THE EMOTIONAL BLOCK IN MATHEMATICS:

A MULTIVARIATE STUDY

by

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ABSTRACT

The purpose of this study was to study the relationships between a group of affective variables, associated with the notion of an "emotional block" in mathematics, and achievement in mathematics. Five independent variables were considered: achievement responsibility (locus of control), measured by the Intellectual Achievement Responsibility Scale; anxiety in mathematics, value of mathematics to society, self-concept of ability to learn mathematics and enjoyment of mathematics, measured by scales from the Sandman battery; and value of mathematics for oneself, measured by an author constructed scale. The three dependent achievement variables were computation, measured by the Stanford Achievement Test and concepts and problem solving measured by the Canadian Test of Basic Skills.

Nonlinear and interactive hypotheses were suggested by the theory of Achievement Motivation.

The scales were administered to 1033 students at the grade six level. The scores were standardized within each class to remove class effects. The sample was randomly split into two samples, one to be retained for cross validation.

No significant difference was found between the variance-covariance matrix of males and that of the females. The data were subsequently pooled.

Stepwise regression analysis indicated that self-concept alone explained approximately 20% of the achievement variance. In the case of computation, mathematics anxiety was also included accounting for an additional 2%.

Principal component analysis and orthogonal rotation of the set of affective scales revealed three factors. These were interpreted as a motivational factor (loadings from self-concept, anxiety and enjoyment), a value factor (loadings from the two value scales), and an achievement responsibility factor. Factor scores for each student were calculated. Using these scores, stepwise regression showed that, with the exception of the value factor entering into the equation for computation, the motivation factor was the only one retained. None of the non-linear or interactive hypotheses were significant.

The above analyses were repeated using the cross validation sample. All the findings were confirmed.

It was concluded that the group of three variables, self-concept of ability, enjoyment and anxiety in mathematics should be included in studies dealing with motivation in mathematics. It was suggested that self-concept could be interpreted as the cognitive component of anxiety and that enjoyment as the emotional component. It was also suggested that attempts to alter anxiety in mathematics could be made by altering self-concept and enjoyment.

Chairman: Dr. Gail Spitler

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Chapter 1

THE PROBLEM

BACKGROUND

Introduction

If a pupil "performs badly and is subjected to continued frustration, he may develop an emotional block that makes future learning impossible. *Such blocks are not unusual in mathematics*" [Italics added.] (Marks, Purdy & Kinney, 1965, p. 47). If this is true, then the prevention of the establishment of the "block" and the removal, or at least the reduction of the "emotional block" whenever it occurs, should be major concerns of mathematics educators. To do this effectively, its behavioral characteristics should be ascertained. It will be argued that the concept of an "emotional block" in mathematics is a common one, often associated with repeated failure. Certain variables such as anxiety, value and enjoyment of mathematics are often used in the mathematics teaching literature to characterize such a "block".

For the purpose of this study "emotional" was considered synonymous with "affective". A "block" was defined in terms of scale scores of one, or a number of, the affective variables associated with an "emotional block." In order to validate the pedagogical literature, the relationships among the "block" variables and between those variables and mathematics achievement were examined.

Research on the presence and effects of these variables, as a group, in the context of mathematics education, has been rather limited. It will be shown, in this and the next chapter, that typically only one of the variables was selected and its relationship to a global measure of mathematics achievement examined. There is, however, some evidence that the variables might interact with each other and with other affective variables when studied in relation to achievement. Consequently, the present study was designed to examine the linear, non-linear, and interactive relationships between variables associated with an "emotional block" in mathematics, and three components of mathematics achievement; computation, concepts, and problem solving.

Emotional Block

Factors affecting success. Crowder and Wheeler (1972) characterized the successful child in a mathematics program as one who

1. feels that he is competent.

2. feels that he is accepted by his teacher.
3. feels that his best effort will be accepted by his teacher.
4. knows that his teacher will plan work that will give him success.
5. knows that each day's work will be a challenge. (p. 4)

Characteristics 1, 4, and 5 may be summarized in the following way: his past work established a success pattern allowing him to predict success at a current task even if it was a challenge.

To convince teachers that there was a commonality among learning theories and that there were principles useful for guiding practice in the mathematics classroom Fremont (1969) cited Hilgard's list of fourteen principles common to most theories of learning. Of these, three dealt with success and its relationship to failure:

4. Success and reward yield more favourable outcomes than failure and punishment.
6. Tolerance for failure is built by success experiences.
12. Learning is aided by knowledge of mistakes and successes. (p. 43)

Fremont (1969) reiterated the above points in his discussion of the slow learner in mathematics. The teacher should "try to involve the students in new experiences offering success" (p. 253). When such is the case Fremont described the student's reaction as follows: "After years of failure in mathematics [there] is a series of quick successes - a series of experiences that cause the student to exclaim, 'Hey, I can do these!'" (p. 524). He continued, "These initial success experiences cannot be overestimated in importance. They are the first steps on the road back for many of these low achievers" (p. 525). Cooney, Davis and Henderson (1975) were quite specific:

> Slow learners need to have successful experiences; they need to get correct answers. This is particularly true for students dominated by fear of failure or hostility. . . . They need confidence and encouragement more than they need to know the basis for particular procedures. (p. 334)

The importance of success when beginning new material was stressed by Marks, Purdy and Kinney (1965, p. 47). They suggested that, "interest in a new activity develops most readily if the pupil has some confidence in his ability to succeed with it." They felt that the teacher should space the difficulty of the new material so that "the pupil always feels that he has a chance to succeed" (p. 47).

The problems associated with carrying out this directive were noted by Biggs and McLean (1969) who stated that determining the readiness of a child

> requires a great deal of skill and experience. It is this kind of skill combined with the art of _devising or contriving situations where every child experiences some successes each day_ that distinguishes the truly professional teacher from the technician. [Italics added] (p. 8.)

Running through all these statements about the effects of success is the theme that a success experience changes the child's assessment of the probability of being successful in a new situation. Implicit is the assumption that the success experience is motivating: that the child would expend more effort in the accomplishment of the new task. On the other hand, one might expect that the experiences of failure would be disabling and inhibiting rather than motivating and enabling as are the experiences of success. Indeed such effects are referred to in the literature.

Factors affecting failure. In the preface to The Slow Learner in Mathematics (Lowry, 1972) the editorial panel stated that "because of a history of failure and near failure, almost all of them have a low opinion of their worth at least as mathematics students." Wells and Shulte (1970) in the same volume stated that "One of the most striking characteristics of low achievers is their fear of failure. . . . their repeated failures have made them skeptical of the value of school" (p. 344). Cooney, Davis and Henderson (1975) stated that: "Students who have had difficulty in learning mathematics are likely to have negative attitudes toward it and be convinced that they cannot understand or do anything of a mathematical nature" (p. 325). Dreger and Aiken (1957) noted that "Many persons report in clinical sessions and in academic classes that they are emotionally disturbed in the presence of mathematics" (p. 344). In the same vein Pikaart and Wilson (1972) distinguished between constructively and defensively motivated learners. They stated,

> "constructively" motivated students are those who have a high level of achievement motivation and a low anxiety, whereas "defensively" motivated students are those who have the opposite pattern. (p. 33)

An individual who experienced repeated failure at a given task would begin to expect failure and when confronted with such a task would tend to avoid or reduce the effort applied to the task. This effect was labelled "learned helplessness" by Weiner (1972) who described it as the "low achievement syndrome, since persons low in achievement motivation do not perceive that effort influences outcome" (p. 210). In this study this effect was associated with responsibility for accepting the results of actions taken in achievement oriented situations.

Variables Associated with an "Emotional Block"

In summary, Dreger and Aiken (1957) cited Schonel who observed, "that backwardness in arithmetic is due as much to emotional as to intellectual factors" (p. 344). The factors identified above in the previous section entitled "Emotional Block" were: anxiety and fear of failure; lack of interest; low estimation of mathematics and its value; low opinion of worth as a learner and lack of confidence in learning; and the inability to accept challenges, low motivation and a belief that effort would not produce any return. For the present study, this list was condensed to the following five variables: a) high anxiety in mathematical situations (M-ANXIETY), b) low enjoyment of mathematics (M-ENJOYMENT) c) low value of mathematics (M-VALUE), d) low self-concept of the ability to learn mathematics (M-SELFCONCEPT), and e) unwillingness to accept responsibility in achievement situations (ACHIEVEMENT RESPONSIBILITY).

It should be noted that ACHIEVEMENT RESPONSIBILITY and Internal-External Locus of Control have been used interchangeably (Weiner, 1972). Crandall, Katkovsky and Crandall (1965) developed the Intellectual Achievement Responsibilty Scale based upon Rotter's (1966) theory of internal-external locus of control.

Since the above variables were associated with the affective domain the following phrases or terms will be used interchangeably; "block" variables, variables associated with an "emotional block," and affective variables.

Problem

The purpose of this study was to clarify the interrelationships of the "block" variables exhibited by some students when performing mathematics. Cronbach and Meehl (1955) operationalize the clarification procedure as follows: "to 'make clear what something is' means to set forth the laws in which it occurs" (p. 290). They also stated that "a construct is some postulated attribute of people, assumed to be reflected in test performance" (p. 283). In short, the methodological literature expressed the belief that some students experience an "emotional block" when confronted with mathematical problems. It was also held that these students, who experience constant or near constant failure in mathematics, evidenced certain behaviors and beliefs tending to reduce the individual's ability to function in mathematical situations. The major hypothesis of this study, then, was that mathematics achievement (M-ACHIEVEMENT) would be a function of the above variables,

M-ACHIEVEMENT = f(M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT, ACHIEVEMENT RESPONSIBILITY).

This does not imply that the construct of an "emotional block" was to be validated. However, it does mean that the set of variables which have often been descriptively linked to an "emotional block" were to be validated in terms of their relationships with achievement.

CASE FOR A NON-LINEAR MULTIVARIATE APPROACH

Independent Variables

Multiple definitions of attitude. Separate scales measuring value, enjoyment, and anxiety in mathematics were not typical at the time of this study. Measures of attitude had been used extensively in mathematics and were being subjected to increasingly intensive and critical analysis.

In one review of several attitude studies Aiken (1972) identified some commonalities in the definitions of attitude.

> Attitude as used in the studies referred to here means approximately the same thing as enjoyment, interest, and to some extent, level of anxiety. (p. 229)

Neal (1969) while giving a list of attitude variables claimed that the the definition of attitude "is not precise, but inventories that measure it include such ingredients as liking or disliking of mathematics, a tendency to engage in or avoid mathematical activity, a belief that mathematics is useful or useless" (p. 632). Khan (1969) correlated several variables such as study habits, achievement anxiety, need achievement, academic interest, and attitude toward teacher, with a standardized achievement test score. He noted that his results "suggest the usefulness of subscore as compared to an overall score and cast doubt on the assumption that attitudes, motivation, and study habits can be represented unidimensionally" (p. 219).

Complex Interrelations. The suggestion of a multivariate approach to the study of the effect of noncognitive variables upon achievement was based on the assumption that the individual scales, insofar as they did not measure the same construct, would give more information than a composite score. A simple interpretation of this was that the scores on several scales would have a higher multiple correlation with mathematics achievement than any single scale. Alpert and Haber (1960) measured the construct of anxiety with two scales, positive (facilitating) and negative (debilitating) anxiety scales. The increase in explained variance of achievement when using the two scales indicated that a multiple scale approach was productive. Therefore, the hypothesis that each scale would add more information led to the postulation of a multivariate linear function such as,

M-ACHIEVEMENT = M-ANXIETY + M-ENJOYMENT + M-VALUE + M-SELFCONCEPT + ACHIEVEMENT RESPONSIBILITY

However, more complex relations might also occur. In particular it could be the case that one variable may moderate the effect of another variable. That is to say, there may be an interaction effect. Wolk and DuCette (1973), showed that locus of control had a moderating effect on a measure of achievement motivation which was correlated with achievement. In fact, Rotter (1966) conceived the construct of locus of control as a moderator variable.

> The effect of reinforcement following some behavior . . . depends upon whether or not the person perceives a causal relationship between his own behavior and the reward. (p. 1)

He continues

> Perhaps one of the major conceptions which bears some relationship to the belief in internal versus external control of reinforcement is that of need for achievement. . . . people who are high in the need for achievement, in all probability have some belief in their own ability or skill to determine the outcome of their efforts. The relationship is probably not linear. (p. 3)

Silverblank (1973) noted another interaction effect. She found that when the means of variable scores were considered, groups could appear similar. However, mathematics majors tended towards extremes of anxiety; they were either unusually secure or severely anxious. The distribution of the scores was as important as the mean.

To facilitate the statement of hypotheses which would relate the variables of this study, a theoretical framework was considered important. Instrumentality theories were found to address the interrelations of value of success, expectation of success, motivation to succeed and motivation to avoid failure. The theory of Achievement Motivation, a specific instance of instrumentality theories (Mitchel & Biglan, 1971, p. 432), will be presented in some detail in Chapter 2. It is sufficient to note here that the Achievement Motivation model was composed of three factors, motivation to succeed, probability of success, and value of success, interacting with each other in the prediction of achievement oriented activity. The model also predicted some non-linear correlations between its factors and achievement oriented activity. The relationship of the variables of the present study and the three factors will be discussed in Chapter 2.

Dependent Variables

Attitude measures have been limited not only by confused constructs but also by poorly delineated referents. That is, the scales have contained items from several different constructs and those scales have been used to measure affect towards several different aspects of mathematics. Some unexpected findings tended to confirm this. Higgins (1970) in his study of attitude changes in the setting of a mathematics laboratory found that students were enthusiastic about the opportunity to participate but "something less than enthusiastic about the content material"

(p. 55). Attitudes about the vehicle and the content should be considered separately.

Aiken (1969) pointed out that

> Attitude toward material to be learned by rote, such as the multiplication table, is not the same variable as attitude toward problems and algebraic symbols. (p. 8)

The measurement of mathematics achievement is often broken into three components; computation, concepts, and problem solving. Because of the possibility of each of the affective variables having different relationships with each of the achievement variables, it was felt that in the present study each of the three achievement components should be analyzed separately. This resulted in five major independent variables and three dependent variables.

Aiken (Aiken & Dreger, 1961) stated that unpublished data collected by him demonstrated "that attitude scale scores are more highly correlated with both ability and achievement measures in the case of females than in males" (p. 14). In a study of sex differences in problem solving Carey (1978) found that the correlations between attitude and problem solving were considerably higher for males than for females.

In summary, Aiken (1970) called for

> a research program . . . to investigate the interactions among the entire domain of affective and cognitive variables in their effects on mathematics learning. Such a program should be multivariate in terms of both input and output variables, and would entail a composite of correlational and experimental research methods. (p. 253)

The present study was considered to be part of such a program.

Importance of the Problem

<u>The validation of a construct</u>. Because of the multivariate, non-linear orientation of this study the number of potential hypotheses was quite large. A number of the possible results could have been statistically spurious and theoretically uninterpretable. Therefore, hypotheses were formed which were based upon relationships suggested by existing research and accepted theoretical models. This was an important aspect of this study. If the variables associated with an "emotional block" were to be considered a useful set then not only should the relationship of each to mathematics achievement be studied but the relationships among themselves should be elucidated. As Nunnally (1970) stated, a construct

> is something that the scientist puts together from his own imagination, something that does not exist as an isolated, observable dimension of behavior. A construct represents a hypothesis (usually half formed) that a variety of behaviors will correlate with one another in studies of indiviual differences and/or will be similarly affected by experimental treatments. (p. 139)

He continued, "determining to what extent all, or some, of those variables correlate with one another or are affected alike by experimental treatments is a necessary step in the validation process" (p. 141).

It may be useful here to note the concept of a nomological net as defined by Cronbach and Meehl (1955).

> 1) to "make clear what something _is_" means to set forth the laws in which it occurs.
>
> 2) The laws . . . may relate (_a_) observable properties or quantities to each other; or (_b_) theoretical constructs to observables; or (_c_) different theoretical constructs to one another.
>
> 3) a construct [must] . . . occur in a nomological net, at least _some_ of whose laws involve observables.
>
> 4) "Learning more about" a theoretical construct is a matter of elaborating the nomological network in which it occurs,
>
> 5) An enrichment of the net such as adding a construct or a relation to theory is justified if it generates nomologicals that are confirmed by observation or if it reduces the number of nomologicals required to predict the same observations.
>
> 6) "operations" which are qualitatively very different "overlap" or "measure the same thing" if their positions in the nomological net tie them to the same construct variable. (pp. 290-291)

If the multivariate nature of the set of affective variables was confirmed by this study, then the variables used would suggest specific counteracting experiences which should then be examined in future research for those subjects identified as having the "block". If the hypothesis of a complex interactive relationship between the noncognitive variables and mathematics achievement was confirmed then it would suggest that any experimental manipulation of one variable must be done expecting different effects at several levels of a second.

This study was considered important then because it would delineate the interrelations of a number of variables currently of interest individually and collectively. It was also considered an important first step in the generation of experimental hypotheses. It would provide insight into the the degree of complexity of the attitudinal domain. Moreover, the establishment of a theoretical framework appropriate to a complex conceptualization of attitude variables in mathematics education is the theoretical contribution of this study and will be elucidated in Chapter 2.

RESEARCH HYPOTHESES

Summary of the Problem

The reviewed literature associated with methods of teaching in mathematics education states that an "emotional block" is related to mathematics achievement. The literature also suggests that the "block" is composed of several more specific constructs which are typical of attitude scales: anxiety, enjoyment, value, and self-concept. Achievement responsibility, or locus of control, is also suggested in relation to "learned helplessness".

The literature on attitude toward mathematics indicated that attitude variables are probably related differently to several different referents of mathematics. Therefore, the "block" or affective variables were related to three achievment measures; computation, concepts, and problem solving. It was also argued that complex interactions might exist between the variables, and that the achievement motivation model described three affective constructs which interacted in achievement related activity.

Generalization across Sex

Nunnally (1967) declared that:

> if both sexes are included in an analysis , it is wise to standardize scores separately for the two before correlates are computed. If that is not done, sex should be included as another variable in the analysis. (p. 370)

Rather than standardizing scores separately for the two sexes which would lead to results with effects of sex removed, this study included an analysis for sex effects. It was hypothesized that there would be no significantly different correlations among the affective and achievement variables for males and females. If this hypothesis was not accepted then all the following hypotheses would be tested separately for males and females.

Affective Inter-Scale Correlations

It was hypothesized that there would be significant[1] correlations among the variables associated with the "block."

It was hypothesized that a principal component analysis of the affective variables would result in a three factor solution which, after orthogonal rotation, would be interpretable as the following three factors and their

---

[1]The word significant when unmodified will mean statistically significant.

components.

Factor 1: M-ANXIETY, M-ENJOYMENT, ACHIEVEMENT RESPONSIBILITY
Factor 2: M-SELFCONCEPT
Factor 3: M-VALUE

Affective-Achievement Scale Relationships

It was hypothesized that each of the affective scales would be correlated with each of the three aspects of mathematics achievment. Because the achievement motivation model suggested that the probability of success may have a non-linear relation to achievement it was hypothesized that self-concept would have a relation of the second degree with the measures of achievement. The equivalence of self-concept and probability of success, to be discussed in Chapter 2, was based on logical arguments rather than on empirical findings. Therefore, it was hypothesized that some of the other affective variables would also be non-linearly related to achievement.

It was further hypothesized that when grouped together by multiple regression a sub-set of the independent variables would be correlated more with each of the three achievement measures than any individual independent variable. It was hypothesized that one or more additional variables would add significantly to the variance explained by the variable having the maximum correlation with the achievement variables.

It was also hypothesized that linear composites derived from the factor score coefficient matrix of the rotated solution would correlate significantly with the achievement scores. As the Achievement Motivation model suggested interactions among the three factors of the model, it was hypothesized that the interaction terms of the linear composites representing those factors would add further explained variance to that of the achievement scores.

STATISTICAL HYPOTHESES

Significance versus Strength of Relations

Wherever an appropriate test could be made, the following null hypotheses were tested at the .01 level of significance. This level was chosen to reduce the overall error rate of the analyses. It should be noted that as the sample size was large and as tests of significance are related to sample size that the degree or size of the relation was most important. Thorndike (1971) stated:

> The emphasis on construct validation should be on the strength of each relation rather than merely on its statistical significance. Construct validation aims more at comprehension than numerical results. (p. 465)

In addition the large sample size gave adequate power so that the .01 alpha level would not make the probability of a Type II error inordinately large.

Generalization across Sex

It was hypothesized that:

(1) There would be no significant difference between the

variance-covariance matrix of the males and that of the females.

It should be understood that if the null hypothesis was rejected a separate test for males and females would be made for the following hypotheses.

Affective Inter-Scale Relationships

It was hypothesized that:

(2) There would be no significant correlations among the "block" variables, M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT, and ACHIEVEMENT RESPONSBILITY.

(3) No simple factor structure would emerge from a principal component analysis of M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT, and ACHIEVEMENT RESPONSIBILITY.

(4) If a simple structure emerged from a principal component analysis the orthogonal rotation would not reveal the following loading pattern:

Variable	Factor Loading		
	F1	F2	F3
M-ANXIETY	high	low	low
M-ENJOYMENT	high	low	low
ACHIEVEMENT RESPONSIBILITY	high	low	low
M-SELFCONCEPT	low	high	low
M-VALUE	low	low	high

Affective-Achievement Scale Relationships

It was hypothesized that:

(5) Each of M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT

and ACHIEVEMENT RESPONSIBILITY would not be significantly correlated with each of the achievement measures; computation, concepts, and problem solving.

(6) The quadratic component of each of M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT, and ACHIEVEMENT RESPONSIBILITY would not be significantly correlated with measures of computation, concepts or problem solving.

(7) Linear multiple regression using the "block" variables M-ANXIETY, M-ENJOYMENT, M-VALUE, M-SELFCONCEPT, and ACHIEVEMENT RESPONSIBILITY would not significantly increase the explained variance of the largest of the correlations in (5).

(8) Stepwise regression would not include additional variables beyond the variable maximally correlated with each of the achievement scores.

(9) If a simple structure did emerge then near orthogonal measures from the factor scores would not correlate with the three measures of achievement.

(10) Interactions from the factor scores in (9) would not significantly increase the explained variance of each of the achievement measures.

Chapter 2

RELATED RESEARCH

INTRODUCTION

It was shown in Chapter 1 that an "emotional block" may be characterized by a number of constructs; anxiety, enjoyment, value, and self-concept in mathematics. It was also suggested that if Atkinson's (1956, 1958) theory of Achievement Motivation was used, these variables might interact among themselves and with a measure of achievement responsiblility when related to achievement in mathematics. In this chapter research specifically related to mathematics attitude including anxiety, enjoyment, value, and self-concept of mathematics, and locus of control, is reviewed. In each of the separate sections sex related effects will be noted.

The thrust of the argument in the sections devoted to the individual constructs will be that the more closely the scales measuring the constructs are related to the subject matter in question the stronger the relation between measures of the construct and achievement in the subject area. The theory of achievement motivation will be presented in some detail and a model will be identified based on the theory.

Each of the affective variables will be identified with one of the three constructs of the achievement motivation model.

ATTITUDE VARIABLES

Number of Studies

As an indication of the importance of these variables it should be noted that for the years 1974-1978 16.1% of the dissertations and 9.4% of the journal-published reports as listed by Suydam and Weaver (1974, 1975, 1976, 1977, 1978) in the *Journal for Research in Mathematics Education* included measures of self-concept, anxiety, achievement responsibility or attitude. The numbers and percentages for each of the five years may be found in Table 1.

Table 1

Percentages of Dissertations and Journal-Published Reports Dealing with Affective Variables Listed in the Suydam Reports (1974-78)

	Reports			Dissertations		
Year	N	Total[1]	%	N	Total[2]	%
1974	7	76	9.2	44	299	14.7
1975	5	112	4.5	44	264	16.7
1976	5	99	5.0	37	266	13.9
1977	11	112	9.8	52	273	19.0
1978	26	176	14.8	56	343	16.3
Total	54	575	9.4	233	1145	16.1

[1]Total number of reports
[2]Total number of dissertations

Typical Studies

The importance of the present study stems from the belief, expressed in the mathematics teaching literature, that low achievers have some form of "emotional block" revealed by certain affective characteristics. Although studies have correlated individual variables with achievement and have attempted to change some of the variables experimentally, all the variables have not been considered simultaneously. The multivariate approach was emphasized by Wylie (1974) and Aiken (1970, 1976) when complex phenomena such as self-concept or attitude were to be studied.

DuCette and Wolk (1972) noted that difficulties are encountered when studying dependent variables, such as achievement, using only one independent variable.

> It is also highly characteristic of such research [Internal-External Locus of Control] that highly molar dependent variables such as overall academic performance or social activism have been studied. While such behaviors are undoubtedly more interesting than variables such as level of aspiration or risk-taking, the problem in studying them is that they are so highly overdetermined that the predictability from any one specific variable will be slight. (p. 494)

Underlying the concern for attitude is the notion that positive attitudes would increase the likelihood that a student would attend to mathematics and thereby increase the probability that he would learn. Krathwohl, Bloom and Masias (1964) supported the notion of two different approaches to the study of the relationship between achievement and attitude.

> As viewed from the cognitive pole, the student may be treated as an analytical machine, a "computer" that solves problems. In contrast, viewed from the affective pole, we take greater cognizance of the motivation, drives, and emotions that are the factors bringing about achievement of cognitive behavior. (p. 57)

As an example they continued, "Note for instance the prevalence of girls who dislike mathematics and so cannot learn it" (p. 57). There is an implied relationship of causality.

Khan and Weiss (1973) suggested that the relationship was functional rather than causal. They stated, "academic successes help promote satisfaction with school, which in turn increases the possibility of future successes" (p. 770).

It should be noted here that a number of statements were found which indicated causal relations and yet were based upon correlational data. For example Poffenberger and Norton (1959) studied the differences between a group that liked mathematics and one that did not. They used a number of scales such as the attitude toward mathematics of parents and siblings, and the encouragement and grade expectations of the parents. They concluded "that self-concepts in regard to mathematical ability are well established in the early school years and it is very difficult for even the best teacher to change them" (p. 174). The implication was that if self-concept could be raised then achievement would rise as a result. Another example was that of Lindgren, Silva, Faraco, and De Rocha (1964) who correlated attitude toward problem solving and success in arithmetic as measured by achievement tests. In their discussion of results they asked "Why are problem-solving attitudes more of a factor in arithmetic achievement in some classes than others?" (p. 45). Again, although the study was correlational, there was an implication that poor attitudes cause poor arithmetic achievement.

