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PREDICTING SENIOR HIGH SCHOOL SUCCESS THROUGH STUDENT EVALUATION IN JUNIOR HIGH SCHOOL

by

© DAN THACHUK

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled PREDICTING SENIOR HIGH SCHOOL SUCCESS THROUGH STUDENT EVALUATION IN JUNIOR HIGH SCHOOL

submitted by Dan Thachuk

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DEDICATION

This study is dedicated to those individuals in the the County of Red Deer #23 who provide either direct or indirect service to students through counselling. It is hoped that the information obtained in this study will be helpful to them as they assist students in making decisions regarding academic choices at the high school level.

ABSTRACT

The purpose of the study was to determine the most powerful predictors of senior high school achievement in grade 10 by analyzing student test results used in grade 9. Predictor variables used in the study were junior high school results from (a) teacher assigned marks in grade 9, (b) the Differential Aptitude Tests, (c) the Canadian Tests of Basic Skills, (d) Alberta Provincial Achievement Tests in Social Studies (1983) and Mathematics (1984). The grade 10 courses used as criterion variables in the study were those from which students were required to choose as part of a high school program.

In this study, correlations were established between subtests of both the Canadian Tests of Basic Skills and the Differential Aptitude Tests. A factor analysis was also completed by using subtests from both standardized tests. Relationships were further determined between: (a) the C.T.B.S., D.A.T., and teacher marks assigned in grade 9 'core' subjects, (b) the C.T.B.S., D.A.T. and teacher marks assigned in grade 10 subjects, (c) grade 9 teacher marks in 'core' academic subjects and grades assigned to students in grade 10 subjects. This was done through correlations, expectancy tables and a step-wise multiple regression analysis.

Results indicated that achievement at the grade 10 level could in part be predicted through the use of specific subtest scores from both the Differential Aptitude Tests and Canadian Tests of Basic Skills. However, results further indicated that teacher-assigned marks in grade 9 were the most powerful predictors of grade 10 achievement. Predictive power was sometimes increased when predictors other than teacher marks were used as independent variables together with teacher scores.

A major purpose of this study was to use step-wise regressions to establish regression equations and expectancy tables which could be used by guidance counsellors when working with students. This was completed as originally intended.

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CHAPTER 1

INTRODUCTION

Classroom teachers and guidance counsellors in a junior high school use a variety of tests, measurements and other evaluative information when determining the degree to which a student has progressed in a specific subject area and in predicting that student's performance at a subsequent grade level. Qualitative information, including teacher judgements regarding student participation, interest in the presented material, and the overall attitude of the child is used in conjunction with quantitative information such as the student's performance on teacher-made examinations and on standardized tests. Both subjective and objective data form the basis for decision-making which involves teachers, guidance personnel, parents, and the student as active participant.

The focus of this study is on the quantitative information which is used in school course selection. The problem presented pertains to the confidence with which high school performance can be predicted through the examination of data such as teacher marks and scores from aptitude and achievement tests at the junior high school level. Qualitative information is certainly recognized as an important element that school professionals use in predicting a student's success at high school. However, quantitative information is useful because of the objectivity of its nature. If a school professional can determine whether teacher-assigned final marks and student performance on completed standardized tests have any value in determining how well one is likely to achieve at a senior high school level, then that same information can be confidently used as students at the grade 9 level are counselled towards making decisions.

Students in the ninth grade in Alberta schools have important decisions to make.

Decisions made relevant to high school course selection determine one's eligibility for entry into post-secondary institutions, and will further establish which of two types of Alberta High School Diplomas one can obtain. *(See Appendix A).* More generally, the choices will determine whether learning experiences in high school are challenging and gratifying, or frustrating.

For these students, the necessity to make decisions relevant to course selection is a new experience. During eight previous years of school involvement, few choices regarding course selection were necessary. Perhaps there had been some selection of optional courses at the junior high level. However, previous decisions of importance which considered promotion, modification of school programs or acceleration were made by professionals in consultation with the child's parents, but not in consultation with the individual who would be most affected by the decisions. For the first time in the student's school life the responsibility for decision making shifts at the grade 9 level.

The decisions in question are usually easy for students who have experienced many previous years of school as a challenge and who have had the ability and confidence to succeed with strong academic marks. A high school program involving selection of the most challenging courses will likely be made. Other students, who may have experienced much frustration through nine years of grade school, and whose academic grades have reflected this, may also have choices to make which are obvious to them. These individuals may select course materials which will allow them to satisfy the minimum requirements for an Alberta High School Diploma, or they may decide that further education is best obtained outside the school system.

For a third group of students the choice is less obvious. Results which they obtain in norm-referenced standardized tests may not be consistent with teacher-assigned marks. Non-constructive attitudes towards a teacher or towards school in general may be factors which have inhibited maximum effort and performance, typical of a child who may be an underachiever. There could exist an inconsistency between school marks obtained in grade

9 and those received in a previous grade level. Factors such as these make the choices regarding high school courses more complicated.

The school guidance counsellor becomes a facilitator in helping the student maximize levels of ability and achievement. Usually through either group or individual counselling sessions, the counsellor supplies the student with information which helps crystallize opinions about performance and ability. It is important that information referred to is accurate. Goldman (1961) identifies the counsellor's role in this regard:

> The purpose of counselling however, is usually to give help in making decisions and plans for the future and in choosing among alternative courses of actions in the world of reality. In this category tests contribute to the planning and choosing process by giving the client additional information (including clarification and confirmation of previous information) about himself in relation to the facts about an occupation or an educational program (p. 25).

In the context of this study, the responsibility to which Goldman refers becomes one of assisting students in choosing alternatives based on previous knowledge regarding test results. Gronlund (1985) further suggests that "the more comprehensive the picture of the pupil's strengths and weaknesses in various areas is, the more effective the guidance and counselling will be" (p. 9).

The school personnel who are involved in providing school guidance have access to information which is presumed to be indicative of a student's strengths and weaknesses. Knowing the predictive value of that data will help determine whether that information is as useful as it may appear at the outset.

This study concentrates on measures which are used in the County of Red Deer, an Alberta school system incorporating approximately 5,000 students in grades 1 to 12. Specifically, the focus is on the test results in this school system at the junior high school level which are intended to measure attainment of basic skills and achievement in major subject areas, as well as to gauge a student's overall ability. The question of whether results of student achievement in (a) the Canadian Tests of Basic Skills ("C.T.B.S.") administered in grade 8, (b) the Differential Aptitude Tests ("D.A.T."), (c) teacher-assigned marks and (d) Province of Alberta achievement tests (all which are administered in grade 9) can be used to predict student progress in 10 academic subjects in the tenth grade is the major emphasis in the study. As grade 9 students make choices relevant to high school course selection, the 10 courses for which prediction would be most useful in terms of program planning are as follows:

Biology 10	Mathematics 10	English 10
Chemistry 10	Mathematics 13	English 13
Physics 10	Mathematics 15	Social Studies 10
Science 11		

Choices made which involve the selection or exclusion of any of the above courses will basically determine the academic route which a student will pursue and will also determine the difficulty or challenge which will be experienced during high school. For purposes of this study, five questions are examined:

(1) What relationship is evident among scales on the C.T.B.S., D.A.T., grade 9 year-end teachers' marks and Provincial test results?

(2) What relationship exists between teacher marks in grade 10 and (a) the C.T.B.S., (b) the D.A.T., (c) Provincial achievement tests?

(3) What relationship exists between the D.A.T. and the C.T.B.S.?

(4) What relationship exists between teacher marks in grade 9 and those in grade 10?

(5) Which predictor variable at the grade 9 level is the most powerful determiner of performance in core grade 10 subjects?

CHAPTER 2

REVIEW OF THE LITERATURE

The scope of this review is focused on variables which can be used by school guidance counsellors to predict student performance at the high school level in the Province of Alberta. The review includes the following:

(A) An overview of prediction and standardized testing.

(B) An investigation of the C.T.B.S. and D.A.T.

(C) A review of teacher-assigned marks as predictors of student performance.

(D) A review of Alberta Department of Education Achievement Tests.

(E) An overview of the above as they pertain to use in Red Deer County #23.

(A) An Overview of Prediction and Standardized Testing

Predicting human performance is a reality in our society. Assumptions are made regarding a wide age range of persons by decision-makers such as parents, teachers at kindergarten and grade school, personnel at post-secondary institutions, and employers in the work place. These assumptions are accompanied by subsequent decisions which are based on previously acquired information.

Much of this information is subjective. A parent's decision to disallow a child entry into kindergarten because of a perceived maturity level is an example, as is a job interviewer's decision to hire an applicant because of a perception about the successful candidate. Both instances are based on judgements of the decision-maker and are sometimes influenced by opinions from others.

The use of objective information is also a part of the prediction reality. A kindergarten teacher may share with parents the results of a standardized readiness test which is intended to measure preparedness for grade school. A university may require that an admission test be written by graduate school applicants. A classroom teacher may use a variety of objective measures in order to assess student performance, including standardized tests which are intended to determine aptitude or achievement level in specific areas.

Objective information is often the type preferred. Gronlund (1985) identifies an objective measure as "one on which equally competent scorers will obtain the same scores" (p. 18). Objective measures are less vulnerable to controversy or dispute in that the scorer cannot alter the results. This type of information includes all standardized tests used in classrooms.

Hills (1981) identifies a standardized test as one "which is always given under the same conditions so that scores can be compared across groups" (p. 136). The test is an objective measure which is perceived by many educators to have predictive value. An aptitude test which places a student at the eighty-fifth percentile in reading when results are compared to those obtained by the same age group suggests to a teacher that the individual is functioning at a certain performance level. It also suggests that certain expectations can be made of the student in future course work.

Standardized tests have become an important component of a total school evaluation program. However, there remains a danger in the misinterpretation of these measures. Most memorable is Rosenthal's study cited in *Pygmalion in the Classroom*. Rosenthal and Jacobsen (1968) suggested, "Even when the administration of one of these tests is more or less appropriate and valid, the results may influence the teacher's prophecy about the child's subsequent intellectual performance" (p. 55).

As is recognized among most professionals involved in education, this research indicated that students perform as is expected of them by teachers. It is further plausible that teacher expectations are often established in part by the use of standardized tests which are available to school systems.

Critics of standardized test use have argued for the abolition of these measures in school systems, citing examples of test misinterpretation. Numerous cases have been disclosed involving the placement of a student into a special education class based on results of an ability test which discriminated against poor readers. Other cases have involved the use of tests which have been culturally biased against the individual to be examined. Thus many measures used in specific situations were not valid for the intent of the examiner.

The above position is not one of the majority of educators. Buros (1978) identifies over 1,100 tests which are available for varying purposes related to measurement. Popham (1981) offers a fascinating history of educational testing through many centuries, suggesting that standardized testing has been used for educational accountability, program evaluation and performance prediction. Cronbach (1984) identifies a major strength of standardized tests by stating that "tests are almost unique in being reproducible and explicit. Since the validity of interpretations and decision rules can be checked out, information from tests is more likely to be steadily improved than is appraisal of other kinds" (p. 3).

Gronlund (1985) identifies standardized test use as it relates to placement evaluation which is relevant to prediction. He suggests that "placement evaluation is concerned with the pupil's entry performance and typically focuses on questions such as (1) Does the pupil possess the knowledge and skills needed to begin the planned instruction?" (p. 11).

Standardized tests will likely continue to be an important component of education. The purposes of these measures are wide ranging, the tests are open to careful scrutiny, and there exists test utility regarding placement evaluation (which involves predicting future performance). I support the continued use of standardized tests, with the conditions that (a) standardized tests are used with supporting information and (b) the measures are valid for their intended use.

A.1 Validity and Prediction

The strength of a test in predicting student achievement is inherent in the concept of validity, and more specifically in criterion-related evidence used to determine the *degree* of validity in a test. In referring to a counsellor's role in the use of testing material, Goldman (1961) suggests:

> There is always an assumption, whether stated or not, that the test results provide information which is valid for the action in question. In connection with grade placement, for example, it is assumed that a pupil's scores on achievement tests will tell something about how well he will do in one grade as compared to another (p. 17).

The importance of test validity cannot be overemphasized. Assumptions are made by educators regarding test validity, and interpretations are based on these assumptions. A stanine score, or a percentile score may offer both the professional and the student misleading information if the degree of validity in a test has not been previously analyzed.

Gronlund (1985) cites the nature of validity in relation to testing and evaluation:

> (1) Validity refers to the appropriateness of the interpretation of the results of a test or evaluation instrument. . .and not to the instrument itself.
> (2) Validity is a matter of degree; it does not exist on an all-or-nothing basis.
> (3) Validity is always specific to some particular use.
> (4) Validity is a unitary concept (p. 57).

He further suggests that types of evidence which measure the degree of test validity include content, criterion-related and construct, and that the most meaningful use of test scores can be obtained if attention is focused on all types. In this thesis, criterion-related evidence of validity is emphasised, but not without attention to other types.

Anastasi (1976) states that "criterion-related validity indicates the effectiveness of a test in predicting an individual's behavior in specified situations" (p. 140). In this study the specified situation is the performance level which is attained by students in senior high school courses.

The American Educational Research Association, in *Standards for Educational and Psychological Testing* (1985), identifies *predictive* or *concurrent* criterion-related validity:

> A predictive study obtains information about the accuracy with which early test data can be used to estimate criterion scores that will be obtained in the future. A concurrent study serves the same purpose, but it obtains predictive and concurrent information simultaneously (p: 11).

In determining whether scores from the predictor variables in this study are valid for their intended use, criterion-related evidence is important.

(B) The Canadian Tests of Basic Skills and the Differential Aptitude Tests

Both the C.T.B.S. and the D.A.T. have traditionally been very popular testing instruments in numerous Alberta Schools. The C.T.B.S. has been used to supplement evaluative information which has been gathered by teachers relevant to their students' achievement levels in basic school subjects. The D.A.T. has been used as an indicator of student abilities in major areas and as an instrument for career guidance. The distinction between the two tests is that the C.T.B.S. is intended to assess achievement, while the D.A.T. is designed to measure aptitude.

Hopkins and Antes (1978) differentiate between aptitude and achievement tests:

> Achievement tests are used primarily to determine what has been learned after student exposure to instruction. Aptitude tests predict before instruction how students will perform on tasks after instruction. Both aptitude tests and achievement tests are ability tests which predict future performance (p. 344).

Traditionally, test results from both the C.T.B.S. and the D.A.T. have been norm-referenced. Hopkins and Antes (1985) emphasise that the distinction between a norm-referenced test and a criterion-referenced test is in the way the results are interpreted. A norm-referenced test is defined by the authors as "a form of interpreting test scores which employs the practice of comparing a student's performance such as local, state, or national averages" (p. 474). Hopkins and Antes (1985) further identify a criterion-referenced test as "a way of interpreting a test score that compares an individual's performance to a defined behavior domain" (p. 469).

Popham (1981) states that criterion-referenced testing has become very popular in the last 15 years. A probable rationale is that there is an increasing trend by school systems towards mastery of skill areas, teaching to objectives, and a general awareness of the need for accountability within the last two decades.

Printouts available from scoring services for the D.A.T. and the C.T.B.S. have offered norm-referenced information to schools through stanines, grade equivalents or percentile scores. Criterion-related information has been made available to C.T.B.S. users.

At this time, the first type of information is used more extensively by school systems after either test is administered, although the issue of accountability has resulted in an increased emphasis towards criterion-related results. A more specific investigation of both measures follows.

B.1 Canadian Tests of Basic Skills

An adaptation of the Iowa Tests of Basic Skills ("I.T.B.S."), the C.T.B.S. is intended for use with students at all grade levels. Hieronymus, Lindquist, Hoover and King (1982) indicate that a Multi-level Test Battery should be used with students at the grade 3 to 8 level. Tests are categorized according to specific age groups of children. The Multi-level test booklet includes all questions to be completed by students who are between 9 and 14 years of age, usually in grades 3 to 8. The construction of a reusable test booklet allows a student to complete only questions which are intended for a specific age level or grade, although some overlap exists when students complete the same test at consecutive grade levels.

The Multi-level Battery includes tests identified as Vocabulary, Reading, Language, Work-Study Skills and Mathematics. Three of these measures are further broken down into components. For example, C.T.B.S. Language includes four tests upon which a Total Language score is calculated.

Hieronymus et al. (1982) suggest that one purpose of the measure is to "indicate the extent to which individual pupils have the specific readiness skills and abilities needed to begin instruction or to proceed to the next step in a planned instructional sequence" (p. 3). This purpose is most closely related to prediction, in that obtained scores at year-end can be used in order to ascertain whether a child will have difficulty in the following academic year. The authors point out that the tests must be used carefully and that "test results should never replace teacher judgement" (p. 3). Thus the emphasis is on using the tests as a supplement to information gathered by teachers.

A critical review by Birch (1972) suggests that this measure compares favorably with its predecessor, the I.T.B.S. Both measures are identified as reputable in terms of overall test construction:

> The same level of technical sophistication that gave the Iowa Test its finer qualities is evident in the design of the C.T.B.S. and the production of norms. Standardization was on a group of over 30,000 children drawn from a stratified random sample of some 225 schools from the English speaking sectors in all provinces of Canada (p. 16).

The C.T.B.S. allows comparison of student achievement with students in other Canadian provinces, and offers a school system the option of obtaining local norms. The latter has become an increasingly popular option, as it invites the comparison of students within a school system.

Review of the literature indicates that the C.T.B.S. is not without limitations. Birch (1972) suggests that "the battery aims at the evaluation of generalized educational skills and abilities, not content achievement" (p. 7). Hieronymus and King (1975) recognized the limitation of the C.T.B.S. They explained the issue of content validity by suggesting that:

> Validity is the task of the test interpreter. Because it is impossible to design one achievement test satisfying nationwide objectives, the editors suggest that administrators decide the relationship of the test to local objects (p. 6).

