Effects on Mathematics Achievement in Grade Eight." In this connection, I hope to collect data from Grade Eight students enrolled in various schools across the province. I will be conducting this research personally and hope to be in your area before the end of May. Regarding this I would like to ask permission to administer the Canadian Test of Basic Skills, Mathematics section only, to the Grade Eight students in your school as well as to administer a short questionnaire designed to measure anxiety and confidence. Also I would like to use each student's CTBS 6 Mathematics score from the cumulative records if this is possible.

Enclosed is a copy of the objectives of the research and a list of questions I want to answer. If the study goes well, there may indeed be some important implications for our Mathematics teachers.

It is hoped that the following schools can be used in the study.

Thank-you in advance for your help and cooperation in this endeavor.

Sincerely,

Sharon Whitt

30 Tobin Cres.
St. John's, NF
April 25, 1988

Dear Parent,

I am a graduate student at Memorial University of Newfoundland and I am presently conducting a study regarding Mathematics Achievement in the Junior High School. During the month of May, I hope to collect information from Grade Eight students across the province in order to investigate the relationship between students' feelings about mathematics and their achievement in that subject. Consequently, this letter is to ask permission for your child to complete a questionnaire on mathematics anxiety and confidence, as well as a mathematics achievement test. Also, it will be necessary for me to compare these results with his/her previous mathematics achievement on the Canadian Test of Basic Skills as recorded on his/her permanent school record.

This study is a private one conducted under the supervision of the Education Department of Memorial University and results will not in any way affect your child's grades. Rather they will enable educators to become more aware of the various factors which influence mathematics achievement. Any information thus gathered will certainly be kept confidential and no students or schools will be identified in the final report.

Please return the following note to acknowledge your co-operation in this research. Thank-you very much for your help in this endeavor.

Sincerely,

Sharon Whitt

Parental Consent Form

I agree that my child__________________ may participate in this mathematics study.

YES _______ NO _______

PARENT'S SIGNATURE

____

This is a sample of the second letter sent to principals. In order to ensure anonymity, any references to the specific board of individual schools has been deleted.

30 Tobin Cres.
St. John's, NF
April 29, 1988

Principal

Dear Sir:

Christian Greetings.

Thank-you very much for your positive response to the research plans about which I wrote to you recently. The Superintendent has also encouraged me in this endeavor. However, he has recommended that I obtain parental consent for the students to participate. In this connection, please find enclosed 25 copies of a letter to the parents of the Grade Eight students which need to be returned with the signature of the parent or guardian. If you feel it would be helpful, you could also attach a letter to them, indicating the school's support and approval of the project. In any case, it seems that this procedure must be followed since my study requires student subjects. When the work is completed,you will certainly receive a copy of the findings of the study.

Secondly, it appears that there is also a problem concerning student anonymity in this research since school records must be used. To overcome this obstacle,it appears that I need to solicit the help of one or two teachers who would acquire the mathematics scores of CTBS 6 from the records and document them by student number rather than name. The student would then use the same identification number on the data that I will collect directly. I am hopeful that this can be worked out by contact with the co-operating teachers.

Let me assure you that I do not want to make extra work for you or your staff, but it seems that there are many precautions which must be taken when undertaking research of this nature. I believe, however that it is necessary that we study the influences which affect mathematics achievement in the hope that we can improve the teaching of mathematics for the benefit of our students and of education in general. So again, I want to express my appreciation to you, your staff, and your students for co-operating in this research.

Sincerely,

Sharon Whitt

Appendix B

Anxiety - Confidence Questionnaire and Answer Key

Mathematics Anxiety-Confidence Questionnaire

1. Student Identification Number ____________

2. Name of School ______________________

3. Address of School (Town) ______________
4. Your age __________

5. Sex: Male ______ Female ______

6. What is the sex of your math teacher this year ?
   Male _____ Female _____

For each of the following statements, choose only one of the choices provided. Place a check mark (✓) beside your choice.

	Strongly Agree 1	Agree 2	Disagree 3	Strongly Disagree 4
1. I get a sinking feeling when I think of trying hard math problems.	☐	☐	☐	☐
2. I usually have been at ease during math tests.	☐	☐	☐	☐
3. Mathematics usually makes me feel uncomfortable.	☐	☐	☐	☐
4. Mathematics usually makes me feel nervous.	☐	☐	☐	☐
5. My mind goes blank and I am unable to think clearly when working mathematics.	☐	☐	☐	☐
6. I usually have been at ease in math classes.	☐	☐	☐	☐
7. I haven't usually worried about being able to solve math problems.	☐	☐	☐	☐
8. I'm no good in math.	☐	☐	☐	☐
9. I can get good grades in mathematics.	☐	☐	☐	☐

	Strongly Agree 1	Agree 2	Disagree 3	Strongly Disagree 4
10. I'm not the type to do well in mathematics.	☐	☐	☐	☐
11. Generally, I have felt secure about attempting mathematics.	☐	☐	☐	☐
12. For some reason even though I study, math seems unusually hard for me.	☐	☐	☐	☐
13. I am sure I can learn mathematics.	☐	☐	☐	☐
14. I am usually nervous during math tests.	☐	☐	☐	☐
15. I feel very relaxed when working mathematics.	☐	☐	☐	☐
16. I usually worry about being able to solve math problems.	☐	☐	☐	☐
17. I am the type to do well in mathematics.	☐	☐	☐	☐
18. I feel insecure about attempting mathematics.	☐	☐	☐	☐
19. I am good in math.	☐	☐	☐	☐
20. Mathematics is easy for me.	☐	☐	☐	☐