The correlations of attitude with achievement are usually low but consistent. Aiken (1969) noted that, "the correlations between attitude and achievement in elementary school, although statistically significant, are typically not very large" (p. 9). A number of problems have limited the contribution of predictive power by measures of the affective domain. Limitations of measuring instruments (Aiken, 1973, p. 416), degree of self-insight, conscientiousness with which pupils fill out the inventory (Aiken, 1969, p. 9), and the stability of attitudes varying with the maturity of the pupils (Aiken, 1972, p. 230). As one of the problems noted above was that the affective variables have been studied in isolation, some of the literature associated with each variable will be presented.

ANXIETY IN MATHEMATICS

General Anxiety

There are some conflicting results on the effects of anxiety. Denny (1966) provided evidence that high anxiety, as measured by the Manifest Anxiety Scale, facilitated the achievement of subjects with high intelligence but that the reverse was true for those with low intelligence. Mazzei and Goulet (1969), using the Test Anxiety Questionnaire (TAQ), found that "high anxiety (TAQ) did not unequivocally lead to inferior performance (relative to low anxiety) when Ss are given ego-stress instructions" (p. 602). However, both sets of results indicated a disordinal interaction with high anxiety being more facilitating than low anxiety for students with high intelligence, and more inhibiting than low anxiety for students with low intelligence. The differences in the results of the two studies may be explained by the fact that whereas Mazzei and Goulet used the Test Anxiety Scale (TAQ) Denny used the Manifest Anxiety Scale (MAS). It may be the case that the two scales measured anxiety toward two different sets of objects, situations, or conditions.

The theory behind this possibility was stated by Sarason (1975):

> Our behavior is determined in part by the information available to us. Information at our disposal is, in turn, influenced by whether we attend to it. (p. 175)

He continued

> In my view, a person's level of test anxiety is, to a significant degree a product of experiences that influence what he attends to in himself and the world . . . . Two response components have been emphasized by writers who espouse this view. One is emotional and autonomic reactivity - sweating, accelerated heart rate, etc. The other concerns cognitive events - e.g., saying to oneself while taking a test, "I am stupid," "Maybe I won't pass." (p. 175)

In discussing test anxiety he gave a specific example.

> In Test Anxiety Type A, a person gets upset before, during, and after tests because of relatively isolated unfortunate experiences (for example, a traumatizing teacher in the third grade). Test Anxiety Type B is characterized by (a) anxiety and worry in other areas and (b) conflict and ambivalence over achievement and being evaluated. (p. 175)

That the TAQ and the MAS, measures of anxiety, are related to two different sets of conditions is supported by the results of a study done by Osler (1954). He found that stress related to task performance (failure on a similar testing situation) had different effects than stress resulting from an unrelated source such as a note from the school office about a complaint against the student. The former group displayed depressed test performance, the latter did not. Similar effects of stress resulting from academic failure were found by Gibby and Gibby (1967) who had teachers tell students that they were disappointed with the students' English marks and passed out fail grades as well. They found "a significant decrement in word fluency score following the stress of the experimental conditions" (p. 37). They also found significant changes on five of the six categories of the Intelligence Rating Schedule which asked the student how parents, peers, and themselves would rate their intelligence.

Along this same line Dreger and Aiken (1957) cited a factor analysis by O'Connor of the Taylor Manifest Anxiety

Scale which displayed five distinct factors. From this they argued that attempts to measure more specific anxiety constructs would be more productive. Alpert and Haber (1960) studied the relationships of three general anxiety scales and three specific anxiety scales with the Scholastic Aptitude Test, college grade point average (GPA), and grades given in a psychology course. They found that correlations among the specific scales were higher than those among general scales as well as those between general and specific scales. Further, correlations between general scales and the cognitive tests were typically lower than those between the specific scales and the cognitive tests. (See Table 2).

Table 2

Correlations Between General and Specific Anxiety Scales and Several Measures of Achievement

	Rel	AI	AS	TS	AAT-	AAT+	GPA	Psych	SAT
MAS	.89	.39	.32	.32	.38	-.33	.01	-.08	.10
AI	.84		.34	.28	.37	-.25	-.04	-.05	.13
AS	.73			.38	.30	-.24	-.06	.14	-.24
TAS	.82				.64	-.40	-.24	-.21	-.18
AAT-	.87					-.48	-.35	-.26	-.29
AAT+	.83						.37	.23	.21

Taylor Manifest Anxiety Scale (MAS); Welsh Anxiety Index (AI); Freeman Anxiety Scale (AS); Mandler-Sarason Test Anxiety Scale (TAS); Achievement Anxiety Test-Debilitating (AAT-); Achievement Anxiety Test-Facilitating (AAT+)
(Alpert & Haber, 1960, p. 209.)

They concluded,

> Specific anxiety scales and general anxiety scales measure, to a significant extent, something

> different. Furthermore, it appears that the variable which the specific scales measure, and which general scales do not, is involved in academic performance to such an extent that the specific scales are better predictors of academic performance than are the general anxiety scales. (p. 209)

Alpert and Haber also considered the difference between facilitating and debilitating anxiety. They stated that an absence of response to a negative item may not be a measure of motivation when stress is present and therefore items sampling responses to the positive effects of anxiety should be included in a scale. They found that in three groups (N = 93, 92, 96) the correlations between GPA and the facilitating anxiety scale were .36, .32, .50 and between GPA and debilitating anxiety -.45, -.08, and -.40. However, the combined multiple correlations with the two anxiety scales predicting GPA were .50, .32, and .54.

<u>Specific Anxiety</u>

Suin, Edie, Nicoletti, and Spinelli (1972) citing an earlier publication (Suin, 1970) stated,

> Over one third of the students who actively sought help through a counselling center behavior therapy program described their primary problem as connected with mathematics. (p. 373)

On the basis of this they developed a Mathematics Anxiety Rating Scale (MARS). The scale was composed of 98 items "describing practical situations that involve mathematics e.g., 'working on an income tax form,' 'checking over your monthly bank account,' or 'figuring the sales tax.'" (p.

373). They found that the scale had a test-retest reliability of .78 and a correlation of -.35 with the Differential Aptitude Test. The mean score for the students seeking therapy for mathematics anxiety was 256.9 and that of the norming group was 187.3.

These results on the specificity of anxiety suggested that a scale measuring anxiety in a mathematcs situation be examined and compared to a more general measure. Dreger and Aiken (1957) began the "endeavor to detect the presence of a syndrome of emotional reactions to arithmetic and mathematics tentatively called 'Number Anxiety'" (p. 344). They administered the Taylor Manifest Anxiety Scale (TMAS) to 704 subjects with three items of relatively low reliability replaced by three items relating to number anxiety. They then subjected the fourteen most valid items of the Taylor scale and the three mathematics anxiety items to a cluster analysis. The three mathematics anxiety items clustered together. They found that the three items had a correlation of -.44 with mathematics grade. On the other hand, Szetela (1973) found that Mathematics Anxiety had a strong relation to the Test Anxiety Questionnaire ($p < .0001$).

Some sex differences have been noted. Kahn (1969) correlated achievement anxiety with attitude scores on the SCAT. The correlations were .305 for males and .509 for females. Szetela (1973) found that test anxiety and intelligence correlated -.24 for males and -.11 for females.

In summary these studies indicated that measures of achievement anxiety are better predictors of achievement than more general measures of anxiety. However, there was no clear evidence that mathematics anxiety scales were superior to the tests of achievement anxiety. The studies also indicated possible sex differences.

VALUE

The value component may be divided into at least two sub-constructs; one, the value of mathematics for society, another, the value of mathematics for oneself. No literature was found that indicated which of these value constructs would be the most important for the prediction of mathematics achievement. However, information from the theory of achievement motivation suggested that the value of mathematics for oneself would be the more appropriate. Raynor (1974) stated a generalized theory of expectancy value:

> the strength of tendency to act in a certain way depends upon the strength of expectancy that an activity will result in a consequence and the value of that consequence to the individual summated over all expected consequences of the activity. (p. 126)

In his study he found that

> College students classified high in n-Achievement [need for achievement] and low in Test Anxiety (Ms > Maf) received higher grades in an introductory psychology course, and were relatively more concerned about doing well than anxious when the grade was seen as highly related to future goals than when it was not. (p. 132)

Writing about the same study in a different article Raynor (1970) concluded,

> that a student's characteristic achievement motivation for this particular course is revealed only when immediate performance is important for future career success. (p. 32)

It appeared necessary that some account should be made of the perception students have of the incentives that success in mathematics might have for them. Although the possible set of incentives was large, a number were idenitfied which would possibly be appropriate for upper grade, elementary school students. Career goals, as Raynor suggested, might be important to some elementary school students. They might also perceive success in mathematics as having an effect on their future life, although not necessarily career oriented. They might feel that success in mathematics was important for success in other courses being taken concurrently. If the student valued those future outcomes and courses then that value might have an effect on their orientation to mathematics.

Aiken (1974) developed a Value of Mathematics scale for use at the college level. The scale correlated .27 (Pearson r) with the SAT-M and .40 with high school grades.

SELF-CONCEPT OF ABILITY TO LEARN MATHEMATICS

Global Self-Concept

As with the construct of anxiety it will be argued, with somewhat more consistent evidence, that a measure of self-concept of achievement in a specific subject would predict achievement more strongly than a general measure.

Self-concept has been used in a global sense of self-worth such as "integrity of the whole or any part of his self-structure" (Anderson, 1965, p. 9), or as "a complex and dynamic system of beliefs which an individual holds true about himself, each belief with a corresponding value" (Purkey, 1970, p. 7).

On the other hand, Smith (1960) analyzed 70 bipolar adjectives into five factors: self-esteem, anxiety-tension, independence, estrangement, and body image. He noted that his findings helped explain the poor relationship between tests of self-concept and external criterion of adjustment. "It seems likely that investigators dealt with measures which may have unwittingly confounded several self-concept variables" (p. 191). The notion of a global self-concept appears to have the same problems associated with it as did the notion of a global attitude. The argument will be made that a self-concept scale related to mathematics achievement is the most appropriate for this study.

Specific Self-Concept

The restriction, or narrowing, of the construct has a basis in the literature. Brookover, Erickson and Joiner (1967) defined self-concept of academic ability as being symbolic behavior such that "when individuals publicly define their academic ability, we may observe what we refer to as self-concept of academic ability behavior" (p. 9). To find out if this was an adequate restriction Patterson (1967) correlated a general self-concept of academic ability (SCA) and several specific subject oriented scales with subject achievement. He found that

> the specific SCA Scales were, with one exception, significantly better predictors of achievement in the parallel subject than was the general SCA scale. (p. 163)

However, sex differences occurred. Patterson (1967), in the same study, found that "Among female 'uniform' achievers, the general SCA scale is a significantly better predictor of specific grade achievement than are the specific SCA Scales in all subjects except social studies" (p. 163). This was not true for males. In a study related to mathematics achievement Bachman (1970) found that a general self-concept of ability scale predicted mathematics achievement better than either the mathematics self-concept or social studies scales. However, with intelligence controlled the mathematics self-concept predicted mathematics achievement better, for males, than did the general self-concept. For girls, the mathematics self-concept scale and the general self-concept scale were equally good predictors. (See Table 3.)

One problem associated with Bachman's study is that

Table 3

Correlations between General Self-Concept of Ability, Mathematics Self-Concept, Social Studies Self-Concept, and Mathematics Achievement[1]

Variables Correlated with Math Achievement	Zero-Order Correlations		IQ Controlled	
	Males	Females	Males	Females
General Self-Concept	.45	.60	.20	.37
Math Self-Concept	.48	.55	.29	.36
Social Studies Self-Concept	.32	.46	.03	.20

[1] Bachman, 1970, p. 176.

when a general intelligence scale was used to partial out results of a "cognitive" character it partialled out some of the desired variance insofar as the intelligence scale contains numerical items. Indeed, when mathematics achievement was controlled the correlation between mathematics self-concept and intelligence was .05 for males and -.16 for females (Bachman, 1970, p. 177). It should be noted that using a more general self-concept scale Piers and Harris (1964) found no sex differences.

From the evidence cited there is no clear-cut superiority of a mathematics self-concept of ability scale over a general scale. However, the findings of other studies indicated a consistent trend in that direction. For example, Piers and Harris (1964), using their own wide range self-concept scale, found that its correlation with grade six achievement was .32. Koch (1972) correlated the Tennessee Self-Concept Scale, another wide range scale, with mathematics achievement and found a relation of .25. These results were quite low compared to the results of Bachman noted above. Moreover, the use of a measure of general intelligence as a covariate may have masked a stronger relationship than has been demonstrated. Finally, in terms of the face validity of the construct it was considered more appropriate to use the mathematics self-concept of ability scale than a general scale.

LOCUS OF CONTROL

Although locus of control had been studied in the context of achievement, the work appeared to have been done by individuals interested in the construct itself rather than by mathematics educators. Some of the lack of interest could be attributed to the seemingly conflicting findings of a number of studies.

Hjelle (1970) found no relationship between quality point average (QPA) of grades given at university and Rotter's Internal-External Locus of Control scale (I-E). He gave two possible explanations. First

> there may be an over abundance of college Ss who have arrived at an external view of the world as a defense against failure but who are initially highly competitive. Thus, externals would still maintain comparatively strong achievement motivation in clearly structured competitive situations. . . . Second, the I-E dimension is probably not generalizable across situations, and in the highly structured academic achievement situation there is probably more specificity determining QPA than in other kinds of competitive situations. (p. 326)

If the first explanation is true then the relationship between grades and locus of control should be studied at at younger age. However, Weston (1968) correlated arithmetic achievement with styles of learning, responsibility for intellectual academic achievement, and parental attitudes. He found that measures on the Intellectual Achievement Responsibility Questionnaire were not related to grade six mathematics achievement and only to problem solving and total arithmetic at grade four.

It should be noted that the Intellectual Achievement Responsibility Questionnaire is a scale more specific to achievement than the Rotter scale. Thus Hjelle's second explanation for low correlations with achievement appeared to be unsatisfactory. Crandall, Katkovsky and Crandall (1965) using the same scale found that it correlated positively and significantly with almost all the scales of the Iowa Test of Basic Skills for children in grades 3, 4, and 5 but only occasionally related to scales on the California Achievement Test in grades 6, 8, 10, and 13. It would appear then, that the locus of control variables might be related to mathematics achievement at a younger age. However, as the relationship is not large enough nor consistent enough to be considered an "emotional block", the situation may be more complex than can be described by simple first order correlations.

Wolk and DuCette (1973) studied the relationship of an achievement motivation scale with an estimate of success at "pursuit rotor tasks", an estimate of the level of task difficulty preferred by the subject, an estimate of the percentage of fellow students who would be surpassed by the subject on a psychology examination, performance on midterm and final exams in psychology, and performance on the Scholastic Aptitude Test Verbal and Quantitative scales. The correlations were calculated for each of the two levels on Internal-External Locus of Control. Table 4 shows that with one exception only the internal subjects demonstrated significant correlations. That exception is with the quantitative scale of the SAT. The "significantly different correlations between variables for the moderated groups" (Wolk & DuCette, 1973, p. 66) suggested that locus of control was a moderator variable. That is to say, the correlations between achievement and the studied measures differed among groups of subjects who were at different levels on the I-E dimension.

The data suggested that locus of control may be acting as a moderator variable for other noncognitive variables. This may be a third explanation of the low and inconsistent relations between this variable and achievement. Another example is that of Lintner and DuCette (1974) who studied locus of control, academic failure and student response to praise. On a coding task they found a disordinal interaction for males on locus of control and praise, whereas, females showed a small, non-significant response to praise. On a second task, the Gates-McGintie Reading Test, they found sex

Table 4

Correlations between an Achievement Motivation Measure and Various Behaviors for Internal and External Locus of Control Subjects

	Internals	Externals	Z(int-ext)[1]
Ps est Task[2]	-.28**	+.01	1.24
Ps est Test[3]	-.29**	+.04	1.65**
Preference	+.44***	+.10	1.81**
Test Perf Midterm	+.39***	-.14	2.70***
Test Perf Final	+.37***	-.04	2.09**
SAT Verbal	+.41***	-.09	2.18**
SAT Quantitative	+.33**	-.27*	3.02***

*p < .10 **p < .05 ***p < .01

[1]Z statistic of the difference between the scores of the Internals and the Externals.

[2]Estimated probability of success at the pursuit rotor task.

[3]Estimated proportion of fellow students surpassed by the subject.

differences on the main factors of prior failure, and praise, but no interactions within the sex factor. Again interactions appeared inconsistently within the same study. Daniels and Stevens (1976) using Rotter's I-E scale found a disordinal interaction with instructional methods. Therefore, because of the potential interactions between locus of control and the other affective variables it was deemed important to include this variable in the present study.

The only information found that specifically related locus of control to sex was Crandall, Crandall and Katkovsky (1964) who found that there were no significant differences.

SUMMARY OF INDIVIDUAL AFFECTIVE VARIABLES

In summary, the literature dealing with affective variables showed that the relation of the variables with mathematics achievement was significant but low. However, the literature outside the area of mathematics education, particularly that related to achievement motivation, suggested an alternative approach to the conceptualization of the variables as an inter-related set with some of the variables acting as moderators of others. That is, the relationship of one variable with a second may be different at several levels of a third. An example of this was Marjoribanks' study (1976). She found that with 12 year old English children the relation between attitude and achievement varied with level of ability. This line of argument led to the hypothesis that a much more complex function than had been tested might relate mathematics achievement to the affective variables of this study. In Chapter 1 it was suggested that looking for interactions and non-linear relationships with no theoretical framework could not be justified. However, the Achievement Motivation Model did provide such a framework and will therefore be presented in some detail.

THE MODEL OF ACHIEVEMENT MOTIVATION

Achievement Motivation

Assumptions of the model. It should be understood in the following discussion that in the literature of Achievement Motivation the words "motive" and "motivation" are not used synonymously. Feather (1966 b) described motive as a latent disposition of personality whereas strength of motivation depended upon level of expectation and incentive value.

Atkinson and Reitman (1956) were quite specific:

> we conceive a <u>motive</u> as a latent disposition to strive for a particular goal-state or aim, e.g.; achievement, affilliation, power. . . . The term <u>motivation</u> can then be used to designate the aroused state of the person that exists when a motive has been engaged by the appropriate expectancy, i.e.; an expectancy that performance of some act is instrumental tc attainment of the goal of that motive. (p 361)

Achievement Motivation has a large literature exemplified by the works of Atkinson (1958), Atkinson and Feather (1966), Atkinson and Raynor (1974), Atkinson and Reitman (1956), Weiner (1972), and Weiner and Kukla (1970). It is a specific instance of instrumentality theories which are "distingushed by the hypothesis that the behavior of an individual is in part determined by a) his expectations that the behavior will lead to various outcomes and b) his evaluation of those outcomes" (Mitchell & Biglan, 1971, p. 432). Differences between these theories concern

> the way in which subjective probability is included in the different analyses. The discrepancy concerns whether or not concepts which are akin to utility in various models are taken to be independent of subjective probability. (Feather, 1966, p. 32)

Atkinson's model gives motives and incentive values independent status and he suggests that "the valence or utility of an incentive may be considered as a function of strength of motive and incentive value (Feather, 1966 a, p. 35) The theory of Achievement Motivation proposes that both the individual's expectation of success and failure and his evaluation of that success and failure be assessed.

Atkinson's (1974) model of Achievement Motivation is really one of resultant achievement oriented tendency. He assumes,

> that all individuals have acquired a motive to achieve (Ms) and a motive to avoid failure (Maf). That is to say all persons have some capacity for interest in achievement and some capacity for anxiety about failure. . . . One of these motives produces a tendency to undertake activity . . . . It is assumed that the two opposed tendencies combine additively and yield a resultant achievement oriented tendency (p. 18)

Algebraically, Tr = Ts + T-f where Tr stands for resultant tendency, Ts for success oriented tendency and T-f the failure avoidance tendency. However, the success component is modified by the expectation of success at the task and by the incentives which may accrue upon successful completion of the task. Although motivation to succeed is enhanced by the ease of the task it may also be somewhat decreased by the reduced incentive to expend energy on an easy task. The failure component is modified in a parallel way but in the opposite direction. Again, algebraically;

$$Ts = Ms \times Ps \times Is \quad \text{and,}$$

$$T\text{-}f = Maf \times Pf \times If$$

where Ms, Ps, and Is are, respectively, motivation toward success, probability of success and incentive value of success. Maf, Pf and If are, respectively, motivation to avoid failure, probability of failure, and the incentive value of failure. The six independent variables are reduced in number by postulating that the sum of the probability of success and the probability of failure is one (1.0). Two other postulates reducing the number of variables are that the sum of the incentive value of success and the probability of success is one (1.0) and that the incentive value of failure is the negative of the probability of success. Symbolically these assumptions are:

$$Is = (1 - Ps),\ Pf = (1 - Ps) \text{ and, } If = -Ps$$

<u>The model and empirical support</u>. Litwin (1966) tested the hypothesis that estimated value of success was a negative linear function (1 - Ps) of the estimated probability of success. He had subjects designate a monetary value to be associated with various rings on a ring toss game. He found that

> the estimates were linear, and the average slope of all the value estimates was approximately equal to the 1 - Ps line. However, the slope of the achievement-oriented *S*s value estimates was somewhat larger than the 1 - Ps line. (p. 114)

Combining the above expressions:

$$Tr = Ms \times Ps \times (1 - Ps) + Maf \times (1 - Ps) \times (-Ps)$$

$$= (Ms - Maf) \times Ps \times (1 - Ps)$$

This last expression led to a quadratic interaction of Ms - Maf with Ps^2. There was some empirical support for this interaction.

Probability of success is assessed by asking subjects their perception of their potential level of achievement (Atkinson & Feather, 1966; Moulton, 1974). This was considered similar to the measurement of self-concept of ability to learn. Brookover and Erickson (1969) held that positive self-concept was a necessary but not sufficient condition for achievement.

> Although a significant proportion of students with high self-concepts achieved at a relatively lower level (approximately 50 per cent), practically none of the students with low self-concepts of ability achieved at a high level. (p. 106)

When graphed with achievement as the abcissa and self-concept as the ordinate this would appear much like an inverted capital "L" (r) which would suggest a quadratic relation.

Karabenick and Youseff (1968) grouped pairs of words into three sets. The sets of words were to be used in a paired associate learning task. The three groups of words were equated on mean difficulty and on the variance of difficulty. The three groups were randomly designated easy, intermediate, or hard. Different colors were associated with each group. The words were presented to the subjects in their respective colors. The subjects were told the significance of the colors. The results of the study showed that:

> persons for whom Ms > Mf [Mf is equivalent to Maf] performed better than those for whom Mf > Ms at tasks designated as being of intermediate difficulty, but the performance of these groups did not differ when tasks were easy or difficult. In addition, whereas persons for whom Ms > Mf tended to perform better at intermediate difficulty tasks, than at easy or difficult tasks, persons for whon Mf > Ms performed better on easy or difficult tasks than at those designated as being of intermediate difficulty. (p. 418)

This was supported by Feather (1961) who found that subjects with Ms > Mf tended to persevere longer at tasks perceived as being of intermediate difficulty than those which were perceived as being easy or hard. On the other hand, subjects with Mf > Ms tended to persevere at easy or difficult tasks. It might be expected that if subjects tended to behave as Feather found then achievement would be higher on those tasks at which the subjects tended to persevere.

In summary, the achievement motivation model suggested that the levels of Motivation to Succeed, Probability of Success, and Value of Success influenced the degree of attention and perseverance. The present author held that in the school situation variations in perseverance would lead to variations in academic achievement. These relations, which may be represented as follows, will serve as the Achievement Motivation model used in the present study.

```
1. Motivaticn to Succeed
                                    Attention
2. Probability of Success  --->                 ---> Achievement
                                   Perseverance
3. Value of Success
```

The arrows above serve only to indicate a relationship. It is not intended that they imply a causal relationship, nor that the direction is only as indicated.

There were five variables identified in the section of the "emotional block" in mathematics; anxiety, enjoyment, value, self-concept and achievement responsibility. Yet the Achievement Motivaticn model is tripartite. The following discussion will relate each of the five variables to one of the three levels of the Achievement Motivation model which are indicated in the above diagram. That the model is quite flexible in this respect is supported by Moulton (1974) who stated

> it is recognized that the total strength of tendency to perform a task requiring skill includes tendencies associated with other incentives contingent upon successful performance. An important fact about many of these "extrinsic" incentives such as social approval, prestige, money, etc., is that the more difficult the task is perceived to be by others, the greater the magnitude and/or quality of these incentives received as a result of success. (p. 81)

The "block" variables were associated with each of the achievement motivation categories, as presently worded, in the following way.

Variables of this Study Related to the Model

Level one: motivation to succeed. Anxiety about mathematics was, in this study, related to the Motivation dimension (Ms - Maf). Motivation to succeed has usually been assessed by using the Thematic Aperception Test. However, the test is somewhat unreliable in that "the conditions under which the testing is done may be sufficiently motivating to produce marked changes in the level of achievement or affiliation imagery for the groups as a whole" (Atkinson, 1958, p. 35). The Test Anxiety Questionnaire has been typically used to measure the motivation to avoid failure. In some studies rather than using the difference between measures of Ms and Maf a measure of Maf has been used by itself. In the present study the achievement motivation model was used to suggest possible interactions between variables and not to validate the model itself. Therefore it was proposed that Mathematics Anxiety closely corresponded to the Test Anxiety Questionnaire and was therefore related to the motivation dimension of the model.

Enjoyment of mathematics was considered somewhat the opposite of anxiety. Sandman (1973) found a correlation of -.76 between anxiety and enjoyment of mathematics, tending to confirm this supposition. Therefore, enjoyment was also associated with Motivation to Succeed.

Achievement Responsibility, or locus of control, is closely related to the theory of Achievement Motivation. Weiner (1972) held that persons with low achievement motivation felt that effort did not influence the outcome of an activity and that the opposite was true for persons with high achievement motivation. As this dimension was represented by achievement responsibility it was proposed that achievement responsibility would also correspond to motivation to succeed. Woulk and DuCette (1973) commented on the degree of correspondence of the two theories.