One difficulty in addressing the issue of content validity in [illegible] manner is in the assumption that local school administrators have the time or expertise to engage in validity studies. Often the existence of face validity may be a major contributing factor in decisions to accept or reject a battery of tests.

Equally as important, not all schools within Alberta will accept or reject the test based on the same information relevant to content validity. For instance, all school systems in the Province of Alberta are under direction to teach the same basic course content. Yet there is differing opinion as to whether a standardized test like the C.T.B.S. is relevant. In referring to the abolition of C.T.B.S. use in one Alberta system, Froggatt (1984) states, "However, as the Alberta curriculum changed, the C.T.B.S. content no longer matched the Provincial requirements. The teaching staff seldom used the test results" (p. 6).

Other school systems continue to use the measure, accepting the existing content relevancy, despite that the content of courses taught is required by law to be the same. The degree of content relevancy is left to the discretion of individual test interpreters.

In investigating construct and criterion-related evidence, the I.T.B.S. will be examined, taking into account that the I.T.B.S. is similar in construction and in purpose and that little current information is available regarding the C.T.B.S. A critical review by Airasian (1985) points out that "the test is somewhat lacking when it moves beyond content validity into other validity realms" (p. 719). The author does suggest that the test exhibits evidence of criterion-related validity when compared to other measures of achievement and ability. "However criterion-related validity is not construct validity and the issue of what construct or constructs the I.T.B.S. assess is not addressed satisfactorily in the interpretive materials available" (p. 720).

The overall consensus in the literature is that despite its limitations, the C.T.B.S. and I.T.B.S. are good instruments with which to assess generalized educational skills. The technical quality is generally described as high. Good support materials are available to teachers and counsellors. More doubt is expressed when the achievement tests are used to measure course content.

The I.T.B.S. and C.T.B.S. continue to be a part of a variety of research concerned with prediction. Loyd, Forsyth and Hoover (1980) investigated the relationship between two achievement tests (one being the I.T.B.S.) and future high school and college success. In reference to high school success, the correlations between high school grade point average and I.T.B.S. results were as follows: Vocabulary (.34), Reading (.39), Language Total (.47), Mathematics Total (.43), Composite (.49). The authors concluded that the relationship between high school success and one's proficiency in basic skills is significant, as measured by the I.T.B.S.

An interesting disclosure was made in this study and is relevant to this thesis. Loyd et al. (1980) indicate that "the correlation coefficients between achievement test scores and four year high school G.P.A. was quite similar across grades" (p. 1119). This concept is supported by Thompson (1979) in an investigation of predictive validity as a measure of learning potential: "It should be noted that correlation coefficients were also similar in magnitude across grade levels" (p. 80). Those findings could support the use of grade 8 C.T.B.S. results to predict grade 10 academic success, without the necessity to re-administer the achievement test at a grade 9 level.

Literature regarding the ability of the C.T.B.S. to identify students with learning problems is cited by Fisk and Janzen (1981). The C.T.B.S. was included as one of seven test instruments designed to identify learning disabled students. The students were best identified by the Language variable when using six achievement variables from the C.T.B.S. However, five other major variables of the C.T.B.S. contributed far less. The authors state that "Academic measures, with the exception of the C.T.B.S. language subtest, appear to contribute little towards the prediction of group membership" (p. 259).

In this specific study, learning disabled students were best identified through factors other than achievement. A step-wise multiple regression selected the Language subtest of the C.T.B.S. as fourth in a 20 step regression analysis.

The above results are important to the study in this thesis, although the purpose in each study is vastly different. Learning disabled children are usually identified by teachers as experiencing a lag in academic areas, especially reading and mathematics. However, in the study by Fisk and Janzen, the variables in the C.T.B.S. specifically intended to measure concepts related to reading and mathematics made an insignificant contribution in identifying students with learning problems. It is suggested that the measure may be questionable in identifying junior high school students having problems in mathematics or reading and who could benefit from a high school program which places less emphasis on the acquisition of concepts in these subject areas.

Luce and Hodge (1978) completed a study which in part compared achievement on the C.T.B.S. with performance on the Canadian Lorge-Thorndike Test. They found that a significant correlation was established between the two tests. This reseach supports other findings which suggest that the C.T.B.S. may more closely resemble an ability measure than one which determines achievement. In referring to the I.T.B.S., Airasian (1985) suggests:

> As test constructors strive to move from items which test recall of content to items which assess more general understandings, concepts and skills - as the I.T.B.S does - they risk constructing tests which measure general ability rather than achievement (p. 720).

As does its American model, the C.T.B.S. attempts to accomplish a variety of objectives. It would appear that in most cases it has been stronger in identifying general abilities of students, and perhaps less-powerful in purposes relevant to prediction of future student success. The study by Loyd et al. (1980) did show a significance when addressing high school prediction through use of the I.T.B.S. However, the criterion variable was the overall grade point average in high school and not performance in specific subjects. Research which shows that the achievement test is closely related to measures of ability is of importance and will be addressed in Chapter 5 of this thesis.

B.2 Differential Aptitude Tests

Bennett, Seashore and Wesman (1982) indicate that the D.A.T. originally developed in 1947 is still intended "to provide an integrated, scientific and well standardized procedure for measuring the abilities of males and females in grades 8 to 12 for purposes of educational and vocational guidance" (p. 5). An indication of the popularity of the test is reflected in the number of research studies completed. Buros (1978) and Mitchel (1985) together cite over 400 critical reviews.

The purpose of the D.A.T. is two-fold. It is primarily a test which measures basic abilities through six subtests and also measures achievement in areas related to language and spelling. Uses of D.A.T. test results are two-fold as well. The tests are intended for counsellor use in assisting students in (a) educational pursuits and (b) vocational endeavors. For purposes in this thesis, the review concentrates on areas related to educational goals.

The skills which each of the eight test measures within the D.A.T. is intended to measure is outlined by Bouchard (1978):

> The D.A.T. purports to provide measures of six basic aptitudes and two achievement variables. The aptitudes are Verbal Reasoning (a comprehension test utilizing analogies), Numerical Ability (a computation type test embodying only arithmetic principles, no words are used), Abstract Reasoning (a figural reasoning test where the respondent must infer a rule or principle from a series of figures), Clerical Speed and Accuracy (a perceptual speed test requiring quick and accurate perception of similarities and differences), Mechanical Reasoning (. . .requiring the understanding of basic physical principles), and Space Relations (basically a test of mental manipulation, mental paper folding). The achievement variables are Spelling (recognition of misspelled words) and Language Usage (recognition of poorly formed or non-grammatical sentences) (p. 655).

The above would suggest that each subtest, because it measures a specific aptitude, could be specifically used as a predictor of skills relevant to its intended use. Research by Gronlund (1985) indicates that evidence to support this assumption is lacking:

> The evidence of differential prediction, however, is rather disappointing. One might expect the Verbal Reasoning to predict English achievement best, the Numerical Ability score to predict mathematics and science achievement best, the Spatial Relations scores to predict achievement in mechanical drawing best, and so on. A review of the extensive data prescribed in the manual, however, revealed only slight differences in prediction from one area to another. The best predictor of school marks in all courses turned out to be the general mental ability measure (VR + NA) (p. 313).

Other research supports the above. Critiques by Bouchard (1978) and Linn (1978), suggest that there is very little differential validity among tests. Sander (1985) concludes that most recent versions of the D.A.T. have similar characteristics. Some critics suggest that there is not a necessity to administer all subtests to students if a select number can be used to make predictions of future performance. Herman and Gallo (1973), in comparing D.A.T. scores of grade 9 Alberta students with grade 12 results from the same group, suggested that the overall Verbal Reasoning/Numerical Ability ("Vr/Na") scores were the best predictors of achievement. The authors did suggest that when boys and girls are studied separately, "specific subtests can be chosen for male and female groups" (p. 239).

The subtests identified were different for each group. Male achievement was best predicted by scores in Vr/Na, Spelling and Mechanical Reasoning; female achievement was best predicted by Language Usage, Abstract Reasoning and Mechanical Reasoning. When both groups were combined as one, the best overall predictor of success was the Vr/Na score.

Conclusions from the above would suggest that (a) the D.A.T. can be a good predictor of overall academic success if specific subtest scores are taken, (b) caution must be used in interpreting test results to both sexes by using the same subtests as one would for a total group and (c) specific subtest scores may or may not correlate with areas of achievement which should be similar to D.A.T. scores.

Mogull and Rosengarten (1974) included three subtests of the D.A.T. as predictor variables used to predict success in high school algebra in a co-educational high school. Also included as predictors were (a) teacher final mark averages for mathematics in grade 8 and (b) the Iowa Algebra Aptitude Test.

Correlations between ninth grade algebra scores and independent variables were as follows:

D.A.T. Verbal Reasoning	.524	
D.A.T. Numerical Ability	.460	
D.A.T. Abstract Reasoning	.374	
Iowa Algebra Aptitude Test	.565	
Eighth Grade Teacher Mathematics Mark	.696	(p. 36).

This suggests that although teacher marks are strongest predictors, the specific D.A.T. subtest result obtained in Verbal Reasoning is similar in correlation to the Iowa Algebra Aptitude Test (which is specifically intended to measure skills related to understanding algebraic concepts). Noteworthy is that the Numerical Ability subtest, which would be expected to be the strongest D.A.T. predictor of algebra scores, is not as strong an indicator as the Verbal Reasoning subtest.

Omizo (1980) examined the predictive validity of the D.A.T. to student high school grades in engineering, mathematics, science courses and the overall composite grade point average of the students involved. Results indicated that five D.A.T. variables were valid predictors of success in the three criteria above. Specifically, as a predictor measure for mathematics, the Numerical Ability score was not as strong a variable (.25) as the scores in Abstract Reasoning (.47), Clerical Speed and Accuracy (.60), Space Relations (.37) and Language Usage (.38). Similar results were reported for the science criterion variable.

The Abstract Reasoning subtest was determined to be the most valid predictor of all measures of academic performance. In this study the correlation between Verbal Reasoning and the four criterion variables was relatively low (engineering .11, mathematics .10, science .13, composite .17). The above would indicate that the D.A.T. can be used as a predictor of all measures of academic performance. However, caution must be exercised in concluding that any given subtests can be categorically used for prediction in certain areas. The ability of the D.A.T. to predict success in mathematics is an example. Mogull and Rosengarten (1974) indicated that Verbal Reasoning is a good predictor of success in algebra, whereas Omizo's study (1980) showed this subtest to be insignificant. Perhaps one must look more specifically at the content involved in mathematics before making assumptions about which D.A.T. subtest will best measure the general academic area of mathematics.

The studies above support Gronlund's contention that differential prediction in the D.A.T. is questionable. In many cases, certain tests are better predictors of success than others, but often are not the tests which one would expect to show strength. In other cases, four or five subtests of the D.A.T. make similar contributions as predictors. Nothing in the studies above would negate literature which suggests that the Vr/Na score is not a strong predictor of academic success, although instances were noted whereby Verbal Reasoning and Numerical Ability sometimes were weaker predictors of academic success when separately correlated with criterion variables.

Despite limitations, the D.A.T. has been used to predict future performance. Studies indicate that significant correlations between D.A.T. subtests and measures of future performance have contributed to validity through criterion-related evidence. As with the use of any standardized tests, caution must be exercised regarding test interpretation. The D.A.T. and the C.T.B.S. can be meaningful instruments when used with other information, such as teacher-made tests.

(C) Teacher-made Tests

Teacher-made tests are most often intended to measure concepts previously taught in the classroom. Karmel (1970) suggests that purposes of teacher testing include (1) certification of pupil achievement and (2) measuring outcomes of instruction (p. 6). As a fundamental component of basic classroom instruction, tests are used to check student understanding of material covered. In referring to classroom tests, Froggatt (1984) states, "they are developed by the classroom teacher for use directly within the context of a particular unit of material and its related objectives" (p. 18). The unit of material can range from that taught in one lesson to that covered within an academic year.

Gronlund (1985) further identifies classroom tests as those involved in (1) placement evaluation, (2) formative evaluation, (3) diagnostic evaluation and (4) summative evaluation, suggesting that the measures are useful in all four areas (p. 118). The emphasis in this paper is on test use in placement evaluation.

Teacher-made tests are usually criterion-referenced or objective-referenced in their use. Lien (1980) states:

> An objective-referenced test is designed to determine whether a student has mastered a specific learning objective. The objective that has been measured is one that has been determined to be important. . .test items are designed to determine a mastery of the objective (p. 88).

The emphasis in these tests usually shifts from one involving comparisons with other groups of students to one involving the mastery of material taught. Simply stated, percentages become more relevant than percentiles.

Advantages of teacher-made tests relate to (a) instruction relevancy, (b) content validity and (c) criterion-related validity. In constructing examinations, teachers can take into account material which has been previously stressed in the teaching process and which likely is relevant to concepts which must be taught to fulfill curricular requirements.

Relevant to instructional purposes which could best be categorized in Gronlund's test identification as formative and diagnostic evaluation, the concept of motivation is important. Karmel (1970) indicates that "well constructed tests which reflect classroom instruction can increase student learning by helping to develop study habits and directing intellectual energy toward the desired educational objectives" (p. 6). Hunter (1981) refers to importance of immediate feedback as a motivational tool which teachers use. Construction of tests which can measure skills taught and can indicate to students their performance level can be part of a motivational strategy which is determined by the teacher. Areas identified by the teacher as weak can be retaught and retested.

The motivational factor is sometimes lacking when students complete tests which are not teacher-made. Both teachers and counsellors are cognizant of the difficulty in motivating some individuals to complete tests which may seem meaningless towards the acquisition of a grade. The validity and reliability of standardized tests can sometimes be questioned under these circumstances.

A second advantage of teacher tests is identified by Hills (1981):

> If a teacher wants to measure what her students know, it is very convenient simply to ask them questions to which they can respond correctly...second—it would be hard to find a published test that would fit the day to day or week to week needs of the teacher. . .the teacher's own test can be tailored to her own objectives and to the material that has been emphasised in her class (p. 15).

Hills is referring to content validity. The Government of the Province of Alberta, in Section II (2) of the *School Act* (1980), indicates that instructors must teach the curriculum as prescribed. Objectives for teaching can be planned according to that curriculum and can carefully measure student attainment of objectives. Wolf (1982) states:

> The actual determination of content validity is made by comparing the items in a test with the content and objectives of a particular domain to see how well they match. . .content validity is typically built into a test from the outset by the selection and/or construction of appropriate items (p. 1992).

The classroom teacher can accomplish this. The evident degree of content validity will help to ensure acquisition of concepts appropriate to the Alberta Provincial curriculum

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and will further strengthen the prospect of criterion-related validity. The relationship of the two validity types is identified by Gronlund (1985):

> Although content validation is of primary concern with criterion-referenced mastery tests, we might also be interested in using the test results to make predictions about pupils. . .such instructional decisions require some evidence (criterion-related validation) that our decisions are soundly based (p. 77).

Gronlund (1985) further suggests that this evidence can be obtained through the use of an expectancy table. Hills (1981) identifies such a table in Figure 1.

FIGURE 1 **Example of an Expectancy Table**

HIGH SCHOOL AVERAGE	*FIRST YEAR COLLEGE AVERAGE*				
	F	D	C	B	A
A	1	15	24	40	20
B	2	22	53	18	5
C	8	39	37	15	1
D	19	56	22	3	

(p. 269).

It is noteworthy that expectancy tables are not reserved only for use with teacher-made tests in prediction of future performance. These tables can be built using a variety of norm-referenced and criterion-referenced tests. However, it is emphasized that a high degree of content validity (often suspect in some norm-referenced tests) can be constructed in a teacher-made test, thus strengthening the expectancy table.

The numerous disadvantages of teacher-made tests have been elaborated upon in many texts in evaluation and measurement. Ebel (1979) identifies seven disadvantages of these measures. Three of these include (a) reliance on subjective data (b) reliance on absolute standards of judgement and (c) failure to analyze the quality of the test (p. 66).

The first disadvantage includes the concept of reliability, which is simply defined by Ahmann and Glock (1981) as "consistency of results" (p. 238). Many instances at all levels of education have been identified in which a teacher may have graded a test in a different manner from another teacher responsible for the same grade or subject. Many factors are involved in this reality. Rosenthal and Jacobsen (1968) identified a *teacher expectation phenomenon* as an example of this. Pupils performed according to teacher expectations and were marked accordingly. Secondly, many test items such as essay questions are subject to evaluation which may be inconsistent among teachers. Finally, teacher judgements on performance may be altered by the extent of pupil participation and overall student conduct. An example of this occurs when a teacher allows or deducts specific marks for performance or punctuality in completion of work. The test results become suspect, as measurement has been based on extraneous criteria.

A second disadvantage involves the establishment of unfair standards. This may occur when a teacher marks a class *on the curve*, when the group in no way resembles a normal distribution of students. A further example includes the harsh or lenient marking of test items based on the instructor's perception regarding standards of instruction.

Thirdly, teachers often have neither the time nor the expertise to analyze a test in terms of quality. Various authors including Ahmann and Glock (1981), Ebel (1979) and Popham (1981) have recognized this. The authors subsequently have placed considerable emphasis on improving tests in schools. Specific chapters in textbooks above are concerned specifically with the issue. In reference to some teacher-constructed tests, Ahmann and Glock (1981) suggest, "unfortunately they are often carelessly constructed and interpreted" (p. 14). Karmel (1970) states, "it is true that poorly constructed tests make our present system even worse" (p. 6).

Despite the above concern, evidence indicates that teacher grades generally are good predictors of future student performance at all educational levels. Fisk and Janzen (1981) suggested that "teachers not only seem to be able to predict student academic achievement, they also appear to be effective in identifying learning disabled students" (p. 258). As noted previously in this chapter, Mogull and Rosengarten (1974) established a strong correlation between teacher marks in high school algebra and marks assigned the previous year. Numerous studies indicate the existence of strong positive correlations between teacher marks in one grade and those awarded at the subsequent grade level.

