# THE RELATIONSHIP BETWEEN SECONDARY SCHOOL STUDENTS' AND THEIR PARENTS' ACHIEVEMENT IN MATHEMATICAL PROBLEM SOLVING

by

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ABSTRACT

The present study investigated the relationship between parent and child achievement in mathematics problem solving. Stafford, assuming that mathematics problem solving is a sex-linked trait, proposed that the correlational pattern between family members should be in the following order of magnitude: father-daughter approximately equal to mother-son, greater than mother-daughter, with the father-son being the lowest.

Volunteer parents and their children wrote a mathematics problem test. Correlation coefficients were calculated between the various family members to test the predicted order of the correlations.

Stafford also hypothesized the mean score of boys on mathematics problem solving tests should be higher than that of the girls. Therefore, the mean scores of boys and girls on a mathematics problem test were compared.

The findings for the predicted ordered correlation coefficients neither confirmed nor refuted Stafford's hypothesis. Possible causes of the inconclusive results are the problems of small sample size and restriction of range.

Also, there was no significant difference found between mean scores of boys and girls in mathematics achievement. This and the above finding, however, for reasons mentioned in the study, do not necessarily show that Stafford's hypothesis is invalid.

Examiners: [redacted]

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CHAPTER I

# THE PROBLEM

## Introduction

One of the most controversial issues in education today has to do with whether certain facets of intelligence are inherited or are the result of environmental influences. Supporting inborn influences in the nature-nurture controversy, Osborne *et al.* (1967) state that seventy-two percent of the variance for numerical facility, seems to be genetically determined. Stafford (1972) also supports the importance of genetic factors. His hypothesis that quantitative reasoning is a sex-linked trait is partly based on the observation that in spatial and numerical tasks, the mean score of males exceeds the mean score of females. Male superiority in quantitative reasoning is indicative of this mode of inheritance. In support of this conclusion are most of the studies summarized by Terman and Tyler (1954) who report significant differences in favor of boys in arithmetic tests requiring reasoning. Also, Anastasi (1958) reviewed the literature on sex differences in intellectual functions and found that in commonly used tests, sex differences are slight, but verbal tests do tend to favor girls, whereas numerical and spatial relations tests tend to favor boys.

Stafford, assuming quantitative reasoning is a sex-linked trait, proposed a unique ordering of family correlations according to the magnitude of the coefficients. He suggests that the father-daughter and mother-son correlations should be the largest, with mother-daughter next, and a zero correlation for father-son. The reason for the ordered correlational pattern can be seen in Figure 1 and will be discussed further later. Briefly, a mother who expresses a sex-linked recessive trait will have sons all having this trait but her daughters may or may not possess the trait. On the other hand, a father expressing the trait may have daughters having the trait but there is no way such a father can pass on a sex-linked recessive trait to his son.

Stafford has observed that a few studies discussed in the review of the literature do in fact seem to indicate that there is a unique set of family correlations in arithmetic problem solving scores.

## Statement of the Problem

The problem that the present study investigated, which is based on the assumption that achievement on an arithmetic problems test is a sex-linked recessive trait, is whether the expected unique ordering of family correlational patterns previously described, is borne out by the data collected from the sample used in this study.

## Importance of the Study

The results of the study will contribute to the findings of Stafford and others in the area of relationship between family members in mathematical problem solving test scores. Furthermore, in summarizing the results of a number of studies, Stafford reported that the mean father-daughter correlation was (r = .22), the mother-son correlation was (r = .30), the mother-daughter correlation was (r = .27) and the father-son correlation was (r = .11). These findings do not conclusively show that his proposed ordered correlational pattern is correct.

## Limitations of the Study

The findings and conclusions reached in this study are limited in their application inasmuch as the results cannot be generalized. It was difficult to obtain a representative sample of parents since volunteer parents had to be relied upon. Even these were limited in number.

Also, it was difficult to construct a test which accurately measures the mathematics problem solving of grade nine students through adults. It was assumed in this study that adults and grade ten students had no advantage over grade nine students on the Mathematics Problem Test.

# CHAPTER II

# REVIEW OF RELATED LITERATURE

## Background Information in Genetics

It is quite often said that boys take after their mother, girls after their father. As far as biological inheritance is concerned, this is true and to a very limited extent only for a few special traits. These traits are called sex-linked. The term "sex-linked" refers to genes in the X chromosome without partner genes in the Y. The number of sex-linked genes varies greatly between species. Ohno (1967) states that in humans, the X chromosome forms about five percent of the whole chromosome material in the female and approximately half of that in the male; it carries many sex-linked genes which affect the most varied characters. According to latest figures, McKusick and Chase (1973) report 92 known sex-linked traits and an additional 65 suggested but not yet proven.

Sex-linked genes form the one major exception to the rule that in sexually produced organisms, all genes occur in pairs; for they are without partner genes in all XY individuals, such as fruit-fly males, men, or hens. This has an important consequence. XY individuals cannot be heterozygous for sex-linked genes. They cannot, therefore, carry recessive sex-linked genes masked by their normal alleles, and every sex-linked gene - whether dominant or recessive - manifests itself in the XY sex. Figure 1 illustrates the results of various unions of normal and color-blind partners. It assumes that color blindness in man is caused by a recessive sex-linked gene, which we may call "cb". A woman, with two X chromosomes, may be genotypically "cb cb" and phenotypically color-blind, or "++" and normal-seeing, or "cb +" and normal-seeing; a man, with one X chromosome, can only be "cb" and color-blind, or "+" and normal-seeing.

It should be noted that a mother always has two X chromosomes. She transmits one of these to all her children, sons as well as daughters. Half the children will inherit one of the X chromosomes, half will inherit the other. On the other hand a father always has one X and one Y chromosome. He transmits his X chromosome to all his daughters, his Y chromosome to all his sons. He never transmits an X chromosome to a son since each spermatozoon carries either the X or the Y, not both. Also a daughter has two X chromosomes. She has inherited one of them from her mother, the other one from her father, in the same way

| Color-blind Mother | | | Normal Father |
|---|---|---|---|
| $X^{cb}\ X^{cb}$ | | | $X^{+}\ Y$ |
| $X^{cb}\ X^{+}$ Normal Daughter | $X^{cb}\ X^{+}$ Normal Daughter | | $X^{cb}\ Y$, $X^{cb}\ Y$ Color-blind Sons |

| Normal Mother | | | Normal Father |
|---|---|---|---|
| (a) $X^{cb}\ X^{+}$ | | | $X^{+}\ Y$ |
| $X^{cb}\ X^{+}$ Normal Daughter | $X^{+}\ X^{+}$ Normal Daughter | $X^{cb}\ Y$ Color-blind Son | $X^{+}\ Y$ Normal Son |
| (b) $X^{+}\ X^{+}$ | | | $X^{+}\ Y$ |
| $X^{+}\ X^{+}$ | $X^{+}\ X^{+}$ | $X^{+}\ Y$ | $X^{+}\ Y$ |

All Normal

| Normal Mother | | | Color-blind Father |
|---|---|---|---|
| $X^{cb}\ X^{+}$ | | | $X^{cb}\ Y$ |
| $X^{cb}\ X^{cb}$ Color-blind Daughter | $X^{+}\ X^{cb}$ Normal Daughter | $X^{cb}\ Y$ Color-blind Son | $X^{+}\ Y$ Normal Son |

| Normal Mother | | | Color-blind Father |
|---|---|---|---|
| $X^{+}\ X^{+}$ | | | $X^{cb}\ Y$ |
| $X^{+}\ X^{cb}$, | $X^{+}\ X^{cb}$, | $X^{+}\ Y$, | $X^{+}\ Y$ |

All Normal

| Color-blind Mother | | | Color-blind Father |
|---|---|---|---|
| $X^{cb}\ X^{cb}$ | | | $X^{cb}\ Y$ |
| $X^{cb}\ X^{cb}$, | $X^{cb}\ X^{cb}$, | $X^{cb}\ Y$, | $X^{cb}\ Y$ |

All Color-blind

FIGURE 1. Results of Various Unions of Normal and Color-blind Partners.

as she has inherited one member of each pair of autosomes from one of her two parents. Genetically, therefore, she has inherited exactly half her genes from each of her parents and is as much her mother's as her father's daughter. Finally, a son has an X and a Y chromosome. He has inherited his X from his mother, his Y from his father. He inherits only one sex chromosome from each of his parents; he cannot, therefore, inherit an X from his father. Thus all his sex-linked genes come from his mother's side, and in respect to these genes - but only in respect to them - he is his mother's and not his father's boy.