> Both theories, for example, make predictions about the type of risk that certain subjects prefer, ... persistence, shifts in level of aspiration, and success estimation . . . . Even more than this, both theories make very similar predictions about the performance of certain subjects on these dependent variables. . . Indeed, there is so much

> overlap in these theories in both theoretical structure and predictions that a question can be raised as to their discriminant validity. (p. 61)

<u>Level two: probability of success</u>. Self-concept of mathematics achievement was considered to be related to Probability of Success. The technique for assessing the probability of success (Ps) was "simply to ask <u>S</u>s to state their own probability of success with respect to tasks" (Moulton, 1974, p. 79) or an estimate was often inferred from the value give to achieving at a certain level at a task or from an estimate of the proportion of the population the subject would surpass at the task. These procedures appeared to be reasonably close to asking students to evaluate the strength of agreement with items such as, "This task is easy" or "This task is hard." As this was close to what the student was asked to do in assessing the self-concept of his ability in mathematics, self-concept was associated with probability of success.

<u>Level three: value of success</u>. Value of Mathematics was considered close to Value of Success in the Achievement Motivation model and therefore was associated with that dimension.

The hypothesized relationships between the three levels of variables of the theory of Achievement Motivation and the five variables of interest in this study may be summarized as follows:

Motivation to Succeed = Anxiety in Mathematics

+ Achievement Responsibility
+ Enjoyment of Mathematics

Probalility of Success = Self-Concept of Ability in Mathematics

Value of Success = Value of Mathematics

It was not expected that there would be a clear distinction among these three levels of the Achievement Motivation model because of the already identified relations between some of the constructs of this study. For example Kempler (1962) administered the Luchin's water jar test which he termed a mechanization on problem solving scale to 107 college students. He identified 30 students as rigid problem solvers and 30 as nonrigid. He found that on a questionnaire of self-confidence in mathematical ability rigid students were significantly less confident than nonrigid and that the rank order correlation between results on the Luchin's water jar test and the self-confidence questionnaire was .32 ($p < .01$). He stated "the rationale for this study was that low self-confidence should arouse anxiety which in turn will lead to rigidity" (p. 51). Moreover, DeAnda (1977) found that the Intellectual Achievement Responsibility Scale accounted for 12% of the variance of the Coopersmith Self-Esteem Scale. This corresponded to a correlation of .35. However, Siu (1973) classed the Intellectual Achievement Responsibility Scale, the Test Anxiety Scale for Children and the Gumpgookies' Motivation to Achieve Scale as motivation scales. Because of these conflicting results and interpretations the above relationships are deemed a reasonable hypothesis.

SUMMARY

In this chapter the literature related to the five "emotional block" variables was examined and evidence presented that scales measuring those constructs should be closely related to the subject area being considered. One of the constructs, anxiety, had somewhat ambiguous evidence in this respect. Therefore both specific and general scales were included. It was also argued that the five variables could reasonably be associated with one of the three independent constructs of the Achievement Motivation model. This model was also used to justify testing non-linear and interactive hypotheses. In general the evidence pointed to potential sex related effects which would have to be taken into consideration.

Chapter 3

INSTRUMENTATION, DESIGN AND PROCEDURE

INTRODUCTION

In Chapter 1 it was shown that there is a literature indicating that a significant proportion of mathematics students appears to have an "emotional block" inhibiting their achievement in mathematics. Anxiety, enjoyment, value, and self-concept of mathematics were identified as the components of the "block". The Achievement Motivation model was used to suggest possible interactions among the components when related to achievement motivation. A further variable, locus of control or achievement responsibility, was suggested by the model.

In Chapter 2 it was argued that the more closely an attitude scale was related to a subject area the more strongly correlated it would be with achievement in that area. It was further suggested that although there was some evidence that anxiety in mathematics is more highly correlated with mathematics achievement than a more general measure, that a general measure should be included. Evidence of sex related effects occurs in the literature and therefore the statistical design was constructed accordingly.

In this chapter, the instrumentation, design and procedure will be described. The results of a preliminary analysis concerning the decision to include or exclude TASC in the testing of the major hypotheses will be presented. The procedure used for eliminating inter-class differences will also be described.

INSTRUMENTATION

As four of the seven affective scales used in this study were taken from the Sandman (1973) battery, a general description of his study will be presented. The details associated with each of the four scales will be described in the sections related to the individual affective constructs. Following that the three achievement scales and the teacher response scales will be discussed.

The Sandman Study

Sandman's review. In his study Sandman (1973) reviewed the construction and validation procedures used for some of the more prominent mathematics attitude scales such as Dutton's (1954) Thurstone Scale, Aiken and Dreger's (1961) Mathematics Attitude Scale, (which has a number of items similar to those used on anxiety scales), Hoyt and McEachern's (1958) scale, and Hoyt's (1960) fifteen sub-scale Minnesota Pupil Opinions Scale. He also reviewed Ericksen's (1962) study in which the Hoyt-McEachern scale was divided into six sub-scales, and Antonnen's (1967) use of the Hoyt scale in the longitudinal study of mathematics attitude. In the Antonnen study factor loadings of the scales on the principal component were used to generate a single score for attitude. In general, Sandman's criticisms were that the sub-scales were formed on a basis of face validity, no attempt at item factor analysis was made, and that only correlations with other mathematics attitude scales, achievement and IQ were presented. These data established only convergent validity.

For example, he cited Mastantuono and Antonnen (1971) who administered Dutton's Thurstone Scale, a Likert-type version of Dutton's scale, Hoyt's Minnesota Pupil Opinions Scale, a semantic differential scale developed by Antonnen, an intelligence test, and the Iowa Test of Basic Skills. The correlations among the attitude scales were between .66 and .79; the correlations of attitude with achievement and intelligence ranged, respectively, between .07 and .25, and .03 and .14. The attitude scales tended to measure something in common, and they had a relationship with mathematics achievement slightly stronger than with intelligence.

Sandman cited several multi-dimensional scales of attitude. Hussen (1967) used one in the International Study of Achievement in Mathematics. The sub-scales were attitude toward mathematics as a process, attitude toward the place of mathematics in society, and views about mathematics teaching. However, Sandman noted that the reliabilities were so low that

Johnson (1970) was advised not to use the scales when he asked permission to use them.

A second multi-dimensional scale noted by Sandman was that used in the National Longitudinal Study of Mathematics Achievement (Romberg & Wilson, 1969). Each of the seven sub-scales is a Likert scale. They were Math vs. Non-Math, Math Fun vs. Dull, Math Easy vs. Hard, Actual Math Self-Concept, Ideal Math Self-Concept, Facilitating Anxiety, and Debilitating Anxiety. There was no attempt to validate the scales in terms of the stated constructs but some evidence from relationships between results on the preliminary forms and other variables was noted. It was quite clear from Sandman's review that attitude scale construction in mathematics education had proceeded rather haphazardly and at a somewhat unsophisticated level.

<u>The Sandman Scale Construction</u>. Attitude measures have been less than adequate because of confounded constructs as well as confused referents. As noted in Chapter 1, Sandman (1973) was quite critical of the construction of attitude scales. His alternative was to take items from seven of the already cited attitude instruments, rewriting many and assigning them to one of eight constructs: Perception of the Mathematics Teacher by the Student, Anxiety Toward Mathematics, Value of Mathematics in Society, Self-Concept in Mathematics, Perception of Mathematics Class, Perception of Mathematics Materials, Enjoyment of Mathematics, and

Motivation in Mathematics.

Although the scales were similar to the scales used in the National Longitudinal Study of Mathematics Achievement, Sandman noted that many of the items in those scales did not appear to be measuring the constructs of interest and that some of the vocabulary used seemed inappropriate for younger secondary students. Ten items for each construct were selected for a preliminary scale (equal positive and negative items) and the scales were distributed to persons skilled in test construction and mathematics education. The Materials Scale was eliminated, as were two items from each of the other scales, because of a lack of consistency of the items. This left seven scales of eight items each. The scales were piloted, and on the basis of correlations between the items and the scales four questionable items were identified and reworded. The scales were then administered to 2547 students in grades eight and eleven in California and Indiana. The item correlation matrix was subjected to principal component analysis followed by varimax rotation. Seven factors emerged, six of which could be identified with the six attitude constructs that the instrument was designed to measure. As the items of the Perception of the Mathematics Class scale did not load on the seventh factor, the scale was eliminated. The correlations between the six remaining scales are shown in Table 5.

Table 5

Correlations Between the Sub-scales of the Sandman Inventory

	1	2	3	4	5
1 Teacher	1.00				
2 Anxiety	-.46	1.00			
3 Value	.36	-.40	1.00		
4 Self-Concept	.34	-.72	.33	1.00	
5 Enjoyment	.41	-.76	.45	.66	1.00
6 Motivation	.36	-.64	.45	.59	.76

Basis of Scale Selection

It is on the basis of the more rigorous construction of the Sandman scales and their identifiable factor structure that four of the scales were selected for use in this study. The Teacher scale was not used because perception of the teacher by the student did not appear from the literature to be related to an "emotional block" in mathematics. The Motivation scale was not used because only three of eight items loaded on the motivation factor. Thus, scales measuring anxiety in mathematics, enjoyment of mathematics, value of mathematics, and self-concept of mathematics ability were all taken from the Sandman battery. Apart from the reasons that will be given for each of the scales specifically, some general considerations that governed the selection of the Sandman scales for this study were:

(1) The development of the scales was based upon a set of constructs similar to that used in the National Longitudinal Study of Mathematics Achievement. These constructs had appeared in other various, often used

mathematics attitude scales. It was apparent then that these constructs were of recognized importance. As the items were selected from the pool of items contained in a number of popular attitude scales, construct similarity was further ensured.

(2) Sandman followed a credible procedure in construction of his scales: construct identification, item selection, face validation by experts, pretest analysis, re-writing, and then empirical validation of scales by factor analysis of the items.

(3) Factor analysis of the Sandman scales could be an aid to the interpretation of the results of the present study. To the extent that the scales shared common variance and items could be shown to load on factors associated with other variables, an explanation of various finding would be enhanced.

(4) The length of the Sandman scales was an important consideration. Together with the addition of the value of mathematics for society scale, the Test Anxiety Scale for Children, and three achievement tests some two hours of testing time was represented. Although longer scales often have greater reliability, the increased administration time of a number of longer tests would likely have caused reduced reliability because of fatigue. In addition it was felt that the coefficients of homogeity of the scales (.77 to .86) were quite

acceptable.

For further justification of the inclusion of each of the scales refer to the corresponding section in the following more detailed analysis.

ANXIETY IN MATHEMATICS

From the evidence presented in Chapter 2 it was concluded that specific achievement anxiety scales tended to relate more strongly to achievement than did general anxiety scales. However, it was not clear that mathematics anxiety scales were more strongly related to achievement in mathematics than a more general anxiety scale. Therefore two anxiety scales were included in this study; Sandman's (1973) Anxiety Toward Mathematics Scale and Sarason's (1958) Test Anxiety Scale for Children.

Sandman factor analysed the items of this scale along with other attitudinal items. The analyis produced loadings of the items from the anxiety scale on the identified anxiety factor as follows; .20, .31, .54, -.34, .58, .62, .58, -.24. The second and eighth items loaded -.59 and .61 on the enjoyment factor. This accounts to some extent for the correlations of the anxiety and enjoyment scales (-.76). The scale is reproduced below. The numbering is not the original.

1. I feel at ease in a mathematics class.
2. When I hear the word mathematics, I have a feeling of dislike.

3. I feel tense when someone talks to me about mathematics.
4. It doesn't disturb me to work mathematics problems.
5. Working with numbers upsets me.
6. It makes me nervous to even think about doing mathematics.
7. It scares me to have to take mathematics.
8. I have a good feeling toward mathematics.

Several reasons led to the selection of this scale. First, there were positive as well as negative items in the scale, which was shown to be important by Alpert and Haber (1960). Second, the scale was short yet had a moderately high internal consistency (.86) compared with the reliability of .82 of the TAQ (Alpert & Haber, 1960). Third, although the scale correlated with another, the existing factor analysis identified the individual items accounting for the degree of overlap, thus aiding interpretation.

The Test Anxiety Scale for Children (TASC) (Sarason, Davidson, Lighthall & Waite, 1958) was selected as the more general achievement anxiety scale because it was the school age analog of the Test Anxiety Questionaire which was developed for college age students. (See the first set of 30 items in Appendix D.) as can be seen from Table 2 in Chapter 2 the results of the Alpert and Haber (1960) study indicated that the test anxiety measures were more strongly associated with achievement measures than were the more general measures of anxiety. The TASC was a relatively short, 30 item, test with a four month test-restest reliability of .666 (Sarason, Davidson, Lighthall, Waite & Rubush, 1960)

ENJOYMENT

Scales measuring enjoyment of mathematics and value of mathematics were developed by Aiken (1974). The enjoyment scale had an Alpha Coefficient .95 and correlated .38 with the mathematics scale of the Scholastic Aptitude Test and .23 with high school grade. As the scale was developed for college students it was felt that one written for younger students would be more appropriate. Sandman's scale filled this need. It was felt that an internal consistency of .85 for an eight item scale was acceptable for this study. Again the items from this scale loaded on a single factor when analysed together with other attitude items. According to the Sandman analysis the loadings were .73, .62, -.55, -.47, -.49, .47, .32 and .32. Item 4 loaded on the anxiety factor and item 8 on the self-concept factor. The scale is reproduced below. The numbering is not the original.

1. Mathematics is something which I enjoy very much.
2. Working mathematics problems is fun.
3. I would like to spend less time in school doing mathematics.
4. I don't like anything about mathematics.
5. I would like a job which doesn't use any

mathematics.

6. I enjoy talking to other people about mathematics.

7. I like to play games that use numbers.

8. Mathematics is more of a game than it is hard work.

VALUE

Value of Mathematics to Society

Although Aiken (1974) had developed a value of mathematics scale it was felt that the shorter Sandman scale written for the lower secondary grades was more appropriate.

It has been argued that Sandman's set of scales was a carefully constructed, well documented instrument. The established inter-relationships of the scales (See Table 5.), it was argued, would aid interpretation in the present study. However, Sandman's factor analysis indicated a degree of independence and validity of the value scale. The item loadings on the value of mathematics for society were .55, -.45, .41, .58, .64, .61, and -.45 with item 8 loading .31 on the anxiety factor. The items are reproduced in the next section together with the items from the Value of Mathematics for Oneself Scale. It should be noted that the Sandman scale, 8 items long, had an internal consistency of .77.

Value of Mathematics for Oneself

It has been argued that the measures of the value of mathematics used in this study should include items pertaining to incentives related directly to the student. Neither Sandman's (1974) Value of Mathematics to Society nor his Motivation in Mathematics scales fit this criterion. It was felt that, in addition to the Value of Mathematics to Society Scale, a scale more student-oriented should be included. To accomplish this end, a scale purporting to measure Value of Mathematics for Oneself was developed by the present author. It was developed from a number of items selected from various attitude scales and reworded to suit the reading and comprehension levels of grade 6 students. Wherever possible the items were constructed parallel to those of the Sandman value scale. Because of the established validity of the Sandman value scale, items were chosen that closely parallel the items of that scale. The two scales are compared below.

Value of Math to Society	Value of Math for Onself
1. Mathematics is useful for the problems of everyday life.	1. Mathematics is useful for my problems in everyday life.
2. There is little need for mathematics in most jobs.	2. There is little need for mathematics in the jobs I would want.
3. Most people should study some mathematics.	3. Doing well in mathematics helps me in other subjects.
4. Mathematics is helpful in understanding today's world.	4. Mathematics helps me understand today's world.
5. Mathematics is of great importance to a country's development.	5. If I got better marks in mathematics I would enjoy mathematics more.
6. It is important to know	6. It is important for me to

mathematics in order to get a good job.	know mathematics in order to get a good job.
7. You can get along perfectly well in everyday life without mathematics.	7. I can get along perfectly well in everyday life without mathematics.
8. Most of the ideas in mathematics aren't very useful.	8. Most of the ideas in mathematics aren't very useful to me.

SELF-CONCEPT OF ABILITY IN MATHEMATICS

Although Patterson (1967) and Bachman (1970) used scales of self-concept of ability to achieve in mathematics, the scale in the Sandman (1973) battery was used. The major reason was that the Sandman scale appeared as a factor when the items, along with other attitudinal items, were subjected to factor analysis. The loadings of the items on the anxiety factor were -.62, .68, .56, -.49, -.31, .69, .38, and -.17. Item 2 loaded .31 on the enjoyment factor while items 4, 5, and 8 loaded .46, .32, and .39 respectively on the anxiety factor. The internal consistency was .83. The scale is repreduced below. The numbering is not the original.

1. I don't do very well in mathematics.
2. Mathematics is easy for me.
3. I usually understand what we are talking about in mathematics class.
4. No matter how hard I try, I cannot understand mathematics.
5. I often think, "I can't do it," when a mathematics problem seems hard.

6. I am good at working mathematics problems.
7. I remember most of the things I learn in mathematics.
8. If I don't see how to work a mathematics problem right away, I never get it.

LOCUS OF CONTROL

The scale selected to measure locus of control was the Intellectual Achievement Responsibility Scale (Crandall, Katkovsky & Crandall, 1965). They stated that "there has been no demonstration so far that such beliefs [in locus of control] are consistent across all areas of experience" (p. 93). As their major concern was with school achievement they developed the IAR scale which differed from Rotter's (1966) I-E scale, Battle & Rotter's (1963) Children's Picture Test of Internal External Locus of Control, and Bailer's (1961) Locus of Control Scale in several respects. First, the other scales "contain items describing reinforcement in a number of motivational and behavioral areas such as affiliation, dominance, achievement and dependency" (p. 93). Second, the other scales

> include a variety of sources and agents such as luck, fate, impersonal social forces, more-personal "significant cthers," etc., the IAR limits the source of external control to those persons who most often come in face-to-face contact with a child, his parents, teachers and peers. (p. 93)

In their initial administration of the scale they found a two month test-retest reliability of .69 for the whole scale, no significant sex differences, moderate correlations with IQ (.26 at grades 3, 4, 5: .16 at grades 6, 8, 10, 12) and socio-economic status (.08 at grades 3,4, 5: .11 at grades 6, 8, 10, 12). They noted that the Locus of Control Scale and the Children's Picture Test had a much stronger relationship to socio-economic status than the IAR scale. In a second study (Crandall, Crandall & Katkovsky, 1965) they found that the scores on the negative items, the positve items, and the total scale for both younger and older children, resulted in only two significant correlations with the Children's Desireability Questionaire (a measure of the degree to which children give socially desired responses): -.26 for younger children on the total I-E scale and -.15 for older children on the positive items. It should be noted that in this latter study they analysed the success items and the failure items separately. This procedure was also used by Lintner and DuCette (1974). They felt that as the positive and negative scales correlated .45 they would combine them. Because of the low correlation the two scales were considered separately in this study. They were referred to as the Intellectual Achievement Responsibility Scale - Success (IARS) and the Intellectual Achievement Responsibility Scale - Failure (IARF).

ACHIEVEMENT TESTS

The set of achievement scales was made up of the Mathematics Concepts and Mathematics Problem Solving scales (level 12) from the Canadian Test of Basic Skills : Form 4 and the Arithmetic Computation test from Stanford Achievement Test (1964). The Canadian Test of Basic Skills (CTBS) was selected because it was standardized and validated on 30 000 Canadian subjects. Further, its precursor, the Iowa Test of Basic Skills, often had been used in attitude - achievement studies (e.g., Antonnen, 1974; Mastantuono, 1971; and Weston, 1968).

In a review of the CTBS Birch (1972), McDonald Professor of Education, McGill University stated,

> Unless a user is able to select an appropriate sample of subjects, carry out his own item analysis and reliability and validity studies, he must accept, on the reputation of the test designer, many of the bases upon which his conclusions are made. It is thus reassuring to be able to use a test like _the Canadian Test of Basic Skills_. It is in fact, simply a Canadian version of the well known _Iowa Test of Basic Skills_. (p. 16)

Form 4, although not metricated, reflected some recent curricular changes made in British Columbia. Even though teachers had been using the metric system exclusively in mathematics classes in the three years preceding the testing, the British system of measurement was still in common use in the community and the students had been taught that system in earlier grades. Moreover, only two items required knowledge of the relation between units (e.g., Which of the following measurements is the greatest? 1) 5 quarts 2) 6 pints 3) 1 gallon 4) 3 quarts 1 pint.). Thus it was felt that the scale was valid and that if students could not answer the questions the effect would be consistent across the sample.

There was no computational scale included with the Canadian Test of Basic Skills. The Arithmetic Computation scale of the SAT: Form W (1964) was selected to fill this void. Riedesel's (1965) only criticism of the Stanford Achievement test was the emphasis on computation in light of changes in mathematics content emphasis. However, as the scale was being selected for use as a computational instrument, the criticism was considered an advantage. Further, as there had been no change in the format of the presentation of computational questions the early date was not deemed significant. In more recent versions the number of questions had been reduced. However, an advantage to this version was that it was well reviewed, widely accepted and still used by the school district participating in this present study.

TEACHER RESPONSE SCALES

In order to give some strength to the construct validation of the chosen affective scales in relation to the characteristics associated with the "emotional block" in mathematics, teachers' opinions were sought about pupils who may have such blocks. Two methods were used. The first was a response to a check list of nine characteristics using each student as a referent. The characteristics were behaviors that students with an "emotional block" might exhibit. This was similar to the procedure used by Sarason, Davidson, Lighthall and Waite (1958) in their initial validation of the Test Anxiety Scale for Children (TASC). They asked teachers to respond to a 17 item scale of anxiety behavior which included items such as

> Does the child exhibit unwarranted fidgeting (e.g., squirming, restless behavior) when called upon to recite in class?
>
> Does the child become upset or anxious when a test is announced in class or he is called upon to recite? (p. 106)

In the current study it was hypothesized that an "emotional block" existed which would lead to negative forms of behavior in response to mathematics thus reducing achievement. The Krathwohl, Bloom and Masias (1964) taxonomy of affective objectives was used to construct the check list items. It was felt that the level of affect displayed by students with an "emotional block" would be high in the taxonomy. Level 2.3, Satisfaction in Response, was the lowest level at which responses could fall and still be considered a "block."[1] Krathwohl et al stated that

> The testing for overt manifestations of satisfaction involves two matters: (1) deciding which behaviors

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[1] They noted that "the categories of the affective domain structure are developed to handle primarily positive values rather than aversions, fears, and dislikes." However, they continued, "It is believed that, with very little interpretation..., the framework can be used for those 'negative' types of objectives one is likely to find in the school curriculum" (p. vii).

> are indicative of satisfaction; (2) developing a method of systematically recording the manifestations of satisfaction. (p. 133)

The above quotation was a positive statement of affect whereas the construct of an "emotional block" was negatively oriented. A negative statement at the same level would have "satisfaction" replaced with dissatisfaction, aversion or dislike. Examples in the taxonomy included behaviors such as voluntary statements, laughing, and various body movements.

The next level in the taxonomy was 3, Valuing. The Krathwohl et al description was,

> At the lowest level of Valuing, he is at least willing to permit himself to be so percieved and at the higher levels he may behave so as to further this impression actively. (p. 139)

For example a student who remarked directly to the teacher that he hated mathematics would be considered at level 3.2, Preference for a Value. Avoidance behavior and involuntary physical reactions would be interpreted as being at level 3.3, Commitment, because Krathwohl et al stated, "there must also be a considerable investment of energy in the object or phenomenon".

There was no attempt to have teachers gather evidence of affective responses above level 3. For example, level 4.1, Conceptualization of a Value, required

> evidence that the student has developed evaluative judgements with regard to the object he values; (2) evidence of abstract or symbolic thinking about the value object; (3) evidence of generalization about a set or class of values of which the object is a member. (p. 157)

Apart from all teachers not having opportunities to observe such behavior, the list of behaviors would have become unacceptably long.

The list of characteristics were identified from the literature cited in Chapter 1. An attempt was made to sample both verbal and physical behaviors and to follow the examples of Sarason et al (1958). The list of behaviors had to be kept short otherwise, for a class of 30 students, the required number of responses would increase rapidly and thus tend to reduce the amount of consideration given to each response. The following nine characteristics were decided upon. A short label appears in parentheses following each one. These labels will be used in the subsequent tables and discussion.

While the student is <u>doing mathematics</u> have you observed that he/she

1. tends to give random answers to questions during mathematics class? (Random Answers)

2. appears tense during mathematics lessons? (Appears Tense)

3. expresses anxiety or nervousness about mathmetics? (Expresses Anxiety)

4. tends to increase disruptive behavior during mathematics class? (Disruptive Behavior)

5. says that no matter what he/she does he/she can't do mathematics? (Expresses Inability)

6. has hands that shake when doing mathematics? (Hands Shake)

7. says that mathematics is useless? (Says Mathematics Useless)

8. sometimes refuses to answer questions during

mathematics period? (Refuses to Answer)

9. fidgets more during mathematics lessons? (Fidgets More)

Appendix A has the complete set of instructions given to the teachers for the use of this scale. As this was a teacher-response, student-behavior checklist, and the behaviors entered the analysis individually this was referred to as the set of student behaviors or simply Student-Behaviors.

The second form of teacher response was to have them rank the students as to the degree to which they felt the students fit a description based upon the above characteristics. The description follows:

> A student with the block may give random answers to questions or may refuse to answer them at all. He/she may appear tense, have hands that shake as he/she writes, fidget or increase disruptive behavior in the mathematics class. The student may tell you that he/she feels anxious or nervous about mathematics or that mathematics is useless. He/she may state that no matter how hard he/she works it seems to make no difference.

The procedure for ranking was a simple ordering of all the names of the grade six students in the class in terms of the above characteristics. The set of instructions given to the teachers for the above scale may be found in Appendix B. This measure was referred to as RANK.

AGE AND GRADE LEVEL CHOSEN

Antonnen (1969) studied the differences in attitudes between 1017 students in grades 5 and 6 and the same group of students in grades 11 and 12. He found that attitude scores declined sharply. Evidence cited earlier in the discussion of locus of control suggested that this study be done with students who were as young as possible in order to reduce the likelihood of students "arriving at an external view of the world as a defense against failure" (Hjelle, 1970, p. 326).

However, the ability of the students to answer self-report items in a discriminating manner suggested that the sample be chosen from an older group if possible. The Sandman inventory was written for grade 8 students and had been administered successfully to that group. The Intellectual Achievement Responsibility Scale was developed for school children in both elementary and secondary levels.

It would appear that the optimum grade level was grade eight. But because, in the locale of this study, there was an elementary-secondary school split between grades seven and eight the present study was done with grade six subjects. Grade seven students were not selected because it was felt that at the time of the testing, spring, they would be quite concerned about their forthcoming move to the secondary school.

