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A comparative investigation of the relationship between algebra grades and differential aptitude test subtests to geometry grades

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APPROVAL SHEET

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CHAPTER I

THE PROBLEM AND OBJECTIVES

Counselors and teachers have long wanted a system to predict a student's probable level of achievement in the next higher course. This has been especially true in the academic areas such as English and mathematics. To do so involves many factors and the attempt has not yet proven successful.

I. THE PROBLEM

After three years of teaching both Algebra II and Trigonometry, and Fused Geometry, the author has become aware of the need for predicting a student's probable level of achievement in the next higher mathematics course. This is particularly true when colleges may be more selective in admitting their students, when more students want to go to college, or are pushed into college by their parents. High school mathematics teachers are being asked to cover more content material in the same number of allotted days. This means that more material is being concentrated in a class period. Because of this and crowded classrooms, less time is available for individual instruction. The capable student (A or B average grade) understands the material. In the author's opinion, an average student (C average grade) will understand about half of the material, but the below average student (D or F average grade) is lost. Therefore he becomes easily discouraged and quits producing to his capacity. What is needed is an adequate way of grouping students according to their ability.

Several schools do this, but is their method of grouping satisfactory? Most grouping is based on grades in the previous class. This may be adequate for such subjects as English, foreign language, business, and history, but the author does not believe that it is satisfactory for mathematics because of the course sequence.

The Algebra I - Geometry - Algebra II sequence has fallen victim to the incorrect method of predicting success in the next course. In the school system researched, success in each succeeding course is largely based on grades earned in the previous mathematics course. This is not satisfactory for several reasons.

First, grades alone should not be predictors of success, since for some pupils, grades are influenced by academic and nonacademic factors.

Secondly, the content of the Algebra courses is different from that of the Geometry course. An Algebra book covers topics such as factoring, irrational numbers, complex fractions, graphing, and logarithms.[1]

An example of an algebra problem is

$$3 = 2\sqrt{x} + x$$

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[1]Mary P. Dolciani, Simon L. Berman, Julius Freilich, Modern Algebra, Structure and Method, Book One (Boston: Houghton, Mifflin Company, 1962), pp. v-x.

By following certain solution procedures, the answer may be obtained. For this problem, and all other problems of this type, the following steps should be taken in sequence.

> "1. Isolate the radical term in one member of the equation.
> 2. Square both members.
> 3. Solve the resulting equations.
> 4. Check
> Substitute, and then take the principal root of the number in the radicand."[2]

By using this sequence, all irrational equations of this type can be solved provided the student's numerical knowledge of mathematics is correct.

However, in geometry, there are five main divisions to each geometric proof. They are the Given, To prove, Figure, Analysis, and the Proof.[3] Each proof section begins with the Given and proceeds to the Conclusion. But the immediate sequence will change with each problem. Just because one sequence works with problem #12 doesn't mean that this same sequence will work with problem #14.

And finally, space relationships are used more in geometry than in the algebra courses. In an algebra course, a student does not need to perceive the conclusion and is not

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[2]Ibid.

[3]Ray C. Jurgensen, Alfred J. Donnelly, Mary P. Dolciani Modern School Mathematics: Geometry (Boston, Houghton Mifflin Company, 1969), pp. 107-110.

Listed below are the problems to be investigated.

1. What are the problems involved in predicting each student's potential level of achievement in geometry?
2. Can Algebra I final grades be used solely as a basis for predicting Fused Geometry grades?
3. Are Algebra II final grades a better predictor of Fused Geometry grades than Algebra I final grades?
4. Are the Differential Aptitude Test subtests on Numerical Ability, Abstract Reasoning, and Space Relations significant predictors of Fused Geometry grades?
5. Can both Algebra I and Algebra II final grades and the Differential Aptitude Test subtests previously mentioned be used in combination to add significantly to the prediction of first semester Fused Geometry grades?

The author is especially interested in the last problem since previous studies have indicated that the five variables collectively do not add to the prediction of a student's achievement level in geometry.

CHAPTER II

REVIEW OF LITERATURE AND STANDARDIZED TESTS

The literature previously published on this subject is scarce. Very little research has been completed within the last ten years.

I. REVIEW OF THE LITERATURE

Several works by Gerald S. Hanna proved to be of interest. The author did not find any articles which dealt specifically with the problem.

Hanna's article on "An Attempt to Validate Empirically Derived Interest Scale and Standard Kuder Scales for Predicting Success in High School Geometry" was one relating geometry grades to certain questions on the Kuder Preference Record (Vocational). He was trying to find a reason "... for variance in criteria of learning".[1] A stratified random sampling of 94 Kuder answer sheets (Form CM) was taken. An empirically derived key was made by using an item discrimination index to select the responses to be tested. The key was compared with the composite criterion scores. Each composite criterion score was composed of cumulative marks in first year algebra (5 point scale), cumulative marks in first year general mathematics (5 point scale)

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[1]Gerald S. Hanna, "An Attempt to Validate an Empirically Derived Interest Scale and Standard Kuder Scales for Predicting Success in High School Geometry," _Educational and Psychological Measurement_, XVI (Summer,1966), p. 445

and the subject's own prediction of his geometry marks (5 point scale). The study was cross-validated by comparing the composite criterion scores with the scores from the empirically derived keys.[2]

Empirical key correlation with composite criterion was .50 before allowance for shrinkage. With the cross-validation, the correlation was .27.[3] Using both the derived and standard Kuder scales, a multiple regression equation was tested. However neither scale contributed significantly to predicting geometry grades.[4]

Super and Crites had found a significant relationship between Kuder Preference Record, (Vocational) and various areas of study, especially science, mathematics, and literature.[5] Townsend found a correlation of .31 between the Strong Vocational Interest Blank for Men and the Cooperative Plane Geometry Test.[6]

Hanna also listed four areas in which studies have been surveyed for predicting geometric success. The areas were abilities, aptitudes, interests, and temperament. Little recent work has been completed in comparing abilities to geometry grades. Early researchers related course marks to

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[2] *Ibid.* p. 447 [3] Ibid. [4] *Ibid.* p. 448

[5] *Ibid.* [6] *Ibid.* pp. 445-446

achievement tests in geometry, arithmetic, and algebra. However, two of the three geometric aptitude tests were based on algebraic achievement.[7]

In the area of geometric aptitude, there has been little research in twenty years.

II. THE STANDARDIZED TESTS

Since few studies of the problem have been completed, a survey of the standardized geometry tests was completed to determine their usefulness in predicting geometry grades. A review of five tests: the Seattle Plane Geometry Test: Evaluation and Adjustment Series; the Iowa Test of Educational Development: Test 4, Ability to Do Quantitive Thinking; Orleans Geometry Prognosis Test: Revised Edition; Lee Test of Geometric Aptitude, 1963 Revision; and the Iowa Plane Geometry Aptitude Test.

Several tests were eliminated because of lack of information on validity and reliability. Any test that could not be administered in a normal class period was eliminated. No resource material printed before 1959 was researched. Since the orbiting of Sputnik on October 4, 1957, the high school mathematics courses have been revised in content and in sequence; therefore any information printed before 1959 would

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[7]Gerald S. Hanna, "A Summary of the Literature of Geometry Prediction with Emphasis Upon Methodology and Theory," <u>School Science and Mathematics</u>, LXVI (November,1966), p. 723

probably be irrelevant.