Thus a woman transmits color blindness to her sons no matter whom she marries. If she is heterozygous - and normal-sighted - about half her sons will be color-blind; if she is homozygous and herself color-blind, all her sons will be affected. No woman - either heterozygous or homozygous - can have color-blind daughters by a normal-sighted man. Color-blind women are much rarer than color-blind men. This is easily understood if we consider that any man who carries the cb gene on his one X chromosome is color-blind, while a woman needs to carry the gene on both her X chromosomes in order to show its effect.

As we have seen, Stafford feels that quantitative reasoning may be a sex-linked trait and therefore is passed along the same way as color-blindness and hemophilia.

The review of related literature will be divided into four parts. The first will be of correlational studies similar to the study reported herein. The second will be of studies which involves another human trait which appears to be sex-linked. The third will be a study which appears to contradict Stafford's hypothesis and the fourth will be a study which supports his hypothesis.

## Studies Relating Mathematics Achievement Within Families

Willoughby (1927) administered a battery of tests to investigate family similarities in mental abilities. Among these tests was the Arithmetic Reasoning Test which was taken directly from the National Intelligence Test. Approximately 100 mothers, 90 fathers and their children were tested in an evening and inter-family correlations were calculated. He found the father-daughter relationship to be ($r = .41$), mother-son ($r = .23$), mother-daughter ($r = .34$), father-son ($r = .16$) and father-mother ($r = .34$).

Another study undertaken to check for family resemblances in numerical ability was that by Carter (1932) who administered the Courtis Standard Research Tests in Arithmetic to 108 families where both parents and one or more children over 12 years of age were available. The Courtis Test had four subtests: addition, subtraction, multiplication and division. His findings were as follows.

The father-daughter correlation was (r = .04), mother-son was (r = .12), mother-daughter was (r = .24), father-son was (r = .10) and father-mother was (r = -.04).

Stafford (1963) replicated the above studies using a test of Mental Arithmetic Problems. He found the father-daughter correlation to be (r = .18), mother-son (r = .51), mother-daughter (r = .21), father-son (r = .07) and father-mother (r = .06).

Stafford summarized the above three studies and reported the average father-daughter correlation (r = .22), mother-son (r = .30), mother-daughter (r = .27), father-son (r = .11), and father-mother correlation (r = .12) roughly fits Stafford's hypothesis based on the assumption that quantitative reasoning is a sex-linked trait.

## Studies Which Report Evidence that Spatial Visualization is a Sex-Linked Trait

In the second category of related literature is a study by Bock (1967) and reported by Garron (1970). It relates to the present study because it suggests that spatial visualization is a sex-linked recessive trait. Bock reports three observations consistent with Stafford's hypothesis, and one observation which is inconsistent. First, the mean score of males exceeds the mean score of females on a test of spatial visualization. Second, the male distribution is bimodal, with an anti-mode near the

50th percentile. This biomodality suggests that there may be but two discrete levels of spatial ability within the population, rather than a continuous distribution. Third, when the distribution of all scores is divided at the anti-mode, half of the males and one-fourth of the females excel. Thus, the proportion of the females excelling is the square of the proportion of males excelling - a finding consistent with expected gene frequencies. Bock, however, also notes that all girls who excel, and are therefore assumed to carry the recessive allele on both X chromosomes, should have fathers who excel, since these fathers must carry the recessive allele on their one X chromosome if it is to be transmitted to their daughters. Unfortunately, Bock's sample has six females who excel, but whose fathers do not. Since the only departure from expectation involves fathers who do not excel, Bock suggests that the departure may reflect inadequate motivation on the part of these fathers. Thus, the departure from expectation may not necessarily contradict Stafford's hypothesis.

Stafford (1961) also did a study to test whether spatial visualization is a sex-linked recessive trait. A measure of spatial visualization, the Identical Blocks Test, was given to 104 fathers and mothers and their 128 teenage children (58 sons and 70 daughters). Raw scores were converted to standard scores, partialling out age differences. Males averaged significantly higher than females, for parents as well as children. The results of the Pearson r's reported as father-mother (r = .03), father-son (r = .02), father-daughter (r = .31), mother-son (r = .31) and mother-daughter (r = .14) along with the above finding lead Stafford to conclude that aptitude for visualizing space has a hereditary component which is transmitted by a sex-linked recessive gene.

### A Study Contradicting Stafford's Hypothesis

In the third category of related literature is a study by McClearn (1967) who found that the occurrence of impaired spatial abilities in women with Turner's syndrome also implicates the X chromosomes in the expression of these abilities. It should be noted that McClearn does not suggest that this fact necessarily supports Stafford's specific hypothesis that the inheritance of superior abilities is sex-linked and recessive. If anything, findings about these women and their impaired abilities contradict Stafford's hypothesis. To see why this is so one must understand the abnormality.

Turner's syndrome is a set of somatic abnormalities associated with abnormalities of the sex chromosome pair in phenotypical women. These women may have any one of a number of X chromosome abnormalities, but about half have a single X chromosome (XO), rather than the normal female (XX) or normal male (XY) pair. Women with an XO sex chromosome complement are similar to normal males in that both have a single X chromosome. Thus, women with Turner's syndrome and an XO sex chromosome complement, as well as normal males, have but one allele of each gene located on the X chromosomes, while normal females have two alleles, one on each of their two X chromosomes. It has been found that women with Turner's syndrome appear to have a characteristic pattern of abilities (Garron & Vander Stoep, 1969). Verbal abilities appear to be normal, while spatial abilities are impaired (Garron, p. 148). There may be an impairment of numerical abilities, but this has not been clearly established yet (Alexander & Money 1966).

In the light of the above Garron (p. 149) concludes:

> The hypothesis that superior spatial and numerical abilities are transmitted by sex-linked (X chromosome), recessive genes may be seen to be paradoxical, however, when applied to the instance of the impaired abilities of women with Turner's syndrome. As has been noted, women with Turner's syndrome and an XO sex chromosome complement have but one of the genes located on the X chromosomes, as do normal males, since both have but one X chromosome. Therefore, the incidence of the expression of recessive traits in women with Turner's syndrome and an XO sex chromosome complement ought to be similar to the incidence of the expression of these traits in normal males. Thus, the spatial and numerical abilities of these women, and of normal males,

> ought to be similar and equally superior to these abilities in normal females. In fact, these abilities in women with Turner's syndrome are inferior to those of normal females, which in turn are inferior to those of normal males.

## A Study Supporting Stafford's Hypothesis

Finally, there is Stafford's own study to test the hypothesis of sex-linked transmission of mathematical ability. He administered a test of quantitative reasoning to 300 pairs of twins, 50 male monozygous, 69 female monozygous, 25 male dizygous, 56 female dizygous and 100 hetero-dizygous (male-female) pairs, ages 12 to 18. As a result of this study, Stafford (1972, p. 198) concludes:

> it appears that in general there is an underlying hereditary component for a proficiency in quantitative reasoning which fits the sex-linked recessive model fairly well. This "have" or "lack" quality results in two normal curves, one below and one above 54.5. Whether an individual is placed in the top curve or the bottom curve would, therefore, depend largely upon his genetic composition but where he is placed within the curve would depend upon the effect of a host of environmental components. . . .

## Summary

The review of the literature has examined the evidence related to Stafford's hypothesis that quantitative reasoning is a sex-linked trait. All seven studies with the exception of one tend to support the hypothesis. However, there have been very few studies specifically investigating the mathematics problem-solving achievement of parents and their children.

A review of the literature reveals that there is a need for further research in this area due to the limited number of studies and their indefinite conclusions. The present study has been designed to meet this need.

# CHAPTER III

# RESEARCH DESIGN

## Description of the Sample

The students in this study, both boys and girls, were enrolled in academic mathematics in grades nine and ten at Belmont-Fisher Secondary School. The school, up until the fall of 1973, was made up of separate junior secondary and senior secondary buildings under separate administrations but is now a single secondary school enrolling approximately 1700 students. It is located between Langford, Colwood and Metchosin, all suburbs of Victoria. Langford is an area of low income families while mainly lower middle class families reside in Colwood and Metchosin.

