A STUDY OF THE PREDICTIVE VALUE OF
THE BATTERY OF PSYCHOLOGICAL TESTS
USED BY
THE COUNSELLING OFFICE OF
THE UNIVERSITY OF BRITISH COLUMBIA

by

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A STUDY OF THE PREDICTIVE VALUE OF THE BATTERY OF PSYCHOLOGICAL TESTS USED BY THE COUNSELLING OFFICE OF THE UNIVERSITY OF BRITISH COLUMBIA.

Abstract

The study was undertaken in an attempt to provide the counsellors of the University of British Columbia Counselling Office with information as to the predictive value of three psychological tests used in the Office battery. These tests were:

1. The Henmon-Nelson Tests of Mental Ability - For College Students - Form A.
2. The Purdue Placement Test in English - For Colleges and Senior High Schools - Form A.
3. The "J" Mathematics Test, University of British Columbia.

Since the test results were being used primarily to assist in the counselling of incoming freshmen, the predictive values of the tests were determined in terms of first year marks - Average Final, English Composition Final and Mathematics 101 Final marks.

A sample of 150 students was chosen in which all volunteered for testing and counselling in the summer of 1950 and had completed the compulsory English courses and the elective Mathematics 101 course as part of a full first year's work during the 1950-51 university session.

By various correlation methods, coefficients of correlation were calculated between the variables and the criteria singly and in all possible combinations. From these, regression equations were constructed and the most useful transposed to graphs for ease in use.

Results of the investigation were typical of those reported by most authors who had conducted similar studies. The Henmon-Nelson Test, a test of general intelligence, was found to be of little use in prediction when used alone in terms of correlation coefficients. It was found to be of some value, however, when used in combination with the other variables. Considered on the basis of expectancy tables, the extremes of test's distribution were helpful in isolating the extremes of the criteria.
Abstract (Cont'd.)

The Purdue Placement Test alone was the best predictor of the English Composition Final mark, and, with the "J" Mathematics Test, was the best predictor of the Average Final mark. The most useful single variable predicting the latter mark was found to be the "J" Mathematics Test. Prediction of the Mathematics 101 Final mark was very difficult and unreliable because the distribution was not sufficiently normal.

Nowhere in the literature were correlation coefficients reported that bettered those of this investigation, suggesting that the three tests presently in use were producing results typical of similar measures used elsewhere in prediction. An adequate comparison would only be possible if likely alternatives were used on the same sample in the same setting with the same controls and techniques as were those in this study.

Various recommendations for further study were listed. The most important of them was one concerning the predictive value of the high school record, which, in the literature, excelled psychological test results in importance. Analyses of other factors in prediction such as motivation, personality traits and interest patterns were also suggested.

Within the limitation that the results could apply only to freshmen entering university and volunteering for testing and counselling, the study indicated that the three tests could be effectively used in prediction.
ACKNOWLEDGEMENTS