There still exists a mistrust by lay people and influential educators alike regarding the validity and reliability of teacher-made tests. Specific to the Province of Alberta, some inconsistencies have existed between marks given by different school systems for performance in the same subject. Inconsistencies even occurred in schools within the same system. Compounding the question of reliability was whether teachers were measuring what was supposed to be taught in specific courses. Disclosures of high school graduates not being able to communicate properly left suspicion with many parents, school board members and even executives at the Alberta Department of Education.

The result was an emphasis on a *back-to-the-basics* program in schools. With this was the return to standardized testing which was both criterion-referenced and norm-referenced in its use. The testing allowed for monitoring of students and school systems at a central level and also provided jurisdictions with results which invited comparison to a province-wide mean. Provincial achievement testing became a reality in 1983.

(D) Provincial Achievement Tests

Provincial Achievement Tests were reintroduced to Alberta Schools following an 11 year absence. The Alberta Education *Student Evaluation Branch Bulletin* (Vol. 1, No. 15, Jan. 1983) states that "the Achievement Testing Program is administered in accordance with regulations pursuant to Section 11 (1) (g) of the *School Act* (p. 2). The Government of the Province of Alberta *School Act* (1980) specifies a regulation which pertains specifically to the regulatory power of the Minister of Education to make regulations regarding the examination of pupils (p. 7).

The rationale for the reintroduction of achievement tests has been expressed by senior administrators at the Provincial level and at the local school level. Dr. Clarence Rhodes, Educational Consultant for Alberta Education Planning Services in Edmonton indicated to this researcher that the reintroduction was based on a general conservatism in

Alberta society which was reflected at the Provincial level through public demands for accountability in education (personal communication, August 7, 1986). Mr. R.E. Cope, Superintendent of Schools for the County of Red Deer #23, indicated that a major rationale was the desire by the Department of Education to regain a measure of central control over school systems in the Province (personal communication, August 8, 1986).

The Alberta School Trustees' Association (1983) states that "the major aim of the Alberta Student Achievement Testing Program is to establish, promote, and maintain standards (p. 9B-2). Specific to the grade 9 achievement tests used as predictor variables in this study, the rationale for testing as identified by the Alberta Education *Student Evaluation Branch Bulletin* (Vol. 3, No. 12, Nov. 1983) states:

> The purpose of the Achievement Testing Program is to provide educators, trustees and others with information significant at the provincial and local levels, relative to student knowledge, understanding and skills acquired in relation to program objectives in selected subjects at grades 3, 6, and 9. The achievement tests are administered on a cyclical basis in the following four subject areas: language arts, social studies, mathematics and science (p. 1).

Although the four statements of rationale for test reintroduction identified above are not directly relevant to prediction of high school success, it is suggested by this researcher that the measures which are used at the grade 9 level could be valuable in this purpose. The tests should exhibit a high degree of content validity, as test construction is directly relevant to objectives identified by the Alberta Department of Education. Assuming that teachers in Alberta schools follow the course of studies which has been prescribed by the Alberta Department of Education, these measures will exhibit a high degree of both content validity and criterion-related validity. This is consistent with the premise that validity is a unitary concept. The Alberta School Trustees' Association (1983), in *School Boards Action and Words* suggests, "if the student achievement tests are valid and reliable, they can be seen as useful indicators as to whether or not high priority curricular aims have been achieved" (p. 9B-3). Assuming that both validity and reliability are evident in these measures, the indicators referred to above can be used to determine whether students will succeed in related subjects at the next grade level.

More specific information regarding the Social Studies and Mathematics Provincial Achievement Tests administered in 1983 and 1984 are identified in Figure 2. Information is cited from (1). Alberta Education *Grade 9 Social Studies Achievement Program, Provincial Report (October 1983)*, and (2) Alberta Education *Student Evaluation Grade 9 Mathematics Achievement Test, Provincial Report (October 1984)*.

FIGURE 2 Data Regarding the Provincial Achievement Tests

	Social Studies Provincial Achievement Test (1983)	*Mathematics Provincial Achievement Test (1984)*
Administration Date	June 14, 1983	June 12, 1984
Areas Evaluated	Specific to Program of Studies for Social Studies 9 and Mathematics 9, as provided by Provincial Curriculum Branch	
Students Exempted	Special Education students, English as Second Language students, and those who receive instruction in language other than English.	
Mark Weightings	70% multiple choice 30% written response	100% multiple choice (75 questions)
Test Emphasis	Value Objectives 12% Knowledge Objectives 44% Skill Objectives 44%	Knowledge 16 items Comprehension 27 items Application 26 items Open Search 6 items
Total Students	23,639 students in 104 jurisdictions	27,121 students in 558 public schools
Reliability	Kuder-Richardson Formula 20 reliability (internal consistency) coefficient .89	Kuder-Richardson Formula 20 reliability (internal consistency) coefficient .92
Target Mean	60%	66%
Achieved Mean	59.2%	66.3%
Minimum Standard	40% (15th percentile)	50%

In reference to Figure 2, there would appear to be a high degree of content validity. Areas evaluated were specific to the Province of Alberta curriculum. Test emphasis was towards three major objectives in Social Studies 9 and four in Mathematics 9. The attained mean in both tests approximates the target mean. A high degree of content validity is relevant to an increased criterion-related validity.

The Alberta Education *Student Evaluation Grade 9 Mathematics Achievement Test, Provincial Report* (October 1984) suggests that caution should be used when interpretations are made. Reasons suggested are as follows:

> (1) The amount of testing time limits the extent to which it is possible to test the objectives in the curriculum.
> (2) Whenever achievement is assessed, there are errors of measurement.
> (3) The size of the jurisdiction relates to the stability of results from one year to the next.
> (4) The motivational levels of the students greatly influence the achievement scores.
> (5) As with any paper-and-pencil test, scores will be affected by reading skills as well as by the skills that the test is intended to measure (p. 22).

In conclusion to this chapter, it is stressed that the five cautions identified are specifically relevant only to the Provincial tests but to standardized tests and teacher-made tests in general. If there is a high degree of validity in a given measure, and if correlations established suggest a strong positive relationship between predictor and criterion variables, one must still examine variables which affect test performance. Ebel (1986) places the problem of prediction in perspective by stating:

> But the success of a person in school or on the job depends to a considerable extent on the efforts of the person. It depends on unforseen contingencies and on a multitude of unmeasured variables. The best predictions we can make are often crude and imprecise. Nor need we labor incessantly to make them more precise. In education and employment the best use that can be made of a test score is to encourage rather than to predict success (p. 306).

(E) Test Use in the County of Red Deer

Figure 3 identifies the testing program in the County of Red Deer for students who were included in this study. Two groups of students were included (as explained in further detail in Chapter 3). This format has been used in past years with students other than those who were selected for purposes of this thesis. The year of test administration may have been different. The grade level tested and the month during which test administration was completed has remained the same.

FIGURE 3 Testing Program for the County of Red Deer #23.

Group	*Date*		*Test Results Recorded*	*Grade*
	May	1982	C.T.B.S.	8
	October	1982	D.A.T.	9
	November	1983	Teacher assigned marks. (Final	
1	March	1983	June mark weighted by marks	
	June	1983	in November and March)	
	June	1983	Provincial Social Studies test	9
	May	1983	C.T.B.S.	8
	October	1983	D.A.T.	
	November	1984	Teacher assigned marks (Final	9
2	March	1984	June mark weighted by previous	
	June	1984	marks in November and March)	
	June	1984	Provincial Mathematics test	9

A brief elaboration on the use of each measure for purposes of high school course selection is identified below.

(1) Canadian Tests of Basic Skills

The C.T.B.S. can be used to assist teachers in planning appropriate academic programs for students. Tests traditionally have been administered in May of an academic year. Results are available before year-end. They are used as one measure by which students are grouped for class membership in the following academic year.

Grade 8 is the final year for the C.T.B.S. administration. Counsellors and teachers use the results for (a) feedback on basic skill attainment and (b) grouping purposes. Although an item analysis is available for the C.T.B.S., it is not usually requested by schools. Counsellors may use the grade 8 results as an indicator of high school success. However, more emphasis is usually placed on grade 9 information which is more current and perceived to be more relevant for counselling purposes. Thus the D.A.T. is used more often, as counsellors work with prospective high school students.

(2) Differential Aptitude Tests

The D.A.T. is used with grade 9 students as part of a career study. Students are requested to identify (1) school subjects they prefer, (2) the number of years they wish to remain in school, (3) their self-perceived ability levels and (4) their choice of occupational groups. The students complete eight subtests and receive a printout which compares results obtained on the D.A.T. to their choices. Feedback is then given regarding the appropriateness of the choices made.

Counsellors and teachers have used results from the D.A.T. to assist students in making decisions relevant to high school course selection. It is emphasised that the results are used in conjunction with other data.

(3) Teacher-awarded Marks

Students are assigned marks for work done during time intervals between each reporting period. June marks are recorded for this study. They are comprised of an average for previous marks assigned. All awarded marks include weightings for test results and for essays and projects which are submitted by students. Students may be deducted marks for incomplete projects or for assignments returned past a due date. Counsellors examine teacher marks together with obtained subjective information. Students subsequently receive counselling regarding the selection of high school courses, placing much emphasis on this type of information.

(4) Provincial Achievement Tests

Provincial Achievement Tests are written in grade 9 on a cyclical basis. As tests were completed in Social Studies and Mathematics during 1983 and 1984 respectively, they will be administered again in another four years. To this time, counsellors and teachers have not used these test results for counselling purposes relevant to grade 10 placement. A major reason involves the time during the academic year in which the exam is administered. As student registration often takes place in the spring of the previous academic year, results are not available when high school course selection is made.

Future counselling could incorporate results from Provincial Achievement Tests. High school registration is still viable in late summer or early fall. As well, Provincial test results could certainly be used for counselling of students who enroll in courses offered in the second semester of a school year. The second semester usually begins in February of an academic year. Most high school courses offered are whole entities in either semester.

Summary

The tests described above are most often used conjunctively. When discrepancies occur between two measures, the counsellor may explore the reasons involved. A counselling session with a student may include the investigation of contradictory information.

Selection of courses is made by the student and is confirmed in a signed *program* by the parents. Although teachers and counsellors may suggest to a student that a certain course or group of courses be attempted in grade 10, the final decision is with the parent.

CHAPTER 3

METHOD

(A) Background

The County of Red Deer incorporates towns, villages, hamlets and farms within a central Alberta area located east, south and west of the City of Red Deer. Communities include the towns of Bowden, Innisfail, Penhold and Sylvan Lake. The villages of Delburne and Elnora, along with the hamlets of Benalto and Spruceview also comprise a part of the population base. An approximate total of 30,000 residents live in the County of Red Deer.

Major industries in the area include farming, oil and gas, and occupations related to services in various communities surrounding the City of Red Deer (population 55,000). Some County residents choose to engage in occupations within the city and to reside in areas outside the city limits. Their children are most often enrolled in schools in the County school system.

Fourteen schools accommodate approximately 5,000 students in all grades. Six schools register students at the high school level, although no school in the system is a self-contained high school. Five of these six institutions enroll children in grades 1-12, while the sixth includes a grade 7-12 clientele. Other schools can be described as *feeder schools* for those which house high school populations.

(B) Sample

The sample for this study is comprised of 593 high school students, including 296 males and 297 females. All individuals had at least completed a grade 10 level in the County of Red Deer #23. Most were continuing instruction in either a grade 11 or a grade 12 program within the school system. Test scores were available for the sample group in some or all of the following criteria:

(1) C.T.B.S. - grade 8 results.

(2) D.A.T. - grade 9 results.

(3) Teacher-assigned marks in Language Arts 9, Mathematics 9, Social Studies 9 and Science 9.

(4) Grade 9 Alberta Provincial Achievement Test results in Social Studies (1983) and Mathematics (1984).

(5) Teacher-assigned marks in Biology 10, Chemistry 10, Physics 10, Science 11, Mathematics 10, 13, 15, English 10, 13, and Social Studies 10.

When the information was gathered, the student group consisted of 286 pupils in grade 11 and 307 students in grade 12. Thus the sample was adequate to account for any missing data and for low enrollment in some grade 10 subjects to be used as criterion variables.

(C) Procedure for Data Acquisition

In November of 1985 I obtained permission from Mr. R. E. Cope, Superintendent of Schools in Red Deer County #23, to collect information relevant to this thesis from available student records. Principals and guidance counsellors in each of six high schools were subsequently contacted. They were most co-operative in making available results of the standardized tests and teacher-assigned marks for students included in this sample.

Emphasis throughout the research was on protecting the confidentiality of student information. Students were identified by numbers. Names were never used in any portion of the study. After results were recorded, information was appropriately refiled. Grade 12 students were identified as group 1, and grade 11 students as group 2. The grouping was for purposes of convenience, as the sample was treated as one group containing both grade 11 and grade 12 students. Figure 3 identifies the time of year when both groups completed assignments upon which marks were based. The following information was retrieved from individual student records, counsellors' files and principals' records in the schools involved:

(1) Grade Equivalent Results for the Canadian Tests of Basic Skills

Stanine scores, percentile rankings and grade equivalent scores are typically recorded in a scoring service for the C.T.B.S. For purposes relevant to this thesis, grade equivalent scores were recorded for the following subtests:

(a) Vocabulary

(b) Reading

(c) Language

(d) Work-Study Skills

(e) Mathematics

A grade equivalent score was also recorded for the C.T.B.S. Composite score, which takes into account performance on all subtests. The Composite score is only available when all subtests within the C.T.B.S. are completed.

(2) Raw Scores for the Differential Aptitude Tests

Printout information from the D.A.T. records both raw scores and percentiles. It is important to note that raw scores are meaningless when an interpretation of test data is considered. However, raw scores are more appropriate than percentile scores when data is *initially* obtained for purposes of statistical analysis. In this study, raw scores were recorded for the following D.A.T. subtests:

(a) Verbal Reasoning

(b) Numerical Ability

(c) Vr/Na

(d) Abstract Reasoning

(e) Clerical Speed and Accuracy

(f) Mechanical Reasoning

(g) Space Relations

(h) Spelling

(i) Language Usage

Eight D.A.T. subtests are intended to measure separate aptitudes. The Vr/Na score combines performance on each of the two separate subtests, and was recorded for purposes identified in this thesis.

(3) Percentages for Teacher Marks in Grade 9

Percentages which were awarded to students in June of the academic year were recorded for the following subjects:

(a) Language Arts 9

(b) Mathematics 9

(c) Social Studies 9

(d) Science 9

The marks awarded in these *core subjects* were based on work completed during the academic year and on results of a student exam in June of that year.

(4) Percentages for Grade 9 Provincial Achievement Tests

Percentages were recorded for the following standardized achievement tests which were mandatory for all students in the Province of Alberta during 1983 and 1984:

(a) Provincial Achievement Test in Social Studies - 1983

(b) Provincial Achievement Test in Mathematics - 1984

(5) Percentages for Grade 10 Teacher Marks

These were recorded in grade 10 courses which students selected as part of their programs. Expectedly, not all students enrolled in all 10 subjects used in this study. Student records from which information was retrieved indicated that four or five choices were made from the list below. Marks used in this study were obtained for each student in some of the following:

(a) Biology 10

(b) Chemistry 10

(c) Physics 10

(d) Science 11

(e) Mathematics 10

(f) Mathematics 13

(g) Mathematics 15

(h) English 10

(i) English 13

(j) Social Studies 10

Marks available for each student were dependent on the type of program in which a student was enrolled. A student enrolled in an *academic route* would likely register in courses such as Biology 10, Chemistry 10 and Mathematics 10. Students who chose an easier course of studies would enroll in subjects such as Mathematics 13 and English 13. From the above subjects, each student would likely have recorded results on four of five grade 10 subjects.

Subtests of the C.T.B.S. and D.A.T., grade 9 and 10 core subjects, and Provincial tests were included as separate variables. It would be possible within this structure to determine correlations between one predictor variable and another, or between a grade 9 and a grade 10 result.

As expected, a number of student records did not include data on some predictors. Some students did not complete the C.T.B.S. in the eighth grade due to (a) local school decisions to administer only selected subtests of the test, (b) local school decisions to administer the test to grade 8 students in alternate years, or (c) an absence by students during testing times. Table 1 identifies the number of students for whom results were available in each predictor and criterion variable used in the study.

Results were recorded on an 80 column "spread sheet" which identified by number (a) the student, (b) the school, (c) the student's group, (d) the gender of the individual and (e) results of the available data. The information was transferred to the Michigan Terminal System at the University of Alberta. It was subsequently analyzed with the *Statistical Package for the Social Services (SPSSx).*

TABLE 1

NUMBER OF STUDENTS SAMPLED FOR EACH PREDICTOR AND CRITERION VARIABLE

VARIABLE	STUDENTS	VARIABLE	STUDENTS
C.T.B.S.		*GRADE 10 SUBJECTS*	
Vocabulary	385	Mathematics 10	356
Reading	387	Mathematics 13	146
Language	358	Mathematics 15	68
Work-Study Skills	323	Social Studies 10	564
Mathematics	356	Science 11	93
Composite	317	Biology 10	458
D.A.T.		Chemistry 10	430
Verbal Reasoning	467	Physics 10	245
Numerical Ability	468	English 10	440
Vr/Na	463	English 13	116
Abstract Reasoning	464		
Clerical Speed & Accuracy	463	*GRADE 9 PROVINCIAL TESTS*	
Mechanical Reasoning	465	Social Studies (1983)	244
Space Relations	467	Mathematics (1984)	264
Spelling	460		
Language Usage	464	*GRADE 9 TEACHER SCORES*	
		Language Arts 9	580
GRADE 9 PROVINCIAL TESTS		Mathematics 9	580
Social Studies (1983)	244	Social Studies 9	579
Mathematics (1984)	264	Science 9	579

(D) DATA ANALYSIS

A description of data analysis is detailed below, addressing each question posed in Chapter 1 of this thesis.