A student in grade nine or ten has a choice of taking either academic mathematics which leads to university entrance or general mathematics. There are approximately 200 academic mathematics nine and 200 academic mathematics ten students.

Volunteer parents and their children chosen from the above population took part in this study.

## Description and Development of the Measuring Instruments

### Mathematics Attitude Scale

The Mathematics Attitude Scale designed by Aiken (1963) found in Appendix A is a series of twenty statements - some positive and some negative towards mathematics. The student reads each statement and indicates on a response sheet how strongly he agrees or disagrees with the statement. The scale has five points: strongly disagree, disagree, undecided, agree, and strongly agree.

A Likert scale was used to measure the student's attitude towards mathematics. That is, if a student strongly agrees with a positive statement towards mathematics, he is given a score of five. If he strongly disagrees with a positive statement, he is given a score of one. On the other hand, if he strongly agrees with a negative statement, he receives a score of one and if he strongly disagrees with a negative statement, he receives a score of five. The total attitude score is the sum of the scores on each statement. Therefore, the higher the score, the more positive the attitude towards mathematics. The highest possible score on the Mathematics Attitude Scale is 100, the lowest is 20 with a median equal to 60.

Mathematics Problem Test

The questions on the Mathematics Problem Test were selected, edited and revised from the twelve forms of the Canadian Recruiting Tests (CRTX - 1 to CRTX - 12) which are unpublished experimental forms of an intelligence test developed for use with adults in the Canadian Armed Forces. Two forms of the Mathematics Problem Test were prepared for this study. The initial forms consisted of questions very similar to those in the mathematics problem sections of the Canadian Recruiting Tests. The initial forms were administered to grade nine and ten academic mathematics students of Dunsmuir Junior Secondary School in the Sooke School District. Table 1 gives the information for the initial forms of the test.

TABLE 1

TEST STATISTICS FOR INITIAL FORMS OF THE MATHEMATICS PROBLEM TEST

| Test Form | Grade | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Nine | | | | Ten | | | |
| | Number | Mean | Standard Deviation | KR 20 | Number | Mean | Standard Deviation | KR 20 |
| A | 25 | 10.56 | 3.89 | .751 | 23 | 14.48 | 4.01 | .819 |
| B | 19 | 12.42 | 3.15 | .645 | 23 | 14.00 | 3.20 | .671 |

The mean score of the grade nines was compared to the mean score of the grade tens on each form. A value of t = 3.36, significant at the .01 level, was found for Form A but there was no significant difference between the mean scores of grade nines and tens in Form B.

Table 2 shows the item statistics for the initial forms of the Mathematics Problem Test. The difficulty of the item is a measure of the proportion of examinees who responded correctly. Hence, if an item has .700 under the Difficulty column, 70% of the students writing the test answered the item correctly. The discrimination index of an item is a measure of how well the scores on a particular item are correlated with the total scores on the test. The number reported under this column is a biserial correlation coefficient.

The items in Table 2 which have an asterisk under the Difficulty or Discrimination column were reworded or completely revised before they were included in the final forms. An item whose difficulty was below or above the range .20 to .90 and whose discrimination index was less than .30 was not included in the final forms. It should be noted that some items did not satisfy these conditions but were still left unchanged. Closer examination reveals that they were quite good items at the other grade level. Item #10 (Appendix B) of the initial Form A was a poor item not because of the wording or the problem itself but probably

TABLE 2

ITEM STATISTICS FOR THE INITIAL FORMS OF

THE MATHEMATICS PROBLEM TEST

| | Form A | | | | Form B | | | |
|---|---|---|---|---|---|---|---|---|
| Item No. | Grade 9 (N = 23) Difficulty | Discrimination | Grade 10 (N = 23) Difficulty | Discrimination | Grade 9 (N = 19) Difficulty | Discrimination | Grade 10 (N = 23) Difficulty | Discrimination |
| 1 | .400 | .437 | .609 | .686 | .632 | .441 | .783 | .692 |
| 2 | .240 | .550 | .565 | .876 | .737 | .210* | .565 | .310 |
| 3 | .600 | .681 | .957 | -.061 | .632 | .574 | .957 | -.295 |
| 4 | .800 | .948 | .783 | .604 | .842 | .849 | .826 | .634 |
| 5 | .640 | .303 | .913 | .545 | .263 | .046* | .478 | .647 |
| 6 | .360 | .659 | .478 | .755 | .211 | .828 | .348 | .404 |
| 7 | .800 | .948 | .913 | 1.025 | .789 | .676 | .826 | .106 |
| 8 | .760 | .839 | .826 | .714 | .632 | .175* | .870 | -.064* |
| 9 | .760 | .343 | .826 | .799 | .842 | .365 | .739 | .668 |
| 10 | .280 | -.181* | .348 | .416 | .474 | .177 | .565 | .655 |
| 11 | .720 | .639 | .870 | .585 | .474 | .722 | .526 | .793 |
| 12 | .280 | .552 | .522 | .824 | .263 | .404 | .522 | .886 |
| 13 | .480 | .756 | .826 | .630 | .842 | .434 | .826 | .053 |
| 14 | .460 | .623 | .652 | 1.022 | .895 | .811 | .870 | .768 |
| 15 | .440 | .726 | .783 | .125 | .737 | .210 | .826 | .952 |
| 16 | .750 | .731 | .870 | .841 | .895 | .169 | .826 | .423 |
| 17 | .739 | .474 | .682 | .670 | .611 | .486 | .545 | .273 |
| 18 | .238 | .264* | .636 | .771 | .500 | .932 | .650 | .514 |
| 19 | .667 | .682 | .762 | .476 | .706 | .795 | .833 | .514 |
| 20 | .579 | .257 | .857 | .752 | .688 | .486 | .933 | .636 |

because it was a corrected misprint which still left the testee in doubt as to whether the lot in question was an $8,000 lot or an $18,000 lot. Item #18 of the same form probably had a poor discrimination index because many students probably made a mistake in multiplication rather than in understanding the problem. Therefore when the question was revised, simpler numbers were used.

Although Item #2 of the initial Form B wasn't exceedingly poor, it was revised to resemble Item #2 of initial Form A. Item #5 of initial Form B was probably ambiguous and hence the item was completely changed. Finally, Item #8, like #18 above, was revised since many who got it wrong probably multiplied incorrectly. They knew how to do the problem and understood it but made a mechanical error which may account in part for the low discrimination.

The final forms of the Mathematics Problem Test were administered on February 6, 1974 to four classes of academic students taking grade nine mathematics and four classes of academic students taking grade ten mathematics at Belmont-Fisher Secondary School. In each class, Form A was given to half the students and Form B to the other half during the first administration period. Five minutes after they had written the first form, each student wrote the other form. This procedure was followed to eliminate practice effects which would affect the results since the means of each of the two tests were compared at each grade level for equivalency.

The inter-form reliability coefficient, a Pearson product-moment correlation coefficient was calculated and was found to be .79.

Table 3 gives the test statistics for the final forms of the Mathematics Problem Test.

TABLE 3

TEST STATISTICS FOR FINAL FORMS OF THE MATHEMATICS PROBLEM TEST

| Test Form | Grade | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Nine | | | | Ten | | | |
| | Number | Mean | Standard Deviation | KR 20 | Number | Mean | Standard Deviation | KR 20 |
| A | 86 | 12.07 | 3.92 | .732 | 97 | 14.51 | 3.97 | .790 |
| B | 86 | 12.98 | 3.59 | .709 | 97 | 15.18 | 3.51 | .750 |

A t-test was used to compare the mean scores of grade nines and tens on each form of the test. A value of $t = 2.50$ significant at the .05 level was found for Form A and a value of $t = 4.15$ significant at the .01 level was found for Form B.

It was assumed, however, as with the typical standardized test that there is really no underlying difference in ability between grade nine and ten students.

Although grade tens score higher than grade nines on the Mathematics Problem Test, it must be remembered that the academic grade ten students who participated in the study are a more select group than the academic grade nines. Some of the students in grade ten moved to the non-academic stream after grade nine and this could account for the difference.

Table 4 shows the item statistics for the final forms of the Mathematics Problem Test.

Item #6 in Table 4 Form A has a poor discrimination index for grade nine students; however, it has a good discrimination index for grade tens. Similarly, Item #2 Form B has a poor discrimination index for grade nines and a better one for grade tens. Table 4 shows that most items on the final forms fit the conditions required of a "good" item described earlier.