KEY:

Anxiety Construct Item	Questionnaire Item	SA	A	D	SD
A 1	# 1	4	3	2	1
A 2	# 2	1	2	3	4
A 3	# 3	4	3	2	1
A 4	# 4	4	3	2	1
A 5	# 5	4	3	2	1
A 6	# 6	1	2	3	4
A 7	# 7	1	2	3	4
A 8	#14	4	3	2	1
A 9	#15	1	2	3	4
A10	#16	4	3	2	1

Confidence Construct Item	Questionnaire Item	SA	A	D	SD
C 1	# 8	1	2	3	4
C 2	# 9	4	3	2	1
C 3	#10	1	2	3	4
C 4	#11	4	3	2	1
C 5	#12	1	2	3	4
C 6	#13	4	3	2	1
C 7	#17	4	3	2	1
C 8	#18	1	2	3	4
C 9	#19	4	3	2	1
C10	#20	4	3	2	1

Appendix C

CTBS Score Sheet

PERSONAL INFORMATION

I.D.# __________

SCHOOL : ____

Test M-1: Mathematics Concepts

80	1 2 3 4	88	1 2 3 4	96	1 2 3 4	104	1 2 3 4	112	1 2 3 4	120	1 2 3 4
81	1 2 3 4	89	1 2 3 4	97	1 2 3 4	105	1 2 3 4	113	1 2 3 4	121	1 2 3 4
82	1 2 3 4	90	1 2 3 4	98	1 2 3 4	106	1 2 3 4	114	1 2 3 4	122	1 2 3 4
83	1 2 3 4	91	1 2 3 4	99	1 2 3 4	107	1 2 3 4	115	1 2 3 4	123	1 2 3 4
84	1 2 3 4	92	1 2 3 4	100	1 2 3 4	108	1 2 3 4	116	1 2 3 4		
85	1 2 3 4	93	1 2 3 4	101	1 2 3 4	109	1 2 3 4	117	1 2 3 4		
86	1 2 3 4	94	1 2 3 4	102	1 2 3 4	110	1 2 3 4	118	1 2 3 4		
87	1 2 3 4	95	1 2 3 4	103	1 2 3 4	111	1 2 3 4	119	1 2 3 4		

Test M-2: Mathematics Problems

51	1 2 3 4	57	1 2 3 4	63	1 2 3 4	69	1 2 3 4	75	1 2 3 4	81	1 2 3 4
52	1 2 3 4	58	1 2 3 4	64	1 2 3 4	70	1 2 3 4	76	1 2 3 4	82	1 2 3 4
53	1 2 3 4	59	1 2 3 4	65	1 2 3 4	71	1 2 3 4	77	1 2 3 4		
54	1 2 3 4	60	1 2 3 4	66	1 2 3 4	72	1 2 3 4	78	1 2 3 4		
55	1 2 3 4	61	1 2 3 4	67	1 2 3 4	73	1 2 3 4	79	1 2 3 4		
56	1 2 3 4	62	1 2 3 4	68	1 2 3 4	74	1 2 3 4	80	1 2 3 4		

Test M-3: Mathematics Computations

70	1 2 3 4	78	1 2 3 4	86	1 2 3 4	94	1 2 3 4	102	1 2 3 4	110	1 2 3 4
71	1 2 3 4	79	1 2 3 4	87	1 2 3 4	95	1 2 3 4	103	1 2 3 4	111	1 2 3 4
72	1 2 3 4	80	1 2 3 4	88	1 2 3 4	96	1 2 3 4	104	1 2 3 4	112	1 2 3 4
73	1 2 3 4	81	1 2 3 4	89	1 2 3 4	97	1 2 3 4	105	1 2 3 4	113	1 2 3 4
74	1 2 3 4	82	1 2 3 4	90	1 2 3 4	98	1 2 3 4	106	1 2 3 4	114	1 2 3 4
75	1 2 3 4	83	1 2 3 4	91	1 2 3 4	99	1 2 3 4	107	1 2 3 4		
76	1 2 3 4	84	1 2 3 4	92	1 2 3 4	100	1 2 3 4	108	1 2 3 4		
77	1 2 3 4	85	1 2 3 4	93	1 2 3 4	101	1 2 3 4	109	1 2 3 4		

Appendix D

Instructions for Testing

These instructions were read to the participating students. For the administration of the CTBS tests, the instructions found in the CTBS (Teacher's Guide) were followed.

Collecting Data Instructions to Students

Test #1 -- Anxiety-Confidence Questionnaire

Instructions to be read to students:

This is a very important questionnaire, and will take only about 15 minutes to complete. This study is examining how you and other students feel about mathematics and whether these feelings might affect your mathematics achievement. The purpose is to add to present knowledge about factors which influence student learning. This way hopefully teachers will be able to improve mathematics education. I want to encourage you to express your true feelings, and thank-you in advance for your participation.

I will give you an example now.

Being regarded as smart in mathematics would be a great	SA	A	D	SD

thing.

Now we will complete the questionnaire. I will read out each statement once, then the choices, and finally repeat the statement before going to the next item.

(All the items on the questionnaire will now be read orally as the students make their choices.)