(1) What relationship is evident among scales on the C.T.B.S., D.A.T., grade 9 year-end teachers' marks and Provincial test results?

Pearson product-moment correlations were used to establish relationships among all predictor variables in the study. Correlations established relationships among the following variables:

(a) subtests within the C.T.B.S.

(b) subtests within the D.A.T.

(c) the C.T.B.S. and core grade 9 subjects

(d) the D.A.T. and core grade 9 subjects

(e) Alberta Provincial Achievement Tests and results from Mathematics 9 or Social Studies 9

(2) What relationship exists between teacher marks in grade 10 and, (a) the C.T.B.S., b) the D.A.T., (c) Provincial Achievement Tests in Social Studies and Mathematics?

Pearson product-moment correlations were used to identify these relationships. Specific correlations investigated the following:

(a) The relationship between C.T.B.S. subtest scores and all high school marks in grade 10.

(b) The relationship ~~between~~ Vr/Na ~~subtest~~ scores on the D.A.T. and all high school marks in grade 10.

(c) The relationship between achievement variables on the D.A.T. (Spelling, Language Usage) and results in English 10, 13, or Social Studies 10.

(d) the relationship between Alberta Provincial Achievement Tests in either Social Studies (1983) or Mathematics (1984) and grade 10 marks in Mathematics 10, 13, 15, or Social Studies 10.

(3) What relationship exists between the D.A.T. and the C.T.B.S.?

A factor analysis was used to explore the internal structure of predictor variables in the C.T.B.S. and the D.A.T. The examination of predictor variables in the D.A.T. and C.T.B.S. was an extention of the questions identified in l(a) and 1(b) above. A decreased number of factors was obtained.

(4) What relationship exists between teacher marks in grade 9 and those in grade 10?

This relationship was investigated through the use of expectancy tables which cross-tabulated with the following variables:

(a) Social Studies 9 and Social Studies 10

(b) Language Arts 9 and English 10

(c) Mathematics 9 and Mathematics 10

(d) Mathematics 9 and Physics 10

(e) Language Arts 9 and Biology 10

(f) Science 9 and Chemistry 10

This relationship partly addressed the major question relevant to prediction of grade 10 courses from grade 9 criteria. Six distinct frequency *cells* were constructed. Percentages represented within each cell were based on marks which are typically assigned by teachers at the duration of a course. For example, a mark of 39% is a failing mark at the grade 10 level. No credits are assigned to a student when a mark of between 0 to 39% is achieved. However, a mark of between 40 to 49% will earn a student credits in a high school course, while a mark of between 50 to 59% will permit a student to enroll in a *20 level* subject during the following academic year. Thus, if a student wishes to enroll in a grade 11 subject, he must obtain at least a 50% in the grade 10 pre-requisite to that subject. There is very little difference in skills attained by a student who received 49% as compared to one who achieves 50%. However, there is an important difference relevant to the availability of alternatives during the following academic year.

Typically, teacher marks tend to form *clusters* which are best identified through the cells below:

Cell	*Student Mark Earned*
1	0 - 39%
2	40 - 49%
3	50 - 59%
4	60 - 69%
5	70 - 79%
6	80 - 100%

The purpose for construction of expectancy tables was to investigate trends in marks assigned in grade 10 when grade 9 marks were achieved by students in the previous academic year. For example, a cross-tabulation could determine that students who scored between 50% and 59% in Mathematics 9 would tend to score within a certain percentage range at the grade 10 level. More specifically, it could be determined that x students scoring between 50% and 59% in Mathematics 9 would score between 50% and 59% in the following academic year.

(5) Which variable at the grade 9 level is the most powerful predictor of performance in core grade 10 subjects?

A step-wise multiple regression *(pin.10 and pout.15)* was used for this purpose. The probability for inclusion (*pin .10*) and probability for exclusion *(pout .15)* are levels of significance for the regression. When using *pin .10*, there is a 10% chance that a variable not significant to the regression will be included. When using *pout .15*, chances are 15 out of 100 that a variable which should have been included in the equation was not. The best predictors for each of the grade 10 subjects used as a criterion variable in this study were established. The criteria of *pin .10* and *pout .15* was used because of this study being exploratory in nature. Five separate combinations of predictor variables and criterion variables were studied. A step-wise regression analysis was completed using the following:

(a) Grade 9 teacher marks with each criterion variable.

(b) Grade 9 teacher marks and Provincial Tests with each relevant criterion.

(c) Grade 8 C.T.B.S. and grade 9 D.A.T. with each criterion variable.

(d) C.T.B.S., D.A.T. and grade 9 teacher marks with grade 10 subjects.

(e) Grade 9 teacher marks and D.A.T. results with grade 10 subjects.

Using coefficients and the *constant* established in the regression, a regression equation was calculated for each criterion variable analyzed in (4) and (5) above.

CHAPTER 4

RESULTS

The findings in the study address five major questions previously identified in Chapter 3. Each question is analyzed separately using relevant statistical methods.

Sample Population

Although there were 21 predictor variables and 10 criterion variables used in this study, the entire sample of 593 students was not used in each analysis. The number of cases for each variable upon which statistics were based has been cited in Table 1.

(A) QUESTION 1

What relationships exist among scores in the Canadian Tests of Basic Skills, Differential Aptitude Tests, Grade 9 core subjects and Provincial test results?

This question was addressed in part through examination of subtests within the C.T.B.S. and the D.A.T. Each standardized test was analyzed separately. Results are reported in Tables 2 and 3 respectively.

In the C.T.B.S., the Composite score (a confounded variable which is comprised of scores from other subtests) showed an expected strong positive correlation to other variables. The strongest relationship of .91 was evident between Composite and Work-Study Skills. The latter test requires a student to use reference materials effectively.

When the Composite C.T.B.S. score is excluded in the examination, strong correlations are maintained among all other subtests. Relationships between tests intended to measure skills relevant to language areas are expectedly strong and also correlate highly to the test which measures mathematical abilities. Work-Study Skills shows a strong relationship to areas which measure language and mathematics.

Table 3 identifies correlations among eight subtests of the D.A.T., and with the

TABLE 2

CORRELATIONS BETWEEN CANADIAN TESTS OF BASIC SKILLS SUBTESTS

	Read	Lang	WkSt	Math	Comp
Voc	.742	.698	.689	.630	.847
Read		.760	.779	.730	.906
Lang			.767	.723	.892
WkSt				.802	.909
Math					.876

Legend
Voc - Vocabulary
Read - Reading
Lang - Language
WkSt - Work-Study Skills
Math - Mathematics
Comp - Composite

n = refer to Table 1
$p<.05$

TABLE 3

CORRELATIONS BETWEEN SUBTESTS OF THE DIFFERENTIAL APTITUDE TESTS

	Na	Vr/Na	Abst	Cler	Mech	Space	Spel	Lang U
Vr	.628	.920	.514	.148	.396	.487	.488	.638
Na		.877	.593	.157	.345	.541	.459	.603
Vr/Na			.611	.161	.419	.569	524	686
Abst				.204	.413	.610	.352	.578
Cler					.008	.007	.204	.182
Mech						.512	.109	.291
Space							.199	.377
Spel								.655

Legend
Vr - Verbal Reasoning
Na Numerical Ability
Vr/Na - Verbal Reasoning/Numerical Ability
Abst - Abstract Reasoning
Cler - Clerical Speed and Accuracy
Mech - Mechanical Reasoning
Space - Space Relations
Spel - Spelling
Lang U - Language Usage

n = refer to Table 1
$p<.05$

confounded variable Vr/Na. Unlike relationships within the C.T.B.S., correlations within the D.A.T. vary widely in degrees of significance. Expectedly, Vr/Na correlates strongly with both components of which it is comprised. Strong correlations are also evident between Vr/Na and Language Usage (.69). The two achievement variables of Spelling and Language Usage exhibit a positive correlation with each other (.66). A further positive relationship is evident between Language Usage and both Verbal Reasoning and Numerical Ability (.64 and .60 respectively).

Clerical Speed and Accuracy showed little or no significance with all other variables. Relationships of least significance were between Clerical Speed and Accuracy and both Space Relations and Mechanical Reasoning.

Question 1 was also examined by establishing the relationship between grade 9 teacher marks and both the D.A.T. and C.T.B.S. Each of four subjects was correlated with 14 variables. Tables 4 and 5 report the findings.

In comparing teacher marks with achievement variables of the C.T.B.S., it is observed that assigned grades in Language Arts 9 are correlated more positively with variables in the C.T.B.S. than are teacher marks assigned to Mathematics 9. For example, the teacher mark for Language Arts 9 has a stronger relationship to C.T.B.S. Mathematics (.72) than does the teacher mark for Mathematics 9 (.67). The degree of differential validity decreases, in that predictor variables other than those intended to measure Language Arts 9 become similarly powerful in predicting achievement.

Meaningful relationships were also recorded between Science 9 and C.T.B.S. Reading (.67), Work-Study Skills (.69) and Mathematics (.71). Most positive correlates with marks in Social Studies 9 were Reading (.61) and Mathematics (.60).

Within the DAT., Vr/Na exhibits a strong positive relationship when compared to grade 9 subjects. The correlation between Vr/Na and Science 9 is .70, while the correlation between Vr/Na and Language Arts 9 is .69. These are the two strongest relationships recorded in Table 5.

TABLE 4

CORRELATION BETWEEN THE CANADIAN TESTS OF BASIC SKILLS AND GRADE 9 SUBJECTS

	C.T.B.S.					
	Voc	Read	Lang	WkSt	Math	Comp
Language Arts 9	.609	.681	.736	.657	.720	.763
Mathematics 9	.441	.550	.531	.606	.673	.632
Social Studies 9	.564	.607	.534	.551	.602	.638
Science 9	.592	.670	.611	.685	.711	.731

Grade 9 Subjects

Legend
Voc - Vocabulary
Read - Reading
WkSt - Work-Study Skills
Lang - Language
Math - Mathematics
Comp - Composite

n = refer to Table 1
$p < .05$

TABLE 5

CORRELATIONS BETWEEN THE DIFFERENTIAL APTITUDE TESTS AND GRADE 9 SUBJECTS

Differential Aptitude Tests

Grade 9 Subjects	Vr	Na	Vr/Na	Abst	Cler	Mech	Space	Spel	LangU
Language Arts 9	.583	.666	.692	.484	.235	.223	.361	.577	.602
Mathematics 9	.514	.657	.648	.453	.157	.270	.493	.325	.419
Social Studies 9	.520	.565	.603	.465	.290	.228	.388	.442	.517
Science 9	.589	.674	.698	.556	.143	.424	.493	.424	.525

Legend
Vr - Verbal Reasoning
Na - Numerical Ability
Vr/Na - Verbal Reasoning/Numerical Ability
Abst - Abstract Reasoning
Cler - Clerical Speed and Accuracy
Mech - Mechanical Reasoning
Space - Space Relations
Spel - Spelling
LangU - Language Usage

n = refer to Table 1
$p < .05$

The achievement variables of the D.A.T. show a relationship no stronger to Language Arts 9 than do the Verbal Reasoning and Numerical Ability subtests. Language Usage shows a correlation co-efficient of .60 with Language Arts 9, whereas Numerical Ability exhibits a co-efficient of .67.

Similarly, the correlation co-efficient of .58 between D.A.T. Spelling and Language Arts 9 is no stronger than the relationship between Verbal Reasoning and Language Arts 9. Taken separately, both Verbal Reasoning and Numerical Ability show strong relationships with grade 9 marks.

Weakest relationships existed when comparison was made between both Clerical Speed and Accuracy and Mechanical Reasoning to student achievement in grade 9 subjects. The only exception to this is noted in the relationship between Mechanical Reasoning and Science 9. A correlation of .42 is cited in Table 5.

The final examination of Question 1 compared student performance in Provincial Achievement Tests to achievement in four grade 9 core subjects. Expectedly (as shown in Table 6), a high correlation was recorded between Mathematics 9 scores and the 1984 Provincial Mathematics exam (.74). The 1984 Provincial Mathematics test also correlated positively to performance in Science 9 (.76). The 1983 Provincial Social Studies results showed strong correlations with achievement in Social Studies 9 (.63), but an equally strong relationship to performance in Science 9 (.65) and Language Arts 9 (.66).

(B) QUESTION 2

What relationship exists between teacher marks in grade 10 and (a) the Canadian Tests of Basic Skills, (b) Differential Aptitude Tests, (c) Provincial Achievement Tests?

Table 7 examines the correlation between six C.T.B.S. variables and performance in five academic subjects related to high school english and mathematics. The strongest relationship was evident when C.T.B.S. subtests were correlated with English 10 (the more difficult of two available high school courses which enrolled 440 students from this sample). C.T.B.S. Reading showed a positive relationship of .61 with English 10, as did

TABLE 6

CORRELATIONS BETWEEN PROVINCIAL ACHIEVEMENT TESTS AND GRADE 9 SUBJECTS

	Provincial Mathematics 1984	Provincial Social Studies 1983
Mathematics 9	.744	.501
Social Studies 9	.630	.628
Science 9	.756	.650
Language Arts 9	.653	.659

n = refer to Table 1
$p<.05$

TABLE 7

CORRELATIONS BETWEEN CANADIAN TESTS OF BASIC SKILLS SUBTESTS AND HIGH SCHOOL SCORES IN ENGLISH AND MATHEMATICS

	C.T.B.S. Subtests					
	Voc	Read	Lang	WkSt	Math	Comp
English 10	.480	.610	.613	.560	.564	.662
English 13	.338	.282	.524	.064	.363	.404
Mathematics 10	.324	.442	.397	.540	.513	.564
Mathematics 13	.196	.336	.335	.309	.434	.409
Mathematics 15	.346	.436	.413	.154	.362	.439

Grade 10 Subjects

Legend
Voc - Vocabulary
Read - Reading
Lang - Language
WkSt - Work-Study Skills
Math - Mathematics
Comp - Composite

n = refer to Table 1
$p<.05$

the C.T.B.S. Language score. The C.T.B.S. Composite score showed the most significant relationship with English 10. The recorded correlation coefficient was .66.

Correlations between the C.T.B.S. and English 13 were less impressive. This non-academic subject included 116 students from the studied sample. Vocabulary and Reading correlated at .34 and .28 respectively with English 13. The relationship between Work-Study Skills and English 13 showed no significance (.06).

Correlations established when the C.T.B.S. was analyzed with Mathematics 10, 13 and 15 ranged from insignificant (.06) to meaningful (.44). A correlation of .15 between Work-Study Skills and Mathematics 15 was recorded. The relationship between Work-Study Skills and Mathematics 10 was identified as .54.

Generally, the C.T.B.S. subtests correlated more positively with academic subjects than with Mathematics 13, Mathematics 15 and English 13. An example is relevant to Work-Study Skills. The correlation with English 13 is recorded as .06, but the correlation with English 10 is identified as .56.

A further examination of the C.T.B.S. and high school courses is cited in Table 8. Strong relationships are evident when six C.T.B.S. variables are correlated with Social Studies 10, Chemistry 10 and Biology 10. The C.T.B.S. Composite score correlates most highly with Social Studies 10 (.72) and Chemistry 10 (.65). Correlations with Physics 10 are not as strong, and the relationship to Science 11 shows little significance.

Table 9 indicates the relationship between the Vr/Na subtest (an intended measure of overall general aptitude) and 10 subjects ~~offered in~~ the tenth grade. Correlations with the academic courses (Mathematics 10, Social Studies 10, Biology 10, Chemistry 10, Physics 10 and English 10) range from .42 to .67. Weaker relationships are evident when Vr/Na is correlated with Science 11 and English 13.

The correlation between the D.A.T. achievement subtests and high school scores in English show some significance. A higher correlation is noted when D.A.T. Spelling and D.A.T. Language Usage are correlated to Social Studies 10, as identified in Table 10.

TABLE 8

CORRELATIONS BETWEEN CANADIAN TESTS OF BASIC SKILLS SUBTESTS AND HIGH SCHOOL SCORES IN SOCIAL STUDIES AND THE SCIENCES

	C.T.B.S. Subtests					
	Voc	Read	Lang	WkSt	Math	Comp
Social Studies 10	.635	.682	.621	.623	.633	.720
Chemistry 10	.455	.591	.541	.625	.570	.651
Biology 10	.494	.614	.624	.558	.509	.624
Physics 10	.287	.461	.350	.475	.401	.487
Science 11	.201	.262	.275	.064	.195	.209

Grade 10 Subjects

Legend
Voc - Vocabulary
Read - Reading
Lang - Language
WkSt - Work-Study Skills
Math - Mathematics
Comp - Composite

n = refer to Table 1
$p<.05$

TABLE 9

CORRELATION BETWEEN THE VERBAL REASONING/NUMERICAL ABILITY SUBTEST ON THE DIFFERENTIAL APTITUDE TESTS AND GRADE 10 SUBJECTS

	Differential Aptitude Tests (Vr/Na)		
	Vr/Na		Vr/Na
Mathematics 10	.576	Biology	.574
Mathematics 13	.451	Chemistry 10	.642
Mathematics 15	.434	Physics 10	.422
Social Studies 10	.668	English 10	.532
Science 11	.202	English 13	.377
Grade 10 Subjects			

n = refer to Table 1
$p<.05$

TABLE 10

CORRELATION BETWEEN DIFFERENTIAL APTITUDE TESTS ACHIEVEMENT VARIABLES AND RESULTS IN ENGLISH 10, 13 AND SOCIAL STUDIES 10

	D.A.T. *Spelling*	D.A.T. *Language Usage*
English 10	.382	.472
English 13	.237	.352
Social Studies 10	.439	.528

n = refer to Table 1
$p<.05$

In Table 11, correlations between Alberta Provincial Achievement Tests in both Social Studies (1983) and Mathematics (1984) are established with four high school subjects. The correlation between the Provincial Mathematics (1984) exam and three of four academic subjects investigated were significantly positive. The relationship between grade 10 teacher marks and the Provincial Mathematics achievement test is not as strong as that between Provincial Mathematics (1984) and teacher marks in Mathematics 9, as earlier cited in Table 6. Noteworthy is that Provincial Social Studies (1983) results correlated almost equally as strong with Mathematics 10 (.52) as did the 1984 Provincial Mathematics exam (.56). Of further importance is the high positive correlation between Provincial Social Studies (1983) and Social Studies 10 (.72).