It can be seen in Table 5 that there is a significant difference between mean scores on the final forms of the Mathematics Problem Test for grade nine students. The same holds true for grade ten students. Since the means and standard deviations are not equal at each grade level, they cannot be considered equivalent forms.

TABLE 4

ITEM STATISTICS FOR THE FINAL FORMS OF

THE MATHEMATICS PROBLEM TEST

| | Form A | | | | Form B | | | |
|---|---|---|---|---|---|---|---|---|
| Item No. | Grade 9 (N = 86) Difficulty | Discrimination | Grade 10 (N = 97) Difficulty | Discrimination | Grade 9 (N = 86) Difficulty | Discrimination | Grade 10 (N = 97) Difficulty | Discrimination |
| 1 | .640 | .508 | .794 | .520 | .640 | .704 | .773 | .651 |
| 2 | .453 | .436 | .557 | .471 | .628 | .131 | .691 | .385 |
| 3 | .674 | .658 | .794 | .610 | .826 | .588 | .907 | .682 |
| 4 | .744 | .512 | .907 | .555 | .895 | .443 | .918 | .702 |
| 5 | .767 | .508 | .866 | .847 | .721 | .467 | .814 | .868 |
| 6 | .349 | .240 | .536 | .579 | .198 | .588 | .351 | .499 |
| 7 | .919 | .541 | .948 | .332 | .814 | .589 | .794 | .581 |
| 8 | .756 | .713 | .887 | .791 | .686 | .762 | .784 | .517 |
| 9 | .640 | .857 | .897 | .738 | .733 | .635 | .897 | .846 |
| 10 | .459 | .533 | .464 | .713 | .477 | .570 | .691 | .668 |
| 11 | .565 | .726 | .784 | .783 | .512 | .513 | .619 | .619 |
| 12 | .318 | .377 | .371 | .527 | .302 | .414 | .381 | .681 |
| 13 | .682 | .559 | .732 | .765 | .686 | .479 | .825 | .739 |
| 14 | .518 | .609 | .604 | .682 | .709 | .553 | .856 | .832 |
| 15 | .447 | .476 | .625 | .828 | .756 | .615 | .856 | .716 |
| 16 | .871 | .538 | .926 | .897 | .907 | .640 | .938 | .531 |
| 17 | .482 | .552 | .553 | .573 | .619 | .347 | .794 | .478 |
| 18 | .470 | .638 | .734 | .745 | .386 | .684 | .681 | .759 |
| 19 | .707 | .551 | .813 | .929 | .867 | .857 | .879 | .773 |
| 20 | .762 | .690 | .911 | .704 | .707 | .687 | .897 | .449 |

TABLE 5

A COMPARISON OF MEAN SCORES BETWEEN FINAL FORMS
OF THE MATHEMATICS PROBLEM TEST AT EACH GRADE LEVEL

| | Form A | | | Form B | | | |
|---|---|---|---|---|---|---|---|
| Grade | N | Mean | Standard Deviation | N | Mean | Standard Deviation | t |
| Nine | 86 | 12.07 | 3.92 | 86 | 12.98 | 3.59 | 3.5* |
| Ten | 97 | 14.51 | 3.97 | 97 | 15.18 | 3.51 | 2.7* |

* $p < .05$

## Procedure

Three hundred letters were sent out to parents of grade nine and ten students taking academic mathematics requesting volunteers to write Form A of the Mathematics Problem Test. Only Form A was used since it had not been established that Form A and Form B were equivalent forms and also because of the smallness of the sample. Approximately 30 parents volunteered and wrote the test on the evenings of February 26 and February 27, 1974. The parents reported as instructed in the letter to a regular classroom at Belmont-Fisher Secondary School. They were asked to fill in the information at the top of the response sheets and were shown how to properly mark the answers on the computer scored answer sheets. Also, the parents were assured of the confidential nature of the results of the test.

As mentioned earlier, the final forms of the Mathematics Problem Test were administered to grade 9 and 10 students of Belmont-Fisher Secondary School on February 6, 1974. The scores on Form A of those students whose parents had volunteered for the study were separated and used for further analysis.

Students whose parents had taken part in the study were asked to write the Mathematics Attitude Scale on February 25, 1974. The students were given a sample item so they would know how to indicate their feelings towards mathematics on the response sheet.

## Hypotheses to be Tested

The following hypotheses stated in the null form were considered in this study. A significance level of $p < .05$ was required for non-acceptance.

The results of first four hypotheses will add information to Stafford's proposal that there should be a unique ordering of the correlation coefficients between various family members. The fifth hypothesis is being tested to find out whether positive attitudes can be used to predict achievement in mathematics. The results of the last hypothesis will also add information to Stafford's proposal that there should be differences in mathematics problem-solving scores between boys and girls.

1. The Pearson product-moment correlation between father and daughter scores on the Mathematics Problem Test Form A will be zero.

2. The Pearson product-moment correlation between mother and son scores on the Mathematics Problem Test Form A will be zero.

3. The Pearson product-moment correlation between mother and daughter scores on the Mathematics Problem Test Form A will be zero.

4. The Pearson product-moment correlation between father and son scores on the Mathematics Problem Test Form A will be zero.

5. The Pearson product-moment correlation between the Mathematics Attitude Scale and the Mathematics Problems Test for those boys and girls whose parents also participated in the study will be zero.

6. There will be no significant difference between the mean scores on the Mathematics Attitude Scale of boys and girls whose parents also wrote the Mathematics Problem Test.

7. There will be no significant difference between the mean scores of boys and girls taking part in the standardization of the final forms of the Mathematics Problem Test.

## Statistical Analysis

A Pearson product-moment correlation coefficient was calculated for father-daughter, mother-son, mother-daughter and father-son results to determine if there was any significant relationship between relatives on Form A of the Mathematics Problem Test. Table F in the appendix of Ferguson (1971) was used to test for the significance of the correlation coefficients.

A "t" test was used to test for significant differences in the mean attitude scores between males and females. A "t" test was also used to test for significant differences between the mean scores of boys and girls on both forms of the Mathematics Problem Test.

A Pearson "r" was calculated to determine if there was a significant relationship between scores on the Mathematics Attitude Scale and achievement on the Mathematics Problem Test.

CHAPTER IV

# RESULTS, DISCUSSION AND INTERPRETATION

## The Results

Of the twenty-four families that participated in the study, there were eight in which only the father showed up to write the test, ten in which only the mothers participated and six in which both parents wrote the Mathematics Problem Test. Table 6 summarizes the relationship between scores of the parents and their children on the Mathematics Problem Test. A Pearson product-moment correlation coefficient was calculated in each case.

TABLE 6

RELATIONSHIP BETWEEN SCORES OF PARENTS AND THEIR CHILDREN ON THE MATHEMATICS PROBLEM TEST

| | Father-Daughter (N = 13) | Mother-Son (N = 14) | Mother-Daughter (N = 9) | Father-Son (N = 7) |
|---|---|---|---|---|
| Pearson r | -.27 | -.19 | .75 | -.01 |

Since there were thirteen pairs of fathers and daughters writing the test, a correlation coefficient of .55 is necessary to be significant at the .05 level. The calculated value of the correlation coefficient was -.27. Therefore Hypothesis 1 was not rejected. Similarly, there were fourteen mother-son combinations and a correlation of .53 is necessary to be significant at the .05 level. Since the correlation coefficient was -.19, Hypothesis 2 was not rejected. The nine monther-daughter combinations resulted in a correlation coefficient of .75 and this was the only coefficient that is significant at the .05 level. Hence Hypothesis 3 was rejected. Finally, there were seven father-son combinations and the correlation coefficient of -.01 was not significant. Therefore Hypothesis 4 was not rejected.

When the correlation coefficient was calculated to see if there was any significant relationship between scores on the Mathematics Problem Test and Mathematics Attitude Scale, the following results were found. A correlation coefficient of .42, significant at the .02 level, was obtained from the results of thirty-one students who wrote both of the above instruments. Therefore Hypothesis 5 was rejected. Whether more positive attitudes are a result of higher achievement or vice versa cannot of course be concluded from this study.

Table 7 compares mean attitude scores of boys and girls whose parents also participated in the study. There was no significant difference in mean attitude scores between boys and girls. Therefore Hypothesis 6 was not rejected.