The information of the Seattle Plane Geometry Test: Evaluation and Adjustment Series was sparse. Information is needed on the predictive validity of this test. The test was designed for use with students who have had one semester of geometry, its functional value as a predictor of first semester geometry grades would be worthless.[8]

The Iowa Test of Educational Development: Test 4, Ability to Do Quantitive Thinking is a forced choice test with five selections in each item.[9] There is no adequate data on reliability and the title and purpose are misleading. This test is not challenging to the brighter student since it has only an average range of difficulty.[10]

The third test reviewed was the Orleans Geometry Prognosis Test: Revised Edition. Arthur Traxler states that this test is

> A test for the prediction of geometry ability of pupils who have not studied the subject. Similar in purposes and general form to Orleans Algebra Prognosis Test. Contains several brief lessons, each followed by a short test. One form requires 39 minutes of working

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[8]Oscar K. Buros (ed.), <u>The Fifth Mental Measurements Yearbook</u> (Highland Park, New Jersey: The Gryphon Press,1959), p. 613

[9]Oscar K. Buros (ed.), <u>The Sixth Mental Measurements Yearbook</u> (Highland Park, New Jersey: The Gryphon Press,1965), p. 872

[10]<u>Ibid</u>., p. 873

time; overall administration time about 45 minutes. Not much data on reliability and validity available, but would seem to be one of the better tests of its kind.[11]

Until more information is available, this test is of questionable value as a predictor of grades in geometry.

With the Lee Test of Geometric Aptitude, the publisher recommends developing local norms. This test is administered in four parts which comprise a total of fifty items. The 1963 revision takes 26 to 40 minutes to complete.[12] Designed for the student who has not studied geometry, the test measures geometric aptitude. Split-half reliability is reported as .91.[13] Norms are based on ninth grade students in ten secondary schools in Pennsylvania, California, and Wisconsin. However, no description of the schools is given.[14]

Kenneth F. McLaughlin states that the "predictive validity coefficients with second semester plane geometry marks were obtained with values of .51 and .55".[15]

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[11]Arthur E. Traxler and Robert D. North, Techniques of Counseling (New York and London: Harper and Row, Publishers, 1966), p. 69

[12]Buros, The Sixth Mental Measurement Yearbook, pp.916-917.

[13]Traxler and North, loc. cit.

[14]Buros, The Sixth Mental Measurement Yearbook, p. 917

[15]Ibid.

Review comments by Lynnette B. Plumlee were not more valuable for assessing the test's predictive value. She listed the same validity coefficients as McLaughlin did. There is no evidence of how previous knowledge affects test validity. Since many junior high school courses in mathematics include some introduction to geometry, the assumption of unfamiliarity may be false.[16]

Even though this test can be used to measure geometric aptitude, sole emphasis should not be placed on this test when grouping students by ability.[17] Since the investigator is trying to predict first semester geometry grades, this test could not be used since it was intended for use with second semester geometry marks.

The last test evaluated was the Iowa Plane Geometry Aptitude Test. This test gives considerable promise for rating geometric aptitude. Traxler gives this brief review:

> A prognostic test for high school pupils who have studied no geometry. One Form. Total working time, 44 minutes. Authors report Kuder-Richardson reliability of .887 for revised edition based on 260 ninth-grade pupils. The authors also report a correlation of .705 with a test of achievement in geometry and one of .592 with first-and second-semester grades. Percentile norms are available based on 1754 pupils tested in September before the beginning of instruction in plane geometry.[18]

As expected correlation with first-and second-semester

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[16] *Ibid.*, p. 919 [17] *Ibid.*

[18] Traxler and North, *op. cit.*, p. 68

geometry marks was not high. The correlation was slightly greater than chance but less than .600. The Kuder-Richardson reliability was above .700. However, the Iowa Plane Geometry Aptitude Test was not selected because it was based on instruction in plane geometry. This course is seldom taught today. Instead it has been and is being replaced by a Fused Geometry course. Plane geometry dealt with only two-dimensional figures; fused geometry incorporates both two-and three-dimensional figures in the same course and even in the same chapter. Therefore, the Iowa Plane Geometry Aptitude Test would not be as representative of course content as it was several years ago.

Since none of the five standardized tests reviewed would be suitable for this study the author reconsidered using the Differential Aptitude Test. After an examination of its purpose and critiques, the author decided to use the Numerical Ability, Abstract Reasoning, and Space Relations subtests of the Differential Aptitude Test.

One reason for choosing these subtests was the availability of test results. All eighth grade students in Virginia Schools must take the Differential Aptitude Test. The results are recorded in each student's cumulative folder. Since the investigator had access to these folders, it would be easy to obtain the students' raw scores.

The second reason for choosing these subtests is that none of the five standardized tests was adequate for the purpose of this study. The aim is to provide teachers and counselors with one method (not the method) of helping the student with his course electives. Since the Algebra grades and the Differential Aptitude test subscores are available to the counselor, he could use them more readily than to give a completely different standardized test which takes time and is expensive.

The final reason for choosing the three subtests is that they measure abilities which are pertinent to the geometric content. The Abstract Reasoning subtest contains fifty items, with well-printed and large drawings.[19] John B. Carroll states that:

> Abstract Reasoning requires the student to indicate which of a series of choices properly carries out the logical development exhibited by a sequence of figures. It was intended to be a nonverbal measure of reading ability. This intention was well realized in the test, but factorial studies show that to some extent, it is also a measure of the student's ability to visualize spatial patterns and shapes; this undoubtedly explains some of its correlations with another test, Space Relations.[20]

The Space Relations subtest measures the ability to visualize objects and forms in two or three dimensions.[21] Thus two facets of the geometry course are covered in these two subtests - logical sequence and space relations.

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[19] Buros, The Fifth Mental Measurements Yearbook, p. 674

[20] Ibid., p. 671 [21] Ibid.

The third area needed was numerical reasoning. While the Numerical Ability subtest information was scanty, Buros did state that the subtest measures number and reasoning factors.[22]

Lee Cronbach gives additional information of the predictive value of the Space Relations, Numerical Ability, and Abstract Reasoning subtests to geometry grades. Several studies are presented in his book; however, none of the validations are stable enough nor predictive enough to make any substantial claims. Correlation of geometry marks with the subtests mentioned range from .02 to .61. The Space Relations subtest correlates positively with geometry marks, but the range is from .02 to .57. From two classes in the same school, the obtained correlation coefficients were .20 and .53 respectively. This is too large a difference on which to base significant findings. Ranges from .14 to .56 were obtained by correlating Abstract Reasoning subscores with geometry marks. Again, the two classes in the same school had widely different correlations, .19 and .56. Numerical Ability subscores with geometry marks yielded the most significant correlations of any of the subtests. The correlations ranged from .06 to .61. However, the range with the two classes was .34 and .57. Again

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[22] <u>Ibid</u>., p. 674

there is a wide difference.[23]

Even though the results cited above do not have encouraging predictive values, the subtests were chosen for possible improvement value. The author wishes to improve the correlations by the addition of first semester Algebra I and Algebra II grades to the multiple correlation with Differential Aptitude Test subscores.

Norman Frederiksen, Director of Research for the Educational Testing Service, believes that the Verbal Reasoning subtest, the Numerical Ability subtest, and the sentence part of the Language Usage subtest are the best predictors for mathematics, English, science, and the social sciences.[24] However, he does not state how significant a predictor these subtests are. Therefore, the author did not choose this combination for this study.

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[23]Lee J. Cronbach, Essentials of Psychological Testing (New York, Evanston, and London: Harper and Row, Publishers, 1960), pp. 277-278.

[24]Buros, The Fifth Mental Measurements Yearbook, p. 675.

CHAPTER III

INVESTIGATION

This chapter gives the details of the investigation. The groups and the variable combinations are presented along with the statistical methods used.

I. THE NULL HYPOTHESES

For this investigation, four null hypotheses will be tested:

1. Algebra I final grades are not significant predictors of first semester Fused Geometry grades.
2. Algebra II final grades are not better predictors of first semester Fused Geometry grades than are Algebra I final grades.
3. The Differential Aptitude Test subtests on Numerical Ability, Abstract Reasoning, and Space Relations are not significant predictors of first Semester Fused Geometry grades.
4. Algebra I final grades, Algebra II final grades, and the aforementioned subtests taken collectively do not add significantly to the prediction of first semester Fused Geometry marks.