It was also noted by Aiken (1976) that "The late elementary and early junior-high grades are viewed as being particularly important to the development of attitude toward mathematics." (p. 269)

Because the Sandman scales had not been administered to grade 6 students, there was some concern about the appropriateness of the language and phrasing in the items. In order to compensate for lower comprehension levels, the items of all scales were recorded on tape by the present author. The tape was then duplicated and played back to the students as the scales were being presented in written form.

SUBJECTS

The subjects were selected from a large school district in British Columbia. There were 64 elementary schools and annexes enrolling approximately 14 000 students. The district bridged both rural and urban areas with little industry or business. The largest proportion of the working population commuted to a nearby urban center.

For administrative convenience the district was divided into five areas: two residential-commercial areas, two residential areas interspersed with small farms, and one farmland area.

As there were materials for approximately 450 students, it was possible to administer the tests and questionnaires to 14 to 16 classes at a time. Schools within each area were contacted in order of size and were asked to take part in the study. This was done until the set of materials was committed. In this manner some 63 classes from

29 schools were contacted. Because of last minute considerations such as sports days and camping trips the final number of classes was 59. Three more classes were eliminated from the study because teachers failed to supply all the requested information. The final sample consisted of 56 classes from 26 schools with 1186 students participating.

As much of the analysis was to be done with complete sets of data, subjects who missed taking a test were eliminated, thus giving the final total of 1033 subjects from grade six. Some of the classes in the study were composed of grades five and six, or six and seven. Such classes were called "splits". These splits are referred to as "class types" in the following text. Only the grade six subjects from these classes were included in the study although grade five and seven students were included in the administration of the tests at the teacher's request. Table 6 summarizes the class type, sex and number of subjects.

Table 6

Table of Class Type, Sex and Number of Subjects

	Classes	Boys	Girls	Total
5-6 split	11	53	63	116
6 only	33	410	380	790
6-7 split	12	66	61	127
Total	56	529	504	1033

PILOT

A pilot study was conducted to assess the adequacy of the written instructions for both students and teachers, the handling of the materials, the audibility of the tapes, and reliability of the experimenter made Value of Mathematics for Oneself Scale. The two teacher response scales were included for purposes of evaluating the administrative instructions and the response procedures. No attempt was made to gather evidence for the reliability of teacher responses, or of the validity of the two scales as it was considered that the number of teachers in the pilot sample was too small. A school in the same district was selected. Two classes, with a total of 50 students, undertook the pilot administration. A meeting with the participating teachers was held in order to convey the purpose of the pilot. The teachers were asked to be as critical of the format of test booklets, response sheets and the administration booklet as possible. They also were asked to indicate any sources of difficulty or confusion that arose during the administration. The final forms of the materials may be found in Appendices A, B, C, D, and E. A description of the set of materials given to each teacher will be found in the section entitled "Materials".

The eight items of the Value of Mathematics for Oneself Scale were administered together with eight randomly selected items from the achievement responsibility scale and six items from the Test Anxiety Scale for Children. Items from the three scales were included because of the different response formats and administration instructions.

As a result of the pilot the administration booklet was reorganized and some wordings changed. The Hoyt estimate of the reliability of the Value of Mathematics for Onself Scale was .63 which was considered adequate in the light of the large sample of the main study. It should be noted that the large sample would not affect the reliability (unless the test variance was increased) but would tend to balance the effect of increased error variance in the testing of hypotheses. Item-scale correlations were calculated after the item scores were corrected for reverse polarity. All the items had positive correlations ranging from .17 to .56. The mean was 17.56 and the standard deviation was 5.15 with a maximum possible of 40 and a minimum of 8.

MATERIALS

Affective Scales

Each teacher was given an administration booklet which outlined the order in which the materials were to be administered, the timing of the test administration, and the instructions that were to be read to the students before the students were to begin responding. See Appendix C for the complete administration booklet.

The affective scales were split into three parts each characterized by response style. The Test Anxiety Scale for Children (TASC), the first part, required the students to respond yes or no. The second part, the Intellectual Achievement Responsibility Scale, required the students to select one of two possible alternative statements which they thought best completed a sentence. Items from the two scales were placed in the same order as in the original study of Crandall, Katkovsky, and Crandall (1965). Part three was composed of items from the four affective scales selected from the Sandman battery (Anxiety Toward Mathematics, Value of Mathematics in Society, Self-Concept in Mathematics, Enjoyment of Mathematics), and an author constructed scale Value of Mathematics for Oneself. The response mode for this set of items was a five point Likert scale; strongly agree, agree, don't know, disagree, and strongly disagree. Items from each of the scales used in the third part were randomly ordered. The reported reliabilities of each of the scales together with the number of items and the abbreviations used in the text can be found in Table 7. For a fuller description of each of the scales see Chapter 3.

The three parts together with directions and examples for the students were placed into a booklet which is reproduced completely in Appendix D. An added benefit of the order noted in Table 7 was that the scales pertaining specifically to mathematics were placed last. Thus, a bias toward mathematics would not be present when the students

Table 7

Table of Scales, Abbreviations, Number of Items for the Affective Scales

Scale	Abbr.	Items
Test Anxiety Scale for Children	TASC	30
Intellectual Achievement Responsibility: Success	IARS	17
Intellectual Achievement Responsibility: Failure	IARF	17
Anxiety Toward Mathematics	MANX	8
Enjoyment in Mathematics	ENJOY	8
Value of Mathematics	VALSOC	8
Self-Concept in Mathematics	SELFCON	8
Value of Mathematics for Oneself	VALSEL	8

answered the more general scales. TASC was placed first because the response mode was considered to be the simplest and therefore a good introduction to responding to an affective scale.

It was felt that differing reading abilities of students might affect the number of questions answered on the affective scales and the level of understanding with which the students responded to the items. In order to reduce these effects a cassette tape was prepared with the experimenter reading the items. Twenty copies were made of the tape to ensure consistency of the oral delivery. The student responses were, for all the above scales, made on one response sheet. The sheet was developed especially for this study in order to facilitate key-punching of the data directly from the sheets. See Appendix E for an example of the answer sheets.

Achievement Tests

The three achievement tests were to be administered in the following order: Arithmetic Computation, Mathematics Concepts, and Mathematics Problem Solving. This order was chosen because it was thought that the computation scale would be the most familiar and should be first. The concepts and problem solving scales were contained in the standard CTBS booklet and were administered in the order that they appeared. This tended to reduce complexity of the administration. It was also thought that the word problems may have tended to increase anxiety more than the concepts questions and, as anxiety was one of the characteristics under examination in this study, the placing of the problem solving scale last would eliminate its effect on the other scales.

The tests, names, abbreviations used in this study, the number of items, reliability, and the publisher's normed means for grade six appear in Table 8.

Each of the tests had a multiple choice response format. Again students responded on a special answer sheet to facilitate key-punching. As the first items for this grade level in the CTBS was item 52 for the concept scale and 40 for the problem solving scale the response sheets were numbered accordingly. See Appendix E for an example of the answer sheets.

Table 9 summarizes the sequencing of the tests and the

Table 8

Scales, Abbreviations, Number of Items, Reliabilities, and Normed Means of the Achievement Tests

Scale	Abbr.	Number of Items	Rel.	Norm Mean
Stanford Achievement Test:				
Arithmetic Computation	COMP	39	.87	24.3
Canadian Test of Basic Skills:				
Mathematics Concepts	CONC	45	.86	20.1
Problem Solving	PROB	31	.83	13.3

most desirable timing of the test administration.

Table 9

Prefered Sequence and Spacing of Scale Administration[1]

	Mon.	Tues.	Wed.	Thur.	Fri.
Morning	TASC break IARS IARF	MANX VALSEL VALSOC SELFC ENJOY	no tests	COMP	PROB
Afternoon				CONC	

[1]In all cases the sequencing and the two day separation between affective and achievement tests were to be maintained. Timing could be altered to suit the school organization. Timing here refers to time at which the tests should be administered, not the time allowed for the testing session.

PROCEDURE

Materials for approximately 375 students were assembled. This set was sufficiently large to administer to the students of one geographic region. The administration of the tests was done in 5 sessions, each a week long, one for each of the five geographic regions. After the initial contact had been made with the principals of the participating schools, all teachers of a region with classes involved in the study were invited to a meeting. At the meeting the purpose and description of materials were given. Questions about use of the results, confidentiality of the data, and time required were answered.

A set of materials was provided to each participating teacher. It included an administrative booklet, a set of cards for ranking the students on the description of a student who might have an "emotional block" in mathematics, a set of IBM mark-sense cards, one for each student, upon which they recorded the students identification number and observed Student-Behaviors, a class set of the affective scale booklets, a copy of the cassette tape, answer sheets for the three affective scales, a class set of each of the Stanford Arithmetic Test and the Canadian Test of Basic Skill booklets, and answer sheets for the achievement tests.

The affective scales were administered before the achievement scales in order to reduce possible effects of the longer achievement testing session. It was suggested to the teachers that the affective scales be administered in two sessions; preferably on two consecutive mornings. However, because of school organization and platooning the only absolute requirements were the test order and the rest period between each of the three groupings of scales; TASC, IAR, and the attitude scales.

The achievement tests had similar requirements with a two day lapse between the administration of the affective and achievement scales. See Table 9 above for the preferred administration schedule.

DATA DESCRIPTION

For each student the following pieces of data were gathered: identification number, sex, teacher identified behaviors from the Student Behavior checklist, rank on the description of behaviors that may be associated with an "emotional block" in mathmatics, three achievement test scores, and eight affective test scores.

Teacher Responses

Sex was coded 1 for male, 0 for female. The teachers were asked to mark the number on IBM cards which corresponded to an observed behavior from the Student Behavior checklist. Blank cards were allowed. The rank was obtained by having the teachers put the names and identification numbers of the students on the cards provided. They placed the cards in order from most to least like the description provided. They then copied down the identification numbers of the students in the order that they appeared on the cards. Appendix B has the instructions given to the teachers. The identification numbers were then numbered from 1 to the number of students in the class by the experimenter. A rank score was obtained by giving all students above the median rank a one (1), and those below a zero (0).

Affective Scales

The TASC scale, which consisted of yes and no answers, was coded 1 if yes and 0 if no. The items of the IARS and IARF scales were made up of two alternative endings to a given statement. The alternatives were coded 1, 2. Items with negative polarity were reversed. MANX, and VALSOC, SELFCON, ENJOY, and VALSEL were 5 level Likert scales which were coded Strongly Agree = 1 to Strongly Disagree = 5. For each of the five scales those items with negative polarity were reversed. For each of the eight affective scales the score on each was calculated by adding up the value of the items. Because some of the items were omitted, the scores were adjusted by using the following author developed formula which had the effect of replacing the missed items with a value equivalent to the mean of the answered items.

$$Y = \frac{(N + M)}{N} \sum_{i=1}^{N} Xi$$

In the formula above N denotes the number of answered items, M denotes the number of omitted items, and Xi the item score. Thus a student who typically chose higher valued item responses would have the unanswered items weighted more heavily than would a student who chose the lower valued item responses.

Data Reliability

The data were key-punched by the staff at the university computer center. Because of the volume of data, several computer programs were written by the author to check for key-punching errors. As each item had a limited number of possible answers, a computer program was written to check through all the data and select those student records that had responses out of range. Another key-punching error was the dropping or the adding of an item or two thus finishing a set of data in the wrong column. A computer program was written to print out the number of the last column of each of the scales. These were then checked with the original answer sheets. A third program was written to calculate the scores for the three achievement tests which were then scanned. Any set of scores which was widely divergent was checked. A random set of 50 answer sheets for both the affective and achievement scales were checked item by item with the edited data. The resulting error rate was 0.5%.

An item analysis program, LERTAP, (Nelson, 1974) was run on the affective scales and each item was checked for extreme loadings which might indicate incorrect coding, reversing, or scoring. Only one item on one scale, IARF was negative (-.01). The item was checked for proper selection and polarity and found correct. Reliabilities were calculated before further analyses because of the shortness of the Sandman scales and because the study used subjects two years younger than the sample Sandman used for development. There was a slight attentuation of reliability, the largest of which was VALSOC which showed a drop from .77 to .69. Of greater concern were the drops of IARS, from .66 to .52 and IARF, from .74 to .59. However, the reliabilities were considered adequate, particularly as the sample size (1033) would give adequate power for the analyses.

Achievement Tests

A similar procedure was carried out on the achievement scales. Each item was examined for extremely low or negative correlations with the whole test which may have indicated incorrect coding, reversing, or scoring.

Only one item on the three achievement tests had a distractor which had an equal or higher correlation with the whole scale than did the correct response. This item was checked for keying and coding and found correct. The Hoyt estimates of reliability for the tests were calculated and are reported in Table 10 together with the means, standard deviations, maximums and minimums of the scales.

PRELIMINARY ANALYSES

Before the hypothesized models were tested two preliminary issues had to be addressed: the first was the unit of analysis and the second was whether or not TASC should be included in the ensuing analyses.

Table 10

Means, Standard Deviations, Maximum Score, And Hoyt Reliability for the Achievement and Affective Scales

N = 1033

Scale	Mean	S.D.	Min	Max	Hoyt Rel.	Rep. Rel.[1]
COMP	18.76	7.33	0	39	.88	.87
CONC	23.94	8.54	0	45	.88	.86
PROB	16.33	6.23	0	32	.85	.83
TASC	12.55	5.78	0	30	.84	.67[2]
IARS	29.52	2.39	17	34	.52	.66
IARF	27.54	2.83	17	34	.61	.74
MANX	18.89	5.94	8	40	.81	.86
VALSOC	31.91	4.91	8	40	.69	.77
SELFCON	28.33	5.94	8	40	.81	.83
ENJOY	24.95	6.81	8	40	.82	.85
VALSEL	29.81	5.23	8	40	.68	.69

[1]Reported reliability.
[2]Four month test-retest reliability.

Unit of Analysis

The literature upon which the hypotheses were based invariably used the individual as the unit of discussion or analysis. However, the majority of the literature was based on studies in experimental psychology in which individuals could be randomly assigned to treatment groups. In this study subjects were part of intact groups and it was held desirable to remove class effects in the case that a student's self-concept, for example, was not formed independently of the environment or class in which the student found himself. For example, Fennema and Sherman (1978), in their review of the literature on sex related differences in mathematics achievement, stated that

The spotty nature of the finding of superior

> mathematics [for males] which was always found in conjunction with a host of less favourable attitudes by females, suggests that important negative influences may exist within the schools themselves. (p. 202)

The unit of analysis issue was resolved in two steps; the first dealing with differences among class means, and the second with differences among class variances.

In the first step univariate analyses were done for each of the eleven variables within each class type (grade level split) using computer programs from the Statistical Package for the Social Sciences (SPSS) (Nie, Hull, Jenkins, Steinbrenner & Bent, 1975). Of the 33 analyses the null hypothesis was not rejected at the .05 level in only 9 cases: TASC, IARS, AND IARF in the grade 5-6 split, MANX and SELFCON in the grade 6 classes, and TASC, MANX, SELFCON, and ENJOY in the grade 6-7 split. See Table 11 for a summary of these results. A table of the 56 class means and standard deviations may be found in Appendix F. The grand means for the affective scales were: TASC, 12.5; IARS, 29.5; IARF, 27.5; MANX, 18.9; VALSOC, 31.9; SELFCON, 28.3; ENJOY, 25.0; and VALSEL, 29.8. The grand means for the achievement tests with the normed means in parentheses were: COMP, 18.8 (24.3); CONC, 23.9 (20.1); and PROB, 16.3 (13.3). Because the class means were significantly different in most if not all cases it was decided to adjust the raw scores by taking deviations from the class means.

For the second step a Bartlett-Box tests of

Table 11

Univariate Analysis of Variance Using Each of the Achievement and Affective Variables as Independent Variables and Class as Dependent Variable

Variable	MSB	df Between	MSW	df Within	F ratio	F prob
Grade 5-6 split						
COMP	116.1	10	42.94	105	2.71	.005*
CONC	117.5	10	59.04	105	1.99	.041*
PROB	66.7	10	31.06	105	2.15	.027*
TASC	24.7	10	25.15	105	.98	.463
IARS	7.3	10	4.67	105	1.56	.129
IARF	9.3	10	8.10	105	1.15	.333
MANX	103.2	10	29.11	105	3.55	.001*
VALSOC	54.5	10	21.18	105	2.57	.008*
SELFCON	55.8	10	26.41	105	2.11	.030*
ENJOY	135.6	10	43.23	105	3.14	.002*
VALSEL	77.2	10	29.06	105	2.66	.006*
Grade 6 only						
COMP	318.3	32	42.97	756	7.41	.000*
CONC	422.7	32	60.24	756	7.02	.000*
PROB	172.2	32	33.89	756	5.08	.000*
TASC	93.0	32	32.89	756	2.83	.000*
IARS	11.0	32	5.67	756	1.94	.002*
IARF	18.1	32	7.47	756	2.42	.000*
MANX	41.6	32	35.98	756	1.16	.254
VALSOC	60.1	32	22.96	756	2.62	.000*
SELFCON	47.5	32	36.23	756	1.31	.118
ENJOY	87.0	32	44.49	756	1.96	.001*
VALSEL	74.1	32	25.38	756	2.92	.000*
Grade 6-7 split						
COMP	179.4	11	37.46	115	4.79	.000*
CONC	355.5	11	39.80	115	8.93	.000*
PROB	204.6	11	18.99	115	10.77	.000*
TASC	39.2	11	29.01	115	1.45	.160
IARS	11.8	11	5.07	115	2.33	.013*
IARF	25.6	11	6.92	115	3.70	.000*
MANX	28.7	11	30.03	115	.96	.490
VALSOC	48.0	11	19.46	115	2.47	.008
SELFCON	57.0	11	32.71	115	1.74	.073*
ENJOY	54.8	11	43.23	115	1.27	.252*
VALSEL	44.8	11	20.52	115	2.19	.020

*p < .05

homogeneity of variance for the class variances were calculated. This was done with the classes grouped again according to grade type, and also on all classes together. This analysis was also done by a computer program from SPSS. As can be seen from Table 12 when all classes were grouped only two variables CONC and IARS showed significant differences in variance between classes.

Table 12

Table of the Results of the Bartlet-Box Tests of Homogenieity Of Variance on Each of the Affective And Achievement Measures

	Grade Organization							
	5-6 Split		6 Only		6-7 Split		Combined	
Scale	STAT	PROB	STAT	PROB	STAT	PROB	STAT	PROB
CALC	1.11	.35	1.45	.05*	1.18	.30	1.30	.07
CONC	1.52	.12	1.55	.02*	1.09	.36	1.54	.01*
PROB	.37	.96	1.02	.44	.61	.83	1.04	.40
TASC	.95	.49	1.34	.10	1.43	.15	1.32	.06
IARS	1.20	.29	1.11	.31	2.45	.005*	1.39	.03*
IARF	.92	.51	1.17	.23	1.96	.03*	1.26	.10
MANX	1.04	.41	1.25	.16	1.25	.25	1.22	.12
VALSOC	.77	.66	1.12	.29	.66	.78	.95	.58
SELFCON	.94	.50	1.45	.05*	.86	.58	1.26	.09
ENJOY	1.04	.40	.75	.84	.95	.49	.82	.83
VALSEL	.41	.94	1.56	.02*	.66	.78	1.17	.18

*p < .05

Since moderate departures from the assumption of homogeneity of variance do not seriously affect the sampling distribution of the F-statistic (Winer, 1971, p. 205) it was decided not to reject the null hypothesis that there would be no significant differences among the class variances. The analyses proceeded as if all the class variances were estimates of the same pooled variance. Thus the deviation scores were standardized within each class to a mean of 0 and a standard deviation of 1.

From the tests of analysis of variance and homogeneity of variance on separate types of class organizations (splits) it appeared that none of the grade groupings was any more extreme than the other. Therefore, grade type groupings were not considered in further analyses.

The effects of the standardization on the inter-scale correlations may be seen in Table 13. The differences are slight. In all future discussion the word "scores", when used in conjunction with achievement or affective scales, will mean scores standardized within class with mean zero and standard deviation one.

Inclusion or Exclusion of TASC

The second preliminary question to be considered was whether or not the Test Anxiety Scale for Children (TASC) was to be included in further analyses. This decision rested on whether or not TASC could be shown to measure something different from Anxiety in Mathematics (MANX) and which scale could be shcwn tc have greater predictive and concurrent validity in the measurement of anxiety in the mathematics classroom. All correlational and linear regression analyses

Table 13

Table of Correlations Between Achievement and Affective Variables Using Scores Standardized Within Class, and Raw Scores*

		COMP	CONC	PROB	TASC	IARS	IARF	MANX	VSOC	SCON	ENJOY
COMP		1.00									
CONC	S	.64	1.00								
	R	.70									
PROB	S	.66	.66	1.00							
	R	.69	.72								
TASC	S	-.23	-.33	-.28	1.00						
	R	-.24	-.33	-.31							
IARS	S	.16	.09	.10	-.14	1.00					
	R	.16	.13	.13	-.14						
IARF	S	.01	-.03	-.06	.08	.26	1.00				
	R	.03	.01	-.03	.09	.28					
MANX	S	-.42	-.39	-.35	.33	-.25	.02	1.00			
	R	-.36	-.33	-.32	.32	-.24	.01				
VALSOC	S	.18	.25	.17	-.09	.16	.09	-.36	1.00		
	R	.16	.21	.15	-.03	.18	.12	-.36			
SELFCON	S	.45	.49	.45	-.43	.26	-.07	-.71	.34	1.00	
	R	.41	.46	.43	-.44	.27	-.04	-.72	.32		
ENJOY	S	.32	.27	.27	-.11	.22	.07	-.72	.41	.55	1.00
	R	.25	.21	.22	-.09	.21	.10	-.72	.42	.55	
VALSEL	S	.17	.19	.14	-.03	.16	.10	-.37	.67	.30	.49
	R	.15	.16	.12	.02	.16	.12	-.37	.70	.29	.51

*S = Standardized score correlations, R = Raw score correlations

were performed using the Triangular Regression Package (TRP) written and supported by the University of British Columbia computing staff (Le & Tenisci, 1977).

First, the correlation between MANX and TASC was .32. This indicated that the two scales were measuring different constructs. Moreover from Table 14 it can be seen that MANX accounted for a greater proportion of variance in the achievement variables than did TASC. Although MANX and TASC

Table 14

Squared Correlations Between MANX, TASC
and the Achievement Variables

	COMP	CONC	PROB	MANX
MANX	.17	.15	.13	1.00
TASC	.05	.11	.08	.10
MANX + TASC	.18	.20	.16	

combined to contribute a significant proportion of explained variance ($p < .001$), the additional proportion of explained variance attributable to TASC was at most 5% in the case of CONC. However, when compared with the proportion of variance explained by MANX alone (15%), the 5% was considered substantial. On the other hand the data in Table 15 showed that when the other mathematics affective scales were taken into account the increase in explained variance of the achievement variables when TASC was added was at most 2%. It appeared that the influence of TASC was small. In terms of construct validity MANX appeared to be the most appropriate measure to use in the following analyses. However, the issue of whether or not MANX could be shown to have a degree of concurrent validity as a measure of mathematics anxiety was still to be addressed.

Table 15

Partial Ccrrelations, and Multiple Squared Correlations of TASC when Predicting Achievement Scores

	Partial Correlation of TASC[1]	F prob	Squared[2] Multiple R Without TASC	Squared[2] Multiple R With TASC
COMP	-.0341	.446	.2192	.2193
CONC	-.1218	.006	.2447	.2560
PROB	-.1597	.0004	.2069	.2271

[1]All other affective variables held constant.
[2]All other affective variables in the regression equation.

There were two validating measures used. The first of these was RANK (the ranking by teachers of students on a description of behaviors which may be associated with an "emotional block"). The second was the set of observed behavioral characteristics of anxiety noticed by teachers in the mathematics classroom. The RANK scores were dichotomized within each class, the lower half having a score of zero (0) and the upper half a score of one (1). To give some evidence of consistency point biserial correlations were then calculated between RANK and each of the behavioral characteristics. They ranged between .09 and .23. See Table 16.

A table of intercorrelations of the characteristics may be found in Appendix H. Treating each of the behaviors as an item of a test, a Hoyt estimate of reliability was calculated. The result was .70. This was not a legitimate use of the Hoyt estimate as the 1033 response sets were made by only 56 teachers. Although it did suggest that the teacher report variables were consistent with each other, it may also have been a result of the "halo effect."

> Typically a strong initial positive or negative impression of a person, group, or event tends to influence ratings on all subsequent observation. (Isaac & Michael, 1971, p. 58.)

In turn, only one of the teacher report variables, #6, Hands Shake, correlated more strongly with with TASC than it did with MANX. The difference was not significant. In addition the correlations of the behaviors with the achievement variables, although not high, are all in the expected direction. The negative correlations are an artifact of the scoring of the behavioral characteristics; one for the presence of the behavior and zero for its absence. A summary of these data may be found in Table 16. This evidence of concurrent validity, in addition to that of the construct validity noted above, suggested MANX was the most appropriate variable to retain for the analyses of the hypotheses of the study.

STATISTICAL PROCEDURES

Statistical Significance

The level of significance chosen for this study was .01. This level was chosen in order to reduce the overall error rate for the entire set of analyses. It was felt that this was necessary because of the large number of implied tests of significance in regression analysis. Indeed, for any

Table 16

Inter-correlations among RANK, Characteristics from a Behavioral Checklist, the Achievement Variables, TASC, and MANX

	Characteristic									
	1	2	3	4	5	6	7	8	9	RANK
RANK	-.33	-.40	-.34	-.18	-.26	-.16	-.18	-.17	-.26	1.00
TASC	.13	.14	.16	.04	.09	.10	.07	.08	.13	-.22
MANX	.23	.20	.23	.13	.18	.09	.16	.09	.18	-.36
COMP	-.34	-.24	-.25	-.17	-.19	-.10	-.14	-.14	-.29	.40
CONC	-.32	-.24	-.26	-.14	-.21	-.12	-.17	-.15	-.25	.42
PROB	-.30	-.25	-.25	-.13	-.22	-.10	-.15	-.11	-.25	.41

1. Random Answers 2. Appears Tense 3. Expresses Anxiety 4. Disruptive Behavior 5. Expresses Inability 6. Hands Shake 7. Says Mathematics Useless 8. Refuses to Answer 9. Fidgets More

single selection of a variable as the strongest predictor from amongst k independent variables, Kupper, Stewart, and Williams (1976) suggest that alpha divided by k would be an appropriate level with which to control Type I error. They also note that this would increase the probability of a Type II error which may be just as serious and that a more liberal alpha could be chosen "when specific significant relationships are anticipated a priori" (p. 14). Therefore, as the number of independent variables for the tests of this study typically were between three and seven, an alpha level of .01 was considered reasonable. In addition, because of the large size of the sample, the power was considered adequate to keep the Type II error rate to an acceptable level.