(C) QUESTION 3

What relationship exists between the D.A.T. and the C.T.B.S.?

Table 12 identifies the relationship between these standardized tests. The strongest correlation is between the Composite score on the C.T.B.S. and Vr/Na (.83). The Vr/Na subtest also shows a strong connection with all other variables on the C.T.B.S.

The achievement variables of the D.A.T. are related in meaningful ways to specific C.T.B.S. subtests. The Language Usage subtest of the D.A.T. correlates highly with the Language variable of the C.T.B.S. (.68). The D.A.T. Spelling subtest bears a strong relationship to the Language subtest of the C.T.B.S. This correlation is identified as .71.

Correlations between other D.A.T. subtests and the C.T.B.S. ranged in the degree of significance. The correlation between Clerical Speed and Accuracy and all C.T.B.S. subtests was of little significance, ranging from .16 to .27. Mechanical Reasoning did not correlate highly with specific subtests of the C.T.B.S. The correlation between the D.A.T. subtest and C.T.B.S. Reading was .37. The relationship between Mechanical Reasoning and C.T.B.S. Language was .28. Space Relations displayed the strongest relationship of these remaining variables when compared with the C.T.B.S. Recorded correlations ranged from .39 to .53.

TABLE 11

CORRELATION BETWEEN PROVINCIAL ACHIEVEMENT TESTS AND HIGH SCHOOL SCORES IN SOCIAL STUDIES AND MATHEMATICS

	Math 10	Math 13	Math 15	Soc 10
Prov Math	.559	.362	.512	.606
Prov Soc	.516	.623	.336	.723

Legend
Math 10, 13, 15 - Mathematics 10, 13, 15
Soc 10 - Social Studies 10
Prov Math - Provincial Mathematics (1984)
Prov Soc - Provincial Social Studies (1983)

n = refer to Table
$p<.05$

TABLE 12

CORRELATIONS BETWEEN SUBTESTS IN THE CANADIAN TESTS OF BASIC SKILLS AND THE DIFFERENTIAL APTITUDE TESTS

	C.T.B.S.					
	Voc	Read	Lang	Wk St	Math	Comp
Verbal Reasoning	.712	.691	.609	.622	.632	.720
Numerical Ability	.548	.658	.646	.684	.807	.760
Vr/Na	.713	.752	.699	.729	.787	.827
Abstract Reasoning	.450	.515	.473	.537	.628	.587
Clerical Speed & Accuracy	.161	.190	.185	.195	.265	.222
Mechanical Reasoning	.433	.365	.275	.415	.381	.425
Space Relations	.429	.448	.385	.521	.527	.530
Spelling	.556	.561	.705	.520	.511	.641
Language Usage	.629	.615	.678	.544	.565	.683
D.A.T.						

Legend
Voc - Vocabulary
Read - Reading
Lang - Language
Wk St - Work-Study Skills
Math - Mathematics
Comp - Composite

n = refer to Table 1
p<.05

This question was also addressed by the use of a factor analysis followed by a varimax rotation. Factor loadings are illustrated in Table 13. Included as data for this statistical procedure were all subtests of the C.T.B.S., D.A.T. and four subjects in grade 9 Table 13 contains a summary of information which is more detailed in *Appendix C*.

Factor 1 in Table 13 indicates that a commonality exists with tests which could be identified as *language*. Three C.T.B.S. subtests (Language, Reading,Vocabulary) and three D.A.T. subtests (Language Usage, Spelling, and Verbal Reasoning) are included in this cluster. The subtests which comprise Factor 1 obviously involve an ability to utilize reading and language skills, and more specifically involve an efficiency in using visual cues to recognize correctly written language and to comprehend the same.

The Numerical Ability subtest of the D.A.T., the Mathematics score on the C.T.B.S. and the Work-Study Skills subtest of the C.T.B.S. comprise a second cluster, identified as Factor 2, *numerical*. The core subjects used as marker variables are also included in this group of values. Subtests of the C.T.B.S. and the D.A.T. which are included in this factor require that the student has the ability to complete calculations and to solve simple mathematical problems. Work-Study Skills involves tasks which in part place emphasis on using information presented in numerical form. One must be able to interpret graphs, maps, and tables.

Factor 3 in Table 13 can be classified as *abstract*. Included as a cluster are Abstract Reasoning (.66), Space Relations (.77) and Mechanical Reasoning (.80), all subtests of the D.A.T. These three subtests require one to project a correct answer, taking into account visual cues which are presented on paper. (The skills measured are those which one would attribute to those individuals who are in trades which may require one to draft a blueprint or to show an aptitude in mechanical areas). These three subtests would be the least likely to measure conventional reading skills.

In column 4, Clerical Speed and Accuracy is isolated (.93). It can be labelled as *fine motor*. This test is the only one which is related directly to eye-hand co-ordination

TABLE 13

FACTOR ANALYSIS OF THE CANADIAN TESTS OF BASIC SKILLS, DIFFERENTIAL APTITUDE TESTS AND CORE GRADE 9 SUBJECTS

Factor	Name	Items	Factor Loading
1	Language	Spelling (D.A.T.)	.80
		Language Usage (D.A.T.)	.77
		Language (C.T.B.S.)	.76
		Vocabulary (C.T.B.S.)	.74
		Composite (C.T.B.S.)	.71
		Reading (C.T.B.S.)	.70
		Verbal Reasoning (D.A.T.)	.70
2	Numerical	Mathematics (C.T.B.S.)	.67
		Vr/Na (D.A.T.)	.65
		Work-Study Skills (C.T.B.S.)	.62
		Numerical Ability (D.A.T.)	.57
		Language Arts 9	.67 *
		Social Studies 9	.67 *
		Science 9	.74 *
		Mathematics 9	.85 *
3	Abstract	Mechanical Reasoning (D.A.T.)	.80
		Space Relations (D.A.T.)	.77
		Abstract Reasoning (D.A.T.)	.66
4	Fine Motor	Clerical Speed and Accuracy (D.A.T.)	.93

* Denotes core subjects as marker variables

and o[illegible]ity to work within a strict time frame. A student is required to exhibit skills in eye-hand co-ordination through pencil manipulation. The subtest must be completed within a three minute time frame.

(D) QUESTION 4

What relationship exists between teacher marks in grade 9 and grade 10 ?

Six grade 10 academic-level courses were selected as criterion variables for which prediction of academic achievement was desired. Each grade 10 subject was subsequently examined to indicate which grade 9 core subject would be the most powerful single predictor of grade 10 performance. This was done by selecting the grade 9 core subject which correlated most highly with the criterion variable.

Academic courses were selected over those less academic in scope. An examination of predictor variables suggested that weaker correlations were obtained in relationships between non-academic subjects in grade 10 and the four predictor variables in grade 9. Secondly, students generally request information relevant to their chances for successful achievement in academic areas. Once those chances are evident, the choice becomes that of completing the less academic course by enrolling in the easier route of studies.

Table 14 identifies correlations between grade 9 core subjects and all 10 criterion variables used in this study. Seven expectancy tables were subsequently constructed (Tables 15 to 21). Social Studies 9 was correlated most positively with Social Studies 10 (.72), Physics 10 with Mathematics 9 (.74) and Chemistry 10 with Science 9 (.77). This would be expected, since grade 10 subjects should be predicted by grade 9 prerequisites. An exception to this was Biology 10. This correlates more positively with Language Arts 9 (.71) than with Science 9 (.69). However, the difference in these two relationships is insignificant. Two expectancy tables are constructed for Biology 10. One cross-tabulates Language Arts 9 as the most positive correlate, while the other is referenced to Science 9. The inclusion of the latter table is relevant to this thesis and may have a greater face validity when made available to students.

TABLE 14

CORRELATIONS BETWEEN GRADE 9 CORE SUBJECTS AND GRADE 10 COURSES

	Grade 9 Subjects			
	Lang 9	Math 9	Soc 9	Sci 9
Social Studies 10	.697	.636	.710	.681
Biology 10	.705	.590	.639	.685
Physics 10	.538	.646	.558	.595
Chemistry 10	.634	.741	.633	.770
Mathematics 10	.579	.743	.557	.706
English 10	.713	.560	.577	.579
Mathematics 13	.326	.335	.295	.517
Mathematics 15	.306	.189	.586	.368
Science 11	.218	.042	.154	.314
English 13	.399	.072	.326	.366

Grade 10 Subjects

Legend
Lang 9 - Language Arts 9
Math 9 - Mathematics 9
Soc 9 - Social Studies 9
Sci 9 - Science 9

n = refer to Table 1
$p < .05$

TABLE 15

EXPECTANCY TABLE CROSS-TABULATING SOCIAL STUDIES 9 AND SOCIAL STUDIES 10

	Social Studies 10					
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	4	8	1	0	0	0
40-49	8	12	16	3	1	0
50-59	4	21	54	29	2	2
60-69	1	18	58	79	14	6
70-79	3	1	9	43	48	23
80-100	1	1	2	11	27	48

Social Studies 9

n=558

TABLE 16

EXPECTANCY TABLE CROSS-TABULATING LANGUAGE ARTS 9 AND ENGLISH 10

English 10

%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	0	0	0	0	0	0
40-49	2	1	0	0	0	0
50-59	2	13	32	9	1	0
60-69	3	9	64	50	19	0
70-79	0	5	20	53	37	11
80-100	0	0	3	17	34	51

Language Arts 9

n=436

TABLE 17

EXPECTANCY TABLE CROSS-TABULATING MATHEMATICS 9 AND MATHEMATICS 10

	Mathematics 10					
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	2	1	0	0	0	0
40-49	2	3	2	1	0	0
50-59	24	11	14	5	1	0
60-69	6	17	41	27	6	2
70-79	1	3	26	28	20	6
80-100	0	2	15	14	27	46

Mathematics 9

n=353

TABLE 18

EXPECTANCY TABLE CROSS-TABULATING MATHEMATICS 9 AND PHYSICS 10

			Physics 10			
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	2	1	1	0	0	0
40-49	3	1	0	2	0	0
50-59	1	6	9	5	1	0
60-69	2	8	30	17	5	2
70-79	1	1	19	18	15	8
80-100	0	3	10	18	16	38

Mathematics 9

n=243

TABLE 19

EXPECTANCY TABLE CROSS-TABULATING SCIENCE 9 AND CHEMISTRY 10

			Chemistry 10			
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	0	1	0	0	0	1
40-49	7	13	2	1	0	0
50-59	11	33	26	7	0	2
60-69	7	11	54	46	16	3
70-79	0	4	21	37	30	15
80-100	0	0	2	7	22	43

Science 9

n=425

TABLE 20

EXPECTANCY TABLE CROSS-TABULATING SCIENCE 9 AND BIOLOGY 10

			Biology 10			
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	2	0	0	0	0	1
40-49	7	15	10	5	0	0
50-59	14	26	38	13	5	2
60-69	6	19	54	42	14	3
70-79	1	3	19	36	28	17
80-100	0	1	2	14	23	34

Science 9

n=454

TABLE 21

EXPECTANCY TABLE CROSS-TABULATING LANGUAGE ARTS 9 AND BIOLOGY 10

	Biology 10					
%	0-39	40-49	50-59	60-69	70-79	80-100
0-39	0	0	0	0	0	0
40-49	6	5	3	1	0	0
50-59	13	26	23	4	2	0
60-69	10	25	59	42	7	5
70-79	1	8	30	39	31	10
80-100	0	1	8	24	30	42

Language Arts 9

n=455

(E) QUESTION 5

What grade 9 variables are the most powerful predictors of grade 10 achievement?

This question was examined by analyzing five separate combinations of predictor variables through step-wise multiple regression. Each combination identified when the study method was described in Chapter 3 is addressed separately as this question is addressed. The five combinations are as follows:

(1) Grade 9 Teacher Marks with each Criterion Variable

When the criteria for inclusion were *pin .10* and *pout .15*, either a three-step or four-step multiple regression was recorded for predicting achievement in all academic level courses. One-step or two-step regressions were obtained for other high school courses which required fewer academic skills. When using only teacher marks to identify strongest predictors of achievement, the most powerful regression coefficients were available for Chemistry 10, Mathematics 10 and Social Studies 10. The strongest predictor included Chemistry 10 as the dependent variable. Results in Science 9, Mathematics 9 and Social Studies 9 were included respectively in each step of the regression. The accounted for variance was 67%. Another powerful step-wise regression identified Mathematics 10 as a dependent variable. The accounted for variance was 65%. When academic subjects were used as dependent variables, grade 10 achievement could be predicted with more power than if non-academic variables were considered.

Weakest regression coefficients were recorded for English 13 and Science 11. The variance accounted for was 19.21% when results from Language Arts 9 and Science 9 were included respectively in each step used to predict English 13 performance. When achievement in Science 11 was predicted by using Science 9 in a one-step regression, the total variance accounted for was 9.9%. Science 9 was consistently a good predictor of academic success in grade 10 subjects, accounting for variance in science-related subjects and other subjects as well. Table 22 identifies which variables in grade 9 are the most powerful predictors of achievement at the grade 10 level.

TABLE 22

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT USING GRADE 9 TEACHER MARKS

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	59.20		.56	612.26
2	Mathematics 9	66.66	Chemistry 10	.38	420.81
3	Social Studies 9	67.70		.19	293.43

Standard Error = 8.89
Constant = -14.64
n=424

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	49.74		.51	447.24
2	Science 9	58.60	Biology 10	.42	319.14
3	Social Studies 9	59.31		.16	218.63

Standard Error = 9.44
Constant = -13.73
n=454

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mathematics 9	41.57		.44	170.75
2	Social Studies 9	46.91	Physics 10	.28	105.59
3	Science 9	49.22		.28	76.89

Standard Error = 10.48
Constant = -7.87
n=424

Table 22 continued

TABLE 22 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	50.44		.33	564.86
2	Science 9	57.29	Social Studies 10	.20	371.63
3	Language Arts 9	59.72		.24	273.30
4	Mathematics 9	60.46		.11	211.01

Standard Error = 8.56
Constant = 5.08
n=557

1	Language Arts 9	50.92		.66	449.31
2	Science 9	53.88	English 10	.17	252.31
3	Mathematics 9	54.26		.08	170.43

Standard Error = 8.25
Constant =.74
n=435

1	Language Arts 9	14.89		.32	19.41
2	Science 9	19.21	English 13	.24	13.08

Standard Error = 9.77
Constant = 27.59
n=113

Table 22 continued

TABLE 22 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mathematics 9	55.21		.60	430.24
2	Science 9	64.43	Mathematics 10	.54	315.22
3	Language Arts 9	65.36		.21	218.24

Standard Error = 9.79
Constant = -34.90
n=351

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	26.77		.69	51.92
2	Mathematics 9	30.30	Mathematics 13	.24	30.65

Standard Error = 11.64
Constant = 6.22
n=144

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	34.33	Mathematics 15	.65	33.98

Standard Error = 9.82
Constant = 22.38
n=67

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	9.85	Science 11	.37	9.61

Standard Error = 9.82
Constant = 40.84
n=9

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

(2) Grade 9 marks and Provincial Achievement Test results with grade 10 subjects

Because the Provincial examinations in Social Studies 9 and Mathematics 9 were administered in consecutive academic years, no valid cases would be recorded for purposes of step-wise regression if both were included together with teacher marks as predictor variables. As a result, each Alberta Provincial examination was separately combined with teacher marks as the most powerful predictors of high school achievement were analyzed.

When the Provincial Mathematics (1984) mark was included in Step 3 of a regression used to predict achievement in Social Studies 10, the amount of added variance was only .42%. However, in Mathematics 15, 8.09% of variance was added by using the Provincial Mathematics mark in combination with the Social Studies 9 mark. Noteworthy is that the sample was relatively small, only including 28 people. Results of regressions in which the 1984 Provincial Mathematics exam was included in a step-wise regression are recorded in Table 23.

Table 24 illustrates step-wise regressions in which the grade 9 Provincial Social Studies (1983) results contributed to prediction of academic achievement in 5 of 10 high school courses. As a predictor of achievement in English 13, it placed in the first step of the regression. In predicting student performance in Chemistry 10, the Provincial test accounted for 2.53% of added variance in Step 3. The total variance accounted for in this regression was 75.81%, the most powerful of those listed.

The power with which the Provincial Social Studies (1983) test contributes to specific step-wise regressions relevant to high school courses indicates the degree of content validity in the test, as previously discussed in Chapter 2 of this thesis. Content validity relates to criterion validity. In this context, both Provincial tests are strong predictors of achievement in non-academic subjects. Success on the Provincial Social Studies (1983) exam is a powerful predictor of success in English 13, while performance in the Provincial Mathematics (1984) test will assist in predicting Mathematics 15 scores.