In the chapter on findings, each of the null hypotheses will be evaluated separately.

II. GROUPING

Each subject used was either a student in high school or an alumnus of the high school. The school chosen was a high school in a county in Southside Virginia; the school enrollment for the 1969-70 school year was about 950. The surrounding community was both urban and rural. At the north and western end of the county were three cities each with a population over 15,000. Several large chemical factories are located near or in the county. At the eastern and southern end of the county, the residents are primarily farmers. Since there is only one high school, it represents the population of the county adequately.

A slight problem occurred while trying to collect the data. A military installation is located within the county. Children residing on the base attend the county high school. Also several employees of the chemical factories live within the county. Quite frequently there is a high turn-over rate within the military installation and a smaller turn-over rate at the factories. Therefore, approximately 40% of the students are transient and usually stay only one or two years. It was difficult to find complete data on any given subject.[1]

The high school contains grades 10-12, with students' ages ranging from 15-20. Both male and female students compose the population. These subjects were from two teachers' classes in Fused Geometry during the 1969-70 school year. To help validate the study, two graduate classes 1969 and 1968, were researched.

The subjects were divided into four groups. The high school used is the school where the investigator is employed.

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[1]"Section B, School and Community" (Part of the Evaluative Criteria used when Prince George Senior High School was evaluated by a committee formed by the State Board of Education, Prince George, Virginia, March, 1970)

When the investigator began teaching there the mathematics sequence was Algebra I--ninth grade; Algebra II--tenth grade. Last year, the sequence was changed to Algebra I--ninth grade; Fused Geometry--tenth grade; and Algebra II--eleventh grade. Because of the sequence, the eleventh and twelfth grade students enrolled in Fused Geometry had had Algebra II. However, the tenth grade students were under the new sequence and had completed only Algebra I.

Therefore, the students in the study were divided into two groups: those who had had Algebra II and those who had not had Algebra II. Group I was composed of the students who had completed only Algebra I; this group was called the Non-Graduate I group. The Non-Graduate II group comprised those students who had completed both Algebra I and Algebra II; this was the second group. Table I gives a breakdown of the subjects in the first two groups.

With the alumni, the 1969 and 1968 graduating classes were used. Two groups were formed. Those students who graduated in 1969 comprised the Graduate I group. The Graduate II group contained students who had graduated in 1968. Only those subjects who had completed both Algebra I and Algebra II were accepted as subjects. The 1969 graduating class contained 240 students, but complete data was obtained on only 56 subjects. A greater difference was found with the 1968 graduating class. In this instance, 265 students were graduated; however, only

TABLE I

COMPOSITION OF THE NON-GRADUATE GROUPS

BY GRADE AND SEX

	10th Grade		11th Grade		12th Grade		Totals
	Boys	Girls	Boys	Girls	Boys	Girls	
Non-Graduate I	38	27	4	2	2	3	76
Non-Graduate II	9	3	11	25	6	1	55

39 students comprised the sample.

III. VARIABLE COMBINATION

With the Non-Graduate I group, only four variables were used: Algebra I final grade, the Numerical Ability subtest, the Space Relations subtest, and the Abstract Reasoning subtest. The following combination of variables was tested:

1. Algebra I final grade, the Numerical Ability raw score, the Space Relations raw score, the Abstract Reasoning raw score.
2. Algebra I final grade, the Numerical Ability raw score, and the Space Relations raw score.
3. Algebra I final grade, and the Numerical Ability raw score.
4. Space Relations raw score, and the Abstract Reasoning raw score.
5. Numerical Ability raw score, and the Abstract Reasoning raw score.

Five variables were used with the Non-Graduate II, the Graduate I and the Graduate II groups. With the Non-Graduate II group, the combinations listed below were used:

1. Algebra I final grade, Algebra II final grade, the Numerical Ability raw score, the Space Relations raw score, and the Abstract Reasoning raw score.
2. Algebra I final grade, Algebra II final grade, the Numerical Ability raw score, and the Space Relations raw score.
3. Algebra I final grade, Algebra II final grade, and the Numerical Ability raw score.
4. Space Relations raw score, and the Abstract Reasoning raw score.
5. Numerical Ability raw score, and the Abstract Reasoning raw score.

To test different relationships, two combinations were slightly altered from the Non-Graduate groups. These alterations were used with both the Graduate I and Graduate II groups. Therefore, these combinations of variables were tested:

1. Algebra I final grade, Algebra II final grade, the Numerical Ability raw score, the Space Relations raw score, and the Abstract Reasoning raw score.
2. Algebra I final grade, Algebra II final grade, the Numerical Ability raw score, and the Abstract Reasoning raw score.
3. Algebra I final grade, Algebra II final grade, and the Numerical Ability raw score.
4. Abstract Reasoning raw score, and the Space Relations raw score.
5. Numerical Ability raw score, and the Space Relations raw score.

Combinations 2 and 5 differed from the combinations used in the Non-Graduate groups.

Final grades were used as data because the final grade is an average of the first semester grade and the second semester grade. Therefore variance in grade distribution is kept at a minimum. Also, it was easier to obtain final grades on a greater majority of students. Many of the students are transient; their transcripts contain final grades, rather than semester grades.

IV. STATISTICAL METHODS

A multiple correlation was performed with each variable combination in each group. Therefore twenty multiple correlations were obtained. Those groups with similar combinations were evaluated separately but compared as a group. Each variable combination was tested at least twice. To check the data for bias, a shrunken r was obtained from each variable combination in each group.

A t-test was performed on the regression weight, and on each variable in each combination group. This was done to obtain information on which predictor was significant. The level of rejection was .05.

In all groups a simple Pearson r was obtained between each variable and the Fused Geometry first semester grades. Comparison of these correlations with those reported by Cronbach will be made.

CHAPTER IV

FINDINGS

Since several statistical tests were conducted, it will be easier to evaluate the test results with respect to each null hypothesis.

I. ALGEBRA I GRADES AS PREDICTORS OF FUSED GEOMETRY GRADES

With each group a simple Pearson r was computed to show how well Algebra I final grades could predict first semester Fused Geometry grades. Table II gives the computational results for each group. To compare the results with a normal curve, the mean and standard deviation of each variable was obtained. Figures for the correlation coefficient were rounded off to the nearest ten-thousandths; figures for the mean and standard deviation were rounded off to the nearest thousandths.

With each group, the null hypothesis is rejected at the 1% level. The correlations for the Non-Graduate groups were fairly close together, but this was not true of the Graduate II groups. While all correlation coefficients were higher than the values need for rejection, the author would like to have the numerical range of r's for the four groups more comparable to each other. This, the author believes, would have more meaning to a counselor. With a closer range of r values, the counselor would have more confidence in the predictors and their meaning. Therefore, the counselor could tell the parent

TABLE II

COMPARISON OF THE CORRELATIONS COEFFICIENTS, THE MEANS AND THE STANDARD DEVIATIONS BY USING ALGEBRA I FINAL GRADES TO PREDICT FUSED GEOMETRY FIRST SEMESTER GRADES

	Non-Grad I	Non-Grad II	Grad I	Grad II
Correlation Coefficient (Pearson r)	.6735	.6061	.5013	.7088
$\bar{X}_1$-data- Algebra I Final Grades				
$\bar{X}_1$	3.000	3.291	3.680	3.333
s	1.026	.888	.968	.943
$\bar{Y}$-data- Fused Geometry First Semester Grades				
$\bar{Y}$	2.645	3.418	3.820	3.639
s	1.295	1.260	.953	.887

and/or student with greater assurance that certain criteria are good predictors of Fused Geometry grades. The counselor would know that these predictors have produced almost the same correlation coefficients with each group studied. While Algebra II final grades are significant predictors of first semester Fused Geometry grades, the author would like to have the range of r more stable.