Sex Differences

The null hypothesis was that there was no significant difference between the variance-covariance matrix of the males and that of the females. Although sex differences are often noted in terms of differences between means, the hypotheses of the present study were correlational in nature or, as in the case of the factor analysis, dependent upon the variance-covariance matrix. Differences between means were of little importance. However, for interest, the raw score means and differences were examined and included in Appendix G. In the event that the null hypothesis was rejected separate analyses by sex were to be undertaken. To reduce the risk of a Type II error this hypothesis was tested with p = .10. Glass and Stanley (1970) note that "It might be adviseable in some circumstances to run a risk of a Type I error as large as .10, . . . to insure a reasonable power for a test" (p. 287). The Box procedure as described by Winer (1971, p. 595) was used and was calculated by a one way multivariate analysis of variance program (OWMAR) developed by the Faculty of Psychology at the University of British Columbia.

It should be understood that in the following description it was assumed that a separate analysis for males and females was to be done if the null hypothesis of equal variance-covariance matrices was not accepted. However, for brevity the description will be of one test.

Affective Inter-Scale Relationships

The null hypothesis of no significant Pearson product-moment correlations between affective scales was tested with $p = .01$. The F ratios and probabilities were calculated by the computer program, Triangular Regression Package (TRP) (Le & Tenisci, 1977)

To study the independence of the affective variables a principal component factor analysis was performed followed by orthogonal varimax rotation. The results were compared with the factor structure predicted by the Achievement Motivation model.

All factor analyses, rotations and factor score coefficient generations were performed with the Alberta General Factor Analysis Program (AGFAP) at the University of British Columbia computer centre. The program was authored by Hakstian and Bay (1973).

Reasons for using the results of the principal component analysis rather than the results of a common factor analysis were (1) the current study was considered to be one of exploration, (2) orthogonal or near orthogonal measures were desired, and (3) there was no indeterminacy present in the factor score coefficient computation (Hakstian & Bay, 1973, p. 42-3.)

Two criteria were used to determine the number of factors to be retained in the analysis; the Kaiser-Gutman eigen-value criterion and the Cattell "scree" test. The Kaiser-Gutman criterion stated that the number of factors to be retained should equal the number of eigen-values greater than 1.00 as "this marks the last factor with significant alpha coefficient cf homogeniety" (Cattell, 1966, p. 207). The "scree" test suggested that the number of factors to be retained should be determined by the "scree" remaining at the bottom of the curve when the eigen-values were plotted from highest to lowest.

> Typically the curve falls in a curvilinear fashion and then becomes absolutely straight (except, sometimes, for minor, irregular departures). . . . In large samples there are usually clear representations of _two_ not one, successive straight scree slopes. In this case one takes the line of the upper slope. (Cattell, 1966, p. 206)

To study the factor structure the components were orthogonally rotated using the varimax procedure. Cattell (1966) noted that all analytic methods (methods maximizing a single mathematical function) of finding simple structure by rotation of factors were subject to limitations. However, Nunnally (1967) stated

> The varimax method has proved very successful as an analytical approach to obtaining an orthogonal rotation of factors. Even in those cases where the results do not meet the investigator's concept of a simple structure, the solution usually is close enough to greatly reduce the labor of finding a satisfactory solution. (p. 333)

Affective-Achievement Relationships

This analysis was done in two stages. The first set of analyses used the scores standardized within each class. The second set used factor scores which were also standardized within each class.

Standard score analysis. The hypothesis of no significant Pearson product moment correlations between each affective variable and each achievement variable was tested with p = .01 using the computer program TRP. The quadratic relationship of affective to achievement variables was tested by correlating the squared scores of the affective variables with the scores of the achievement variables.

The hypothesis of no significant multiple correlations was tested using the Le and Tenisci (1977) Triangular Regression Package (TRP) computer program.

A multiple regression equation having a minimum number of affective variables was developed by stepwise regression. Stepwise regression analysis is the process of selecting an independent variable with the largest significant partial correlation. The partial correlation is the correlation of the given variable with the dependent variable having the effects of the already selected variables held constant. The selected variables are then scanned in case any of the selected variables have had their partial correlation reduced below significance by the addition of the new member. Those with non-significant partials are deleted and the process begins again until no new variables have a significant partial.

The hypothesis that there was no significant difference between the R^2 of the resulting minimal equation and that produced with all the affective variables was tested using formula from Kerlinger and Pedhazur (1973, p. 71)

$$F = \frac{(R^2_{y \cdot 1.2 \ldots k_1} - R^2_{y \cdot 1.2 \ldots k_2})/(k_1 - k_2)}{(1 - R^2_{y \cdot 1.2 \ldots k_1})/N - k_1 - 1)},$$

where k_2 equals the number of independent variables of the smallest R^2 and k_1 equals the number of independent variables of the largest R^2.

Factor score analysis. The factors were used to generate a factor scores coefficient matrix. The factor score coefficients were the multiple regression coefficients which related each of the affective variables to each factor. Factor scores were calculated by multiplying the score of each student on each affective scale by the corresponding coefficient for a given factor and summing across the seven affective variables for each of the three factors.

Because the affective variables were interrelated and because the Achievement Motivation model suggested interactions among its three components, several multiple regression analyses were performed using the factor scores and their interactions. The interaction terms were calculated by taking the product of the scores of the factors and using the resulting scores as independent variables in the regression equations. The hypothesis that factor score interactions would not significantly increase the explained variance of each of the affective variables was tested, with p = .01, using stepwise regression.

Cross Validation

Cross validation is the process of confirming the results of an analysis performed on one sample through the comparison of the same analyses performed on a similar sample. In educational research it is often difficult to get a second similar sample. The large initial sample of this study was ideal because splitting the sample in two equal parts would not substantially reduce the power to test the hypotheses. Because it was the intention to examine a number of possible models and to select the best one, the sample was randomly divided into two parts. The first sample, the normative sample, would be used as the set from which the best model was chosen. If a large number of models was generated this procedure would tend to maximize on chance. Thus the second sample would be reserved solely for cross-validation.

The procedure used to select the samples was to assign each subject a random number and then for each class the median random number was found. All the subjects with a number below the median were put into one group and all above were put into the other. A second random number was assigned to the subject with the median random number. If the second number was above .5 the subject was assigned to one group and if below, to the other. The resulting _N_'s were 511 (M = 275, F = 236) for the normative sample (Sample 1) and 522 (M = 254, F = 268) for the cross-validation sample (Sample 2). The followng comparisons were made between Sample 1 and Sample 2.

Cross Validation Hypotheses

It was hypothesised that there was no significant difference between the variance-covariance matrix of the males and that of the females.

It was hypothesized that the correlations among the affective and achievement variables would be similar to those in Sample 1. This was tested using the Box test for equal variance-covariance matrices.

The factor analysis was repeated using the same number of factors found in the initial analysis. An orthogonal Procrustean transformation was made rotating the factors of the second solution to the factor space of the first.

The stepwise regression analysis was repeated for Sample 2.

Chapter 4

RESULTS

INTRODUCTION

In Chapters 1 and 2, a literature was cited which indicated that an "emotional block" inhibited the mathematics achievement of a significant proportion of mathematics students. Anxiety, enjoyment, value, and self-concept of ability in mathematics were identified as the components of the "block". The Achievement Motivation model suggested possible interactions among the components when related to achievement motivation. A further variable, locus of control or achievement responsibility, was suggested by the model.

In Chapter 3 it was argued that four of the Sandman (1973) scales would be the most appropriate measures of the following variables: anxiety of mathematics (MANX)[1], enjoyment of mathematics (ENJOY), value of mathematics for society (VALSOC), and self-concept of mathematics achievement (SELFCON). Also included were the Test Anxiety Scale for Children (TASC), a more general measure of anxiety, the Value

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[1]The capitalized terms in the parentheses will be used throughout the discussion and in the tables.

of Mathematics for Oneself Scale (VALSEL) (developed by the experimenter) and the Intellectual Achievement Responsibility scale, a measure of Locus of Control. This scale was split into two components; responsibility for success (IARS) and responsibility for failure (IARF). Teachers ranked students on a description of behaviors typical of an "emotional block" (RANK), and checked a list of specific behaviors associated with the "block." Three achievement measures were selected; the Arithmetic Computation scale from the Stanford Achievement Test: Form W (COMP) and the Mathematics Concepts (CONC) and Mathematics Problem Solving scales (Level 12) from the Canadian Test of Basic Skills: Form 4 (PROB).

The design, procedure and administration of the materials used with a sample of 1033 subjects were also described in Chapter 3. In addition, a preliminary analysis showed that some class means were significantly different and that homogeneity of class variance could be accepted. Therefore, the scores were standardized with a class mean of zero and a standard deviation of one.

A second preliminary analysis of the concurrent and construct validity of the TASC in comparison with the Sandman Mathematics Anxiety Scale was performed using the three achievement measures and the two forms of teacher response. It was decided to retain the Mathematics Anxiety Scale and to eliminate TASC from further analyses. A summary of hypotheses and statistical procedures used may be found in the last section of Chapter 3.

In this chapter the results of the analyses and cross validation pertaining to the hypotheses are presented.

SEX DIFFERENCES

The focus of this study was the relationship of the affective variables to the achievement variables. Therefore, differences, due to sex, between corresponding correlations were of more interest than differences between means. However, the raw score scale means, standard deviations and differences between means for males and females may be found in Appendix G. The correlations among the variables for both sexes may be found in Table 17.

Because of the redundancy of information in the matrix the hypothesis that there was no significant differences between the variance-covariance matrix of the males and that of the females was tested using the Box procedure as outlined in Winer (1971, p. 595). In order to reduce the probability of falsely accepting the null hypothesis the significance was set at .10. The F ratio was 1.245 with degrees of freedom 55 and 798 277. For $p < .10$ and corresponding degrees of freedom $F = 1.25$. The null hypothesis was not rejected, and the data from the male and female data sets were pooled and the following hypotheses were tested using only the pooled data.

Table 17

Correlations of the Affective and Achievement Scales for Males and Females

	COMP	CONC	PROB	IARS	IARF	MANX	VSOC	SCON	ENJOY
Males									
CONC	.64	1.00							
PROB	.66	.64	1.00						
IARS	.15	.13	.13	1.00					
IARF	-.03	-.07	-.12	.20	1.00				
MANX	-.40	-.39	-.33	-.29	-.04	1.00			
VALSOC	.19	.19	.11	.15	.11	-.35	1.00		
SELFCON	.51	.54	.48	.33	-.05	-.68	.34	1.00	
ENJOY	.34	.26	.26	.25	.02	-.73	.37	.56	1.00
VALSEL	.12	.12	.06	.19	.07	-.37	.59	.34	.51
Female									
CONC	.70	1.00							
PROB	.67	.69	1.00						
IARS	.24	.10	.12	1.00					
IARF	.08	-.02	.02	.37	1.00				
MANX	-.43	-.39	-.33	-.19	-.06	1.00			
VALSOC	.23	.25	.15	.15	.11	-.33	1.00		
SELFCON	.44	.49	.45	.15	-.03	-.74	.24	1.00	
ENJOY	.30	.21	.22	.18	.23	-.73	.35	.57	1.00
VALSEL	.24	.19	.14	.14	.10	-.38	.71	.26	.51

AFFECTIVE INTER-SCALE HYPOTHESES

Correlations

In the following analyses reference will be made to correlations, multiple correlations, squared multiple correlations, and proportion of explained variance. The term correlation will be used to denote a Pearson product moment correlation. Note that when either the correlation or multiple correlation is squared the result is the proportion of variance of the dependent variable explained or predicted by the independent variable or variables.

Correlations between each pair of the affective variables were calculated. The hypothesis that the correlations were not significantly different from zero was tested at the .01 level. The results are shown in Table 18.

Table 18

Inter-correlations of the Affective Variables

	IARS	IARF	MANX	VALSOC	SELFCON	ENJOY
IARF	.276**	1.000				
MANX	-.251**	-.004	1.000			
VALSOC	.143**	.104*	-.341**	1.000		
SELFCON	.244**	-.043	-.702**	.296**	1.000	
ENJOY	.220**	.116**	-.728**	.360**	.564**	1.000
VALSEL	.162**	.077*	-.372**	.652**	.307**	.511**

*p < .05; **p < .01

Only two of the IARF correlations with the other variables were significant (p < .01). Excepting the correlation with IARS of .276, the maximum was .116 with ENJOY. Except for four of the IARF correlations, all others were different frcm zero at the .01 level or better. Therefore in 17 out of 21 correlations the null hypothesis was not accepted. Table 18 suggests that there were at least two groups of variables; the IARS and IARF pair and the rest of the variables. This was born out in subsequent factor analyses.

Although nct part of the formal hypotheses of the study, the affective variables were correlated with teacher rankings of students and the Student-Behavior checklist. Note that as the absence of a behavior was coded 0 and the presence

1, positive correlations were expected with anxiety and the ability to accept responsibility for failure and negative correlations were expected with the other variables. The summary appears in Table 19. Although the correlations were weak (the maximum was .23 between MANX and Random Answers) only seven out of 70 correlations were in the unexpected direction. Of those seven, only one was significantly different from zero ($p < .01$). The results gave some evidence of the construct validity of the affective variables.

Table 19

Correlations between the Affective Variables, RANK, and the Student-Behavior Checklist

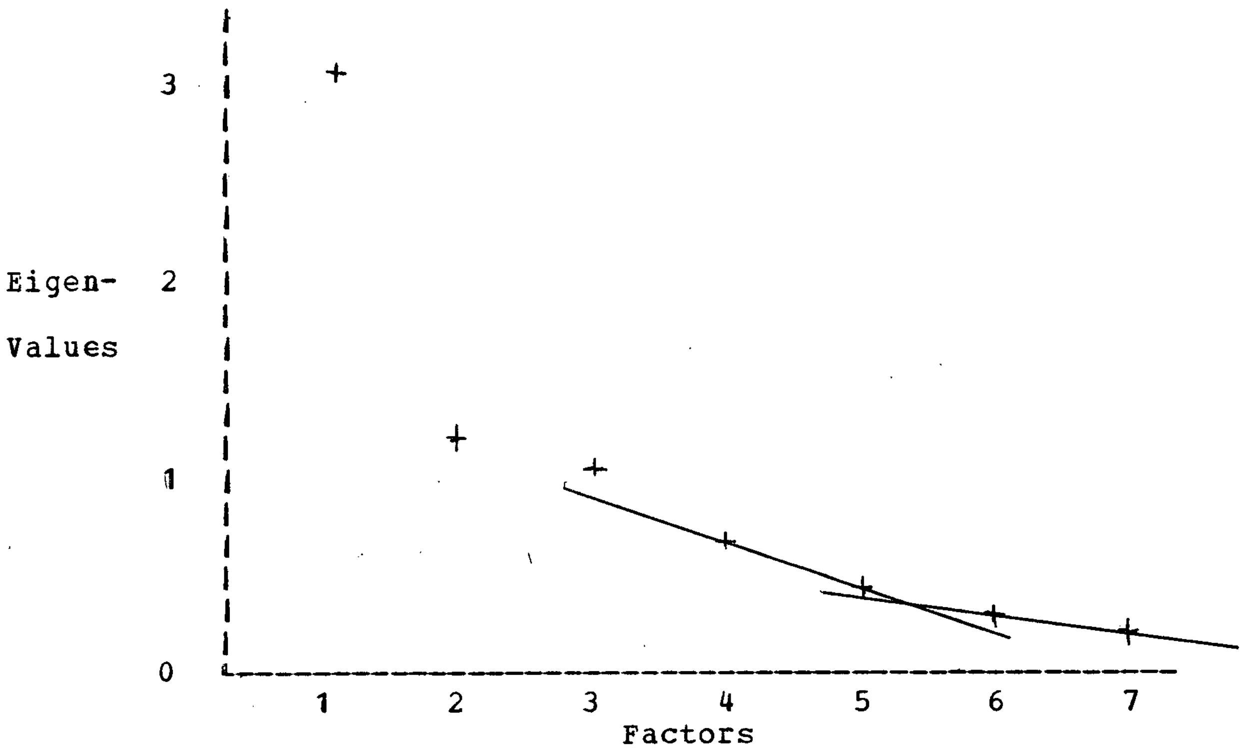
Behavior	IARS	IARF	MANX	VALSOC	SELFCON	ENJOY	VALSEL
Random Answers	-.10**	.04	.23**	-.13**	-.20**	-.13**	-.06
Appears Tense	-.13**	-.04	.15**	-.09*	-.21**	-.11**	-.07
Expresses Anxiety	-.05	.06*	.20**	-.10**	-.23**	-.16**	-.06
Disruptive Behavior	-.10**	.02	.09*	-.02	-.08*	-.07*	-.06
Expresses Inability	-.06	-.01	.19**	-.09*	-.22**	-.14**	-.05
Hands Shake	-.04	.02	.05	.05	-.06	.02	.06
States Mathematics Useless	-.09*	.03	.20**	-.11**	-.17**	-.17**	-.11**
Refuses to Answer	-.05	.03	.04	-.03	-.09*	-.03	.00
Fidgets More	-.11**	.03	.16**	-.05	-.22**	-.16**	-.07
RANK	.07	-.03	-.29**	.18**	.35**	.16**	.09*

*p < .05; **p < .01

Factor Analysis

A principal component analysis of the affective variables was performed which generated the following set of eigen-values: 3.068, 1.206, 1.077, 0.683, 0.446, 0.310, and 0.210. See the graph below for the plot of the eigen-values.

"Scree" of the Eigen-Values from the Principal Component Analysis of the Affective Variables



It was clear from the graph that three factors should be retained according to the "scree" test. This agreed with the Kaiser-Guttman criterion, since there were three eigen-values greater than 1.0. It should be noted that this was the number of factors predicted by the Achievement Motivation theory.

The three factors accounted for 76% of the variance of the affective variables. This was considered acceptable for further analysis.

In order to aid the interpretation of the factors, the three factors were orthogonally rotated using the varimax procedure. The factor loadings are shown in Table 20. The

Table 20

Factor loadings of the Affective Variables on the Orthogonally Rctated, Principal Component Factors

	Factor 1	Factor 2	Factor 3
IARS	.3206	.7372	-.0252
IARF	-.1441	.8427	.1358
MANX	-.8927	-.0554	-.1992
VALSOC	.1695	.0662	.8794
SELFCON	.8672	.0130	.1096
ENJOY	.7603	.1290	.3621
VALSEL	.2589	.0544	.8657

three factors were readily interpretable. Factor 1, having the highest loadings from MANX, SELFCON and ENJOY, was called the Motivational Factor (MF). Note that the negative loadings of MANX were artifacts of the scoring. Factor 2 having high loadings from the two Intellectual Achievement Responsibility scales, was called the Achievement Responsibility Factor (ARF). Factor 3 was identified as the Value Factor (VF) because of the high loadings from the VALSOC and VALSEL Scales. With respect to the hypothesized simple structure, IARS loaded .321 on Factor 1 and ENJOY loaded .362 on Factor

2. However, in the light of the much stronger loadings of the main components, the structure was well defined. The complexities that occurred may have been a result of the requirement of orthogonality maintained in this present study. Cattell (1966) says "orthogonality and simple structure are contradictions. Only in very rare cases do factors happen to be orthogonal" (p. 186). This analysis did not support the factor structure hypothesized in Chapter 1 which was derived from the theory of Achievement Motivation. Contrary to what was expected IARS and IARF did not load on the motivational factor but loaded on a factor of their own. In addition SELFCON, rather than forming a factor of its own loaded with MANX and ENJOY.

The correlations among the affective variables showed a degree of dependence. From the Sandman (1973) factor analysis of the items of four of the affective scales it was known that the scales are not perfect representations of their constructs. The orthogonal rotation, then, allowed an interpretation of the various components of variance because by definition orthogonal factors are independent and have correlation zero.

AFFECTIVE-ACHIEVEMENT RELATIONSHIPS

Correlations

To test the hypotheses that there were linear and non-linear relations between each of the affective variables and the achievement variables, orthogonal polynomials of degree three were calculated. None of the third degree terms were significantly correlated with the achievement scores and therefore only the first and second degree terms were considered. Of the second degree terms two correlations were marginal, MANX with PROB and VALSOC with COMP, and none were significant at the .01 level. Further, with correlations of at most .097 the proportion of explained variance was at most 0.94%. The second degree terms were not retained for further analysis.

In 17 of the 21 first degree relations the null hypothesis was not accepted at the .01 level. See Table 21 for a summary of the correlations of linear and orthogonal second degree terms of the affective variables with the achievement variables.

Three of the IARS linear correlations were significant at the .01 level or better. None of the IARF linear correlations were significant at the .01 level. However, the IARF was retained in the analysis. The theoretical importance of the achievement responsibility variable was as a moderator variable. Thus it was retained to test possible interactions with the other affective variables in predicting achievement.

<u>Regression Analysis</u>

A series of regression analyses were performed. The first model to be tested was that of simple linear multiple

Table 21

Correlations of the First and Second Degree Terms of Orthogonal Polynomials of the Affective Variables with the Three Achievement Variables

Variable and Degree		COMP r	COMP F Ratio	COMP F Prob	CONC r	CONC F Ratio	CONC F Prob	PROB r	PROB F Ratio	PROB F Prob
IARS	1	.190	19.1	.000	.121	7.57	.006	.128	8.51	.004
	2	-.006	.021	.856	.203	.269	.611	.025	.329	.574
IARF	1	.030	.451	.560	-.049	1.24	.265	-.054	1.48	.222
	2	-.003	.005	.901	.002	.002	.919	.039	.791	.378
MANX	1	-.410	103.	.000	-.387	89.7	.000	-.331	62.6	.000
	2	.049	1.23	.267	.069	2.40	.117	.088	3.94	.045
VALSOC	1	.194	19.9	.000	.222	26.3	.000	.124	7.96	.005
	2	.097	4.79	.028	.079	.317	.072	.060	1.85	.171
SELFCON	1	.457	135.	.000	.518	187.	.000	.462	138.	.000
	2	.075	2.87	.087	.006	.016	.868	.028	.403	.533
ENJOY	1	.320	58.1	.000	.236	30.4	.000	.241	31.5	.000
	2	.083	3.51	.059	.039	.777	.382	.060	1.87	.169
VALSEL	1	.157	12.9	.001	.151	11.8	.001	.094	4.57	.031
	2	.034	5.97	.446	.017	.153	.697	.033	.542	.469

regression. For each of the achievement variables all the affective scales were used as independent variables. The multiple correlations, with the squared multiple correlations in parentheses, of the affective variables with COMP, CONC, and PROB were: .483 (.233), .537 (.288), and .468 (.219) respectively. The null hypothesis that the affective variables would not account for a significant proportion of the achievement variables was not accepted at the .01 level. It should be noted that this is not a large increase over the correlations between SELFCON and the achievement variables

(.457, .518, .462).

A series of stepwise analyses was performed to select a minimal sub-set of affective variables which would predict the achievement scores. The criterion was set so that no variables were added to the regression equation unless the increase in variance accounted for was significant at the .01 level. The affective variables SELFCON and MANX appeared in one equation and only SELFCON in the others. The summary of the analyses appears in Table 22.

Table 22

Summary of the Stepwise Analyses Using Standardized Affective Scores as Independent Variables

Dependent Variables	Independent Variables	Partial Correlations[1]	F Ratio[2]	F Prob	Squared Multiple Correlations
COMP	SELFCON	.457	37.2	.000	.225
	MANX	-.140	10.2	.002	
CONC	SELFCON	.518	187.	.000	.268
PROB	SELFCON	.462	138.	.000	.213

[1] This is the partial prior to entry in the equation. Variables are in the order of entry for each equation
[2] F Ratios and F Probs are those associated with the Beta coefficients of the final equation.

In comparison with the maximal equations the loss of explained variance was quite small; a maximum of 2.08%. Using the Kerlinger and Pedhazur equation (1973, p. 71) this difference was significant at the .05 level but not at .01. Therefore the null hypothesis was not rejected.

It would appear that MANX and SELFCON contribute most to the prediction of the achievement scores. However, students may have been responding to the items on those scales influenced by how they responded to other stimuli related to mathematics. In other words, the scales may not be uni-dimensional. Thus the equations outlined above could well have resulted from MANX and SELFCON accounting for variance common to other variables.

Factor Analysis

By correlating the orthogonal factors with the achievement variables through multiple regression the identification of the construct or factor making the maximal contribution was achieved. This was a statistical way of developing independent measures to aid interpretation. As the three factors identified in the principal component analysis could be interpreted in terms of the three factors of the Achievement Motivation model, the hypothesized inter-action effects could be tested.

The rotated principal component factors were used to generate a factor score matrix. Factor scores were calculated for each student from the standardized affective scores using the weights in Table 23. The scores were again standardized within classes as was done initially for the affective and achievement raw scores. It should be noted that the standardization was done using only the subjects from Sample

Table 23

Factor Score Coefficient Matrix

	Factor 1	Factor 2	Factor 3
IARS	.1267	.5801	-.1679
IARF	-.1736	.6852	.0652
MANX	-.4224	.0354	.0980
VALSOC	-.1490	-.0339	.5923
SELFCON	.4357	-.0604	-.1531
ENJOY	.3024	-.0199	.0503
VALSEL	-.0965	-.0487	.5594

1. The correlation matrix of factor scores and achievement scores is shown in Table 24. It can be seen that the correlations between the factor scores are virtually zero.

Table 24

Correlations between Standardized Factor Scores
and Standardized Achievement Scores[1]

	COMP	CONC	PROB	MF	ARF	VF
COMP	1.00					
CONC	.66**	1.00				
PROB	.67**	.66**	1.00			
MF	.43**	.44**	.40**	1.00		
ARF	.07	-.04	-.02	.00	1.00	
VF	.09*	.08	.01	.01	.01	1.00

*p < .05
**p < .01
[1] As the three factor scores are virtually orthogonal the squared correlations of the factor scores with the achievement scores are good estimates of the proportion of variance accounted by any one factor score independently of the others.