TABLE 7

A COMPARISON OF MEAN SCORES OF BOYS AND GIRLS

ON THE MATHEMATICS ATTITUDE SCALE

| Scale | Mean | | t |
|---|---|---|---|
| | Boys N = 17 | Girls N = 18 | |
| Mathematics Attitude Scale | 65.4 | 64.6 | .14 (n.s.) |

Finally Table 8 compares the mean scores of boys and girls on the Mathematics Problem Test.

TABLE 8

A COMPARISON OF MEAN SCORES OF BOYS AND GIRLS

ON THE MATHEMATICS PROBLEM TEST

| Grade Level and Form | Boys | | | Cirls | | | t |
|---|---|---|---|---|---|---|---|
| | N | Mean | Standard Deviation | N | Mean | Standard Deviation | |
| 9A | 37 | 12.22 | 3.91 | 49 | 11.96 | 3.93 | .30 (n.s.) |
| 9B | 37 | 13.00 | 3.57 | 49 | 12.96 | 3.60 | .05 (n.s.) |
| 10A | 53 | 15.13 | 3.63 | 44 | 13.75 | 4.23 | 1.7 (n.s.) |
| 10B | 53 | 15.75 | 3.30 | 44 | 14.48 | 3.63 | 1.8 (n.s.) |

No significant difference was found between boys and girls on either form of the Mathematics Problem Test. The implications of this are discussed at the end of the next section.

## Discussion and Interpretation

The predicted order of the correlations based on the assumption of Stafford's theory implying mathematics problem solving is a sex-linked trait is not supported by the findings of this study. Stafford's hypothesis suggests that the father-daughter correlation should be approximately equal to the mother-son correlation, which should be greater than the mother-daughter correlation, which in turn should be greater than the father-son correlation. However, it should not be concluded from this study that Stafford's hypothesis is incorrect. In carrying out the study, two problems encountered could, in part, possibly account for discrepancies from the expected pattern. The two problems which are interrelated were small sample size and restriction of range. Figures 2 to 5 show actual plots of parent versus offspring scores:

Figure 2 illustrates that the mothers' scores are restricted in range from 16 to 19. That is, the test scores of mothers are concentrated in a small portion of the possible range of scores which range from 0 to 20. If the mothers' scores were not restricted to such a small range, the correlation coefficient between mother and son scores could be much higher. The existing points in Figure 1 appear to belong to the top right hand portion of the interior of an ellipse.

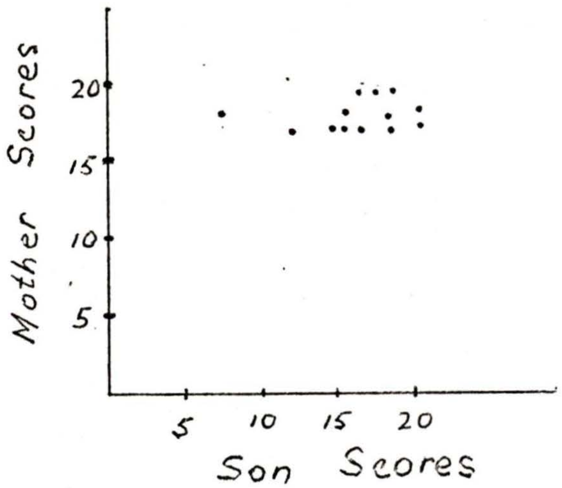


Figure 2. Scatter Diagram of Mother and Son Scores on the Mathematics Problem Test.

In Figure 3, with one exception, the fathers' scores were restricted to between 15 and 19. Again, these scores appear to belong to the top right hand portion of the interior of an ellipse. Restriction of range on the dependent variable tends to lower the correlation coefficients. To see why this is so, suppose the plot of father and daughter scores in Figure 3 actually resulted in a set of points within an ellipse. The narrower the ellipse, the higher the correlation coefficient. If a horizontal line were drawn at a score of 15 on the vertical axis, the shape in that quarter is far from being elliptical. As a matter of fact, points would be scattered all over indicative of a correlation coefficient close to zero.

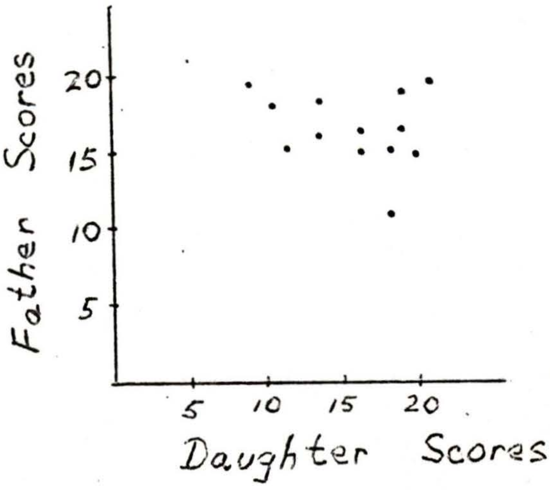


Figure 3. Scatter Diagram of Father and Daughter Scores on the Mathematics Problem Test.

Figure 4 reveals that there is no restriction of range problem here but there is an extremely small sample of nine cases.

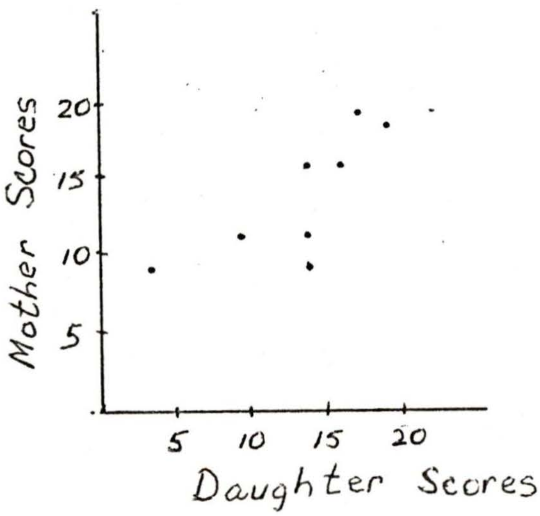


Figure 4. Scatter Diagram of Mother and Daughter Scores on the Mathematics Problem Test.

Figure 5 illustrates that there appears to be no correlation at all between father and son scores. The points are scattered all over. This is exactly what

Stafford's hypothesis suggests for any sex-linked trait, the father has no influence over the son.

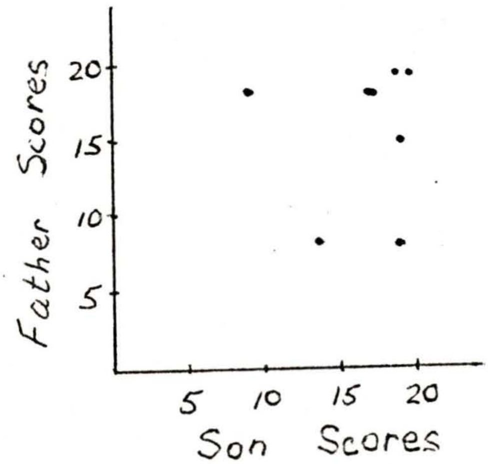


Figure 5. Scatter Diagram of Father and Son Scores on the Mathematics Problem Test.

Although it was evident in Table 8 that there was no significant difference between mean scores of boys and girls on the Mathematics Problem Test, it should not be concluded that Stafford's hypothesis is invalid. Although there are many more color-blind males than females, it does not necessarily follow that there should be noticeably more males than females good at arithmetic problem solving even though the latter may also be a sex-linked trait. The frequency of the gene determines the ratio of superior males to females in any sex-linked trait and if the gene is very frequent, there may not be a significant difference in the scores of males and females.

Furthermore, it can be seen in Table 8 that boys consistently score higher than girls which is partial support of Stafford's hypothesis.

# CHAPTER V

## RECOMMENDATIONS FOR FUTURE STUDY

The major weakness in the present study is one of design, that is, relying on volunteers. The parents who turned out to write the test were mostly of high mathematical ability and this resulted in a restricted range of scores. It is therefore recommended that the present study be conducted with the following changes designed to overcome this difficulty.

In order to obtain a wider range of parent scores, the letter addressed to the parents (Appendix H) could be reworded to emphasize that it is not necessary that participants be good at mathematics problem solving in order to take part in the study. Hopefully, this would result in a larger range of scores on the dependent variable. Also, to encourage more parents to participate, the letter could be worded in such a way that the parents would feel they were making a significant contribution to educational research. Furthermore, if some parents did not reply to the letter, they could be phoned and encouraged to participate. This follow-up adds a personal touch which may result in more parental involvement.