In the school researched, a five letter grade system is used. The average letter grade would be a C, which would be an average student's grade. Two letter grades (D and F) are below average; and two letter grades (B and A) are above average. Each letter grade was converted to a five point scale. A three would be an average grade, and one point on either side of three would be the next higher letter grade. With a normal curve the majority of students would be in the 3.000 range. However, those students taking Algebra and Fused Geometry courses should be preparing for college, and are usually the more capable students. The author would expect the mean to be slightly higher than average, 3.500. The standard deviation should be 1.000 to coincide with the 5 point scale. With the X_1-data, Algebra II final grades, all of the means are between 3.000 and 4.000. The Graduate groups have the means nearest 3.500. The standard deviations show approximately a one point deviation. In analyzing the Y-data, Fused Geometry first semester grades, the means and standard deviations vary more widely and did not have the variations expected.

II. ALGEBRA II GRADES AS PREDICTORS OF FUSED GEOMETRY GRADES

Only three groups will be used to test the second null hypothesis: Algebra II final grades are not better predictors of first semester Fused Geometry grades than are Algebra I final grades. Since the subjects in the Non-Graduate I group had not taken Algebra II, this group could not be used with this hypothesis. Simple Pearson r's were obtained with the remaining groups. Table III gives the data.

Analysis of this data proves to be interesting. The null hypothesis was rejected with each group ($p > .01$). This means that Algebra II final grades are also predictors of first semester Fused Geometry grades. But are Algebra II final grades better predictors? The author believes so. While the highest correlation coefficient is not greater than the coefficients in Table I, the coefficients in Table II are more stable. In the table the means and the standard deviations for both data are more compatible. The two graduate groups showed closer comparisons. With the Algebra II data, the mean difference is less than .040 compared to mean differences of .445 and .485 between the Non-Graduate II and the Graduate II group, and Graduate I group respectively. The Fused Geometry data gives similar results but with less consistency; the difference between the Graduate groups is .181. The mean differences

TABLE III

COMPARISON OF THE CORRELATION COEFFICIENTS, THE MEANS AND THE STANDARD DEVIATIONS BY USING ALGEBRA II FINAL GRADES TO PREDICT FUSED GEOMETRY FIRST SEMESTER GRADES

	Non-Graduate II	Graduate I	Graduate II
Correlation Coefficient (Pearson r)	.6543	.6193	.6170
$\bar{X}_2$-data-Algebra II Final Grades			
$\bar{X}_2$	3.055	3.540	3.500
s^2	1.119	.879	1.041
$\bar{Y}$-data-Fused Geometry First Semester Grades			
$\bar{Y}$	3.418	3.820	3.639
s	1.260	.953	.887

between the Non-Graduate group and the Graduate I and Graduate II groups respectively were .402 and .221.

The standard deviations are also more consistent than with the Algebra I data presented in Table II. However, the deviations are not consistent enough to make any significant interpretations.

Since the correlation coefficients with the Algebra II data are more stable than those with the Algebra I data, Algebra II final grades seem to be better predictors of first semester Fused Geometry grades than are Algebra I final grades.

III. THREE SUBSCORES OF THE DIFFERENTIAL APTITUDE TESTS AS PREDICTORS OF FUSED GEOMETRY GRADES

Several combinations of the Numerical Ability, Abstract Reasoning, and Space Relations subtests were tested. Therefore the tests will be divided into two main subgroups. First, Pearson r's were obtained comparing each subtest and the Y-data. And secondly, multiple correlations using three different pairs of the subtests were used as predictors.

The relationship between the Numerical Ability subtest and first semester Fused Geometry grades was tested. All four groups comprised the sample. Table IV gives the relationship.

Each correlation coefficient is significant at the 1% level of rejection. Therefore the Numerical Ability subtest is a predictor of first semester Fused Geometry grades. However, the correlations obtained are below the correlations listed in

TABLE IV

COMPARISON OF THE CORRELATIONS COEFFICIENTS, THE MEANS AND THE STANDARD DEVIATIONS BY USING THE NUMERICAL ABILITY SUBTEST TO PREDICT FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Grad I	Non-Grad II	Grad I	Grad II
Correlation Coefficient (Pearson r)	.3590	.5534	.4186	.4370
$\bar{X}_3$-data Numerical Ability rawscores				
$\bar{X}_3$	17.197	19.473	19.480	20.889
s	4.814	5.067	5.232	5.990
$\bar{Y}$-data First semester Fused Geometry Grades				
$\bar{Y}$	2.645	3.418	3.820	3.639
s	1.295	1.260	.953	.887

either Table I or Table II. Also the coefficients are lower than the correlation coefficients between the Numerical Ability subtest and geometry grades as reported by Lee Cronbach in Chapter II. Therefore, the author does not believe that the Numerical Ability subtest is a good predictor of first semester Fused Geometry grades.

The correlation between the Abstract Reasoning subtest and first semester Fused Geometry grades was computed. Table V gives the results.

The correlation coefficients of the Non-Graduate groups and the Graduate I group were significant ($p > .01$). But the coefficient of the Graduate II group was not significant and the null hypothesis was not rejected with the Graduate II group. Since only three groups rejected the null hypothesis the Abstract Reasoning subtest should not be used as a predictor of first semester Fused Geometry grades.

The final subtest Space Relations was correlated with first semester Fused Geometry grades. This was the last predictor to be tested singularly. Since a large amount of material in Fused Geometry deals with the relationship between and among objects, it was hoped that this subtest would prove significant. Table VI shows the results of the computations.

The results of these correlations were disappointing. The correlation coefficients for the Space Relations subtest were lower as a group than the Numerical Ability or the

TABLE V

COMPARISON OF THE CORRELATION COEFFICIENTS, THE MEANS AND THE STANDARD DEVIATIONS BY USING THE ABSTRACT REASONING SUBTEST TO PREDICT FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Grad I	Non-Grad II	Grad I	Grad II
Correlation Coefficients (Pearson r)	.4487	.5354	.4606	.3238
X_4-data Abstract Reasoning rawscores				
$\bar{X}_4$	28.434	31.418	33.580	33.333
s	9.665	7.365	7.349	8.544
Y-data First semester Fused Geometry Grades				
$\bar{Y}$	2.645	3.418	3.820	3.639
s	1.295	1.260	.953	.887

TABLE VI

COMPARISON OF THE CORRELATION COEFFICIENTS, THE MEANS AND THE STANDARD DEVIATIONS BY USING THE SPACE RELATION SUBTEST TO PREDICT FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Grad I	Non-Grad II	Grad I	Grad II
Correlation Coefficient (Pearson r)	.4443	.1102	.4430	.2623
X_5-data Space Relations rawscores				
$\bar{X}_5$	24.289	24.655	30.300	31.556
s^5	9.176	9.022	9.720	10.177
Y-data First semester Fused Geometry Grades				
$\bar{Y}$	2.645	3.418	3.820	3.639
s	1.295	1.260	.953	.887

Abstract Reasoning groups. None of the correlations is above .5000 and one coefficient is .1102. In Lee Cronbach's study, the correlation coefficients were from .02 to .57. In testing for significance, the Non-Graduate I group and the Graduate I group had correlations above the level of rejection ($p > .01$). However, the Non-Graduate II and Graduate II groups had non-significant correlation coefficients and the null hypothesis was not rejected for these two groups. Because of the inconsistency in rejecting the null hypothesis, the Space Relations subtest could not be used as a predictor.

It is interesting to note that the Non-Graduate II group had the highest correlation coefficient with the Numerical Ability subtest and the Abstract Reasoning subtest, but the lowest correlation with the Space Relations subtest. No other reciprocal relationship could be found with the remaining three groups.