In order to establish the proportion of variance of the achievement variables accounted for by the three factors, regression equations were generated with the three factors as independent variables. The proportions of explained variance were as follows with variance accounted for by the seven affective variables shown in parentheses for comparison: COMP, .196 (.233); CONC, .202 (.288); and PROB, .162 (.219). The equations are shown in Table 25. The reduction in the proportion of explained variance was not of great importance as a reduction of approximately 24% was expected because the three factors accounted for only 76% of the variance of the seven affective measures. It should be noted that the 24% could have been error variance due to scale reliabilities less than 1.00.

Table 25

Regression Equations of the Three Factor Scores Predicting the Three achievement Scores

Dependent Variable	Independent Variable	Regression Weights	F Ratio	F Prob	Squared Multiple Correlations
COMP	MF	.4359	115.	.000	.196
	ARF	.0722	3.17	.072	
	VF	.0889	4.80	.027	
CONC	MF	.4427	123.	.000	.202
	ARF	-.0350	.756	.389	
	VF	.0745	3.43	.061	
PROB	MF	.4153	97.3	.000	.162
	ARF	-.0225	.286	.600	
	VF	.0071	.029	.842	

The next hypothesis to be tested was that there would be no significant interactions of the affective factors in predicting the achievement variables. To this end the factor scores were combined multiplicatively. Four additional scores were calculated; MF x ARF, MF x VF, ARF x VF, and MF x ARF x

VF. These additional scores were used together with the factor scores in a stepwise regression procedure. Again the criterion for addition to the equation was a signficant increase in explained variance at the .01 level. The null hypothesis not rejected. That is no interaction terms were included.[1] See Table 26 for the summary of the analyses.

Table 26

Summary of Stepwise Analyses Using Factor Scores and Factor Score interactions as Independent Variables

Dependent Variable	Independent Variable	Partial Correlations[1]	F Ratio[2]	F Prob	Squared Multiple Correlations
COMP	MF	.429	114.	.000	.191
CONC	MF	.442	97.5	.000	.195
PROB	MF	.401	97.7	.000	.161

[1]This is the partial prior to entry in the equation. Variables are in the order of entry for each equation.
[2]F Ratios and Probabilities are those associated with the beta coefficients of the final equation.

Clearly the construct underlying the Motivation Factor (MF) was the most important predictor of achievement. MF, however, did not account for a greater proportion of the variance of achievement than did SELFCON alone. Indeed it could be argued that using the principal of parsimony SELFCON was the only

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[1] For interest quadratic functions of the factor scores were calculated and also used interactively in predicting achievement. This was of interest because the Achievement Motivation model predicted a quadratic interaction of probability of success with motivation to succeed. However, none of the quadratic or interactive terms were significantly related to achievement.

explanatory variable necessary. More discussion on this point will appear in Chapter 5.

CROSS VALIDATION

The cross validation analyses were performed on the second of two samples randomly selected from the initial sample as described at the end of Chapter 3. The sample was composed of 522 students, 254 male and 268 female.

The cross validation proceeded in several steps. The first step consisted of testing the equivalence of the male and female variance-covariance matrices. The second step was the calculation of the intercorrelations of the affective and achievement scales and performing an overall test of the equivalence of the variance-covariance matrices of the two samples. The third step was to subject the second sample to factor analysis with a three factor solution followed by an orthogonal Procrustes transformation. The fourth step was to subject the variables to stepwise regression analysis.

Equivalence of Correlations

When the male and female variance-covariance matrices were compared using the Box test, the resulting F ratio was 1.177 with degrees of freedom 55 and 868 095. The difference was not significant at the .10 level. This confirmed the findings of no significant sex differences from the initial analysis.

The correlations of the affective and achievement variables are shown in Table 27. The results may be compared to those in Tables 18 and 20 for Sample 1. The overall test of equivalence of the variance-covariance matrices resulted in an F ratio of 0.987 with degrees of freedom 55 and 3 429 430. This was not significant at the .10 level.

Table 27

Correlations of the Affective and Achievement Scales of Sample 2

	COMP	CONC	PROB	IARS	IARF	MANX	VSOC	SCON	ENJOY
CONC	.64								
PROB	.65	.67							
IARS	.12	.06	.08						
IARF	-.01	-.01	-.07	.25					
MANX	-.43	-.40	-.38	-.24	.03				
VSOC	.17	.27	.21	.18	.07	-.38			
SCON	.44	.47	.44	.27	-.09	-.72	.37		
ENJOY	.32	.30	.29	.22	.03	-.72	.45	.55	
VSEL	.18	.23	.20	.17	.11	-.37	.69	.29	.47

Factor Analysis

The next step was to subject the second sample to component analysis with a three factor solution[1]. The same structure appeared. The factor loadings of the results from the analyses of both samples are in Table 28.

A test of the stability of the factors was made using an orthogonal Procrustean transformation (Hackstian & Bay,

[1] The eigen-values and scree corresponded closely to those of the initial sample.

Table 28

Factor Loadings from the Analyses of Sample 1 and Sample 2

Variable	Factor 1 S1[1]	Factor 1 S2	Factor 2 S1	Factor 2 S2	Factor 3 S1	Factor 3 S2
IARS	.321	.373	.737	.745	-.025	-.037
IARF	-.144	-.215	.843	.822	.136	.165
MANX	-.893	-.883	-.055	-.032	-.199	-.223
VALSOC	.170	.257	.066	.057	.879	.858
SELFCON	.867	.870	.013	.016	.110	.129
ENJOY	.760	.729	.129	.064	.362	.408
VALSEL	.259	.195	.054	.085	.866	.891

[1]S1 = sample 1; S2 = sample 2.

1973). This transformation uses a least squares approximation procedure to rotate a given factor solution to a "target" matrix of factor loadings. In this case the target matrix was the set of factor loadings calculated with the first sample. As there was no test of goodness-of-fit for the algorithm the error matrix appears in Table 29. As there were only 3 errors

Table 29

Error Matrix from a Procrustean Rotation of the Sample 2 Factors to a Target Matrix of Sample 1 Loadings

	Factor 1	Factor 2	Factor 3
IARS	.046	.011	-.023
IARF	-.075	-.021	.025
MANX	.006	.015	-.008
VALSOC	.102	-.001	-.025
SELFCON	.005	.011	.004
ENJOY	-.026	-.056	.032
VALSEL	-.049	.039	.021

greater than .05 and as the solution accounted for 76.4% of the variance of the seven affective variables the factor solution was considered to be adequate. These results indicate a stable factor space.

Regression Analysis

The fourth step was to generate a stepwise regression equation for Sample 2. The results are displayed in Table 30.

Table 30

Summary of Stepwise Analysis Using Sample 2 Standardized Scores as Independent Variables

Dependent Variables	Independent Variables	Partial Correlations[1]	F Ratio[2]	F Prob	Squared Multiple Correlations
COMP	SELFCON	.436	16.74	.000	.215
	MANX	-.177	22.82	.000	
CONC	SELFCON	.468	107.	.000	.229
	VALSOC	.113	6.76	.009	
PROB	SELFCON	.446	38.6	.000	.194

[1]Partial correlations are those just before the variable entered the equation. Variables are listed in the order they entered the equation.
[2]F ratios and probabilities are those of the final equation.

In comparison with the results of Sample 1 the only change in variables included was in the case of CONC where VALSOC entered. The proportions of explained variance were similar except for CONC which had a 3.9% difference. However, as was noted before, the number of tests of significance in regression analysis is quite large. Thus the noted difference could bave been the result of random fluctuation.

As the squared correlations with the seven affective variables included in the equation were .219, .245 and .207

the reduction of explained variance with the stepwise solution was at most 1.6%. This difference was not significant at the .01 level.

The cross validation analysis sustained virtually all findings of the initial analysis.

SUMMARY

The equality of correlations between sexes was not rejected and the data were pooled for all subsequent analyses.

The analyses indicated the "block" variables, with the exception of IARS and IARF were inter-related. The correlations, with IARS and IARF excluded, ranged from .296 to .728.

The teacher response scales were correlated with the "block" variables. SELFCON, ENJOY and MANX were the most strongly related; SELFCON with correlations of .06 to .23 with individual Student-Behaviors and .35 with RANK; ENJOY, -.02 to -.17 and .16; MANX, .04 to .23 and -.29. These data tended to support the construct validity of the affective variables.

It was also shown that the "block" variables, again with IARF excluded, were all significantly correlated with the achievement variables; .094 to .518. There were no significant non-linear correlations: the maximums were MANX with PROB (.088) and VALSOC with COMP (.097).

The relationships between the "block" variables and the achievement variables were examined using multiple and stepwise regression. The multiple correlations with COMP, CONC and PROB were .483, .537 and .468 respectively. Stepwise regression revealed that SELFCON was the major contributor to the explained variance of the achievement variables. MANX, the only other variable to enter, did so once.

To see if the seven "block" variables could be interpreted in a more simple manner, principal component analysis followed by orthogonal rotation revealed three factors accounting for 76% of the variance of the initial seven variables. Factor loadings suggested a Motivation Factor (MF) with strong loadings from SELFCON, ENJOY, and MANX; a Value Factor (VF) with loadings from VALSOC and VALSEL; and an Achievement Responsibility Factor (ARF) with loadings from IARS and IARF. The factors were interpretable and showed a well defined structure even though ENJOY loaded .36 on VF and IARS loaded .32 on MF.

Factor score coefficients were used to calculate MF, ARF and VF factor scores for each subject. Interaction terms were calculated multiplicatively. Stepwise regression using those factor scores showed that MF accounted for the major proportion of explained variance. Contrary to the expectations of the Achievement Motivation model no interaction terms were included in the equations.

The cross validation sustained the findings above with minor exceptions. There was no significant difference between the variance-covariance matrices of the sexes, nor was there a significant difference between the variance-covariance matrices of the two samples. This was tested at the 10% level.

Factor analysis of the second sample showed little change in the factor structure. Procrustean rotation of the Sample 2 factors to the loadings of the rotated Sample 1 factors, accounted for 76.4% of the original variance of the seven affective variables. This suggested a stable factor structure.

Stepwise regression analysis of the second sample showed little differences in explained variance: approximately 20%. The analysis showed consistency in the inclusion of variables.

Chapter 5

DISCUSSION AND CONCLUSIONS

INTRODUCTION

In Chapters 1 and 2, it was shown that there was a literature which indicated that a significant proportion of mathematics students appeared to have an "emotional block" inhibiting their achievement in mathematics. Anxiety, enjoyment, value, and self-concept of in mathematics were identified as the components of the "block". The Achievement Motivation Model was used to suggest possible interactions among the components when related to achievement motivation. A further variable, locus of control or academic responsibility, was suggested by the model.

In Chapter 3 it was argued that four of the Sandman (1973) scales would be the most appropriate measures of the following variables: anxiety of mathematics (MANX)[1], enjoyment of mathematics (ENJOY), value of mathematics for society (VALSOC), and self-concept of mathematics achievement (SELFCON). A preliminary analysis, described in Chapter 3,

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[1]The capitalized terms in the parentheses will be used in the following discussion.

confirmed that the Mathematics Anxiety scale was more valid than the Test Anxiety Scale for Children as a measure of mathematics anxiety. In addition, a Value of Mathematics for Oneself Scale (VALSEL) was developed by the experimenter. The Intellectual Achievement Responsibility Scale was selected as the measure of Locus of Control. This scale had two parts: responsibility for success (IARF) and responsibility for failure (IARF). Two forms of teacher response, a ranking of students on a description of behaviors typical of an "emotional block" (RANK), and a check list of specific behaviors associated with the "block" were also developed by the experimenter. Three achievement measures were selected; the Arithmetic Computation Scale from the Stanford Achievement Test: Form W (COMP) and the Mathematics Concepts (CONC) and Mathematics Problem Solving Scales (Level 12) (PROB) from the Canadian Test of Basic Skills: Form 4.

The design, procedure, and test administration of the materials used with a sample of 1033 subjects were described in Chapter 3. In addition, a preliminary analysis showed that some class means were significantly different and that homogeneity of class variance could be accepted. To remove the effects of class differences in subsequent correlational analyses, the scores were standardized within each class (mean of zero; standard deviation of one). All scale scores used in the analyses of Chapter 4 were standardized in this manner.

In Chapter 4 the hypothesis of equality of the correlations between sexes was not rejected and the data were pooled for all subsequent analyses. The analyses showed, with the exception of IARF, that the "block" variables were inter-related. The correlations with the teacher response scales were low but in the hypothesized direction thus tending to validate the "blcck" variables.

Squared multiple correlations of the affective variables with achievement variables showed modest increases of explained variance and stepwise regression showed SELFCON to be the major contributor to the explained variance of the achievement variables. The squared multiple correlations were between .219 and .288 for the full equations and .213 and .268 for the stepwise equations.

Factor analysis revealed three interpretable factors accounting for 76% of the variance of the initial seven variables. The three factors were interpreted as Motivation (MF), Achievement Responsibility (ARF) and Value (VF). The postulated structure was not observed. However, the factors were clearly interpretable. Regression analysis showed MF to be the major explanatory component. It should be noted that self-concept was the major component of this factor.

Cross validation supported the finding of no sex differences among the correlations of the affective and achievement variables. The factor structure was shown to be stable. The stepwise regression in the cross validation sample typically selected the same variables as done with

Sample 1. The only difference found in the cross validation analysis was that VALSOC was included in the equation for CONC. The proportion of explained variance of the achievement variables was consistently between 19% and 23%; similar to that in Sample 1.

In this chapter discussion of results will centre on three areas: the lack of sex differences; the intercorrelations of the "block" variables and factor analysis; and the multiple and stepwise analyses of the affective variables, factor scores and interactions with the achievement variables. Limitations of the study, conclusions and future research will also be discussed.

SEX DIFFERENCES

When the issue of sex differences in mathematics is raised it is often in terms of average performance. That is questions such as "Do boys, on the average, perform better than girls or vice versa?" are asked. Although this approach was considered parenthetically in this study (see Appendix G), another aspect of sex difference was of more interest. The question here was, "Is the relationship between a given pair of variables the same for boys as for girls?"

A test of equivalence of the variance-covariance matrices showed no overall differences significant at the 10% level. This could cast some light on the inconsistent findings of sex related differences in correlations of affective variables found in the literature, particularly if univariate comparisons were made. For example, it could be that items worded to tap information associated with enjoyment may elicit more information associated with value for the boys than they would from the girls. Thus other studies may find the correlation of enjoyment with mathematics achievement may be different for boys than for girls. However, if value items are specifically included within the scale or in a separate scale the differences may disappear. This could be another reason for choosing a multivariate approach to the relation of affective scales with achievement.

That is not to say that sex differences should be ignored in future research. It should be determined if changes in value change enjoyment in a different manner for the two sexes, and whether or not those changes, in turn, alter achievement in a different manner.

INTERRELATIONS OF THE "BLOCK" VARIABLES

The "emotional block" was characterized in the pedagogical literature as being associated with high anxiety in mathematics, low value of the worth of mathematics to society and self, low enjoyment, low self-concept, and an unwillingness to accept responsibility for either failure or success in achievement situations. Other literature pointed out that anxiety could, in fact, facilitate achievement provided a student was motivated to achieve or had high intelligence. Therefore, it was hypothesized that the variables would be correlated and yet show that they tapped different dimensions. In general this hypothesis was accepted.

It should be recalled that the model of Achievement Motivation, outlined in Chapter 2, held that the behavior of an individual was determined by his expectation that the behavior would lead to various outcomes, his evaluation of those outcomes, and his subjective probability that he could behave in the given way. It would appear reasonable that a student could believe that paying attention in a mathematics class led to better marks and, that better marks were important. Yet, he might also believe that <u>his</u> attention would not lead to <u>his</u> increased achievement. The result of this might be that the student would not attend.

Algebraically the Achievement Motivation model, as described by Atkinson (1958), Atkinson and Feather (1966), and Atkinson and Raynor (1974), led to a three part equation of a resultant tendency (Tr) to act which is

$$Tr = (Ms - Maf) \times Ps \times (1 - Ps),$$

where (Ms - Maf) was the resultant motivation to succeed, less the motivation to avoid failure. Ps was the subjective probability of success and (1 - Ps) was the incentive value of success. The latter was a result of the model's assumption of an inverse relation between Ps and Is. The tripartite equation suggested that a factor analysis would be appropriate.

Principal component analysis yielded three eigen-values greater than 1.00, satisfying the Kaiser-Guttman criterion (Cattell, 1966, p. 206). The "scree" of the eigen-values (Cattell, 1966, p. 206) also suggested three factors. These three factors accounted for 76% of the variance of the original set of seven variables.

In the light of the Achievement Motivation model a three factor solution of the affective variables was particularly interesting. An orthogonal rotation of the factors to increase interpretability led to a Motivation Factor (MF) with loadings from MANX, ENJOY and SELFCON, a Value Factor (VF) with high loadings from VALSEL and VALSOC, and an Achievement Responsibilility Factor (ARF) with loadings from IARS and IARF. SELFCON by the theory should have appeared as a separate factor. However, as Maf in other research had been typically measured with the Test Anxiety Scale, and as it has been argued by the present author that ENJOY should be considered the opposite of anxiety, it was decided to call the first factor the Motivation Factor (MF).

A comparison of the hypothesized and the actual loading patterns from the component analyses follows.

Variable	Hypothesized Factor Loadings F1	F2	F3	Actual Factor Loadings F1	F2	F3
MANX	high	low	low	high	low	low
ENJOY	high	low	low	high	low	low
IARS	high	low	low	low	high	low
IARF	high	low	low	low	high	low
SELFCON	low	high	low	high	low	low
VALSEL	low	low	high	low	low	high
VALSOC	low	low	high	low	low	high

The Achievement Responsibility Factor (ARF) was composed of IARS and IARF. The individual scales had correlations of at most -.251 with the other variables. This may be because the scales were truly independent or that the scales had low internal consistencies; .52 and .61. It might be suggested that the scales, developed in the early 1960's, may have had reduced validity for the students of 1977, or that the scales were a general measure of achievement responsibility rather than being specifically associated with mathematics. This latter was a possibility in light of the evidence, presented in Chapter 2, showing better correlations between measures of anxiety and self-concept and measures of achievement when the affective scales were directly related to achievement in the specified content area. Thus if a mathematics oriented measure of achievement responsibility were developed it is possible future studies may show IARS and IARF to be correlates of other affective measures in mathematics.

It was indicated in Chapter 2 that the theory of Achievement Motivation and Locus of Control theory correspond and that a measure of locus of control would interact with a measure of achievement motivation. Woulk and DuCette (1973) presented evidence for this relation. What was not clear was to which of the three constructs of the Achievement Motivation model locus of control, or achievement responsibility, should be related. Locus of control is the degree to which an individual accepts responsibility for the results of an action or attributes it to some cause external to himself. A belief in self responsibility could suggest that the individual would, in an achievement situation, attend to the task thus increasing the probability of success. Alternatively, a belief in an external cause of level of achievement would suggest indifference, thus reducing the probability of success. Because, in this study, MF has been interpreted as the motivation to succeed and avoid failure, and VF as the value of success, the most likely correspondence of ARF was with the subjective probability of success.

The components of the Motivation Factor, MANX, SELFCON and ENJOY, were strongly intercorrelated. MANX correlated -.728 and -.702 with ENJOY and SELFCON respectively and ENJOY correlated .56 with SELFCON. It should be noted that the negative correlations are an artifact of the scoring of MANX. Sandman (1973) found similar correlations -.76 and -.72. The degree of overlap was also indicated by the results of Sandman's factor analysis of the scales.

For example, Sandman's (1973) study showed that item 4 on the ENJOY scale, "I don't like anything about mathematics," loaded on the anxiety factor. Whereas items 2 and 8 on the MANX scale loaded -.51 and .61 on the enjoyment factor. The items were: "2. When I hear the word mathematics, I have a feeling of dislike," and "8. I have a good feeling toward mathematics." Both items tapped an emotional domain without characterizing a particular form of feeling other than a "dislike" or "good" feeling. It would appear that in the case of item number 2 the intent was to get a response associated with stress without using the word anxiety. The intent of the eighth item likely was to get a response opposite to anxiety. As a further example, items 4, 5 and 8 of the SELFCON scale loaded -.46, .32 an anxiety factor. The items were: "4. No matter how hard I try I cannot understand mathematics," "5. I often think, 'I can't do it,' when a mathematics problem seems hard," and "8. If I don't see how to work a mathematics problem right away, I never get it." There is an underlying sense of frustration in these items which would explain the relationship with anxiety. In turn, item 8 of the ENJOY scale, "Mathematics is more of a game than it is hard work," loaded on the self-concept factor, and gave a sense of degree of difficulty.

These comments are not meant as criticism of the scale construction but rather as an observation of the difficulty of dealing with abstract ideas and being limited, by the age of the subjects, tc a small vocabulary. Although one could argue on the basis of these data that the items could be placed in more appropriate scales, it could also be argued that the complexities of language together with the complex determinants of the affective domain make construction of completely independent scales impossible. Rather than trying to optimize on the arrangement of the items, the components of variance may be better accounted for by factor analysis followed by orthogonal rotation. Indeed that was the approach taken in this study.

The reason for the overlap of the scales in the Value Factor (VF) was clear: the author constructed the VALSEL scale to be parallel to the Sandman scale. The only major difference was that the student was to respond in terms of benefits to himself rather than society. The argument for constructing the scale in this manner was presented in Chapter 3. It is sufficient here to note that the correlation between the two scales was .67. Although this was moderately strong, a degree of independence was suggested. However, the reliabilities of the two scales, VALSOC .68 and VALSEL .69, suggest that the "independence" might be error variance. Indeed when corrected for attenuation due to the reliabilities of the tests (Nunnally, 1967, p. 204) the correlation was .98.

THE RELATION OF THE "BLOCK" VARIABLES TO ACHIEVEMENT

Correlations

The importance of the "emotional block" was the common belief that it had usually been associated with poor achievement. Therefore, it was hypothesized that the variables were correlated with achievement. Apart from IARF the affective variables were significantly correlated with achievement. MANX correlated -.410, -.387, and -.331 with COMP, CONC and PROB respectively. These correlations compared with those of Alpert and Haber (1960) who correlated facilitating anxiety and GPA on three samples of data and found correlations of .36, .32 and .50. Note that the difference in sign is an artifact of scoring. A similar procedure with debilitating anxiety revealed correlations of -.45, -.08 and -.40. The correlations of this study were also consistent with Kahn (1969) who found correlations of .305 for males and .509 for females.

The strongest correlations were between SELFCON and achievement .457, .518, and .462 which compared with Bachman's (1970) correlations of .48 for males and .55 for females when relating mathematics self-concept and mathematics achievement.

In terms of the three achievement variables, MANX and ENJOY were more strongly related to COMP than to CONC and PROB. Whereas, VALSOC and VALSEL were more strongly related to CONC and PROB than to COMP. SELFCON was highest for CONC and similar for COMP and PROB. It was interesting to conjecture about the possible reasons. Mathematics may be thought of as dealing with numbers and a great proportion of mathematics class time in middle and upper elementary school was spent on calculation. As MANX was correlated highest with COMP a possible implication was that mathematics anxiety begins in the early years of school. The higher correlations of VALSOC and VALSEL to CONC and PROB appeared reasonable because of the applied nature of the content in those achievement areas.

The low correlations of IARS and IARF with achievement, the largest was .190, were unexpected in the light of the literature. It was expected that successful students would be willing to accept responsibility for their success, as if accepting a due reward, and poor students to want to reject responsibility for failure as a defense to retain self-respect. The only correlation of a quadratic component that was expected from theory was that of SELFCON with the achievement variables. The hypothesis stemmed from the theory of Achievement Motivation which had substantial experimental support for a quadratic term for the subjects' perceived probability of success. In the present study it was argued that the self-concept of mathematics corresponded closely to that dimension. However, all three correlations of the quadratic term of SELFCON were not significant. The strongest quadratic relations were VALSOC with COMP (.097) and MANX with PROB (.088) ($p < .05$). However as the maximum explained variance was .9% and the variables were not consistent the finding was considered to be of no importance.

Multiple Regression of Standardized Scores and Factor Scores

The pedagogical literature has associated several variables with an "emotional block" in mathematics. As indicated above, the scales measuring those variables were associated with each other yet showed some degree of independence. If the construct of "emotional block" has validity then those variables should all contribute to the prediction of achievement. In other words that portion of independent variance should explain some additional variance of the achievement variables.

When all seven variables were present in the regression equation there was an increase, albeit rather small, in the multiple correlation; .483, .537 and .468 compared with SELFCON by itself; .457, .518 and .462. These differences had $.01 < p < .05$ for COMP and CONC and $p > .05$ for PROB.

Indeed, from these results one would anticipate that one or two of the measures would explain nearly as much as the whole set. Stepwise regression confirmed this. SELFCON appeared in all three regression equations with MANX appearing only in the equation for COMP. In the cross validation analysis the findings were similar. Most of the varince was explained by SELFCON. The othe six measures were weak except for MANX for COMP and VALSOC for CONC.

The question to be raised here is whether the other variables were excluded because the constructs they measure would add no significant explained variance or whether students responding to SELFCON were influenced by more than one construct. The issue is one of unidimensionality of the measures.

Therefore, factor score coefficients calculated from the orthogonal rotation of the principal components were used to generate factor scores. The analysis included the factor scores and their interaction terms. This was a test of the Achievement Motivation theory that interaction terms would increase explained variance. The hypothesis was not supported. Indeed, only one factor, MF, explained 19.1%, 19.5%, and 16.1% of the variance of COMP, CONC, and PROB, respectively. Most of this variance could be accounted for by SELFCON.

It should be recalled that one of the major contentions of this study was that a possible reason for the low correlations between affective variables and achievement was the multivariate nature of the affective domain and the potential interactions among the variables. The present analysis lends support to the multivariate nature of the affective domain in that three factors were needed to span the seven affective measures. However, at least with respect to the seven variables in this study, little support could be found for the hypothesis that the variables interact in the prediction of achievement. Moreover, the analysis of the individual scale scores suggested that SELFCON was the single most important variable of the three grouping under MF. As will be noted later in the section on future research this should not mean that the other variables be dismissed for they may be useful in either more specific achievement situations or at earlier grade levels.

LIMITATIONS OF THE STUDY

Before drawing conclusions and suggestions for further research, some limitations of the study should be emphasized. A major limitation of this study was its correlational nature. Because of this no causal inferences could be drawn. However, it was useful for suggesting probable directions for causal research.