TABLE 23

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT FROM GRADE 9 TEACHER MARKS AND PROVINCIAL MATHEMATICS TEST

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	57.7[illegible]		.44	342.53
2	Language Arts 9	66.34	Social Studies 10	.41	246.39
3	Prov Math	66.76		.06	166.71

Standard Error = 3.66
Constant = 3.66
n=253

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	45.96	Mathematics 15	.58	22.12
2	Prov Math	53.05		.24	14.13

Standard Error = 6.93
Constant = 18.54
n=28

Legend
Prov Math - Provincial Mathematics (1984)

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

TABLE 24

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT FROM GRADE 9 TEACHER MARKS AND PROVINCIAL SOCIAL STUDIES TEST

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Prov Soc	37.42		.32	23.32
2	Language Arts 9	54.67	English 13	.38	22.91
3	Science 9	62.23		.25	20.32

Standard Error =5.72
Constant = 7.22
n = 41

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	55.69		.66	194.77
2	Mathematics 9	66.95	Mathematics 10	.48	156.00
3	Prov Soc	68.06		.14	108.65

Standard Error = 9.17
Constant = -28.74
n = 157

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	53.19		.53	217.03
2	Language Arts 9	65.04	Biology 10	.48	176.76
3	Prov Soc	66.08		.13	122.76

Standard Error = 8.32
Constant = -17.04
n = 193

Table 24 continued

TABLE 24 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	63.95		.59	294.46
2	Mathematics 9	72.60	Chemistry 10	.35	218.54
3	Prov Soc	75.13		.17	165.13
4	Social Studies 9	75.81		.17	127.70

Standard Error = 7.82
Constant = -26.01
n = 168

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	49.69		.79	42.47
2	Prov Soc	55.76	Mathematics 13	.35	26.47
3	Mathematics 9	61.52		.32	21.85

Standard Error = 8.48
Constant = -23.31
n = 45

Legend
Prov Soc - Provincial Social Studies (1983)

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

(3) The C.T.B.S. and the D.A.T. with each criterion variable.

In predicting student performance in grade 10, the C.T.B.S. Composite score was the most powerful contributor to the regression. This is consistent with the correlations previously cited in this chapter. Correlations between this confounded variable and criterion variables were consistently stronger than those which involve (a) any other individual subtest within the C.T.B.S. and (b) any subtest within the D.A.T. It could then be expected that C.T.B.S. Composite would involve powerful regression co-efficients in terms of prediction when these two measures of ability and achievement are considered. Within the table, the total variance accounted for ranged from 17.96% (when Science 11 was used as a criterion variable) to 56.87% when Social Studies 10 was the subject for which prediction was obtained.

Noteworthy was that Work-Study Skills, a C.T.B.S. subtest measuring graphing and research skills, was included in regressions in three instances. This subtest has been sometimes excluded when the C.T.B.S. is administered to students in grade school. C.T.B.S. and D.A.T. subtests used in ten step-wise regressions are identified in Table 25.

(4) Grade 9 teacher marks, results of the C.T.B.S. and D.A.T. with grade 10 subjects

With the exception of Provincial test results, all variables were used in this segment of the study, which is identified in Table 26. Inclusion of the Provincial tests would have diminished the sample by one-half and in some cases would decrease the number of students. Regressions would not be meaningful. Secondly, results of a Provincial exam in grade Social Studies 9 and Mathematics 9 are only made available every four years. Thus the utility of inclusion could be questionable. Finally, the power of Provincial tests had already been determined in combination with grade 9 teacher marks, measures which are all intended to be directly related to the grade 9 curriculum.

In 8 of 10 regressions, grade 9 teacher-assigned marks were included in the first step. When courses academic in nature were used as dependent variables, the predictor which would be described as a prerequisite to a grade 10 course was included in Step 1.

TABLE 25

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT USING THE CANADIAN TESTS OF BASIC SKILLS AND THE DIFFERENTIAL APTITUDE TESTS

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	43.60		.39	129.85
2	Numerical Ability	45.33	Chemistry 10	.37	69.24
3	Work-Study Skills	46.51		.30	48.12
4	Mech	47.73		.23	37.67

Standard Error = 10.93
Constant = -18.28
n = 170

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	42.79	Biology 10	.99	133.16

Standard Error = 11.66
Constant = 24.92
n = 180

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Work-Study Skills	20.12	Physics 10	.47	26.96
2	Mech	23.87		.37	16.62

Standard Error = 12.12
Constant = 1.74
n = 109

Table 25 continued

TABLE 25 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	53.78		.69	259.49
2	Verbal Reasoning	56.27	Social Studies 10	.36	142.81
3	Abst	56.86		-.15	97.10

Standard Error = 9.07
Constant = 1.57
n = 225

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	46.27		.86	152.42
2	Lang U (D.A.T.)	47.09	English 10	.18	78.33
3	Voc (C.T.B.S,)	47.47		.16	53.79

Standard Error = 8.[illegible]
Constant = 1.28
n = 179

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Lang (C.T.B.S.)	21.44		.44	12.28
2	Verbal Reasoning	30.47	English 13	.43	9.64
3	Work-Study Skills	37.82		.36	8.72
4	Math (C.T.B.S.)	45.22		.35	8.67

Standard Error = 7.27
Constant = 21.15
n = 47

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	28.05		1.39	51.08
2	Spelling (D.A.T.)	30.94	Mathematics 10	-.16	29.12
3	Voc (C.T.B.S.)	32.99		-.29	21.17

Standard Error = 11.59
Constant = -27.31
n = 133

Table 25 continued

TABLE 25 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Numerical Ability	21.38	Mathematics 13	.71	18.76
2	Composite	27.26		.43	12.74

Standard Error = 11.42
Constant = 10.78
n = 71

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Reading	31.56	Mathematics 15	.27	12.45
2	Voc (C.T.B.S.)	40.58		.31	8.88

Standard Error = 6.98
Constant = 15.96
n = 29

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Usage	17.96	Science 11	.53	8.54

Standard Error = 10.33
Constant = 47.76
n = 41

Legend
Mech - Mechanical Reasoning
Abst - Abstract Reasoning
Lang U (D.A.T.) - Language Usage (D.A.T.)
Lang (C.T.B.S.) - Language (C.T.B.S.)
Voc (C.T.B.S.) - Vocabulary (C.T.B.S.)
Math (C.T.B.S.) - Mathematics (C.T.B.S.)

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

TABLE 26

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT FROM GRADE 9 MARKS, CANADIAN TESTS OF BASIC SKILLS AND DIFFERENTIAL APTITUDE TESTS

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	48.03		.44	155.23
2	Mathematics 9	57.30	Chemistry 10	.36	112.03
3	Work-Study Skills	60.49		.27	84.71

Standard Error = 9.26
Constant = 14.29
n = 170

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	52.11		.63	193.71
2	Science 9	58.75	Biology 10	.35	126.05
3	Reading (C.T.B.S.)	60.30		.25	89.09

Standard Error = 9.75
Constant = -26.03
n = 180

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mathematics 9	36.14	Physics 10	.50	59.99
2	Science 9	40.26		.31	35.38

Standard Error = 10.67
Constant = 5.70
n = 108

Table 26 continued

TABLE 26 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Composite	53.37		.28	255.26
2	Social Studies 9	60.22		.25	168.03
3	Science 9	62.82	Social Studies 10	.22	124.46
4	Verbal Reasoning	64.10		.28	98.20
5	Abstract R	65.32		-.22	82.50
6	Language Arts 9	66.03		.17	70.62

Standard Error = 8.07
Constant = -2.48
n = 225

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	48.12		.31	165.08
2	Composite	54.81		.34	107.32
3	Mathematics 9	57.13	English 10	.13	78.18
4	Social Studies 9	58.64		.22	62.02
5	Clerical S & A	59.68		-.08	51.50

Standard Error = 7.37
Constant = -6.27
n = 180

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	22.78		.45	12.98
2	Verbal Reasoning	32.92	English 13	.46	10.55
3	Work-Study Skills	41.31		-.36	9.89
4	Mathematics 9	47.33		.32	9.21

Standard Error = 7.13
Constant = 21.88
n = 46

Table 26 continued

TABLE 26 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (E)
1	Mathematics 9	39.87		.50	86.88
2	Work-Study Skills	48.97	Mathematics 10	.32	62.37
3	Science 9	52.86		.29	48.22
4	Language Arts 9	54.08		.22	37.69
Standard Error = 9.58 Constant = 38.60 n = 133					
1	Science 9	31.51		.61	31.74
2	Ma[illegible]	38.73	Mathematics 13	.29	21.49
3	Composite	41.20		.45	15.65
4	Spelling (D.A.T.)	43.86		-.19	12.89
Standard Error = 10.11 Constant = -13.65 n = 71					
1	Social Studies 9	37.33	Mathematics 15	.62	16.09
2	Mathematics 9	46.26		-.21	11.19
Standard Error = 6.64 Constant = 33.53 n = 29					

Table 26 continued

TABLE 26 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mech R	12.38	Science 11	.42	5.65

Standard Error = 10.96
Constant = 42.54
n = 42

Legend
Abstract R - Abstract Reasoning
Cler S & A - Clerical Speed & Accuracy
Mech R - Mechanical Reasoning
Composite - Composite (C.T.B.S.)

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

Exceptions to this were evident when Social Studies 10 and Biology 10 were the dependent variables. In Social Studies 10, the Composite C.T.B.S. was included in Step 1, while in Biology 10 the Language Arts Score was recorded. The strongest regressions were evident when the dependent variables were Social Studies10 and English 10, in which total variance accounted for was 66.03% and 59.68% respectively (refer to Table 26).

(5) Grade 9 teacher marks and D.A.T. results with each grade 10 subject.

Step-wise regressions which were calculated in each case included both teacher marks in grade 9 subjects and results from individual D.A.T. subtests. In 5 of 10 multiple regressions, teacher marks were included in the first two steps. In all except two regressions, a teacher mark was included in Step 1.

The exceptions to this were evident when the dependent variables were English 13 and Science 11. In these regressions, Vr/Na and the D.A.T. Language Usage subtest, respectively, accounted for Step 1. However, the variance accounted for after Step 1 was approximately 12% in each instance, much less powerful than when teacher marks were initial contributors.

Grade 9 courses which would be expected to be predictors of achievement in grade 10 were generally strong contributors in courses which were the most academic in scope. Science 9 and Mathematics 10 together acounted for over 66% of the variance when Chemistry 10 was the dependent variable. Mathematics 9 and Science 9 together accounted for over 48% of the variance in Physics 10. Table 27 identifies ten regressions when using the identified predictors and criteria.

Step-wise regressions identified in Tables 22 through 27 can be calculated through (1) the use of scores obtained in each of the predictor variables, (2) the recorded regression coefficient which is included in each step and (3) the identified constant. *Appendix B* identifies the method by which equations can be derived, using appropriate information cited in all regression equations above.

TABLE 27

STEP-WISE MULTIPLE REGRESSION PREDICTING GRADE 10 ACHIEVEMENT FROM GRADE 9 MARKS AND THE DIFFERENTIAL APTITUDE TESTS

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	57.90		.48	449.71
2	Mathematics 9	66.10		.34	317.80
3	Language Usage	67.54	Chemistry 10	.17	225.38
4	Social Studies 9	68.01		.12	172.18
5	Numerical Ability	68.40		.19	139.86

Standard Error = 8.49
Constant = 11.60
n = 329

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	55.16		.55	423.16
2	Science 9	63.14		.42	293.72
3	Social Studies 9	63.53	Biology 10	.15	198.62
4	Cler S & A	64.05		-.07	151.86
5	Language Usage	64.35		.11	122.76

Standard Error = 9.0
Constant = 15.49
n = 346

Table 27 continued

TABLE 27 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mathematics 9	41.67		.43	133.57
2	Science 9	48.47	Physics 10	.36	87.49
3	Social Studies 9	50.66		.25	63.33

Standard Error = 10.07
Constant = 11.03
n = 189

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	52.47		.37	458.06
2	Science 9	62.72		.24	231.62
3	Abstract R	63.59	Social Studies 10	-.16	179.90
4	Verbal Reasoning	64.07		.35	146.55
5	Language (D.A.T.)	64.60		.16	150.00

Standard Error = 7.93
Constant = 11.03
n = 417

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Arts 9	52.64		.64	369.06
2	Space Relations	54.36		.09	197.13
3	Language Usage	55.42	English 10	.16	136.76
4	Mathematics 9	56.15		.08	105.33
5	Cler S & A	56.83		-.08	86.36
6	Social Studies 9	57.71		.14	73.76

Standard Error = 7.96
Constant = .83
n = 334

Table 27 continued

TABLE 27 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Vr/Na	12.64		.23	11.43
2	Social Studies 9	16.90	English 13	.26	7.93
3	Mathematics 9	21.42		-.17	7.00

Standard Error = 8.67
Constant = 44.36
n = 81

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Mathematics 9	52.19		.53	289.31
2	Science 9	62.23		.50	217.46
3	Numerical Ability	64.55	Mathematics 10	.40	159.60
4	Cler S & A	65.51		-.11	124.39
5	Language Arts 9	66.24		.20	102.44

Standard Error = 9.49
Constant = 29.86
n = 267

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	28.30		.56	40.26
2	Numerical Ability	36.92	Mathematics 13	.67	29.56
3	Mathematics 9	40.63		.26	22.81

Standard Error = 11.04
Constant = -.22
n = 104

Table 27 continued

TABLE 27 continued

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Social Studies 9	33.73	Mathematics 15	.52	23.41
2	Language Usage	38.50		.39	14.08

Standard Error = 9.38
Constant = 22.16
n = 48

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Language Usage	12.00	Science 11	.37	7.91
2	Science 9	17.23		.25	5.93

Standard Error = 10.24
Constant = 40.73
n = 60

Legend
Cler S & A - Clerical Speed & Accuracy
Abstract R - Abstract Reasoning
Vr/Na - Verbal reasoning & Numerical ability

Criteria for inclusion = pin .10, pout .15
$p < .01$ in each step of each regression above (Sig.F)

CHAPTER 5

DISCUSSION

The purpose of this study was to examine the power with which specific junior high school measures could be used to predict achievement in senior high school. Specifically, the measures under scrutiny were the C.T.B.S., D.A.T., Provincial Achievement Tests in Social Studies (1983) and Mathematics (1984), as well as teacher-assigned marks in grade 9. Senior high school courses for which prediction was sought were Biology 10, Chemistry 10, Physics 10, Science 11, English 10, English 13, Mathematics 10, Mathematics 13, Mathematics 15 and Social Studies 10.

Research was facilitated through the analysis of five major questions. Results obtained invite (a) comparisons to be made with other research as cited in Chapter 2, and (b) conclusions to be formulated relevant to a plan of action. The findings in this study can be referenced with other studies and can also serve a function specific to planning a course of action for implementing both standardized tests and teacher-made measures in counselling.

(A) QUESTION 1

What conclusions can be made through examining correlations between:

(1) Subtests within the C.T.B.S.?

(2) Subtests within the D.A.T.?

(3) The C.T.B.S. and grade 9 teacher marks in core subjects?

(4) The D.A.T. and teacher marks in grade 9 subjects?

(5) Provincial Achievement Tests and teacher marks in Mathematics 9 and Social Studies 9?

(1) Correlations within the Canadian Tests of Basic Skills

Correlations within five C.T.B.S. subtests range from .63 to .80 (Table 2). The strong correlations lend support to criticisms of achievement tests which suggest that the tests measure ability more than achievement in specific areas. Luce and Hodge (1978) and Gronlund (1985) indicated that as relationships among subtests increase in degree of significance, the value of achievement tests as discriminators of achievement diminish.

Harris (1978) noted that intercorrelations within the I.T.B.S. ranged from .69 to .83 and that "inspection of the items confirms that a heavy load is placed on the ability to read and understand terms even in the subtests of the Levels Edition on map reading, math problem solving and punctuation, for example" (p. 56).

As the correlations cited by Harris are similar to those obtained in this study, and as the C.T.B.S. and I.T.B.S. are similar in construction and purpose, it is suggested by this researcher that the C.T.B.S. more closely approximates a test of ability than a measure of specific academic skills. This ability is undoubtedly related to one's proficiency in reading.

Taking into account the relationships among subtests, it initially seems questionable whether test administration should include the use of all five subtests. For example, a correlation of .80 between Work-Study Skills and Mathematics would suggest that either one could be a major contributor to predicting performance in achievement areas related to understanding of numerical concepts.

However, there is a major benefit in requiring students to complete all subtests within the C.T.B.S. The attainment of the C.T.B.S. Composite variable adds power to the C.T.B.S. for purposes of prediction. Table 26 makes evident the importance of the Composite score in predicting achievement in both English 10 and Social Studies 10. If one can argue that the C.T.B.S. to some degree approximates a test of ability, then a Composite measure becomes valuable, not unlike the Vr/Na subtest of the D.A.T.

(2) Correlations within the Differential Aptitude Tests

When excluding the confounded variable Vr/Na, correlations between D.A.T. subtests range from .01 to .69 (Table 3). This would suggest that there is evidence of differential validity. For example, the weak relationship between Clerical Speed and Accuracy and all other subtests indicates that the test of perceptual speed measures a skill which cannot be gauged through using any other subtest. Weak relationships between achievement variables of the D.A.T. (Spelling, Language Usage) and Mechanical Reasoning suggest that the latter measures concepts much different than those which are related to the written use of language. The correlation between Mechanical Reasoning and Spelling is .11. The relationship between Mechanical Reasoning and Language Usage is .29. Abstract Reasoning and Space Relations, subtests which emphasize skills relevant to visual perception, also exhibit a weak relationship with the achievement variables.

From D.A.T. inter-correlations cited in this study, it is concluded that individual subtests within the D.A.T. serve as measures of specific skills. I would hesitate to conclude, as did Herman and Gallo (1973) , or Bouchard (1978), that the subtests within the D.A.T. are too highly inter-related to be useful as measures of specific skills. Instead, it is suggested that the ability or inability of D.A.T subtests to assess performance is much more related to specific concepts which the tests measure than to a high relationship among the subtests themselves.

In examining the correlation between individual subtests, noteworthy is the weak relationship between Clerical Speed and Accuracy and other variables. This is explained through examining the purpose of the subtest. It is the one test which measures perceptual speed through exercises which demand eye-hand coordination. Whereas all other subtests can be identified as *power tests*, in which students are given ample opportunity to complete items within a prescribed time frame, success in the D.A.T. is directly related to the number of items completed.