Since none of the subtests alone could be significant predictors of first semester Fused Geometry grades, multiple correlations were computed on different combinations of the three subtests. In all the groups, both the Abstract Reasoning subtest and the Space Relations subtest were tested to see if both of the subtests used collectively could be significant predictors of Fused Geometry grades. Table VII gives the multiple correlations. To test for bias, shrunken r's were also computed; the results are also found in Table VII.

TABLE VII

THE OBTAINED MULTIPLE CORRELATIONS AND SHRUNKEN r's USING BOTH THE ABSTRACT REASONING SUBTEST AND THE SPACE RELATIONS SUBTEST AS PREDICTORS OF FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Grad I	Non-Grad II	Grad I	Grad II
Multiple Correlations	.5125	.5630	.6134	.3698
Shrunken r	.4979	.5455	.5979	.3320
Difference	.0146	.0175	.0155	.0378

With the exception of the Graduate II group, the multiple correlation showed improved predictive value. The shrunken r computations with the first three groups was very close to the actual correlation. If the Graduate II group were omitted, the Abstract Reasoning subtest and the Space Relations subtest combined are better predictors than the aforementioned subtests correlated alone, but not good predictors. For counseling purposes, to be a good predictor the author believes the multiple correlation should be over .7000. All of these correlations were below .6200.

With the two Non-Graduate groups, a multiple correlation was performed with the Numerical Ability raw scores and the Abstract Reasoning raw scores as predictors. Table VIII gives the obtained results.

Using these two variables to predict geometry grades did not improve the correlation coefficients. The Non-Graduate II group results seem rather promising, but the results of the Non-Graduate I group are not impressive to the author. Therefore, until further studies are completed, the Numerical Ability subtest combined with the Abstract Reasoning subtest should not be used to predict Geometry grades.

A different variable combination was used with the Graduate groups. The Numerical Ability subtest and the Space Relations subtest were used to obtain a multiple correlation. The results are given in Table IX.

TABLE VIII

MULTIPLE CORRELATIONS AND SHRUNKEN r OBTAINED BY USING THE NUMERICAL ABILITY SUBTEST AND THE ABSTRACT REASONING SUBTEST AS PREDICTORS OF FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Graduate I	Non-Graduate II
Multiple Correlation	.4710	.6532
Shrunken r	.4552	.6394
Difference	.0158	.0138

TABLE IX

THE MULTIPLE CORRELATIONS AND SHRUNKEN r's OBTAINED BY USING BOTH THE NUMERICAL ABILITY SUBTEST AND THE SPACE RELATIONS SUBTEST AS PREDICTORS OF FIRST SEMESTER FUSED GEOMETRY GRADES

	Graduate I	Graduate II
Multiple Correlation	.6052	.4458
Shrunken r	.5895	.4126
Difference	.0157	.0332

Again there was instability among the two groups. The Graduate II multiple correlation is much lower than the Graduate I group. It would not be wise to state that the Numerical Ability subtest and the Space Relations subtest are significant predictors of Fused Geometry grades.

In order to find an equation which could be used to predict grades, a t-test was performed on each regression weight of each variable of the multiple correlation. Level of rejection was .05. All of the tests performed with the three subtests are reported in Table X.

In Division A, all four groups were tested. With the exception of Graduate II group, the Abstract Relations variable was significant; while in the Graduate II group only the constant was a significant part of the equation. The smallness of the sample could account for this variance. Only once did the Space Relations variable prove significant - in the Non-Graduate I group. This group had the largest number of subjects. Since only two groups, Non-Graduate II and Graduate I, had exactly the same significant variables, an equation to predict geometry grades from the Abstract Reasoning and the Space Relations subtests would not be of much value.

Only the Non-Graduate group was used in Division B. With the Non-Graduate I group, only the Abstract Reasoning variable was significant, while both the Abstract Reasoning and Space Relations variables were significant in the Non-Graduate II

TABLE X

t-TEST RESULTS WITH THE THREE SUBTESTS OF THE DIFFERENTIAL APTITUDE TEST

	DIVISION A			DIVISION B			DIVISION C		
	Using Abstract Reasoning and Space Relations			Using Numerical Ability and Abstract Reasoning			Using Numerical Ability and Space Relations		
	C*	V_{ar}*	V_{sr}*	C*	V_{na}*	V_{ar}*	C*	V_{na}*	V_{sr}*
Non-Graduate I	1.17	2.55**	2.45**	.93	1.39	2.95**			
Non-Graduate II	.99	4.82**	1.15	.82	3.40**	2.97**			
Graduate I	1.99	3.68**	1.85				3.34**	3.54**	1.51
Graduate II	3.36**	1.61	1.10				3.83**	2.31**	.57

*Since the names were abbreviated, the names of the symbols are:

C is the constant
V_{ar} is the Abstract Reasoning Variable
V_{sr} is the Space Relations Variable
V_{na} is the Numerical Ability Variable

**The double asterisk stands for those variable and/or constants which proved significant.

group. Since the two multiple correlations did not yield the same significant equation coefficients, these two subtests could not be used effectively to predict grades in Fused Geometry.

The final division used only the Graduate groups. Here both groups had the same significant factors - the constant and the Numerical Ability variable. But the multiple correlation coefficients were too low to give a strong positive relationship.

Since there was variation among the groups with significant correlations, and since some predictors were not significant over all the groups, the author believes that the Numerical Ability subtest, the Abstract Reasoning subtest, and the Space Relations subtest of the Differential Aptitude Test would not be good predictors of first semester Fused Geometry grades.

IV. REMAINING VARIABLE COMBINATIONS

The fourth null hypothesis was that Algebra I final grades, Algebra II final grades, and the aforementioned subtests taken collectively do not add significantly to the prediction of first semester Fused Geometry marks. This hypothesis was tested with all groups except the Non-Graduate I group. Only the Algebra II variable was omitted from the Non-Graduate I group. The results are given in Table XI.

All of the multiple correlations were above .7000 and

TABLE XI

COMPARISON OF THE MULTIPLE CORRELATIONS, THE SHRUNKEN r's BY USING ALL FIVE VARIABLES TO PREDICT FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Grad II	Grad I	Grad II	Non-Grad I
Multiple Correlations	.7885	.7619	.7450	.7526
Shrunken r	.7673	.7357	.7017	.7377
Difference	.0212	.0262	.0433	.0149

are the best predictors so far. They surpass the correlations previously reported in Chapter II of this study. Even though the Non-Graduate I group deleted the Algebra II variable, this group did not have the lowest correlation. As was the case before, the smallest group, Graduate II, had the lowest multiple correlation. There is a wider difference between the multiple correlations and shrunken r's than with the three subtests, but not enough difference to state that there was a large amount of bias. Using the multiple correlations in Table XI, the five variables would be good predictors of first semester Fused Geometry grades.

A t-test was computed for each variable. Within the four groups, no two groups have the same consistent significant variable predictors.

The results are stated in Table XII.

The Non-Graduate I group had three significant predictors; the constant, the Algebra I variable and the Abstract Reasoning variable. This group had more significant predictors than the other three groups. The omission of the Algebra II variable probably caused this group to have more significant predictors.