A second limitation of this study was the set of measures used. The achievement variables, although in three parts, computation, concepts and problem solving, may still have been too global for the psychological model chosen. It may be the case that the Achievement Motivation model operates at the introduction of new material or new teaching units. Thus while these tests were summative in nature spanning the material of several years, quizzes oriented to a recently taught topic may produce different results.

The affective variables included here were only a subset of possible affective scales. Attitude Toward Teacher and Motivation in Mathematics were two examples of scales not included here. The latter, as interpreted by Sandman (1973), is the degree to which the student chooses to work with mathematical materials outside class by choice rather than need. The individual scales themselves may either have been too limited in the sampling of the construct domain, in some cases, or too general in others. Although this was not likely to be the case in the Sandman scales because the tests were constructed from a pool of items included in many prior scales, it may well have been the case that the author constructed scale Value of Mathematics (VALSOC) was too limited. As was indicated in Chapter 3, this scale was made the same length as the Sandman scales in order to keep the total administration time to a minimum, and the items were, wherever possible, made parallel to the Value of Mathematics for Society scale. On the other hand the Intellectual Achievement Responsibility Scales, (IARS and IARF) may have been too general. They were constructed to measure willingness to take responsibility for success and failure in achievement situations, rather than in the more restricted set of mathematics achievement situations.

Age level was the third limitation. Although the Achievement Motivation model could be operant at the introduction of new material it may also be the case that students had formed major sets of affective orientations by the time they had reached sixth grade. Therefore, if more global measures of achievement were to be used then perhaps earlier grades would be more appropriate.

A fourth limitation was the population from which the sample was drawn. Insofar as socio-economic level and cultural elements differ, the interrelationships described may not hold.

CONCLUSIONS

It would appear that there was an affective factor, MF (motivation factor), which was related to achievement at the grade six level. This factor was composed of the variables called, in this study, mathematics anxiety (MANX), self-concept of ability in mathematics (SELFCON) and enjoyment of mathematics (ENJOY). These three variables tend to correlate more strongly with teacher rankings of students and a teacher-response Student-Behavior checklist than do the other affective variables. This gave some evidence of the validity of these components as a measure of what could be described as an "emotional block" in mathematics. In the stepwise regressions SELFCON was always the first to be included in the analysis of both Sample 1 and 2. In the analysis of factor scores only MF, which had SELFCON as a component, was included.

From the Achievement Motivation model it was predicted that self-concept of ability in mathematics would correspond to subjective probability of success. Since the predicted relations did not appear in the analyses the correspondence was questioned. As SELFCON formed a factor together with ENJOY and MANX a more plausible correspondence was with the motivation factor. In turn the achievement responsibility factor (ARF), particularly the IARS component, showed evidence of independence from MF (motivation factor). In the light of its interpretation as the student's belief in his ability to control his achievement, a possible conclusion is that Intellectual Achievement Responsibility may be interpretable as subjective probability of success. ARF, however, did not display the interactions predicted by the Achievement Motivation model. This may have been because of the correlational, as opposed to experimental, nature of the study. As the achievement responsibility scales focus on the attributes of achievement such as luck, effort, internal control or external control, the confirmation of the above interpretation, through future research, could lead to quite specific programs for changing a student's subjective probability of success. Meichenbaum (1975) stated that

> For some researchers S's sense of control over the threatening situation seems most critical. Presumably a person will appraise a potentially aversive situation as less threatening if he perceives himself as having some measure of control over the aversive stimulus. (p. 239)

Self-concept was found to be a correlate of achievement as were mathematics anxiety and enjoyment. However, the variance of achievement scores accounted for by anxiety and enjoyment was virtually that accounted for by self-concept as was evidenced by the exclusion of the former two variables in the stepwise regression analysis. There was an exception in the case of computation when anxiety was also included. This was confirmed in the cross validation analysis. The factor analysis was another piece of evidence as the three variables loaded on the same factor and again, with the exception of the equation for computation where the value factor was included, the motivation factor was the sole selected factor. Parsimony, then, would indicate that self-concept be accepted as the major explanatory component.

However, it is the contention of the present author that the focus of attention should be on these three variables as a group. When the correlations between the three were corrected for attenuation self-concept was found to correlate -.87 and .69 with mathematics anxiety and enjoyment and mathematics anxiety -.90 with enjoyment. In addition Sarason's (1965) analysis of test anxiety indicated a cognitive component. Meichenbaum (1975) noted that some research had

> demonstrated that the specific emotion experienced by a person depends not only upon his state of psychological arousal, but also on the way in which <u>s</u> <u>interprets</u> or <u>labels</u> this state. They also found that this labeling process itself is influenced by what the person attributes as being the origin of this self arousal. (p. 239)

This researcher holds that the construct of self-concept should be interpreted as the cognitive component of anxiety. The lower correlation, corrected for attenuation, of self-concept and enjoyment (-.69) could indicate a lesser cognitive component in enjoyment of mathematics. The disattenuated correlation of -.88 of enjoyment with anxiety may suggest an emotional counter to anxiety.

Of considerable note was the very minor role of value of mathematics in predicting achievement. However, in retrospect, it was reasonable in that the incentives associated with the value of mathematics tend to be delayed rather than immediate for grade six students. Compared with the immediate effects of anxiety and enjoyment it was little wonder that value was of little importance in predicting achievement in mathematics. It should not be thought that value of mathematics is of no importance. It may be the case that it should be an important and desirable affective outcome in and of itself. The results of this study, however, do suggest that increased achievement not be expected as a result of teaching towards value of mathematics as an affective outcome.

FUTURE RESEARCH

As indicated in the section on limitations correlational studies cannot imply causal relations. However, one advantage correlational studies have over causal studies is that often they can deal with more variables or measures and suggest appropriate covariates and potential interrelations for causal analysis. The discussion of future research will be divided into two sections; correlational and experimental.

<u>Correlational Studies</u>

In this study it was argued that Self-Concept of Abiliy in Mathematics was the equivalent to an assessment of the subjective probabiltiy of success. Self-concept was found, though, to correlate highly with anxiety and enjoyment which are closer to motivation measures. This finding and several other considerations led to an alternative interpretation of self-concept. It could be that a student's answers on the self-concept scale were truthful and that they were estimates of the mark he thought he would receive. Yet this may not correspond to his perception of success in mathematics. For a "D" student success might well be an increase to a "C" in which case a large proportion of students would still surpass him. It is also interesting that the Achievement Motivation model predicted correlations between the quadratic term of subjective probability of success and achievement and yet only two marginal ($.01 < p < .05$) correlations of quadratic terms were found: VALSOC with COMP and MANX with PROB.

These considerations suggest that one possible direction for future research is the development of a Mathematics Intellectual Responsibility scale. It could then be validated in comparison with the Intellectual Achievement Responsibility Scale and then have its construct validation tested as a measure of the subjective probability of success.

As suggested in the limitations section, more research might be done with a view to the expansion of the Value of Mathematics for Oneself scale. It may be the case that VALSOC was not representive enough for young students. Thus two stages of research are indicated. The first is to solicit from youngsters the reasons why mathematics is important for them. For example, an open ended question could be used such as "Mathematics is important to me because ....?" The responses to such a question could form the basis of a Likert scale which could be used in a manner similar to that in this study.

It was also pointed out in the limitations section that the Achievement Motivation model may be valid at the introductory stage for new material. The experience of the present author teaching a year long course in geometry bears this out. At the first of four reporting sessions many good algebra students were a letter grade or two lower than expected and their places were taken by students who had typically performed at a lower level in algebra. However by the second reporting session it was an exceptional case that had not reverted to a ranking similar to that in the previous algebra course. If this informal observation has any force then an appropriate study would take account of the change over time of a group of students in a new mathematics situation. Such a study with periodic testing could be used to answer some causal questions if cross-panel correlation techniques were used.

It may be the case that if samples could be identified that were, for example, more or less achievement oriented, then the interrelations described above might be quite different.

Experimental Studies.

The major finding of this study was that the motivation factor which consisted of self-concept of mathematics, anxiety in mathematics, and enjoyment of mathematics was the only consistent factor predicting achievement and that was also consistent across sex groups. Further, SELFCON formed the basis of that factor. A question that should be asked is "Are these measures related because responses to them are based on similar constructs, or are they related because one of them causes the other two or two of them cause the third, or is there yet another cause underlying the three. Insofar as achievement level causes stress then self-concept of achievement should be related to anxiety and, as noted in the previous section, may be interpreted as the cognitive component of anxiety. In turn, an increase in enjoyment, as the "emotional" aspect of anxiety, would be expected to reduce anxiety. The hypothesis that this experimenter would hold is that as long as enjoyment is sustained, then anxiety will be reduced and self-concept of achievement will be increased.

It should be noted that the results of this study do not show IARS and IARF as important variables in the prediction of mathematics achievement. However, several possibilities have already been suggested. The first is that the measures may invite responses not necessarily related specifically to achievement in mathematics. The second is that the importance of the two variables may be in the introductory stage of material. The third is that relations not showing up in correlational studies may show up in experimental studies. Thus it is possible that focussing on techniques to change the attribution of success and failure may increase learning. It is just this possibility that Bar-Tal discusses (1978) in his article on attribution theory and achievement.

In summary one could conceive of designing experimental procedures to (a) change self-concept of ability, (b) increase enjoyment and, (c) alter the attribution of success and failure. A potentially informative study would use each of the procedures in a three factor, fully crossed design with two levels in each. The two levels of each factor would correspond to the presence or absence of the procedure. A pretest of mathematics anxiety could be included as a fourth factor with two or three levels. Again this factor would fully cross the other three. Post test anxiety and achievement would be the dependent variables.

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Appendix A

INSTRUCTIONS FOR BEHAVIORAL CHECKLIST

On the BACK cf the mark-sense cards provided (one for each student) write the indentification number of each of your grade six students.

DO NOT MARK IN THE COLUMNS UNDER THE HEADING "IDENTIFICATION NUMBER"

on the front of the card mark the oval with 1 in it under the appropriate item number if you have noticed the student exhibiting that behavior in your mathematics class during the year. Some of the students will have a blank card, or you might have only checked off one of the behaviors. However, please include even blank cards with an identification number on their back.

While the student is doing mathemtics have you observed that he/she

1. tends to give random answers to questions during mathematics class?
2. appears tense during mathematics lessons?
3. expresses anxiety or nervousness about mathematics?
4. tends to increase disruptive behavior during the mathematics class?
5. says that no matter what he/she does he/she can't do mathematics?

6. has hands that shake when doing matematics?
7. says that mathematics is usless?
8. sometimes refuses to answer questions during mathematics period?
9. fidgets more during mathematics lessons?

When you have finished please put the cards in the envelope with the YELLOW tab.

Appendix B

INSTRUCTIONS FOR RANKING OF STUDENTS

On the set of cards provided, write the names of each of your grade six students one to a card. Order the cards from most like the description below to least like it. The name of the student most like the description should appear on the top of the deck. On the piece of paper provided, list the identification numbers of the students in the same order as the names appear on the cards: from most like the description to least like it. Beside each identification number indicate male or female.

The following is a description of observable characteristics of students who may have an "emotional block" in mathematics. Try not to consider achievement or ability. Very good students may exhibit the block and very poor students may not.

A student with the block may give random answers to questions or may refuse to answer them at all. He/she may appear tense, have hands that shake as he/she writes, fidgets or increase disruptive behavior in the mathematics class. The student may tell you that he/she feels anxious or nervous about mathematics or that mathematics is useless. He/she may state that no matter how hard he/she works it seems to make no difference.

When you have finished please put the paper in the envelope with the YELLOW tab.

Appendix C

ADMINISTRATION BOOKLET

Thank you for volunteering your time and that of your students to enable me to gather the data I need for my dissertation. I hope the test returns and the results of my study will be of help and interest to you. There are three aspects to this study:

1. A student questionnaire about attitudes and feelings towards mathematics. The questionaire is in 3 twenty minute parts.

2. A set of achievement tests also in three parts, each of which is thiry-five minutes long.

3. A set of materials for you to fill out about your students. This can be done during the test periods so that your time commitment is not increased.

To retain the anonymity of the student and to protect the confidentiality of your replies and those of your students, I have asked you, in the enclosed materials, to give them an identification number. The numbers should be consecutive beginning at 1 and in the same order as your class list. When I return the results of the achievement tests, only the student number will appear.

Although the study is about mathematics THERE IS NO NEED TO DO ALL THE TESTING DURING SCHEDULED MATHEMATICS PERIODS. In fact, for at least the first two questionnaires it would be preferable to give them in some other period.

DO NOT MENTION THAT THE QUESTIONNAIRES HAVE ANYTHING TO DO

WITH MATHEMATICS AS THE FIRST TWO QUESTIONNAIRE SECTIONS CONCERN SCHOOL IN GENERAL.

Please refrain from making ANY evaluative comments about the questionnaire or the use of results until AFTER ALL TESTING IS DONE. In particular sudents will want to know what use you intend to make of the mathematics achievement test results: Are you going to use then for grading? Are they going to count toward the report? The best answer to give is that the test results are going to be used by you to find out areas of strengths and weaknesses so that you can plan future work. Try to avoid a denial of the use of the test results for grading until AFTER the last test. I want to encourage the students to work as hard as possible; just as they would do for you on a class test.

If you have any questions please contact me at the school or at my home.

Thanks again. Jim Gaskill

TEACHER'S ADMINISTRATION INSTRUCTIONS

STUDENT QUESTIONNAIRE

From your class list assign each student an identification number by numbering your list in order. Each sheet filled in by the student and cards filled in by you that relate to individual students must have the same number. This number retains confidentiality of student information, allows me to correlate all the information about each student, and enables me to communicate student results back to you.

Before you begin administering the questionaires, please make sure you have

1. a cassette tape recorder with speaker (from your school).
2. a cassete tape labelled SIDE ONE.
3. an answer sheet for each student.
4. ten extra pencils (Just in case some students don't have one.)
5. an envelope with a BLUE tab.
6. a questionnaire for each student.

Please attempt to administer the questionnaires in the morning on two consecutive days. I suggest the first two before recess, separated by five to ten minutes and the third on the second day before recess.

For purposes of standardization the above sequence would be preferable. However, if platooning or other considerations make it impossible, I will leave it to your discretion. But please have the questionnaires administered during the two days specified on the envelope with the BLUE tab.

Would you also be sure that all materials are collected and returned to the office when you are finished because other classes will be using the same pencils, tapes and questionnaires.

---

1. Set up the tape recorder with the tape cassette SIDE ONE facing up.

2. Hand out the answer sheets. Tell the students not to write on them until you tell them.

3. Tell the students to write the number that you will give them in the space in the upper left hand corner marked IDENTIFICATION NUMBER. Read the numbers from your class list.

4. Say:
   I am going to hand out some booklets. Do not write in them, and do not open them until I tell you.

5. Hand out the booklets. Say:
   The teacher who has sent you these booklets has asked me to read this letter to you.

   Boys and girls:

   I am interested in helping other boys and girls to do better in school. I will be asking you some questions--questions that have no right or wrong answers. They are questions about how you feel. You can answer honestly because I will not know your name. Your teacher will give you a number that you will write on each of your answer sheets. Your teacher will not know your answers because your answer sheets will be placed in an envelope, sealed and delivered to me. However, even though we won't know who your are, your answers are very important so please answer carefully.

On the answer sheet that has been handed out, your answers to the first set of questions will go under the columns with the heading QUESTION SET #1. Try not to change any of your answers. Make your decision before you mark your sheet. If you have to make a change erase the old mark as well as you can.

Each of the following questions needs a yes or no answer. If your answer is yes, circle the YES beside the question number. If your answer is no, circle the NO. Each question must have one answer.

Please look at the example at the bottom of the first page.

Are there any questions? (Pause.)

Open your booklets and answer the questions as they are read from the tape.

6. Turn on the tape.

7. Say:

Close your booklets and turn them over.

8. Give them a 5 - 10 minute break.

9. Say:

Open your booklets to the second set of questions. (Pause.) The answers to the next set of questions will go in the column headed QUESTION SET #2. For the following questions you must select one of the two possible statements that complete the sentence. Remember, each question must have one and only one answer.

Look at the example. (Pause.)

Are there any questions? (Pause.)

Turn over your answer sheets. Answer the questions as they are read from the tape.

10. Turn on the tape.

11. At the end of the second set of questions STOP THE TAPE. DO NOT REWIND. IT IS IN THE CORRECT POSITION TO START THE NEXT SESSION.

12. COLLECT THE ANSWER SHEETS, THE BOOKLETS, AND THE EXTRA PENCILS.

SECOND SESSION

1. Set up the tape recorder with the cassette SIDE ONE facing up. If you have not rewound the tape it should be in the correct position. Turn the tape on to see if QUESTION SET #3 is announced.

2. Hand out the answer sheets. Make sure that the answer sheets get back to the correct childern by using your class list.

3. Hand out extra pencils if needed.

4. Hand out the booklets.

5. Say:

Open your booklets to the instructions for the third set of questions.

In this next section you will be given a number of sentences. If you agree with the statement try to decide if you feel strongly about it. If so you would circle the 1. If you just agree, you would circle the 2. Or you might disagree with the statement. If so try to decide if you feel strongly about it. If you do, circle the 5. If you just disagree circle the 4. If you can't make up your mind or don't understand the sentence, then circle the 3.

Look at the example in your booklet. (Pause.)

Do you have any questions? (PAUSE).

Answer each question as it is read from the tape.

6. Turn on the tape.

7. At the end of the third set of questions
STOP THE TAPE. REWIND THE TAPE

8. Collect the booklets, answer sheets and extra pencils.

9. Place the answer sheets in the envelope with the BLUE tab on it.

10. Return the cassete, booklets, and answer sheets to the office to be picked up. Keep the pencils for the achievement tests that you will give in the next few days.

THANK YOU FOR YOUR EFFORT AND ASSISTANCE.

TEACHER'S ADMINISTRATION INSTRUCTIONS
ACHIEVEMENT TESTS

Before you begin administering the achievement tests make sure you have:

1. A class set of Stanford Achievement Tests (SAT).
2. A class set of Canadian Tests of Basic Skills (CTBS).
3. An answer sheet for each student.
4. Ten extra pencils.
5. An envelope with a RED tab.

The tests should be administered on two consecutive days. The SAT on the morning of the first day, the CTBS-mathematics concepts test on the afternoon of the first day, and the CTBS-problem solving test on the morning of the second day.

For purposes of standardization the above sequence must be maintained. However, although the timing suggested is preferable, plattooning or other considerations may make it impossible. Therefore, the timing will be left to your discretion. If the tests HAVE to be administered on one day then one should be given before recess, one after recess and the last one after lunch. In all cases though, please have the tests administered during the two days specified on your envelope with the RED tab.

Before you hand out any materials please ask your students not to write on the booklets and to mark the sheets only as described.

Would you also be sure that all materials are collected and returned to the office when you are finished because other classes will be using the same pencils and tests.

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1. Hand out answer sheets and foolscap.

2. Tell the students to write the number you are going to give them in the space in the upper left hand corner marked IDENTIFICATION NUMBER. Read the number from the same class list that you used to assign numbers for the questionnaires.

3. Say:

   This is the first of a set of three mathematics tests to find out how much you have learned. These tests are sent by the same person that sent the questionnaires. However, he will return the results of the tests to me, so be sure you do your best.

   I shall give you a test booklet. Do not open it until I tell you to do so.

4. Hand out bocklets.

5. Say:
   Now open your booklets to test 5: Arithmetic Computation, which starts on page 16. Look at the top of the page of your test booklet where it says "DIRECTIONS".

   The directions say; "Work the example in each box. Then look at the possible answers at the right side of the box and see if your answer is given. If it is, circle the letter on your answer sheet which is the same letter as the letter beside the answer that you have chosen. If your answer is <u>NOT</u> given, circle the letter which is the same as the letter beside NG which means not given. Use the foolscap for your work."

   Look at the sample question. 64 minus 23 leaves what? The correct answer, 41 , has been written below the line. The letter beside the 41 in the possible answers at the right side of the box is "c" so you would circle the "c" on your answer sheet.

When I tell you to start, behin with example 1 and do as many examples on pages 16 and 17 as you can. Do not spend too much time on any one example, if you cannot do an example, go on to the next one. When you finish page 17, example 39, go back and check your work on this test. Do not work on any other test. Use the scratch paper for figuring.

READY, GO!

6. Record the STARTING TIME. Add thirty five minutes to it. When this time is reached say:

STOP! Close your booklet and put your pencil down.

7. Collect the booklets, answer sheets, and extra pencils.

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1. At the next session, hand out the answer sheets, making sure that the students get their own answer sheets.

2. Hand out any pencils if needed, and scratch paper.

3. Say:
I shall give you a test booklet again. Do not open it until I tell you to do so.

4. Hand out the booklets for the Canadian Tests of Basic Skills.

5. Say:
Now we are ready for the second mathematics test. Open your test booklet to page 77. (Pause.) Find the section of your answer sheet for test M-1, Mathematics Concepts. (Pause.) The directions I will read to you are a little different, so listen carefully.

This is a test of how well you understand the number system and the terms and operations used in mathematics.

Four answers are given for each exercise, but only one of these answers is right. You are to choose the one answer that you think is better than the other Then, on the answer sheet, find the row of answer numbers that is numbered the same as the exercise. Circle the number on the answer sheet that is the same as the number beside the answer that you think is best.

DO NOT MAKE ANY MARKS ON THE TEST BOOKLET. Use your scratch paper for figuring.

You will have 30 minutes for this test. If you finish early, close your test booklet and wait quietly. Don't look at the other tests in the booklet. If you have any questions, raise your hand. I will help you after the others have begun. Turn to page 81 and begin with exercise 52. Stop when you reach page 83 exercise 96. (Pause.) Does everybody have the right place? (pause.) Ready, go.

6. Record the time. Add 30 minutes. When this time is reached say:

STOP. Close your test booklet.

7. Collect the booklets, answer sheets, and pencils.

At the last session

1. Hand out the answer sheets, making sure that the students get their own answer sheets.

2. Hand out any pencils if needed, and scratch paper.

3. Say:
I shall give you a test booklet again. Do not open it until I tell you to do so.

4. Hand out the booklets for the Canadian Test of Basic Skills.

5. Say
Now we are ready for the third mathmematics test. Open your test booklet to page 87. Find the section of your answer sheet for Test M-2, Mathematics Problem Solving. (Pause.) As the directions I will read are different from those in the booklet listen carefully.

This is test of how well you can solve mathematics problems. The exercises in the test are like the samples shown at the right. After each exercise are three possible answers and a "not given" meaning that the correct answer is not given.

Work each exercise and compare your answer with the three possible answers. If the correct answer is given, circle the number that is the same as the number beside the right answer. If the correct answer is not given, circle the fourth number.

The sample exercises show you what to do.

Now read the first sample exercise. (Pause.) What is the right answer for this exercise? (Pause for reply.) Yes, the second answer, 3, is the correct answer. You would circle the two on you answer sheet to show that the second answer is the correct one.

Sometimes the correct answer is not given. Now read the second sample exercise. (Pause.) What is the correct answer for this problem? (Pause for reply.) Yes, 1, is the correct answer. Since 1 is not one of the suggested answers, you would circle the four on your answer sheet to show that the correct answer is not given.

Work all of the exercises in the test in this way. Do not rework an exercise when your answer is not like any of the three suggested answers. Instead, circle the number 4 and go on to the next exercise. If you cannot work an exercise, leave it and go on to the next one. If you have time, you may return to it later.

Do your work on the scratch paper. Do not write on the test booklet.

You will have 30 minutes for this test. Now find your place to begin. Turn to page 91 and begin with exercise 40. Stop when you reach page 93 exercise 70. (Pause.) Does everyone have the right place? (Pause.) Ready, go.

6. Record the time. Add thirty minutes. When this time is reached say:

Stop! Time is up. Please close your test booklet at once.

7. Collect answer sheets, booklets, and pencils. Put answer sheets in the envelope with the RED tab. Return materials to the office.

THANK YOU ALL FOR YOUR TIME AND PATIENCE.

Appendix D

QUESTIONNAIRE BOOKLET[1]

DO NOT OPEN THIS BOOKLET UNTIL YOUR TEACHER TELLS YOU

Boys and girls:

I am interested in helping other boys and girls to do better in school. I will be asking you some questions--questions that have no right or wrong answers. They are questions about how you feel. You can answer honestly because I will not know your name. Your teacher will give you a number that you will write on each of your answer sheets. Your teacher will not know your answers because your answer sheets will be placed in an envelope, sealed and delivered to me. However, even though we won't know who you are, your answers are very important so please answer carefully.

On the answer sheet that has been handed out write the number that the teacher has given you in the space marked IDENTIFICATION NUMBER.

Your answers to the first set of questions will go under the columns with the heading QUESTION SET #1. Try not

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[1]The first setof 30 items make up the Test Anxiety Scale for Children. The second set of 34 items make up the Intellectual Achievement Responsibility Scale. The Achievement Responsibility Scale was scored and the items split into two sub-scales as described in Crandall, Katkovsy and Crandall (1965).

to change any of your answers. Make your decision before you mark your sheet. If you have to make a change erase the old mark as well as you can.

Each of the following questions needs a yes or no answer. If your answer is yes, circle the YES beside the question number. If your answer is no, circle the NO beside the question number.

For example if question 5 was

5. Do you like dogs?

And your answer was yes, then beside number 5 circle YES.

4. YES NO

5. YES NO

6. YES NO

If you have any questions please ask your teacher.

You must answer every question YES or NO.

1. Do you worry when the teacher says that she is going to ask you questions to find out how much you know?

2. Do you worry about being promoted, that is, passing from the sixth grade to the seventh grade at the end of the year?

3. When the teacher asks you to get up in front of the class and read aloud, are you afraid you are going to make some bad mistakes?

4. When the teacher says she is going to call upon some boys and girls in the class to do arithmetic problems, do you hope that she will call upon someone else and not on you?

5. Do you sometimes dream at night that you are in school and cannot answer the teacher's questions?

6. When the teacher says that she is going to find out how much you have learned, does your heart begin to beat faster?

7. When the teacher is teaching you about arithmetic, do you feel that other children in the class understand her better than you?

8. When you are in bed at night, do you sometimes worry about how you are going to do in class the next day?

9. When the teacher asks you to write on the blackboard in front of the class, does the hand you write with sometimes shake a little?

10. When the teacher is teaching you about reading, do you feel that other children in class understand her better than you?