Another way of obtaining a representative sample of parents would be first to divide the population of parents into three socio-economic groups - high, medium and low. A letter could be sent to a random sample of parents in each socio-economic group describing the nature of the study. Then, trained research assistants could phone the parents, explain the importance of the study in greater detail and ask permission to test the parents in their own homes. This procedure does away with the inconvenience of having parents come to the school and would probably result in a larger number of volunteers.

Finally, another procedure that a researcher might consider would be testing volunteer parents at a meeting of the Parent-Teacher Association.

## REFERENCES


Aiken, Lewis R. Personality correlates of attitudes towards mathematics. *Journal of Educational Research*, 1963, 56, 476-480.

Alexander, D. and Money J. Turner's syndrome and Gerstmann's syndrome: Neuropsychologic comparisons. *Neuropsychologia*, 1966, 4, 265-273.

Anastasi, A. *Differential psychology.* New York: Macmillan, 1958.

Auerbach, Charlotte. *The science of genetics.* New York: Harper and Brothers, 1961.

Bock, R. D. A family study of spatial visualizing ability. Paper presented at the meeting of the American Psychological Association, Washington, D.C., September 1967.

Carter, H. D. Family resemblances in verbal and numerical abilities. *Genetic Psychology Monographs.* 1932, 12, 1-104.

Ferguson, G. A. *Statistical analysis in psychology.* New York: McGraw-Hill, 1971.

Garron, D. C. Sex-linked, recessive inheritance of spatial and numerical abilities and Turner's syndrome. *Psychological Review.* 1970, 72, 147-152.

Garron, D. C. and Vander Stoep, L. P. Personality and intelligence in Turner's syndrome: A critical review. *Archives of General Psychiatry*, 1969, 21, 339-346.

McClearn, G. E. Psychological research and behavioural phenotypes. In J. N. Spuhler (Ed.), *Genetic diversity and human behaviour.* Chicago: Aldine, 1967.

McKusick, V. A. and Chase, G. A. Human genetics. *Annual Review of Genetics.* 1973, 7, 435-473.

Ohno, Susuma. *Sex chromosomes and sex-linked genes.* Berlin: Springer-Verlag, 1967.

Osbourne, R. T., Gregor, A. J. and Miele, F. Heritability of numerical facility. *Perceptual and Motor Skills*, 1967, 24, 659-666.

Stafford, R. E. Sex differences in spatial visualization as evidence of sex-linked inheritance. *Perceptual and Motor Skills*. 1961, 13, 428.

Stafford, R. E. An investigation of similarities in parent-child test scores for evidence of hereditary components. *Research Bulletin 63-11*. Princeton, N.J.: Educational Testing Service, 1963.

Stafford, R. E. Hereditary and environmental components of quantitative reasoning. *Review of Educational Research*. 1972, 42, 183-201.

Terman, L. M. and Tyler, L. E. Psychological sex differences. In L. Carmichael (Ed.), *Manual of child psychology*, 2nd ed. New York: Wiley, 1954.

Willoughby, R. D. Family similarities in mental test abilities. *Genetic Psychology Monographs*. 1927, 11, 234-277.

# APPENDIX A

## MATHEMATICS ATTITUDE SCALE

Directions

Below are a number of statements about Mathematics. On the *separate answer sheet* indicate the extent of your agreement with each statement by using the following key:

A STRONGLY AGREE

B AGREE

C UNCERTAIN

D DISAGREE

E STRONGLY DISAGREE

1. I am always under a terrible strain in a math class.
2. I do not like mathematics, and it scares me to have to take it.
3. Mathematics is very interesting to me, and I enjoy math courses.
4. Mathematics is fascinating and fun.
5. Mathematics makes me feel secure, and at the same time it is stimulating.
6. My mind goes blank, and I am unable to think clearly when working math.
7. I feel a sense of insecurity when attempting mathematics.

8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.
9. The feeling that I have toward mathematics is a good feeling.
10. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.
11. Mathematics is something which I enjoy a great deal.
12. When I hear the word math, I have a feeling of dislike.
13. I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.
14. I really like mathematics.
15. Mathematics is a course in school which I have always enjoyed studying.
16. It makes me nervous to even think about having to do a math problem.
17. I have never liked math, and it is my most dreaded subject.
18. I am happier in a math class than in any other class.
19. I feel at ease in mathematics, and I like it very much.
20. I feel a definite positive reaction to mathematics; it's enjoyable.

APPENDIX B

## MATHEMATICS PROBLEM TEST

(INITIAL FORM A)

<u>Time Limit 20 minutes</u>

1. Of 2,000 cars at the fair, 40% were blue. How many were blue cars?

   A 80
   B 240
   C 600
   D 800
   E none of the above

2. A car was driven 5,000 miles. There are about 1.6 kilometers (km.) in a mile. About how many kilometers was the car driven?

   A 3,125 km.
   B 8,000 km.
   C 31,250 km.
   D 80,000 km.
   E none of the above

3. Four pints of ice cream were to be divided equally among 16 people. If 4 more people came, how much would each person get then?

   A 1/10 pt.
   B 1/5 pt.
   C 1/4 pt.
   D 1/3 pt.
   E none of the above

4. Mae had 1/3 of a cake and Jane had 1/5 of a cake. How much more cake did Mae have than Jane?

   A 1/2
   B 2/15
   C 1/4
   D 1/15
   E none of the above

5. Thirty members were present at a meeting. This is 3/4 of the total membership. How many members are there in the Club?

   A 40
   B 45
   C 50
   D 60
   E none of the above

6. Ann borrowed $4,000 for 1/2 year. The interest rate was 8% per year. How much interest did she pay?

   A $0.16
   B $1.60
   C $3.20
   D $6.40
   E none of the above

7. How many chocolate bars at 2 for 25 cents can you buy for $1.75?

   A 25
   B 7
   C 12
   D 14
   E 28

8. How many feet of strip steel must be bought in order to cut sixteen 2 1/2 foot lengths?

   A 40
   B 38
   C 32
   D 20
   E none of the above

9. A man gets scores of 6, 10 and 8 in target practice. To get an average of 8 for four trials, what must his last score be?

   A 10
   B 9
   C 8
   D 7
   E 6

10. Mr. Brown sold his lot through an agent who charged 5% on the $8,000 sale. How much did Mr. Brown get?

   A $7,600
   B $4,000
   C $1,600
   D $1,400
   E none of the above

11. A package of peas holds 2 1/2 pounds and sells for 75 cents. What is the price per pound for this package?

   A 50¢
   B 35¢
   C 30¢
   D 25¢
   E none of the above

12. George spent half his money and $2 besides. He had $12 left. How many dollars did he have in the beginning?

   A $10
   B $20
   C $24
   D $26
   E $28

13. How many books 1 1/2 inches thick will fill a shelf 3 feet long?

   A 54
   B 48
   C 24
   D 18
   E 12

14. A group of boy scouts leaves camp at 7:30 hiking at a rate of 4 miles per hour. When will they reach their destination which is 7 miles away?

   A 9:00
   B 9:10
   C 9:15
   D 9:45
   E none of the above

15. A sheet of aluminum is cut so that one piece, which is 1/4 of the sheet, is twice as large as each of the other pieces. Into how many pieces is the sheet cut?

A 2
B 3
C 7
D 8
E 9

16. A used portable typewriter can be bought for $85 cash or by paying $25 down and $7 a month for nine months. How much is saved by paying cash?

A $12
B $7
C $5
D $3
E $1

17. A train with 9 passenger cars carries 504 people. If 2 more passenger cars are added, how many does the train carry in all?

A 1,008
B 620
C 616
D 756
E none of the above

18. If a man earns $5.60 an hour and gets time and one half for overtime, how much does he earn in a 40 hour week with 4 extra hours overtime?

A $245.20
B $250.00
C $246.40
D $257.60
E none of the above

19. What will be the cost for gasoline on a trip of 180 miles if a car averages 20 miles per gallon and cost 50¢ a gallon?

A $2.80
B $3.60
C $8.00
D $4.50
E $3.20

20. Five boys were going to rent a boat for a trip. Each boy was to pay $12. How much would each have to pay to rent the boat if one of the boys could not go on the trip?