To determine whether the loss of one predictor would drastically reduce the multiple correlation coefficient, the following tests were run. In the Non-Graduate I group, the Abstract Reasoning variable was deleted; this left only the

TABLE XII

RESULTS OF A t-TEST PERFORMED ON EACH VARIABLE

	C*	V_I*	V_{II}*	V_{na}*	V_{ar}*	V_{sr}*	df*
Non-Graduate I	2.09**	6.08**		.35	2.30**	1.99	71
Non-Graduate II	1.94	.50	3.33**	2.88**	1.81	.29	49
Graduate I	.20	1.48	2.36**	1.17	2.10**	.61	44
Graduate II	1.69	3.25**	.56	.19	.26	1.44	30

*Due to lack of space, the names of the variables were abbreviated. The names are:

C is the constant
V_I is the Algebra I variable
V_{II} is the Algebra II variable
V_{na} is the Numerical Ability variable
V_{ar} is the Abstract Reasoning variable
V_{sr} is the Space Relations variable
df are the degrees of freedom

**The double asterisk indicates the significant variables.

Algebra I variable, the Numerical Ability variable, and the Space Relations variable. The obtained multiple correlation was .7307 with a shrunken r of .7145. Again, the difference is minimal. The t-test yielded only one significant variable - Algebra I variable. Even though the multiple correlations coefficient was above .7000, it was not as good a correlation as the one in Table XI. Not enough comparable data using only these three variables are available to say with certainty that the three aforementioned variables can accurately predict geometry grades.

One final test was conducted with the Non-Graduate I group. Algebra I final grades and the Numerical Ability subtest were used to predict Fused Geometry grades. A multiple correlation of .6861 was obtained and .6766 for the shrunken r. Again the Algebra I variable was significant in a t-test. This multiple correlation was not as good a predictor as the two previously mentioned studies.

With the Non-Graduate II group, two more tests were run. One test used all of the variables except the Abstract Reasoning variable. The multiple correlation obtained, .7723, was slightly lower than the correlation obtained when using all of the variables. Again the shrunken r, .7541, was close to the multiple correlation. With the t-test, two variables were significant - the Algebra II variable and the Space Relations variable. By eliminating one variable, the multiple correlation was slightly lower than with all the variables. Since no comparable study was completed, it cannot be accurately stated that this test would be a good predictor of Fused Geometry grades.

The final test of the Non-Graduate II group was performed using Algebra I and Algebra II final grades and the Numerical Ability subtest. To help validate the results, this test was also performed on the Graduate groups. Table XIII gives the correlations and shrunken r's.

Each multiple correlation is above .7000 and is similar. This is especially true of the Graduate groups. The t-test for significant variables yielded promising results. For both the Non-Graduate II group and the Graduate I group the same variables were significant - the Algebra II variable and the Numerical Ability variable. This similarity of predictors did not occur in any other group combinations. Again, the Graduate II group had different results; only the Algebra I variable was sufficient. This combination of variables seemed to have the most promising outlook since both the coefficients and t-test results were similar.

In both the Graduate groups, multiple correlations were performed using all of the variables except Space Relations. The multiple correlations were .7595 for the Graduate I group and .7240 for the Graduate II group. Little bias was indicated since the difference between the correlation and

TABLE XIII

MULTIPLE CORRELATIONS AND SHRUNKEN r's OBTAINED BY USING ALGEBRA I AND ALGEBRA II FINAL GRADES AND THE NUMERICAL ABILITY SUBTEST AS PREDICTORS OF FIRST SEMESTER FUSED GEOMETRY GRADES

	Non-Graduate II	Graduate I	Graduate II
Multiple Correlation	.7629	.7282	.7240
Shrunken r	.7486	.7092	.6992
Difference	.0143	.0190	.0248

the shrunken r was less than .0360 in both cases. Results of the t-test varied with each group. The Graduate I group had the Algebra II variable and the Abstract Reasoning variable as significant. One variable - Algebra I and the constant were significant in the Graduate II group. Deleting one variable does not greatly detract from the prediction value.

Since the multiple correlations in section IV were the highest obtained during the study and since the correlations were above the level of significance ($p > .01$), the fourth null hypothesis is rejected. Algebra I and Algebra II final grades, and the three subtests taken collectively do add significantly to the prediction of first semester Fused Geometry marks.

V. THE INTERCORRELATIONS

Intercorrelations were computed in each group. The results of the computations are given in Table XIV. There were few significant similarities or differences. Two negative intercorrelations were obtained in the Non-Graduate II group between the Algebra I variable and the Space Relations variable, and between the Algebra II variable and the same subtest. However, this negative relationship did not occur with the other three groups.

One relationship was important. The intercorrelation between Algebra I and Algebra II final grades was above .600 each time it was correlated. This helps to strengthen some counselors' and teachers' belief that Algebra I and Algebra II

TABLE XIV
INTERCORRELATIONS

Group		Algebra I	Algebra II	NA*	AR*	SR*
Non-Graduate I	Algebra I	1.000		.352	.238	.260
	Algebra II					
	NA*			1.000	.529	.352
	AR*				1.000	.517
	SR*					1.000
Non-Graduate II	Algebra I	1.000	.735	.416	.360	.083
	Algebra II		1.000	.314	.344	.025
	NA*			1.000	.476	.022
	AR*				1.000	.421
	SR*					1.000
Graduate I	Algebra I	1.000	.604	.271	.240	.187
	Algebra II		1.000	.419	.324	.404
	NA*			1.000	.676	.502
	AR*				1.000	.436
	SR*					1.000
Graduate II	Algebra I	1.000	.736	.518	.410	.647
	Algebra II		1.000	.544	.437	.307
	NA*			1.000	.384	.417
	AR*				1.000	.281
	SR*					1.000

*Due to lack of space, the group names were abbreviated. The proper (formal) names are:

NA stands for Numerical Ability
AR stands for Abstract Reasoning
SR stands for Space Relations

are correlated and should follow each other in sequence. The remaining intercorrelations were either too varied or too low to mention in detail.

CHAPTER V

SUMMARY AND CONCLUSIONS

Since a large amount of data was presented in Chapter IV, it would be wise to review the premise of the thesis and summarize the results.

I. SUMMARY

This thesis was formulated and carried out in a high school in southside Virginia. Predicting first semester Fused Geometry grades was the purpose of the thesis. The underlying premise was that counselors and teachers should not use Algebra grades as indicators of future grades in Fused Geometry courses. Grades could have been used as means of punishment. The course content in the two subjects is different; perception is more important in the geometry course than in the Algebra courses.

The subjects were divided into four groups. Those students who were graduated in 1969 comprised the Graduate I group. Graduate II group contained those persons who were graduated in 1968. Geometry students from two teachers' classes made up the Non-Graduate groups. Students who had completed the Algebra I course were placed in the Non-Graduate I group. Students who had completed both Algebra I and Algebra II composed the Non-Graduate II group.

Five variables were tested for predictability. They were: Algebra I final grades, Algebra II final grades, and the

Numerical Ability, Abstract Reasoning, and Space Relations subtests of the Differential Aptitude Test. Simple correlation coefficients were obtained between each variable and first semester Fused Geometry grades. Then multiple correlations were computed using various combinations of the variables.

Four null hypotheses were tested:

1. Algebra I final grades are not significant predictors of first semester Fused Geometry grades.
2. Algebra II final grades are not better predictors of first semester Fused Geometry grades than are Algebra I final grades
3. Differential Aptitude Test subtests on Numerical Ability, Abstract Reasoning, and Space Relations are not significant predictors of first semester Fused Geometry grades.
4. Algebra I final grades, Algebra II final grades, and the aforementioned subtests taken collectively do not add significantly to the prediction of first semester Fused Geometry grades.

The first null hypothesis was rejected. However, the range of correlation coefficients was too diffused to state that Algebra I final grades are good predictors of first semester Fused Geometry grades. Algebra II final grades were better predictors and the second null hypothesis was rejected. While the correlation coefficients were not above .7000, each was greater than .6000 and very close together - a difference of less than .0375. Several simple and multiple correlations were performed to test the third null hypothesis. Because of low correlation coefficients and instability of the same predictive variables among the groups, the third null hypothesis was not rejected. Using all five variables in a multiple correlation produced the best coefficients. Therefore the fourth null hypothesis was rejected. Each correlation coefficient was above .7000; however, the t-test did not yield the same significant variable predictors in each group. Eliminating one or two variables produced multiple correlations above .6500 but these correlations were not as high as the coefficients using all five variables.