A strong correlation between Vr/Na and Language Usage is expected, in that Verbal Reasoning (a component of Vr/Na) and Language Usage demand similar strategies in verbal areas. When completing Verbal Reasoning, students are asked to correctly complete the first and last *blanks* of a sentence. Completion of Language Usage demands that students identify errors in a sentence. Both tests require the examinee to recognize a correct phrase or sentence as a total unit.

Predictable is the strong relationship between Spelling and Language Usage. Both are achievement tests which demand recognition of words either in isolation (Spelling) or within the structure of a sentence (Language Usage). Both are also related to a student's breadth of vocabulary.

The relationship between Space Relations and Abstract Reasoning is meaningful (.61). Both tests are non-verbal. Each requires the client to manipulate shapes and configurations. No conventional reading is required.

(3) Correlations between the C.T.B.S. and teacher marks in grade 9 subjects

The question of differential validity comes into focus when correlations between the C.T.B.S. and teacher marks are examined (Table 4). The C.T.B.S. Mathematics mark shows a strong correlation with Language Arts 9 (.72). Social Studies 9 shows a meaningul correlation with C.T.B.S. Mathematics (.60). Thus one may not assume that the best predictor of Language Arts 9 would be C.T.B.S. Reading or that the strongest predictor of Social Studies 9 would be either the C.T.B.S. Reading or Language subtests. Other predictor variables within the C.T.B.S. are as powerful. However, after studying teacher manuals and drawing conclusions about what each test is supposed to measure, there remains a tendency to make such assumptions.

(4) Correlations between the D.A.T. and teacher marks in grade 9 subjects

Table 5 indicates that relationship between the D.A.T. and teacher marks are generally consistent with that expected. Clerical Speed and Accuracy, Abstract Reasoning, Mechanical Reasoning and Space Relations show weaker correlations with grade 9 marks than do Verbal Reasoning, Numerical Ability and Vr/Na. Few skills in grade 9 academic subjects are related to the four non-verbal tests.

Language Usage is positively correlated with Language Arts 9 (.60). However, it is noteworthy that the D.A.T. Numerical Ability subtest and Vr/Na are both stronger correlates with Language Arts 9 than Language Usage or Spelling, the two measures which are identified as achievement variables. This is consistent with the contention made by Gronlund (1985). As noted in Chapter 2, Gronlund suggested that subtests which one would expect to predict achievement in academic courses were not necessarily the strongest indicators. As with the C.T.B.S., it is not to be assumed that achievement variables will logically be stronger predictors of success than other variables designed to measure aptitude. Correlations cited between Grade 9 subjects and D.A.T. subtests do not substantiate this.

The Vr/Na subtest, generally described as the best measure of overall ability, shows strong relationships with all grade 9 results. One would expect this, taking into account that students who are strong in ability perform better in academic subjects. This is consistent with findings cited by Herman and Gallo (1973) and Gronlund (1985) which were cited in Chapter 2 of this thesis.

In this study, correlations between the Verbal Reasoning subtest and grade 9 results are not dissimilar to results obtained by Mogull and Rosengarten (1974). For example, the correlation between D.A.T. Verbal Reasoning and Mathematics 9 is identified in Table 5 as .51. Mogull and Rosengarten's research established that the correlation between Verbal Reasoning and grade 9 algebra scores was .52. In this study, however, the Numerical Ability subtest correlated more positively with Mathematics 9 (.66), than did the same subtest in predicting grade 9 algebra in Mogull and Rosenthal's sample (.46). This can be explained, in that concepts studied in Mathematics 9 are not specifically related only to algebraic concepts, but rather to concepts which require more varied mathematical skills.

These skills are not unlike those which are measured by the D.A.T. Consequently, higher positive correlations exist.

(5) Provincial Achievement Tests correlated with Mathematics 9 and Social Studies 9

The correlation between Mathematics 9 teacher marks and the Provincial Grade 9 Mathematics (1984) mark is strong (Table 6). A correlation of .74 would be expected, in that the Provincial Test is constructed to measure the Alberta Curriculum in Mathematics 9 (Figure 2). There is also a strong correlation between the Provincial Grade 9 Social Studies Test (1983) and Social Studies 9 (.63). This is expected for reasons relevant to content validity.

When one examines the Provincial Social Studies Test (1983) in its relationship to Science 9 (.65), the relationship could initially prove surprising. However, when examining the course content cited in the Alberta Education *Junior High School Science Curriculum Guide* (1978), a rationale is evident. Much emphasis in the curriculum is placed on written work requiring discussion, recording of results, and making inferences. As well, similar writing skills which comprise 30% of the Social Studies Provincial Achievement Test (1983) are required in Science 9.

When reporting the results of each component of Question 1, the implications for action are obvious. High correlations among subtest scores of the C.T.B.S. would suggest that caution be used when interpreting test results. Very questionable is the popular strategy of predicting success in a specific subject area by only analyzing C.T.B.S. test scores which are intended to measure that subject area. Specifically, one should not formulate conclusions about how well a student will perform in Mathematics 9 or Language Arts 9 by only examining performance in C.T.B.S. Mathematics and Reading respectively. High positive correlations suggest that (a) seemingly unrelated subtests to Reading and Mathematics are indeed related and (b) the C.T.B.S. Composite score may be as powerful as an ability measure as the D.A.T. subtest Vr/Na purports to be. Thus an overall scan of the C.T.B.S., with specific emphasis on the Composite score, is useful as a measure of ability.

Correlations within the D.A.T. suggest that specific subtests are useful in analyzing different aptitudes. As correlations between subtests are less significant, the subtests become unique in measuring different skills. Clerical Speed and Accuracy is the most obvious example of this. The test certainly measures a unique skill or aptitude. As test interpreters study the purposes of individual D.A.T. subtests, conclusions can be formed after taking into account student performance in those areas.

In terms of academic prediction, one cannot make assumptions about either the C.T.B.S. or D.A.T. without further establishing the relationships with areas related to academics. Specific to this study, the implications of the results cited above suggest that:

1. C.T.B.S. subtests other than those expected to assess academic performance in mathematics and language are useful to the test interpreter.
2. It should not be assumed that C.T.B.S. subtests intended to best measure success in Language Arts 9 and Mathematics 9 will necessarily do so.
3. The C.T.B.S. Composite score is useful as a measure of ability .
4. In making inferences relevant to academic success, the achievement subtests of the D.A.T. (Spelling, Language Usage) are not categorically the best indicators. Caution should be made if reviewing student performance on these measures in reference to academic achievement.
5. Consistent with other research studies, the Vr/Na subtest of the D.A.T. is good measure of ability, and is useful in predicting academic performance.
6. Subtest scores within the D.A.T. measure unique skills. In reference to academic areas, there is a wide range of correlations between different D.A.T. subtests and academic achievement. Counsellors can make reference to D.A.T. subtests which correlate most positively to academic achievement.

The final implication for action which is relevant to Question 1 pertains to the Provincial Social Studies (1983) and the Provincial Mathematics (1984) exams. Both measures are content-relevant and would have been useful for counselling purposes after test results had been obtained. All Provincial tests are intended as measures of the Alberta Curriculum in a given subject area. Correlations with academic courses (as identified in Table 6) were significant. This leads to the conclusion that Provincial tests should be used for both diagnostic and counselling purposes as much as for summative evaluation of students (and often as an evaluation of teacher performance).

(B) QUESTION 2

What are the implications of the correlations between grade 10 subjects and (1) the C.T.B.S., (2) the D.A.T., (3) Provincial Achievement Tests (1983 &1984)?

Predictor variables were compared in their relationship to grade10 dependent variables. Each combination is addressed below.

(1) C.T.B.S. results and teacher marks in grade 10 subjects

The correlations earlier identified in Tables 7 and 8 substantiate the power of the Composite score as an indicator of academic performance. This is most obvious when comparisons are made between the C.T.B.S. and academic subjects which demand reading ability. The strong correlations of .72 and .66 which were recorded when the Composite score was compared to Social Studies 10 and English 10 reflect this. Success in both Social Studies 10 and English 10 depends to a degree upon one's ability to read with understanding. Weighing scores from other variables, C.T.B.S. Composite is identified as an aggregate score and is likely closely related to general reading ability.

With the exception of these relationships, other correlations established in this study between the C.T.B.S. and high school success are similar to those determined by Loyd, et al. (1980). These authors indicated that the relationship between C.T.B.S. subtests and student grade-point average was between .34 (Vocabulary) and .49 (Composite).

Although an overall grade-point average was not considered in this study, individual correlations between most grade 10 subjects and C.T.B.S. subtests are within this range.

Weaker correlations evident between some C.T.B.S. subtests and non-academic courses (English 13, Mathematics 13, Mathematics 15, Science 11) are explained in that:

(a) The student sample for non-academic courses is significantly smaller than the sample for academic subjects. For example, only 68 students completed Mathematics 15, while 93 students completed Science 11. The sample for Mathematics 10 comprised of 237 students.

(b) Students who complete the C.T.B.S. likely approximate a normal distribution, but those who enroll in a non-academic route do not comprise a similar distribution. Thus one must be cautious when making inferences about correlations obtained from two different distributions, even when the overall student sample remains the same.

(2) D.A.T. Results and Teacher Marks in Grade 10 Subjects

Results obtained from Tables 9 and 10 further substantiate reviews which suggest that the Vr/Na subtest of the D.A.T. correlates significantly with academic performance. When relationships were established between Vr/Na and four core academic subjects in grade 9 (Table 5), correlations ranged from .60 to .70. In establishing relationships between Vr/Na and academic grade 10 subjects, correlations range from between .42 (Vr/Na - Physics 10) and .67 (Vr/Na - Social Studies 10).

As with previously obtained results which correlated D.A.T. achievement variables with academic achievement in Grade 9, results were similar. The Vr/Na subtest was a stronger correlate with English 10, English 13, and Social Studies 10 than were either of the achievement variables which one would expect to correlate positively.

Results from Tables 9 and 10 are consistent with studies completed by Herman and Gallo (1973), which suggest that the Vr/Na subtest is the best predictor of achievement.

Results are also consistent with the contention made by Gronlund (1985), when he suggested that specific D.A.T. subtests do not necessarily predict achievement as expected.

(3) Provincial Achievement Tests (1983 & 1984) with grade 10 subjects

The power with which the Alberta Provincial Social Studies Test (1983) predicts performance in Social Studies 10 is identified in Table 11. A correlation of .72 would suggest that the attainment of concepts in Social Studies 9 as measured by the Provincial exam is a prerequisite for grade 10 performance. The content validity of the Provincial Social Studies Exam (1983) is supported through the identified relationship.

It was surprising that the Provincial Mathematics Test (1984) was a weaker predictor of achievement in Mathematics 10 than was expected. This in part may be explained because of the format of questions used in the exam. As all 75 questions used were multiple choice (Figure 2), the format was different than that used by teachers constructing exams for Mathematics 10.

Teachers of Mathematics 10 place much more emphasis on the *process* involved in obtaining the correct answer, and marks are assigned accordingly. The demand of students by teachers to identify the sequential process in arriving at an answer is not necessary in a 75-question multiple choice exam. As a result, no credit for showing work is given.

The overall relationships between the Provincial tests and grade 10 performance in related subject areas stress the importance of content validity in a test measure. A high degree of content validity increases the probability of criterion-related ability . Validity has been previously identified in Chapter 2 as a unitary concept (Gronlund 1985). Because Provincial tests are content valid, they are also good predictors of future student performance in subsequent grades.

(C) QUESTION 3

What implications are evident in correlations between the D.A.T. and C.T.B.S.?

As expected, there are strong correlations between achievement variables of the D.A.T. and the C.T.B.S. Language subtest. C.T.B.S. Language is comprised of four parts: L1-Spelling, L2-Capitalization, L3-Punctuation, L4-Usage. The D.A.T. Language Usage subtest also examines these basic areas. Table 12 identifies the correlation between D.A.T. Spelling and C.T.B.S. Language as .71 and the relationship between Language Usage and C.T.B.S. Language as .68.

The strongest correlation was noted between Vr/Na and the Composite C.T.B.S. score. Taking into account previously cited information, a correlation of .82 would again suggest that achievement and ability are often difficult to distinguish, and that the C.T.B.S. may indeed approximate an ability test rather than a test which is intended to measure skills in five specific areas.

Weaker correlations between three non-verbal D.A.T. subtests and C.T.B.S. scores would also be predictable, taking into account that the C.T.B.S. is dependent on reading. Although this was generally true, meaningful correlations were established between Work-Study Skills and some non-verbal tests. The correlation between Space Relations and Work-Study Skills was .52. The correlation between Abstract Reasoning and Work-Study Skills was .54. There is some similarity between interpreting graphs, analyzing tables and making interpretations from other visual cues not related to reading. In both these D.A.T. and C.T.B.S.variables, the recognition and comprehension of visual cues other than words become important. Two of three segments which are included in Work-Study Skills relate to the use of visual materials and reference materials. In both of these tests, this use of graphs or pictures is important. In Space Relations and Abstract Reasoning, pictures are in the form of shapes and configurations.

The last correlation of note is between C.T.B.S. Mathematics and the D.A.T. Numerical Ability score. The relationship suggests that students who score well on an ability measure in mathematics will predictably do well in an achievement test designed to measure the area of mathematics.

The factor analysis cited in Table 13 further supports the position that tests of ability and achievement are often difficult to differentiate. The *language* factor identified in Table

13 suggests that an ability to use language effectively in written form will be a commonality to both one's ability and achievement level in areas of basic skills. As it is often difficult to make decisions about predicting student achievement from individual subtests within the C.T.B.S., it also is difficult to differentiate between some measures of ability and achievement. In referring to the I.T.B.S., Harris (1978) suggested that "the general factor is vocabulary and reading ability" (p. 56). In this study, four of five C.T.B.S. subtests and three subtests from the D.A.T. are included in the identified *language* cluster.

The only subtests which are unique to the D.A.T. and not related to the C.T.B.S. are those identified in Table 13 as *abstract* and *fine motor*. Only four of eight subtests within the D.A.T. are included in these categories. Taking this into account, one would question whether specific subtests within the C.T.B.S. and the D.A.T. serve similar purposes. It could be concluded that the administration of both measures could be redundant if used with the same students for purposes of prediction.

After examining Question 3, one implication for counselling is in the way both of these measures are used. It is repetitive to use the C.T.B.S. and D.A.T. in the same year, as a commonality exists among many of the subtests within these measures. A C.T.B.S. Reading score will likely offer a student similar information to that which could be obtained from the D.A.T. Verbal Reasoning subtest.

In the County of Red Deer, the C.T.B.S. and the D.A.T. have not been used in the same academic year. The perceived achievement measure has been administered to grade 8 students, while the measure of ability has been made available for use with students in grade 9. Figure 3 in Chaper 2 specifically identifies test use in this school system. The present philosophy of using both measures in different academic years is consistent with the findings in this study.

Equally as important, a more global implication is in recognizing the limitations of each test. Do the C.T.B.S. and the D.A.T. measure that which they intend to measure? Taking into account research noted in critiques of these tests, as well as in findings cited in this study, one cannot categorically suggest that the D.A.T: is a measure of ability, and that the C.T.B.S. measures achievement. Some subtests within the D.A.T. serve the same purposes relevant to achievement as does the C.T.B.S. (achievement measures in the D.A.T include other subtests besides Spelling and Language Usage). Similarly, specific C.T.B.S. subtests perform the same function as do specific subtests within the D.A.T.

It becomes important for the counsellor to point out to the student that achievement and ability are closely related. It is questionable to suggest that the C.T.B.S. is a measure of achievement, whereas the D.A.T. is specific only to ability. In counselling students, it becomes more rational to suggest that performance within a given achievement subtest is often related to an overall ability in that area.

(D) QUESTION 4

What are the implications of correlations obtained and expectancy tables established to determine the relationship between grade 9 marks and grade 10 marks?

There is a significant correlation between student performance in a grade 10 *academic* course and the performance in a grade 9 pre-requisite. This supports research which suggests that teachers are in the best position to measure a student performance in a given academic area. Thus a teacher's ability to test concepts covered in Mathematics 9 or Science 9 will predict an individual's performance in Mathematics 10 or Biology 10. If the instructor can construct a test which is valid in terms of content, then the student's performance on that measure will also relate to criterion-referenced validity. Simply stated, a test which appropriately measures grade 9 achievement in a specific course will also predict the student's performance in a *followup* grade 10 subject.

In this study, an exception to the form seemed evident when student achievement in Biology 10 was examined. The most positive correlate with Biology 10 was Language Arts 9. On first inspection this may seem inconsistent. However, the Alberta Education *Curriculum Guide, Biology 10-20-30* (1984) indicates that the course work involves (1) the proposal of ideas through formulation of hypotheses, (2) designing experiments and (3) gathering, processing and interpreting data. (pp. 17-27). The attainment of these objectives involves much written work, not dissimilar to the type of effort required of students in Language Arts 9.

Ebel (1979) was previously cited in this thesis as identifying seven disadvantages of teacher-made tests (p. 66). It is suggested by this researcher that whether or not these disadvantages exist, the reality remains that teachers in any given grade are most responsible for measuring performance through tests which are constructed locally. If similar criteria are used by teachers at different grade levels to evaluate students, then there will be a strong relationship between student performance at one grade level and another, provided that the main emphasis of measurement is on the aquisition of course content.

The less positive correlations between predictor variables (including teacher-assigned grades) and grade 10 courses less academic in scope has previously been explained. Suggested was that (a) the sample group which enrolled in these subjects was smaller, and (b) the distribution of students who registered in these subjects was different from the distribution in all of the predictor variables.