A $12
B $15
C $48
D $60
E none of the above

APPENDIX C

MATHEMATICS PROBLEM TEST

(INITIAL FORM B)

Time Limit 20 Minutes

1. A man has paid $20 toward the purchase of a $50 radio. What per cent has he paid?

   A 10%
   B 11 2/5%
   C 20%
   D 30%
   E 40%

2. The scale of a certain map is 1/4 inch to 1 mile. How many miles apart are two towns which are 6 inches apart on the map?

   A 1 1/2
   B 4
   C 6
   D 24
   E 144

3. A man bought a second hand car for $1,000. He made a down payment of $400 and paid the remainder in 12 equal installments. How much was each installment?

   A $500
   B $600
   C $140
   D $50
   E not given

4. Mae had 1/4 of a cake and Jane had 1/5 of a cake. How much more cake did Mae have than Jane?

   A 1/9
   B 2/9
   C 1/20
   D 1/6
   E none of the above

5. A water tank which holds 2,200 gallons is 1/4 full. How many gallons are needed to fill the tank?

   A 550
   B 8,800
   C 6,600
   D 1,650
   E no given

6. At a sale an article sold for $30. This was a reduction of 40% from the original price. What was the original price?

   A $75
   B $70
   C $50
   D $48
   E $40

7. If 2 pounds of potatoes cost 28¢, how much will 5 pounds cost?

A $ .60
B $ .70
C $ .72
D $1.26
E $1.40

8. By delivering papers John was able to save $15.50 every week for 52 weeks. How much did he save?

A $796
B $806
C $816
D $696
E not given

9. A man's marksmanship scores on three trials are 7, 9, 8. If he wished to average 8 on four trials, what must his fourth score be?

A 5
B 6
C 8
D 9
E 10

10. An agent sold a lot for $12,000 charging 6% commission. How much did the owner get from the sale?

A $6,000
B $11,940
C $11,400
D $11,996
E none of the above

11. The price of a 12 ounce package of frozen peas is 27¢. At this rate, what is the price per pound? (16 ounces = 1 pound)

A 30¢
B 32¢
C 33¢
D 36¢
E 45¢

12. George spent half his money and $2 besides. He had $11 left. How many dollars did he have in the beginning?

A $10
B $20
C $24
D $26
E $28

13. How many badges 3 1/2 inches long can be cut from a ribbon 21 inches long?

A 5
B 6
C 6 1/2
D 17 1/2
E 73 1/2

14. A group of boyscouts leaves camp at 7:30 hiking at a rate of 4 miles per hour. When will they reach their destination which is 6 miles away?

A 9:00
B 9:10
C 9:15
D 9:45
E none of the above

15. A sheet of aluminum is cut so that one piece, which is 1/2 of the sheet, is twice as large as each of the other pieces. Into how many pieces is the sheet cut?

A 2
B 3
C 7
D 8
E 9

16. It costs a man $4.30 a week to use his car for getting to work. If he decides to use a bus, paying 50¢ a day for 6 days in fares, how much does he save in a week?

A $1.80
B $1.60
C $1.50
D $1.30
E not given

17. Jack used 1/3 of his bottle of medicine in 6 days. At this rate, how many days should the remainder of the medicine last?

A 2
B 3
C 12
D 18
E not given

18. If a man earns $5.00 an hour and gets time and one-half for overtime, how much does he earn in a 40 hour week with 3 extra hours overtime?

A $222.50
B $215.00
C $200.00
D $212.50
E $215.50

19. A motorist, travelling at 30 miles an hour, gets 20 miles on a gallon of gasoline. If gasoline costs 50¢ a gallon, how much does he pay for gasoline on a 200 mile trip?

A $2
B $4
C $6
D $8
E not given

20. Four boys were going to rent a boat for a trip. Each boy was to pay $15. How much would each have to pay to rent the boat if one of the boys could not go on the trip?

A $12
B $15
C $20
D $60
E none of the above

APPENDIX D

MATHEMATICS PROBLEM TEST

(FINAL FORM A)

Time Limit 20 minutes

1. Of 2,000 cars at the fair, 40% were blue? How many were blue cars?

   A 80
   B 240
   C 600
   D 800
   E none of the above

2. A car was driven 5,000 miles. There are about 1.6 kilometers (km.) in a mile. About how many kilometers was the car driven?

   A 3,125 km.
   B 8,000 km.
   C 31,250 km.
   D 80,000 km.
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3. Four pints of ice cream were to be divided equally among 16 people. If 4 more people came, how much would each person get then?

   A 1/10 pt.
   B 1/5 pt.
   C 1/4 pt.
   D 1/3 pt.
   E none of the above

4. Mae had 1/3 of a cake and Jane had 1/5 of a cake. How much more cake did Mae have than Jane?

   A 1/2
   B 2/15
   C 1/4
   D 1/15
   E none of the above

5. Thirty members were present at a meeting. This is 3/4 of the total membership. How many members are there in the club?

   A 40
   B 45
   C 50
   D 60
   E none of the above

6. Ann borrowed $4,000 for 1/2 year. The interest rate was 8% per year. How much interest did she pay?

   A $ .16
   B $1.60
   C $3.20
   D $6.40
   E none of the above

7. How many chocolate bars at 2 for 25 cents can you buy for $1.75?

A 25
B 7
C 12
D 14
E 28

8. How many feet of strip steel must be bought in order to cut sixteen 2 1/2 foot lengths?

A 40
B 38
C 32
D 20
E none of the above

9. A man gets scores of 6, 10 and 8 in target practice. To get an average of 8 for four trials, what must his last score be?

A 10
B 9
C 8
D 7
E 6

10. Mr. Brown sold his lot through an agent who charged 5% on the $8,000 sale. How much did Mr. Brown get?

A $7,600
B $4,000
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11. A package of peas holds 2 1/2 pounds and sells for 75 cents. What is the price per pound for this package?

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12. George spent half his money and $2 besides. He had $12 left. How many dollars did he have in the beginning?

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14. A group of boy scouts leaves camp at 7:30 hiking at a rate of 4 miles per hour. When will they reach their destination which is 7 miles away?

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D 9:45
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15. A sheet of aluminum is cut so that one piece, which is 1/4 of the sheet, is twice as large as each of the other pieces. Into how many pieces is the sheet cut?

A 2
B 3
C 7
D 8
E 9

16. A used portable typewriter can be bought for $85 cash or by paying $25 down and $7 a month for nine months. How much is saved by paying cash?

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17. A train with 9 passenger cars carries 504 people. If 2 more passenger cars are added, how many does the train carry in all?

A 1,008
B 620
C 616
D 756
E none of the above

18. If a man earns $5.00 an hour and gets time and one half for overtime, how much does he earn in a 40 hour week with 4 extra hours overtime?

A $200.00
B $220.00
C $204.00
D $230
E none of the above

19. What will be the cost for gasoline on a trip of 180 miles if a car averages 20 miles per gallon and gas costs 50¢ a gallon?

A $2.80
B $3.60
C $8.00
D $4.50
E $3.20

20. Five boys were going to rent a boat for a trip. Each boy was to pay $12. How much would each have to pay to rent the boat if one of the boys could not go on the trip?

A $12
B $15
C $48
D $60
E none of the above

## APPENDIX E

## MATHEMATICS PROBLEM TEST

## (FINAL FORM B)

Time Limit 20 Minutes

1. A man has paid $20 toward the purchase of a $50 radio. What per cent has he paid?

   A 10%
   B 11 2/5%
   C 20%
   D 30%
   E 40%

2. A car was driven 8,000 miles. There are about 1.6 kilometers in a mile. About how many kilometers was the car driven?

   A 4,900
   B 12,800
   C 1,280
   D 7,940
   E not given

3. A man bought a second hand car for $1,000. He made a down payment of $400 and paid the remainder in 12 equal installments. How much was each installment?

   A $500
   B $600
   C $140
   D $50
   E not given

4. Mae had 1/4 of a cake and Jane had 1/5 of a cake. How much more cake did Mae have than Jane?

   A 1/9
   B 2/9
   C 1/20
   D 1/6
   E none of the above

5. Fifty members were present at a meeting. This is 5/6 of the total membership. How many members are there in the club?

   A 40
   B 45
   C 55
   D 60
   E not given

6. At a sale an article sold for $30. This was a reduction of 40% from the original price. What was the original price?

   A $75
   B $70
   C $50
   D $48
   E $40

7. If 2 pounds of potatoes cost 28¢, how much will 5 pounds cost?

   A $ .60
   B $ .70
   C $ .72
   D $1.26
   E $1.40

8. How many feet of strip steel must be bought in order to cut eighteen 3 1/2 foot lengths?

   A 34
   B 63
   C 55
   D 64 1/2
   E not given

9. A man's marksmanship scores on three trials are 7, 9, 8. If he wished to average 8 on four trials, what must his fourth score be?