When Algebra I final grades, Algebra II final grades, and the Numerical Ability raw scores were used as predictors in a multiple correlations, the results proved to be of interest. The coefficients were good - above .6000, and three out of the four groups had the same significant predictors - Algebra II final grades and Numerical Ability raw scores. Unfortunately, time did not allow a follow-up of these two variables as predictors.

Intercorrelations showed that only Algebra I and Algebra II final grades had significant relationships. Negative correlations were obtained in the Non-Graduate II group between Algebra I final grades and the Space Relations raw scores and between Algebra II final grades and the same subtest. None of the remaining groups showed negative correlations.

II. CONCLUSION

The study yielded three rejections of the null hypotheses. Algebra II final grades were better predictors of first semester Fused Geometry grades than were Algebra I final grades. However, the best correlations were obtained when all five variables were used in a multiple correlation, even though each group did not have the same significant predictors.

Generalizations cannot be made with this study, for this thesis is only a beginning. It was intended only for one school; the subject size in each group was small.

As far as is known, a comparative work of this type has not been recorded in the last ten years. More research and testing is needed before one can definitely state that the variables used in this thesis are predictors of Fused Geometry grades.

If further research is undertaken, the author would recommend consideration of the following suggestions:

1. More schools should be incorporated into the study so that generalizations may be made. Localization gives only one viewpoint.
2. There should be a larger number of subjects in the sample. Small samples tend to distort the data and results.
3. Random selection of the subjects should be carried out and the results with random selection should be compared with this study.
4. A repetition of this study using first semester Algebra grades plus the subtests as predictors of first semester Fused Geometry grades should be planned and formalized. Also the same study could compare second semester Algebra grades and the subtests as predictors of second semester Fused Geometry grades. And finally a study should be done using final Algebra grades and the subtests as predictors of the final Fused Geometry grades. Time did not allow these comparisons.
5. A continued study should be undertaken at the high

semester Fused Geometry grades than were Algebra I final grades. However, the best correlations were obtained when all five variables were used in a multiple correlation, even though each group did not have the same significant predictors.

Generalizations cannot be made with this study, for this thesis is only a beginning. It was intended only for one school; the subject size in each group was small.

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1. More schools should be incorporated into the study so that generalizations may be made. Localization gives only one viewpoint.
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3. Random selection of the subjects should be carried out and the results with random selection should be compared with this study.
4. A repetition of this study using first semester Algebra grades plus the subtests as predictors of first semester Fused Geometry grades should be planned and formalized. Also the same study could compare second semester Algebra grades and the subtests as predictors of second semester Fused Geometry grades. And finally a study should be done using final Algebra grades and the subtests as predictors of the final Fused Geometry grades. Time did not allow these comparisons.
5. A continued study should be undertaken at the high

school researched in this thesis to validate the results and also to develop local norms.

The author was disappointed that this thesis did not yield a definite predictor of Fused Geometry grades. However, much data was collected and several predictors were promising. Doors to new research were opened, and new questions arose. It is the author's hope that this thesis will provide a basis for new research. Questioning and research lead to learning.

APPENDICES

Appendix A

Explanation of the Code

Upon request of the principal of the high school involved in this study, student names could not be used. Therefore each subject was coded. The code consisted of three divisions. A sample is given to identify the divisions.

Sample	3	-	237	-	M
	Part 1		Part 2		Part 3

Part 1 tells whether the subject is a student in high school or an alumnus. The following symbols were used:

a. in the Non-Graduate groups
   1 - means that the subject was a senior in high school
   2 - means that the subject was a junior in high school
   3 - means that the subject was a sophomore in high school.

b. in the Graduate groups
   G1-means that the subject was a member of the 1969 graduating class
   G2-means that the subject was a member of the 1968 graduating class

Part 2 gives the number of each subject. The missing numbers were assigned to those subjects which were dropped because of incomplete data or who had taken the same subject more than once.

Part 3 gives the sex of the subject

M - stands for male
F - stands for female

The subject's grades in each course were converted to a five point scale. On the five point scale and A was the highest value or 5, and an F was a 1. The scale was:

A was converted to 5
B was converted to 4
C was converted to 3
D was converted to 2
F was converted to 1

The original grades were in letter form with the following numerical values:

A 95-100
B 88-94
C 81-87
D 75-80
F 74 or below

The subtest results are given as raw scores.

Appendix B

Data for the Non-Graduate I Group

Code	Fused Geometry First Semester Grade	Algebra I final grade	Differential Aptitude Subtests Numerical Ability	Differential Aptitude Subtests Abstract Reasoning	Differential Aptitude Subtests Space Relations
1-010-M	4	3	17	28	19
1-088-F	4	3	19	31	29
1-121-M	1	2	11	07	14
1-172-F	3	2	23	34	41
2-003-M	2	3	13	27	28
2-064-F	2	3	13	16	16
2-095-F	4	4	16	35	42
2-110-F	2	2	16	32	13
2-123-M	3	3	12	04	26
2-167-M	3	3	23	36	49
2-212-M	1	2	09	06	14
3-004-F	1	3	21	35	19
3-006-M	2	2	06	32	13
3-014-M	4	4	24	33	39
3-020-M	5	5	20	38	43
3-021-M	5	5	24	40	35
3-023-F	3	5	16	35	44
3-025-F	2	4	21	39	28
3-026-F	2	2	15	18	17
3-031-F	4	4	15	27	26
3-032-F	3	3	12	17	15
3-036-F	4	3	21	42	33
3-039-M	3	2	26	38	24
3-045-F	5	5	16	36	22
3-046-M	1	2	16	36	29
3-050-M	1	2	20	37	25
3-052-F	3	2	11	28	32
3-055-M	2	3	20	27	17
3-056-M	5	3	17	36	36
3-058-F	5	5	20	29	28
3-061-M	1	2	21	21	25
3-062-F	5	5	17	17	21
3-066-F	1	3	10	10	15
3-072-M	2	3	21	38	15
3-073-M	3	4	28	32	18
3-074-F	1	2	20	26	19
3-076-M	2	2	11	27	16
3-077-M	3	2	17	35	27
3-078-F	2	2	20	39	41

Appendix B

Data for the Non-Graduate I Group

Code	Fused Geometry First Semester Grade	Algebra I final grade	Differential Aptitude Subtests		
			Numerical Ability	Abstract Reasoning	Space Relations
3-091-F	3	4	14	31	13
3-099-F	2	3	18	38	24
3-102-F	2	3	13	22	15
3-103-M	1	2	13	34	33
3-105-F	3	3	17	20	09
3-106-F	1	4	14	05	24
3-112-M	2	2	20	33	26
3-113-M	4	4	15	28	16
3-114-M	3	3	14	35	20
3-126-M	2	3	14	27	15
3-134-M	2	1	12	21	15
3-135-F	4	3	18	33	27
3-138-M	1	2	26	29	16
3-140-F	2	3	16	32	22
3-147-M	1	2	17	26	14
3-151-M	1	2	18	15	15
3-152-M	1	3	18	07	18
3-155-M	3	4	18	32	24
3-161-F	5	5	24	46	31
3-165-M	2	2	18	29	33
3-180-M	2	2	19	30	18
3-183-M	2	2	18	19	30
3-184-M	4	5	27	35	19
3-185-M	5	3	27	43	29
3-189-M	3	3	15	24	22
3-193-F	2	4	21	20	13
3-195-M	2	3	21	37	24
3-198-M	4	4	18	39	30
3-199-M	2	2	11	30	21
3-200-M	1	2	08	14	16
3-205-F	2	2	12	32	27
3-207-M	1	2	11	34	32
3-208-M	4	3	17	31	39
3-210-F	2	4	14	22	17
3-211-M	2	2	13	13	17
3-213-F	4	3	14	31	25
3-218-F	5	5	28	40	44