11. Do you think you worry more about school than other children?

12. When you are at home and you are thinking about your arithmetic lesson for the next day, do you become afraid that you will get the answers wrong when the teacher calls upon you?

13. If you are sick and miss school, do you worry that you will do more poorly in your schoolwork than other children when you return.

14. Do you sometimes dream at night that other boys and girls in your class can do things you cannot do?

15. When you are home and you are thinking about your reading lesson for the next day, do you worry that you will do poorly on the lesson?

16. When the teacher says that she is going to find out how much you have learned, do you get a funny feeling in your stomach?

17. If you did very poorly when the teacher called on you, would you probably feel like crying even though you would try not to cry?

18. Do you sometimes dream at night that the teacher is angry because you do not know your lessons?

In the following questions the word "test" is used. What I mean by "test" is any time the teacher asks you to do something to find out how much you know or how much you have learned. It could be by your writing on paper, or by your speaking aloud, or by your writing on the blackboard. Do you understand what I mean by "test" -- it is any time the teacher asks you to do something to find out how much you know.

---

19. Are you afraid of school tests?

20. Do you worry a lot <u>before</u> you take a test?

21. Do you worry a lot <u>while</u> you are taking a test?

22. <u>After</u> you have taken a test do you worry about how well you did on the test?

23. Do you sometimes dream at night that you did poorly on a test you had in school that day?

24. When you are taking a test, does the hand you are writing

with shake a little?

25. When the teacher says that she is going to give the class a test, do you become afraid that you will do poorly?

26. When you are taking a hard test, do you forget some things you knew very well before you started taking the test?

27. Do you wish a lot of times that you didn't worry so much about tests?

28. When the teacher says that she is going to give the class a test, do you get a nervous or funny feeling?

29. While you are taking a test do you usually think you are doing poorly?

30. While you are on your way to school, do you sometimes worry that the teacher may give the class a test?

DO NOT TURN THE PAGE UNTIL THE
TEACHER TELLS YOU

The answers to the next set of questions will go in the column headed QUESTION SET #2. For the following questions you must select one of the two possible statements that complete the sentence. For example

6. If you were given a choice of pie would you choose
   1. apple, or
   2. cherry?

If you prefer cherry then beside number 6. You would circle the 2.

If you have any questions please ask your teacher.

---

1. If a teacher passes you to the next grade, would it probably be
   1. because she liked you, or
   2. because of the work you did?

2. When you do well on a test at school, is it more likely to be
   1. because you studied for it, or
   2. because the test was especially easy?

3. When you have trouble understanding something in school, is it usually
   1. because the teacher didn't explain it clearly, or
   2. because you didn't listen carefully?

4. When you read a story and can't remember much of it, is it usually
   1. because the story wasn't well written, or
   2. because you weren't interested in the story?

5. Suppose your parents say you are doing well in school. Is this likely to happen
   1. because your school work is good, or
   2. because they are in a good mood?

6. Suppose you did better than usual in a subject at school. Would it probably happen
   1. because you tried harder, or
   2. because someone helped you?

7. When you lose at a game of cards or checkers, does it usually happen
    1. because the other player is good at the game, or
    2. because you don't play well?

8. Suppose a person doesn't think you are very bright or clever.
    1. can you make him change his mind if you try to, or
    2. are there some people who will think your're not very bright no matter what you do?

9. If you solve a puzzle quickly, is it
    1. because it wasn't a very hard puzzle, or
    2. because you worked on it carefully?

10. If a boy or girl tells you that you are dumb, is it more likely that they say that
    1. because they are mad at you, or
    2. because what you did really wasn't very bright?

11. Suppose you study to be a teacher, scientist, or doctor and you fail. Do you think this would happen
    1. because you didn't work hard enough, or
    2. because you needed some help, and other people didn't give it to you?

12. When you learn something quickly in school, is it usually
    1. because you paid close attention, or
    2. because the teacher explained it clearly?

13. If a teacher says to you, "Your work is fine," is it
    1. something teachers usually say to encourage pupils, or
    2. because you did a good job?

14. When you find it hard to work arithmetic or math problems at school, is it
    1. because you didn't study well enough before you tried them, or
    2. because the teacher gave problems that were too hard?

15. When you forget something you heard in class, is it
    1. because the teacher didn't explain it very well, or
    2. because you didn't try very hard to remember?

16. Suppose you weren't sure about the answer to a question your teacher asked you, but your answer turned out to be right. Is it likely to happen

1. because she wasn't as particular as usual, or
2. because you gave the best answer you could think of?

17. When you read a story and remember most of it, is it usually
    1. because you were interested in the story, or
    2. because the story was well written?

18. If your parents tell you you're acting silly and not thinking clearly, is it more likely to be
    1. because of something you did, or
    2. because they happen to be feeling cranky?

19. When you don't do well on a test at school, is it
    1. because the test was especially hard, or
    2. because you didn't study for it?

20. When you win at a game of cards or checkers, does it happen
    1. because you play really well, or
    2. because the other person doesn't play well?

21. If people think you're bright or clever, is it
    1. because they happen to like you, or
    2. because you usually act that way?

22. If a teacher didn't pass you to the next grade, would it probably be
    1. because she "had it in for you," or
    2. because your school work wasn't good enough?

23. Suppose you don't do as well as usual in a subject at school. Would this probably happen
    1. because you weren't as careful as usual, or
    2. because somebody bothered you and kept you from working?

24. If a boy or girl tells you that you are bright, is it usually
    1. because you thought up a good idea, or
    2. because they like you?

25. Suppose you became a famous teacher, scientist or doctor. Do you think this would happen
    1. because other people helped you when you needed it, or
    2. because you worked very hard?

26. Suppose your parents say you aren't doing well in your school work. Is this likely to happen more

1. because your work isn't very good, or
2. because they are feeling cranky?

27. Suppose you are showing a friend how to play a game and he has trouble with it. Would that happen
    1. because he wasn't able to understand how to play, or
    2. because you couldn't explain it well?

28. When you find it easy to work arithmetic or math problems at school, is it usually
    1. because the teacher gave you especially easy problems, or
    2. because you studied your book well before you tried them?

29. When you remember something you heard in class, is it usually
    1. because you tried hard to remember, or
    2. because the teacher explained it well?

30. If you can't work a puzzle, is it more likely to happen
    1. because you are not especially good at working puzzles, or
    2. because the instructions weren't written clearly enough?

31. If your parents tell you that you are bright or clever, is it more likely
    1. because they are feeling good, or
    2. because of something you did?

32. Suppose you are explaining how to play a game to a friend and he learns quickly. Would that happen more often
    1. because you explained it well, or
    2. because he was able to understand it?

33. Suppose you're not sure about the answer to a question your teacher asks you and the answer you give turns out to be wrong. Is it likely to happen
    1. because she was more particular than usual, or
    2. because you answered too quickly?

34. If a teacher says to you, "Try to do better," would it be
    1. because this is something she might say to get pupils to try harder, or
    2. because your work wasn't as good as usual?

DO NOT TURN THE PAGE UNTIL YOUR TEACHER TELLS YOU

In this next section you will be given a number of sentences. If you agree with the statement try to decide if you feel strongly about it. If so you would circle the 1. If you just agree, circle the 2. Or, you might disagree with the statement. If so, try to decide if you feel strongly about it. If you do circle the 5. If you just disagree circle the 4. If you can't make up your mind or don't understand the sentence then circle the 3.

For example, if the statement was

8. I like ice cream.

If you love it you would circle the 1.

If you just like it you would circle the 2.

If you can't make up your mind or don't care you would circle the 3.

If you don't like it you would circle the 4.

If you hate it you would circle the 5.

If you have any questions please ask your teacher.

Turn the page when your teacher tells you .

The answers for these questions will go under the column headed QUESTION SET #3.

1. I enjoy talking to other people about mathematics.
2. Mathematics is more of a game than it is hard work.
3. It makes me nervous to even think about doing mathematics.
4. Mathematics is something which I enjoy very much.
5. Doing well in mathematics helps me in other subjects.
6. When I hear the word mathematics, I have a feeling of dislike.
7. I am good at working mathematics problems.
8. If I don't see how to work a mathematics problem right away, I never get it.
9. Mathematics is useful for my problems in every day life.
10. Most people should study some mathematics.
11. I feel tense when someone talks to me about mathematics.
12. I don't do very well in mathematics.
13. I have a good feeling toward mathematics.
14. You can get along perfectly well in every day life without mathematics.
15. Mathematics is helpful in understanding today's world.
16. I would like to spend less time in school doing mathematics.
17. Mathematics is useful for the problems of every day life.
18. I can get along perfectly well in every day life without mathematics.
19. No matter how hard I try, I cannot understand mathematics.
20. Working mathematics is fun.
21. If I got better marks in mathematics I would enjoy mathematics more.
22. Mathematics helps me understand today's world.

23. Mathematics is easy for me.

24. I like to play games that use numbers.

25. There is little need for mathematics in most jobs.

27. I feel at ease in a mathematics class.

28. There is little need for mathematics in the jobs that I would want.

29. It scares me to have to take mathematics.

30. I would like a job which doesn't use any mathematics.

31. Mathematics is of great importance to a country's development.

32. Most of the ideas in mathematics aren't very useful for me.

33. It is important for me to know mathematics in order to get a good job.

34. I don't like anything about mathematics.

35. I remember most of the things I learn in mathematics.

36. It doesn't disturb me to work mathematics problems.

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

38. Working with numbers upsets me.

39. I often think, "I can't do it," when a mathematics problem seems hard.

40. Most of the ideas in mathematics aren't very useful.

THANK YOU FOR ANSWERING ALL THESE QUESTIONS

Appendix E

LAY OUT OF THE STUDENT ANSWER FORMS

Reproduced below are the first few lines of the answer sheets for the achievement tests.

Identification Number

Keypunch Info Only	Card #1	Card #2	Card #3
	Computation Test	Test M-1 Math Concepts	Test M-2 Math Problem Solving
	1. a b c d e	52. 1 2 3 4	40. 1 2 3 4
	2. f g h i j	53. 1 2 3 4	41. 1 2 3 4
	3. a b c d e	54. 1 2 3 4	42. 1 2 3 4

Reproduced below are the first few lines of the response sheets for the affective scales.

Identification Number

Keypunch Info Only	Card #4	Card #5	Card #6					
	Question Set 1	Question Set 2	Question Set 3					
				Strongly Agree	Agree	Don't Know	Disagree	Strongly Disagree
	1. yes no	1. 1 2	1.	1	2	3	4	5
	2. yes no	2. 1 2	2.	1	2	3	4	5
	3. yes no	3. 1 2	3.	1	2	3	4	5

Appendix F

CLASS MEANS AND STANDARD DEVIATIONS OF THE ACHIEVEMENT VARIABLES AND AFFECTIVE VARIABLES

Class	COMP	CONC	PROB	TASC	IARS	IARF	MANX	VSOC	SCON	ENJOY	VSELF
1	16.9	20.5	12.6	14.6	30.0	27.4	19.6	31.0	26.6	25.2	30.0
	6.66	8.63	7.01	5.06	2.10	3.01	5.55	5.28	6.49	6.18	6.01
2	20.0	25.7	16.3	14.5	28.0	26.9	17.4	34.1	29.4	25.7	31.1
	6.36	7.94	5.49	5.01	3.01	2.49	6.26	3.97	5.84	8.20	4.48
3	20.4	29.5	21.1	9.9	29.9	29.3	20.8	31.9	27.9	24.5	29.8
	7.53	8.35	6.03	6.06	2.47	2.02	8.56	3.98	7.30	8.22	3.57
4	18.7	22.6	15.0	11.7	30.0	28.1	21.8	30.4	27.7	20.7	27.2
	8.14	9.38	6.21	6.29	2.17	2.81	6.41	5.40	6.12	5.68	5.45
5	25.1	32.8	22.8	13.9	29.8	29.7	18.3	34.2	28.3	26.4	31.3
	5.04	5.70	3.83	8.49	1.72	1.32	5.22	3.80	5.43	6.29	2.87
6	26.2	33.1	21.7	9.63	29.5	27.2	17.2	32.4	29.5	26.0	30.7
	4.24	5.62	5.04	4.19	2.42	3.47	6.89	4.88	5.51	6.57	4.61
7	19.4	26.5	17.3	11.3	30.7	27.7	18.4	32.3	28.7	24.1	30.8
	5.76	6.28	5.41	5.16	1.74	2.69	5.04	4.94	5.78	6.68	5.46
8	14.2	20.6	13.4	15.2	30.0	27.3	18.2	32.9	29.0	24.0	29.8
	3.85	7.02	4.43	5.21	2.37	2.69	5.00	4.67	6.27	5.83	4.35
9	20.2	29.2	20.1	13.8	29.8	26.8	17.2	32.7	30.2	25.1	29.4
	7.06	6.58	5.78	3.37	2.79	3.11	5.30	5.45	5.66	7.99	4.27
10	22.5	35.3	25.0	8.5	31.8	29.3	21.7	33.2	30.8	18.3	28.8
	2.88	3.50	2.61	1.97	0.98	2.25	2.73	2.32	3.92	2.42	3.49
11	18.3	24.4	15.9	11.3	30.1	26.4	16.8	30.9	29.3	24.1	27.0
	7.54	8.95	6.00	4.11	1.78	2.70	5.06	4.58	4.92	6.67	5.63
13	23.9	28.1	20.1	13.0	29.8	28.7	17.9	32.9	27.6	26.0	31.9
	6.92	8.04	6.35	6.82	2.19	2.70	6.00	4.48	6.24	5.81	4.44
14	17.4	23.6	14.7	12.0	28.2	26.8	19.3	31.3	27.5	26.2	30.0
	6.05	6.79	5.50	5.93	2.94	2.66	5.22	5.27	3.86	5.12	5.83
15	18.2	23.6	15.0	11.9	29.9	29.1	19.4	33.6	27.4	25.8	31.0
	7.77	7.52	5.72	5.88	2.37	2.59	7.34	4.56	7.25	6.51	5.39
16	24.8	27.5	20.2	11.0	29.7	27.4	20.0	33.5	28.6	24.4	30.4
	5.94	6.78	5.35	5.96	2.31	3.16	4.23	4.19	3.22	6.09	5.02
17	14.4	23.0	14.0	11.2	28.8	27.7	19.6	32.6	29.6	26.3	29.5
	5.62	9.29	6.64	7.17	2.66	2.39	7.10	4.67	6.76	6.09	5.71
18	15.2	20.2	12.8	12.2	29.7	28.0	18.3	30.8	28.7	24.8	27.9
	6.03	6.70	5.11	5.78	1.95	2.55	7.10	4.36	5.95	7.59	5.15
19	23.7	26.4	18.7	12.3	29.9	29.2	18.3	33.6	28.3	25.2	33.4
	6.63	7.65	3.35	4.30	2.26	2.68	3.81	5.61	4.36	5.70	4.36
20	18.0	27.5	20.3	11.4	29.8	26.6	21.3	30.2	26.4	22.6	28.6
	7.47	6.76	4.59	5.25	2.66	2.93	5.46	5.26	6.25	6.51	4.54
21	19.4	26.6	19.2	13.1	29.8	27.2	27.7	26.9	23.4	13.8	22.1
	7.21	6.31	5.61	4.94	1.86	3.67	5.29	5.21	5.85	4.41	6.66

22	18.1	16.8	14.1	14.9	28.0	26.1	21.7	31.8	25.7	22.3	32.4
	5.64	3.77	3.79	4.65	1.32	3.66	7.16	5.31	4.27	7.30	5.25
23	23.0	25.3	17.5	12.8	29.0	26.4	19.1	31.7	28.4	26.5	29.7
	7.71	9.52	6.87	6.98	2.37	3.19	6.62	4.86	6.22	7.37	5.12
24	20.9	27.1	17.0	13.5	29.7	28.0	20.9	29.7	28.1	24.1	27.9
	7.56	7.86	6.97	5.58	2.30	2.50	6.93	5.34	4.59	7.05	5.97
25	15.1	22.0	15.4	16.0	29.9	28.5	18.9	34.3	27.9	27.3	33.4
	6.50	8.22	5.36	5.26	2.32	2.70	5.84	3.60	6.75	6.76	3.85
26	19.8	22.8	18.3	11.7	30.2	27.6	16.4	31.2	30.6	27.9	29.8
	7.52	8.03	6.17	6.81	2.50	3.02	5.90	4.90	6.62	6.52	5.53
27	16.1	20.7	13.6	15.2	30.3	27.7	19.0	34.5	28.6	26.9	32.7
	5.00	5.68	3.92	5.01	1.49	3.15	5.42	3.72	6.64	8.20	4.30
28	15.3	21.5	16.9	11.1	28.4	26.7	17.0	30.3	31.3	26.8	29.7
	9.78	7.72	5.61	5.93	2.63	1.16	6.53	4.85	5.68	5.01	3.56
29	12.3	17.9	13.7	14.3	29.7	27.3	18.3	31.6	27.3	24.4	30.6
	6.38	5.34	5.21	6.05	2.67	2.58	3.51	5.27	5.75	6.40	4.47
30	17.7	25.8	17.0	12.5	30.7	28.8	17.4	31.4	29.2	26.9	28.1
	5.40	7.23	5.07	5.93	1.90	2.27	6.13	4.75	5.16	6.62	4.76
31	15.0	18.0	12.0	14.1	31.3	30.5	17.8	35.6	29.0	27.8	31.0
	4.47	10.5	4.50	4.39	1.04	1.93	8.28	4.14	5.15	5.70	6.07
32	23.9	25.3	17.6	12.2	29.4	28.4	17.3	33.3	31.3	26.8	29.4
	7.95	9.05	6.72	6.77	1.54	2.36	5.49	3.82	4.89	6.35	3.84
33	12.7	19.9	11.1	12.3	30.6	28.8	19.2	30.1	28.0	23.8	27.0
	4.76	7.53	5.05	5.55	1.69	1.78	4.17	3.67	6.87	5.53	4.15
35	19.9	20.1	15.4	11.3	29.3	26.8	17.2	32.2	31.6	25.2	30.1
	7.58	7.36	6.24	5.78	3.34	2.55	5.68	7.13	5.33	7.64	7.04
36	25.6	22.4	18.8	10.4	31.5	27.9	13.9	35.1	31.6	28.3	33.5
	3.20	5.76	5.04	2.72	1.51	3.52	3.56	4.85	4.63	9.68	6.95
37	18.1	25.0	19.5	11.6	30.0	28.4	16.5	31.2	32.6	26.4	28.9
	5.61	5.71	3.93	3.14	2.45	2.06	3.96	4.77	4.01	6.99	5.36
38	17.1	19.8	14.6	13.4	29.4	26.5	18.2	30.6	27.4	24.1	28.3
	7.09	8.98	7.09	5.94	2.36	3.42	5.95	4.85	6.91	8.12	5.61
39	21.4	23.8	17.5	13.3	29.0	27.8	18.5	32.5	26.6	26.1	31.0
	7.92	7.58	6.06	5.62	2.27	2.43	6.00	3.52	6.15	6.92	4.89
40	27.0	35.0	24.2	16.8	30.2	25.8	18.2	34.6	29.8	29.2	33.6
	5.24	3.54	3.90	6.06	0.45	3.35	8.35	4.04	8.11	6.22	4.88
41	26.3	27.9	18.1	14.6	29.1	27.6	20.0	30.0	25.0	23.9	27.9
	5.82	5.74	7.08	5.50	2.30	2.33	4.78	4.34	5.45	6.08	4.64
42	15.5	23.0	16.3	13.1	29.0	26.5	17.7	31.8	29.4	24.8	28.7
	5.99	8.31	6.84	5.63	1.97	3.78	5.36	4.51	5.66	5.14	4.26
43	17.7	20.1	14.4	13.7	29.0	28.1	19.7	29.9	28.3	25.1	28.5
	4.15	5.05	3.87	3.73	1.63	3.24	4.35	6.99	5.47	6.31	5.99
44	14.7	17.7	11.2	11.8	28.8	25.2	21.0	29.0	25.4	24.4	29.5
	7.17	6.28	4.24	5.07	2.95	3.19	5.73	4.71	6.48	6.47	5.38
45	16.8	23.3	14.7	12.9	29.4	28.6	19.3	33.5	29.3	28.4	33.9
	5.73	5.32	4.76	5.69	2.17	2.21	5.60	3.81	4.02	6.07	4.24
46	20.6	24.9	16.8	16.0	28.7	28.4	20.3	32.4	25.9	26.8	29.4
	7.02	10.3	6.24	5.68	2.87	2.19	6.87	4.19	5.82	7.28	5.08
47	19.6	24.1	16.4	6.3	28.3	26.5	19.8	25.4	29.4	20.6	24.4
	4.22	8.29	5.39	4.23	2.11	3.24	5.98	6.63	7.57	6.35	6.05
51	12.8	19.3	15.3	11.9	29.2	26.3	18.4	31.0	26.3	26.9	27.9

	4.90	8.37	4.73	7.45	3.00	3.28	6.81	4.17	7.68	6.54	4.79
52	28.9	38.5	24.3	9.7	30.4	27.4	19.9	32.6	30.3	21.5	29.9
	5.34	3.26	3.97	5.08	2.22	1.97	5.87	4.45	3.98	7.67	4.58
53	16.8	20.9	14.4	12.8	28.6	27.1	19.6	32.7	27.2	22.1	28.8
	6.03	7.97	5.25	4.94	2.30	2.48	4.54	3.86	4.66	6.87	4.44
54	17.3	25.2	15.2	13.3	30.0	28.4	18.6	33.8	29.3	25.8	30.6
	6.16	4.84	4.82	4.80	1.73	1.81	3.81	3.49	3.50	3.70	5.66
55	14.6	20.3	13.3	12.6	30.0	28.7	18.1	33.7	26.3	26.0	31.4
	6.47	7.93	5.59	3.84	2.44	2.03	5.49	4.17	5.63	5.51	5.10
56	17.3	20.0	15.3	12.8	28.8	27.8	17.7	32.3	30.5	26.3	31.3
	5.79	9.49	5.68	4.17	2.93	3.37	3.27	5.32	3.78	5.13	5.67
57	17.0	24.7	15.4	8.7	28.8	27.2	19.9	30.3	27.3	24.3	28.9
	7.52	8.05	6.27	4.98	2.35	2.57	4.58	4.63	5.61	6.43	3.73
58	17.3	17.6	12.4	14.0	28.1	26.3	19.5	32.9	26.8	22.4	29.7
	6.00	6.23	5.98	7.98	2.50	2.05	7.90	5.13	8.48	8.00	5.87
59	16.0	20.2	16.3	14.4	28.3	28.8	18.9	34.2	27.0	26.6	31.3
	5.57	6.02	4.79	5.10	2.66	2.33	6.19	3.89	5.76	7.69	3.99
62	21.9	26.8	15.5	15.9	29.6	27.4	18.8	32.4	27.6	24.7	31.0
	5.93	8.17	5.68	4.63	2.37	2.32	4.52	3.58	5.95	5.25	2.60
63	22.4	28.8	20.5	12.8	30.1	26.8	16.8	32.4	29.6	25.9	29.1
	8.33	10.1	5.29	5.57	1.73	3.33	5.18	5.18	4.44	5.33	5.26

OVERALL MEANS FOR EACH TEST

18.7	23.9	16.3	12.5	29.5	27.6	18.9	32.0	28.3	25.0	29.8

OVERAL S.D.'S FOR EACH TEST

7.3	8.5	6.2	5.7	2.4	2.8	5.9	4.9	6.0	6.8	5.2

Appendix G

DIFFERENCES BETWEEN MEANS FOR MALES AND FEMALES

Univariate Analyses of Variance with Sex as a Dependent Variable and the Three Achievement and Seven Affective Scales as Independent Variables

N = 1033

Variable		Mean	S.D.	MSW	MSB	F Ratio	F Prob
COMP	M	17.5	7.24	52.2	1728.3	33.1	.0000
	F	20.1	7.21				
CONC	M	23.7	8.51	73.1	64.3	.9	.348
	F	24.2	8.58				
PROB	M	15.8	6.32	38.4	287.4	7.5	.006
	F	16.9	6.06				
IARS	M	29.4	2.51	5.7	24.0	4.2	.041
	F	29.7	2.26				
IARF	M	27.3	2.89	8.0	46.9	5.9	.016
	F	27.8	2.76				
MANX	M	18.9	6.21	35.3	1.6	.04	.834
	F	18.8	5.65				
VALSOÇ	M	32.0	5.05	24.1	5.7	.24	.627
	F	31.8	4.76				
SELFCON	M	28.8	6.08	35.4	203.3	5.7	.017
	F	27.9	5.81				
ENJOY	M	24.9	7.05	46.5	13.0	.28	.597
	F	25.1	6.57				
VALSEL	M	29.8	5.40	27.5	.3	.01	.922
	F	29.8	5.08				

Analysis of variance showed a significant difference ($p < .01$) favoring the females in both COMP and PROB. Only three of the seven affective variables, IARS, IARF and SELFCON showed significant differences ($p < .05$). Females tended to accept responsibility for failure and success more than males and males had a somewhat higher self-concept in mathematics than did the females. The table above summarizes the one-way analysis of variance for males and females calculated from raw scores on each scale and over the complete 1033 cases; 529 males and 504 females.

Although the differences between males and female means are significant on some of the scales, there are only two pairs of means which differ by more than one scale point: COMP at 2.6, and PROB at 1.1. When these differences are translated into proportions of explained variance the differences become less important. When sex is correlated with the achievement variables the squared correlations show that sex accounts for only 3.8% of the variance of COMP and 2.1% of the variance of PROB.

Appendix H

INTER-CORRELATIONS OF STUDENT-BEHAVIORS

	1	2	3	4	5	6	7	8
1	1.00							
2	.19	1.00						
3	.23	.51	1.00					
4	.30	.06	.01	1.00				
5	.33	.19	.27	.12	1.00			
6	.12	.26	.23	-.02	.06	1.00		
7	.30	.02	.12	.36	.31	.00	1.00	
8	.33	.11	.04	.35	.16	.01	.22	1.00
9	.09	.16	.23	.37	.28	.07	.31	.34

1. Tends to give random answers to questions during mathematics class.

2. Appears tense during mathematics lessons.

3. Expresses anxiety or nervousness about mathematics.

4. Tends to increase disruptive behavior durng the mathematics class.

5. Says that no matter what he/she does he/she can't do mathematics.

6. Has hands that shake when doing mathematics.

7. Says that mathematics is useless.

8. Sometimes refuses to answer questions during mathematics period.

9. Fidgets more during mathematics.