   A 5
   B 6
   C 8
   D 9
   E 10

10. An agent sold a lot for $12,000 charging 6% commission. How much did the owner get from the sale?

   A $6,000
   B $11,940
   C $11,400
   D $11,996
   E none of the above

11. The price of a 12 ounce package of frozen peas is 27¢. At this rate, what is the price per pound? (16 ounces = 1 pound)

   A 30¢
   B 32¢
   C 33¢
   D 36¢
   E 45¢

12. George spent half his money and $2 besides. He had $11 left. How many dollars did he have in the beginning?

   A $10
   B $20
   C $24
   D $26
   E $28

13. How many strips 3 1/2 inches long can be cut from a ribbon 21 inches long?

   A 5
   B 6
   C 6 1/2
   D 17 1/2
   E 73 1/2

14. A group of boyscouts leaves camp at 7:30 hiking at a rate of 4 miles per hour. When will they reach their destination which is 6 miles away?

   A 9:00
   B 9:10
   C 9:15
   D 9:45
   E none of the above

15. A sheet of aluminum is cut so that one piece, which is 1/2 of the sheet, is twice as large as each of the other pieces. Into how many pieces is the sheet cut?

A 2
B 3
C 7
D 8
E 9

16. It costs a man $4.30 a week to use his car for getting to work. If he decides to use a bus, paying 50¢ a day for 6 days in fares, how much does he save in a week?

A $1.80
B $1.60
C $1.50
D $1.30
E not given

17. Jack used 1/3 of his bottle of medicine in 6 days. At this rate, how many days should the remainder of the medicine last?

A 2
B 3
C 12
D 18
E not given

18. If a man earns $5.00 an hour and gets time and one-half for overtime, how much does he earn in a 40 hour week with 3 extra hours overtime?

A $222.50
B $215.00
C $200.00
D $212.50
E $215.50

19. A motorist, travelling at 30 miles an hour, gets 20 miles on a gallon of gasoline. If gasoline costs 50¢ a gallon, how much does he pay for gasoline on a 200 mile trip?

A $2
B $4
C $6
D $8
E not given

20. Four boys were going to rent a boat for a trip. Each boy was to pay $15. How much would each have to pay to rent the boat if one of the boys could not go on the trip?

A $12
B $15
C $20
D $60
E none of the above

APPENDIX F

RAW DATA BY FAMILIES OF SCORES ON THE

MATHEMATICS PROBLEM TEST

(FORM A)

| Family | | Student Boy | Student Girl | Parent Father | Parent Mother |
|---|---|---|---|---|---|
| A | 1. | 16 | | | 17 |
| B | 2. | | 16 | | 19 |
| C | 3. | | 3 | | |
| | 4. | | 13 | | 9 |
| D | 5. | 15 | | | |
| | 6. | 7 | | | 18 |
| | 7. | | 18 | | |
| E | 8. | 12 | | | 16 |
| F | 9. | 18 | | | |
| | 10. | 17 | | | 19 |
| G | 11. | 16 | | | 19 |
| H | 12. | 15 | | | 17 |
| | 13. | 15 | | | |
| I | 14. | 20 | | | 17 |
| J | 15. | 20 | | | 18 |
| K | 16. | | 16 | 16 | |
| | 17. | | 18 | | |
| L | 18. | | 18 | 19 | |
| | 19. | | 20 | | |
| | 20. | 19 | | | |
| M | 21. | | 19 | 15 | |
| | 22. | | 17 | | |

APPENDIX F (Continued)

| Family | | Student | | Parent | |
|---|---|---|---|---|---|
| | | Boy | Girl | Father | Mother |
| N | 23. | | 18 | 11 | |
| O | 24. | 18 | | 9 | |
| P | 25. | 9 | | 18 | |
| | 26. | | 10 | | |
| Q | 27. | | 11 | 15 | |
| R | 28. | 16 | | 18 | |
| S | 29. | 14 | | 9 | 17 |
| T | 30. | | 13 | 18 | 16 |
| U | 31. | 18 | | 19 | 17 |
| V | 32. | | 9 | 19 | 12 |
| W | 33. | 18 | | | |
| | 34. | | 16 | 15 | 16 |
| X | 35. | | 13 | 16 | 11 |

APPENDIX G

RAW DATA OF SCORES ON THE MATHEMATICS PROBLEM TEST (FORM A) VERSUS SCORES ON THE MATHEMATICS ATTITUDE SCALE

| | Sex | Test Score | Attitude Score |
|---|---|---|---|
| 1. | M | 20 | 77 |
| 2. | M | 20 | 75 |
| 3. | M | 9 | 46 |
| 4. | M | 18 | 63 |
| 5. | M | 16 | 76 |
| 6. | M | 18 | 49 |
| 7. | M | 18 | 60 |
| 8. | M | 17 | 71 |
| 9. | M | 12 | 82 |
| 10. | M | 19 | 63 |
| 11. | M | 15 | 50 |
| 12. | M | 7 | 53 |
| 13. | M | 18 | 63 |
| 14. | M | 5 | 68 |
| 15. | M | 16 | 79 |
| 16. | M | 14 | 72 |

APPENDIX G (Continued)

| | Sex | Test Score | Attitude Score |
|---|---|---|---|
| 17. | F | 11 | 59 |
| 18. | F | 10 | 66 |
| 19. | F | 13 | 42 |
| 20. | F | 15 | 75 |
| 21. | F | 16 | 71 |
| 22. | F | 19 | 89 |
| 23. | F | 17 | 69 |
| 24. | F | 18 | 94 |
| 25. | F | 20 | 87 |
| 26. | F | 9 | 66 |
| 27. | F | 3 | 37 |
| 28. | F | 13 | 33 |
| 29. | F | 13 | 46 |
| 30. | F | 16 | 95 |
| 31. | F | 18 | 40 |

## APPENDIX H

### LETTER TO THE PARENTS

Dear Parent:

I am presently doing a study to determine whether or not the adults of today are better at simple mathematical problem solving than their offsprings. I therefore *desperately* need volunteer parents (preferably both) to come to Room 210 at Belmont Senior Secondary School at 7:30 P.M. Feb. 26 or Feb. 27, 1974 to write a short quiz (20 minutes). The results of the quiz will be kept in strict confidence. Please indicate your intentions by putting an "X" in *one* of the blanks below.

| | Tuesday Feb. 26 | Wednesday Feb. 27 |
|---|---|---|
| My spouse and I: | | |
| (a) will attend for sure | ______ | ______ |
| (b) may be able to attend | ______ | ______ |
| (c) do not wish to take part in the study | ______ | ______ |
| (d) only I and not my spouse can attend | ______ | ______ |

Signed ____________________________

Sample Problems from the Quiz

(a) A $7.00 shirt was on sale at 10% off. How much did the shirt cost on sale?

(b) To make concrete, the directions call for 5 bags of cement mixed with 8 gallons of water. How many gallons of water are needed for 20 bags of cement?

# VITA

Surname: LEUNG Given Names: RAYMOND GAR MUN

Place of Birth: VICTORIA, B.C. Date of Birth: DECEMBER 4, 1941

Educational Institutions Attended, with Dates of Entering and Leaving:

| | | | |
|---|---|---|---|
| UNIVERSITY OF VICTORIA | 1959 | to | 1963 |
| UNIVERSITY OF VICTORIA | 1964 | to | 1965 |
| | | to | |
| | | to | |

Degrees, Diplomas, Etc., Awarded, with Dates and Names of Institutions:

| | | |
|---|---|---|
| B.A. | 1963 | University of Victoria |
| | | |
| | | |
| | | |

Honors and Awards:

Publications:

Title of Thesis/Dissertation

THE RELATIONSHIP BETWEEN SECONDARY SCHOOL STUDENTS' AND THEIR PARENTS' ACHIEVEMENT IN MATHEMATICAL PROBLEM SOLVING

Author [redacted]

*Signature*

Raymond Gar Leung

*Name*

March 26, 1975

*Date*