Appendix C

Data for the Non-Graduate II Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests		
				NA*	AR*	SR*
1-065-M	2	2	2	17	16	19
1-128-M	3	3	2	10	24	17
1-132-M	1	2	1	14	18	20
1-141-M	2	2	2	15	24	40
1-194-M	4	3	2	28	33	33
1-204-F	5	4	3	24	32	31
1-209-M	2	2	1	18	29	21
2-001-F	5	2	3	23	35	25
2-005-F	4	4	4	25	32	00
2-007-F	2	4	4	19	35	21
2-008-F	2	4	3	15	28	29
2-024-F	4	3	2	20	31	23
2-035-F	5	4	4	20	32	21
2-057-F	5	4	5	22	36	23
2-068-F	2	3	3	13	20	19
2-069-M	4	3	4	19	36	38
2-070-F	5	4	2	24	42	27
2-080-F	4	4	4	21	41	22
2-082-F	4	4	4	24	38	38
2-084-F	4	2	3	12	37	17
2-085-F	4	4	4	16	34	25
2-094-F	5	5	4	20	16	13
2-097-F	4	4	4	20	35	27
2-100-M	1	4	3	18	32	13
2-101-F	5	4	4	26	40	24
2-107-M	3	3	3	21	39	42
2-108-M	4	3	3	17	43	50
2-109-F	5	4	4	25	37	40
2-120-F	5	5	5	25	38	33
2-129-M	4	3	4	13	26	24
2-148-M	2	3	2	18	24	19
2-158-M	3	2	2	18	37	40
2-159-F	5	5	5	17	37	21
2-163-F	5	5	5	21	33	28
2-166-F	4	4	5	18	31	23
2-174-F	2	2	3	22	31	21
2-175-M	2	2	3	12	11	25
2-176-M	4	3	4	21	38	22

Appendix C

Data for the Non-Graduate II Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests NA*	AR*	SR*
2-186-M	4	4	4	21	36	19
2-187-F	4	3	4	17	30	24
2-190-F	4	3	3	21	27	13
2-201-F	3	3	2	13	31	24
2-202-M	3	3	2	13	31	22
3-002-F	5	4	4	31	36	22
3-015-M	2	3	2	16	34	36
3-027-M	3	4	3	21	31	24
3-030-M	2	3	2	15	38	38
3-071-M	5	3	2	31	45	34
3-083-M	2	2	1	16	31	17
3-087-F	3	3	3	19	31	23
3-150-F	3	4	3	22	30	15
3-164-M	1	2	1	15	12	17
3-192-M	3	3	3	27	25	14
3-196-M	1	2	1	14	26	27
3-216-M	4	4	3	28	33	13

*Due to lack of space, the group names were abbreviated. The proper (formal) names are:

NA stands for Numerical Ability
AR stands for Abstract Reasoning
SR stands for Space Relations

Appendix D

Data for the Graduate I Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests		
				NA*	AR*	SR*
G1-001-M	4	2	2	23	36	20
G1-002-M	5	5	5	28	44	47
G1-003-M	5	5	5	25	45	31
G1-004-M	3	2	2	26	38	29
G1-005-M	3	3	3	13	33	28
G1-006-F	4	5	3	16	34	24
G1-007-M	4	4	4	29	43	43
G1-008-M	5	4	4	22	36	47
G1-009-M	2	3	3	12	33	21
G1-010-F	4	3	4	18	34	33
G1-011-F	4	4	4	19	41	42
G1-012-F	3	4	3	13	30	16
G1-013-M	4	2	3	17	31	27
G1-014-M	5	5	4	26	37	33
G1-015-M	5	5	5	31	45	47
G1-016-F	3	5	4	19	28	34
G1-017-M	5	4	5	23	33	31
G1-018-M	3	5	2	12	32	18
G1-019-M	3	3	3	17	33	25
G1-020-F	5	5	4	24	38	23
G1-021-F	4	3	3	18	25	29
G1-022-M	4	3	3	19	27	25
G1-023-M	3	3	3	25	36	43
G1-024-M	2	3	3	12	04	35
G1-025-F	5	5	5	22	33	34
G1-026-M	4	3	4	17	36	50
G1-027-M	2	3	4	12	18	17
G1-028-F	4	3	3	19	32	37
G1-029-M	3	2	3	14	30	14
G1-030-M	3	3	2	12	23	20
G1-031-F	4	4	3	17	24	19
G1-032-F	5	5	4	22	39	28
G1-033-F	5	4	4	18	41	44
G1-034-M	3	2	4	21	35	20
G1-035-M	4	4	4	26	36	32
G1-036-F	3	4	3	14	20	23
G1-037-F	3	4	3	13	26	23
G1-038-F	5	5	5	16	35	27

Appendix D

Data for the Graduate 1 Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests		
				NA*	AR*	SR*
G1-040-F	5	5	5	29	39	43
G1-043-M	4	3	4	17	31	36
G1-044-M	5	3	3	21	43	50
G1-045-M	5	4	4	23	38	35
G1-046-F	4	3	3	18	34	23
G1-047-F	5	5	5	24	35	21
G1-048-F	3	3	3	23	40	30
G1-049-F	4	3	3	16	38	17
G1-051-M	3	3	3	23	37	32
G1-053-M	3	4	4	09	30	34
G1-054-F	2	4	3	18	31	19
G1-055-M	3	3	2	23	39	36

*Due to lack of space, the group names were abbreviated. The proper (formal) names are:

NA stands for Numerical Ability
AR stands for Abstract Reasoning
SR stands for Space Relations

Appendix E

Data for the Graduate II Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests		
				NA*	AR*	SR*
G2-001-F	3	2	3	19	39	37
G2-002-F	5	5	5	25	40	38
G2-003-M	4	3	3	26	37	30
G2-004-F	4	3	4	19	36	42
G2-005-F	4	3	4	22	32	48
G2-006-M	4	4	3	07	19	01
G2-007-F	3	3	2	26	42	46
G2-008-M	4	3	3	21	37	23
G2-009-M	2	2	2	19	11	12
G2-011-F	4	4	5	25	44	30
G2-013-M	3	3	3	15	34	28
G2-014-M	3	3	3	12	33	38
G2-015-F	3	3	4	24	22	34
G2-016-M	3	3	3	27	37	27
G2-017-M	2	2	2	12	34	18
G2-018-M	4	3	2	16	34	18
G2-019-M	3	2	3	18	33	35
G2-020-M	4	4	5	16	34	27
G2-021-M	4	3	3	27	07	41
G2-022-M	4	4	4	24	35	45
G2-023-F	2	4	5	30	44	24
G2-024-F	4	4	4	22	31	32
G2-025-F	5	5	5	34	44	39
G2-026-M	5	5	5	28	42	32
G2-027-F	4	2	4	17	37	35
G2-029-M	2	2	2	10	26	43
G2-030-F	5	5	4	29	43	30
G2-031-M	3	2	2	14	29	21
G2-032-M	4	3	3	21	40	45

Appendix E

Data for the Graduate II Group

Code	Fused Geometry First Semester Grade	Algebra I Final Grade	Algebra II Final Grade	Differential Aptitude Subtests		
				NA*	AR*	SR*
G2-033-F	5	4	5	25	38	38
G2-034-M	4	3	3	20	21	29
G2-035-F	3	3	4	23	28	38
G2-036-F	5	5	5	26	40	40
G2-037-F	4	4	4	18	32	28
G2-038-M	3	3	2	21	32	25
G2-039-F	3	4	3	14	33	19

*Due to lack of space, the group names were abbreviated. The proper (formal) names are:

NA stands for Numerical Ability
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