A further explanation involves the emphasis in courses such as Science 11, Mathematics 13, 15, or English 13. The subjects are intended for *non-academic* students. For example, in the area of mathematics, it would be reasonable to suggest that weak academic students would experience difficulty in an academic mathematics course if they chose to enroll. However, it would be unsound to suggest that a non-academic grade 9 student would inevitably do well in Mathematics 13 or Mathematics 15. Some students may succeed in a non-academic mathematics course because the content is easier. Others may not, due to factors such as motivation, or an overall inability to do mathematics, despite the level of difficulty. Further compounding the problem in predicting success in non-academic subjects such as Mathematics 15 is that these courses lend themselves more readily to subjective marking. In identifying a program rationale for Mathematics 15, the Alberta Education *Curriculum Guide, Mathematics 15 & 25* (1982) suggests, "it is the responsibility of each teacher to arouse the student's interest and adjust the program to meet individual needs" (p. 2). Thus the emphasis is on measuring student motivation as much as on measuring the mastery of specific content material. Unlike academic subjects in which the aquisition of course content is stressed, the *perceived* interest level of the student is equally as important.

The expectancy tables (Tables 15 to 21) provide interesting information regarding school performance. When examining results of grade 9 students who scored between 80% and 100% in a grade 9 subject, it is evident that these individuals maintained their status in grade 10. Table 16 indicates that 51 of 105 students who scored 80% or above in Language Arts 9 continued to score at or above 80% in English 10. Most other remaining students who were awarded marks of between 80% and !00% in Language Arts 9 scored between 70% and 79% in English 10. This pattern was evident in all expectancy tables.

Equally as important was that students who scored between 50% and 59% or obtained marks between 60% and 69% in grade 9 subjects recorded grade 10 results which were significantly weaker. Table 17 offers a good example. Of the 55 students who achieved between 50% and 59% in Mathematics 9, exactly 35 students failed Mathematics 10, receiving a mark of 49% or lower. Students who scored between 60% and 69% in Mathematics 9 tended to perform more poorly. Of the 99 students in this category, 41 had recorded marks of 50% to 59% in Mathematics 10. Within this same group of 99 students, 23 failed Mathematics 10.

Low numbers of students in the frequency rows which include 0 to 39% and 40% to 49% for grade 9 recorded marks indicate that these students either did not complete grade 10 or were enrolled in non-academic mathematics courses for which expectancy tables were not constructed. Others would not have been awarded credit for grade 9.

The conclusion which can be drawn from information recorded in Tables 15 to 21 is that there is *not* a general decrease in marks at the grade 10 level, but that students who score with an *average* grade 9 mark will usually not perform as well in the following grade.

A second conclusion is that high achievers in grade 9 continue to be strong scholars in grade 10.

From the research completed in reference to Question 4, there are implications for counselling. They are as follows:

1. A strong positive correlation between teacher marks in grade 9 and grade 10 marks awarded in *academic* subjects indicates to the counsellor that stress must be placed on grade 9 results, as counselling is offered the student in regards to enrollment in academic grade 10 courses.
2. Weaker correlations between teacher marks awarded in grade 9 and those awarded in *non-academic* grade 10 courses suggest that the counsellor must analyze other factors than awarded marks for these subjects, when students seek counselling relevant to course selection. Factors such as motivation become important to student performance in these grade 9 subjects.
3. In counselling candidates for grade 10 registration, counsellors should emphasize that students who show a strong performance in grade 9 tend to experience similar success at the grade 10 level (considering motivational factors remain consistent). Students achieving marks of between 50% and 69% in grade 9 subjects tend to perform more poorly in the following grade.

(E) QUESTION 5

What variables can be used with most confidence to predict grade 10 achievement?

This question was addressed in Tables 22 through 27. A discussion of specific questions which each table addresses is outlined below.

(1) Grade 9 Teacher Marks with each Criterion Variable

Table 22 indicates that grade 9 teacher marks are generally powerful predictors of grade 10 achievement in academic courses but are less efficient when prediction is desired for Mathematics 13, Mathematics 15, Science 11 and English 13. As correlations between predictor variables and these grade 10 subjects are generally lower than correlations between predictor variables and academic subjects, less powerful regression coefficients were expected.

The regressions for which the largest percentage of variance is accounted for after the final step (R^2) are the most powerful. In Table 22, most confidence can be placed in regressions which were constructed for Chemistry 10 (R^2 = 67.7%), Mathematics 10 (R^2 = 65.4%) and Social Studies 10 (R^2 = 60.5%). Performance in Biology 10, Physics 10, and English 10 can also be predicted with confidence, taking into account the values of R^2. In reference to Table 22, Science 9 was included in 9 of 10 regressions, suggesting that this predictor variable has predictive power for grade 10 courses other than those in the sciences.

In most cases which involve counselling, the question of concern to both the counsellor and the student is relevant to performance in academic courses. If a student decides that an attempt should not be made to work in an academic course, then the obvious alternative is to register in an easier course of studies. Thus, regressions for academic courses will likely be most useful for counselling purposes. However, regressions for non-academic courses should not be discounted, nor should any other information which will offer the junior high school student insight into probable high school success.

(2) Grade 9 marks and Provincial Achievement Test results with grade 10 subjects

When the Provincial tests were included in regressions with grade 9 teacher marks, the Provincial Social Studies Test (1983) made more of a contribution than did the Provincial Mathematics Test (1984). As cited in Table 23, the Provincial Mathematics (1984) score only contributed in 2 of 10 possible step-wise regressions. The identified contribution it made to prediction in Mathematics 15 was most significant in terms of the recorded variance. However, only 28 students were included in the sample, leaving one to question the results. The inclusion of the Provincial Social Studies Test (1983) accounted for five regressions. In most cases the amount of added variance was limited. This would suggest that the amount of added contribution for purposes of prediction is also limited.

The Provincial Social Studies Test (1983) would have been a strong variable in the step-wise regression which is intended to predict Social Studies 10, as it correlates highly with the criterion variable (.72). It was undoubtedly excluded because of its similarity in strength to Social Studies 9, which itself correlates (.71) with Social Studies 10. In this case, and others in which teacher marks are included in step-wise multiple regression, there is little value in including these specific Provincial results. It could generally be concluded that although Provincial tests have predictive value for grade 10 achievement, they do not replace teacher marks in grade 9 when a combination of teacher tests and Provincial exams is examined through step-wise multiple regression.

(3) The C.T.B.S. and the D.A.T. with each criterion variable.

When using the above variables in step-wise multiple regressions, most confidence can be placed in those which include academic subjects as the dependent variable. Table 25 includes step-wise multiple regressions for all 11 dependent variables used in this study.

The Composite C.T.B.S. score was a meaningful predictor in 6 of 10 regressions. Taking into account the structure of the test, this was expected. As a variable which measures both ability and achievement, the Composite score is a good predictor of grade 10 academic performance. As previously discussed, the Composite score of the C.T.B.S. is a strong positive correlate of achievement in academic high school courses.

Differential Aptitude Tests were weaker predictors than C.T.B.S. measures when academic grade 10 courses were the criterion variables. This is explainable, in that the D.A.T. measures some areas which are far less related to academic success. Numerical Ability and Verbal Reasoning did contribute to regressions as expected.

For counselling purposes, one could use the above combination of predictor variables with readily available teacher marks. There are cases in which students dispute the validity of teacher-assigned grades. A specific instance may occur if the student suggests that a mark assigned by a teacher was unfair, perhaps based on subjective data which is irrelevant.

(4) Grade 9 teacher marks, results of the C.T.B.S. and D.A.T with grade 10 subjects

When 19 of 21 variables are used to calculate step-wise regressions, teacher marks consistently are good predictors of academic achievement in grade 10. Courses which should be the best predictors generally are strong. This is expected, taking into account correlations between teacher marks in grade 9 and grade 10.

Both the C.T.B.S. and the D.A.T. are contributing predictors of achievement, especially in non-academic subjects. In Table 22, teacher marks alone were not powerful predictors of performance in easier courses of study. With the inclusion of standardized tests, as in Table 26, the power of prediction increases. An example of this is evident when English 13 is the dependent variable. In Table 22, Language Arts 9 and Science 9 accounted for a total R^2 of 19.2%. In Table 26, the inclusion of standardized tests with grade 9 teacher marks accounted for a total variance of 47%. It is reasonable that more powerful predictions regarding student achievement in non-academic areas are made when more than teacher marks are examined.

In examining this information, the implications for counselling are evident. Because of the increased complexity of predicting high school success in non-academic courses, standardized measures, such as the C.T.B.S, will be useful to counsellors.

(5) Grade 9 teacher marks and D.A.T. results with each grade 10 subject.

This combination of results is often used in Alberta schools to facilitate both academic and vocational counselling. In this study, the D.A.T. was generally not a significant predictor of success for academic courses. Table 27 indicates that in 8 of 10 regression tables where the D.A.T. and grade 9 teacher marks were included as predictors, the D.A.T subtests were generally secondary in contributory value.

From the results above, it is evident that most D.A.T. subtests are valuable in areas other than academic counselling, probably in those relevant to making vocational choices. This does not discount the fact that specific D.A.T. subtests, such as Vr/Na , are valuable in certain areas relevant to academic counselling. However, the D.A.T is likely more relevant to career counselling, although that contention is beyond the scope of this thesis.

(F) SUMMARY

The purpose of this study has been to provide counsellors with tools which will be of assistance in helping students to make constructive decisions relevant to the choice of grade 10 programs. Observed correlations among predictor variables, together with subsequently constructed expectancy tables and step-wise multiple regressions can achieve this purpose. In assisting students to make decisions which are of importance to their future, it is suggested that the amount of data that can be made available will increase the likelihood that the young adolescent will make choices which will result in successful learning experiences at the high school level.

In completing a study such as this, it is equally as important to recognize that any data, regardless of strength, may have limitations in reference to an individual student. In the student's environment, there may exist circumstances which diminish the predictive value of the information available through the interpretation of any standardized test or teacher-assigned score. It would not be in the best interest of the counselling process to categorically discourage a student from attempting something which that individual has confidence in doing. That confidence may be accompanied by increased motivation.

Ebel (1986) states that, "the success of a person in school or on the job depends to a considerable extent on the efforts of the person" (p.306). Not disregarding this reality, the study has been presented in order to better facilitate student success in learning experiences as provided in a school setting. If used carefully, the information presented in this thesis can be valuable to counsellors who work with junior high school students and can subsequently benefit those to which high school achievement is most relevant, the students themselves.

(G) RECOMMENDATIONS

Taking into account the information received through this research, the following recommendations are made:

(1) That caution be exercised when using subtests within the C.T.B.S. to make assumptions regarding student progess in areas which those subtests are intended to measure. If the C.T.B.S. is used in purposes relevant to prediction, the Composite score is the most effective variable. There is value in requiring students to complete all subtests within the C.T.B.S.

(2) That the C.T.B.S. be examined carefully in terms of content validity, prior to use in the County of Red Deer #23. Authors of the C.T.B.S. stress that content validity is best determined by the users of the test.

(3) That further caution be exercised when using specific subtests within the D.A.T. to make predictions relevant to high school performance. The most useful tests for prediction purposes are Verbal Reasoning, Numerical Ability and Vr/Na. The achievement variables within the D.A.T. are less powerful predictors. Use of the D.A.T. may still offer advantages for use in vocational counselling, although this assumption is beyond the scope of this study.

(4) That the expectancy tables identified in this study (Tables 15-21) be made available to counsellors. Of particular relevance to counselling is that students who achieve *average* scores in grade 9 subjects will tend do less well in grade 10, while *strong* academic students in the ninth grade tend to achieve well at the senior high school level.

(5) That multiple regression equations be made available to guidance counsellors in the school system. In analyzing the regressions in this study, the use of grade 9 teacher test scores is of particular benefit. Results are readily available. Most students receive a ninth grade mark in core academic subjects. With this availability of information, it is relatively simple to construct a multiple regression equation (Appendix B).

(6) That grade 9 Provincial Achievement Tests be used for counselling purposes. Taking into account that these measures are specifically designed and constructed to measure Provincial curricula, their use can be beneficial both in a diagnostic sense and for purposes of predicting senior high school achievement.

(7) That the D.A.T. and the C.T.B.S. be used with individual students for counselling purposes. Particular value of these measures is in cases when teacher results for a particular student are questionable.

(8) That continuing data be gathered for purposes of prediction. Updated grade 9 teacher marks could be used for the construction of expectancy tables and step-wise regressions which would be relevant for counsellor use.

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LIST OF APPENDICES

APPENDIX A

HIGH SCHOOL DIPLOMA AND MATRICULATION REQUIREMENTS

Alberta Education issues two distinct high school diplomas: the General High School Diploma and the Advanced High School Diploma. The diplomas certify that the holder has completed a prescribed program of instruction at a high school or through correspondence instruction under the direction and supervision of Alberta Education.

The diploma does not necessarily grant admission to post-secondary educational institutions. Students should be made aware that there is a variety of entrance requirements for post-secondary institutions and that they should plan their programs accordingly.

1. The General High School Diploma is awarded to a student holding one hundred credits, subject to the following requirements:

   a. Language Arts - a minimum of fifteen credits, five of which must be in English 10 or 13 and five in English 30 or 33.

   b. Social Studies and Social Sciences - a minimum of ten credits, five of which must be earned in Social Studies 10. A maximum of eighteen credits may be earned in the Social Science Options.

   c. Physical Education 10[1] - a minimum of two credits.

   d. Mathematics - a minimum of five credits with a maximum of: (i) ten credits in Grade X, and (ii) fifteen credits in Grades X and XI courses.

   e. Science - a minimum of three credits.

[1]Components of the Physical Education 10 course requirements may be waived on the recommendation of the principal, for good and sufficient medical or religious reasons.

Appendix A continued

APPENDIX A continued

f. Grade XII courses - five credits in English 30 or 33 plus a minimum of ten credits in at least two other Grade XII courses (in addition to English). Where 30-level "A" and "B" courses are available, each is acceptable for diploma purposes (eg., Industrial Education 30A and 30B).

Credits earned in other approved high school courses may be used to obtain the required one hundred.

The General High School Diploma requires credits in English 30 or English 33. However, some students who are working toward the general diploma may wish to obtain credits in other diploma examination courses (e.g., Social Studies 30, Mathematics 30, Biology 30, Chemistry 30, and Physics 30). To obtain credits in these courses, students must also write the appropriate diploma examination regardless of which type of diploma they wish to receive.

2. The Advanced High School Diploma is awarded to a student who:

   a. satisfies the current course and credit requirements for a General High School Diploma as listed above, and

   b. earns course credit in English 30, Social Studies 30, Mathematics 30 and ONE of Biology 30, Chemistry 30, or Physics 30. An Award of Excellence will be granted to a student who qualifies for the Advanced High School Diploma and earns a final average of 80% or higher, with not less than 65% in any one of the four required diploma examination courses. This Award of Excellence will be noted on the student's Advanced High School Diploma.

(Alberta Education, *Junior-Senior High School Handbook*, 1986-87)

APPENDIX B

CONSTRUCTION OF A MULTIPLE REGRESSION EQUATION

Step	Predictor	% Variance Accounted For (R^2)	Dependent Variable	Regression Coefficient (B)	Frequency (Equation) (F)
1	Science 9	59.20		.56	612.26
2	Mathematics 9	66.66	Chemistry 10	.38	420.81
3	Social Studies 9	67.70		.19	293.43

Standard Error = 8.89
Constant = -14.64
n=424

The above was previously cited in Chapter 4, Table 22 of this thesis. An example of how to calculate the regression equation is listed below.

EXAMPLE

If a student obtains marks of 60% in Language Arts 9, 60% in Social Studies 9, 70% in Science 9 and 50% in Mathematics 9, what will his likely mark be in Chemistry 10?

PROCEDURE

The regression coefficient *B* identified in each step is multiplied by the mark that the student obtains in the subject for which the regression co-efficient is valid. The products obtained in each step are summed, together with the *Constant*.

Regression Equation = (B_1 x Science 9 mark) + (B_2 x Mathematics 9 mark)
+ (B_3 x Social Studies 9 mark) + *Constant*.

Specific to achievement prediction in Chemistry 10, the formula is:

(.56 x Science 9) + (.38 x Mathematics 9) + (.19 x Social Studies 9) + *Constant*.
= (.56 x 70) + (.38 x 50) + (.19 x 60) + (-14.64)
= 39.20 + 19 + 10.40 - 14.64
= 54%.

The *predicted* mark for Chemistry 10 is **54%**.

APPENDIX C

FACTOR ANALYSIS OF THE CANADIAN TESTS OF BASIC SKILLS, DIFFERENTIAL APTITUDE TESTS AND CORE GRADE 9 SUBJECTS
(VARIMAX ROTATION) (FACTORS ROTATED = 4)

	h^2	1	2	3	4
Spelling (D.A.T.)	.757	.797	.236	.085	.243
Language (D.A.T.)	.757	.772	.130	.322	.201
Language (C.T.B.S.)	.816	.756	.486	.086	.025
Vocabulary (C.T.B.S.)	.766	.735	.334	.329	.079
Composite (C.T.B.S.)	.951	.715	.590	.303	.007
Reading (C.T.B.S.)	.795	.698	.486	.266	.031
Verbal Reasoning (D.A.T.)	.714	.697	.245	.406	.045
Vr/Na (D.A.T.)	.857	.649	.440	.477	.119
Work-Study Skills (C.T.B.S.)	.767	.535	.621	.306	.026
Language Arts 9	.806	.530	.707	.079	.139
Mathematics (C.T.B.S.)	.818	.474	.673	.365	.085
Numerical Ability (D.A.T.)	.749	.440	.573	.444	.173
Social Studies 9	.649	.389	.670	.137	.172
Abstract Reasoning (D.A.T.)	.717	.319	.254	.662.	.335
Science 9	.751	.296	.742	.331	.050
Space Relations (D.A.T.)	.712	.161	.290	.770	.097
Mechanical Reasoning (D.A.T.)	.706	.128	.162	.804	.130
Mathematics 9	.805	.117	.854	.244	.059
Clerical Speed & Accuracy (D.A.T.)	.891	.102	.115	.058	.929
% Common Variance		38.15	32.76	20.84	8.25
% Total Variance		29.68	25.49	16.21	6.42