THE WRITER WISHES TO EXTEND HIS SINCERE THANKS TO MR. J. F. McLEAN, DIRECTOR, BUREAU OF PERSONNEL SERVICES AND MR. H. O. HAYES, FORMER CounSELLOR IN THE BUREAU, FOR THEIR ADVICE AND ENCOURAGEMENT DURING THE WRITING OF THIS STUDY; TO MR. C. B. WOOD, REGISTRAR, FOR GRANTING PERMISSION TO EXAMINE ACADEMIC RECORDS AND TO PROFESSOR E. S. W. BELYEA FOR VALUABLE SUGGESTIONS IN TECHNIQUE AND DESIGN.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I INTRODUCTION AND BACKGROUND</td>
<td>1</td>
</tr>
<tr>
<td>II REVIEW OF THE LITERATURE</td>
<td>6</td>
</tr>
<tr>
<td>1. General Remarks</td>
<td>6</td>
</tr>
<tr>
<td>2. Factors in Prediction and Their Predictive Values</td>
<td>8</td>
</tr>
<tr>
<td>(a) Intelligence Tests</td>
<td>11</td>
</tr>
<tr>
<td>(b) Aptitude and Achievements Tests</td>
<td>15</td>
</tr>
<tr>
<td>(c) High School Record</td>
<td>17</td>
</tr>
<tr>
<td>3. Criteria and Their Reliability</td>
<td>19</td>
</tr>
<tr>
<td>4. Suggestions Regarding Technique, Validity and Other Statistical Problems</td>
<td>20</td>
</tr>
<tr>
<td>5. Conclusions and Suggestions for Further Study</td>
<td>22</td>
</tr>
<tr>
<td>III DESCRIPTION OF THE PSYCHOLOGICAL TESTS USED IN THE STUDY</td>
<td>26</td>
</tr>
<tr>
<td>1. The Henmon-Nelson Tests of Mental Ability - For College Students - Form A</td>
<td>27</td>
</tr>
<tr>
<td>2. The Purdue Placement Test in English - For Colleges and Senior High Schools - Form A</td>
<td>28</td>
</tr>
<tr>
<td>3. The &quot;J&quot; Mathematics Test</td>
<td>29</td>
</tr>
<tr>
<td>IV STATEMENT OF PROBLEM, LIMITATIONS OF THE STUDY AND TECHNIQUES EMPLOYED</td>
<td>31</td>
</tr>
<tr>
<td>1. Statement of Problem</td>
<td>31</td>
</tr>
<tr>
<td>2. Limitations of the Study</td>
<td>32</td>
</tr>
<tr>
<td>3. Techniques Employed</td>
<td>33</td>
</tr>
<tr>
<td>(a) Sample</td>
<td>33</td>
</tr>
<tr>
<td>(b) Test Administration and Recording of Marks</td>
<td>34</td>
</tr>
<tr>
<td>(c) Statistical Methods</td>
<td>34</td>
</tr>
<tr>
<td>V ANALYSIS OF RESULTS</td>
<td>37</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td><strong>V</strong> ANALYSIS OF RESULTS (Cont'd.)</td>
<td></td>
</tr>
<tr>
<td>2. Coefficients of Correlation between the Variables and the Criteria</td>
<td>42</td>
</tr>
<tr>
<td>3. Relative Predictive Values of the Psychological Tests</td>
<td>45</td>
</tr>
<tr>
<td>(a) The Henmon-Nelson Test of Mental Ability</td>
<td>45</td>
</tr>
<tr>
<td>(b) The Purdue Placement Test in English</td>
<td>52</td>
</tr>
<tr>
<td>(c) The &quot;J&quot; Mathematics Test</td>
<td>53</td>
</tr>
<tr>
<td>4. Selection of the &quot;Best Predictors&quot; of the Various Academic Criteria</td>
<td>54</td>
</tr>
<tr>
<td>(a) Prediction of the Average Final Mark</td>
<td>54</td>
</tr>
<tr>
<td>(b) Prediction of the English Composition Final Mark</td>
<td>56</td>
</tr>
<tr>
<td>(c) Prediction of the Mathematics 101 Final Mark</td>
<td>60</td>
</tr>
<tr>
<td>5. Summary and Conclusions</td>
<td>64</td>
</tr>
</tbody>
</table>

| VI SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY | |
| 1. Summary | 67 |
| (a) Relative Predictive Values of the Psychological Tests | 67 |
| i. The Henmon-Nelson Tests of Mental Ability | 67 |
| ii. The Purdue Placement Test in English | 69 |
| iii. The "J" Mathematics Test | 69 |
| (b) Selection of the "Best Predictors" of the Various Academic Criteria | 70 |
| i. The Average Final Mark | 71 |
| ii. The English Composition Final Mark | 71 |
| iii. The Mathematics 101 Final Mark | 72 |
| 2. Conclusions | 73 |
| 3. Recommendations for Further Study | 75 |

| BIBLIOGRAPHY | 78 |
# TABLE OF CONTENTS (Cont'd.)

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FURTHER REFERENCES</td>
<td>85</td>
</tr>
<tr>
<td>APPENDIX</td>
<td></td>
</tr>
<tr>
<td>A Calculation of a Multiple Coefficient of Correlation by the Dolittle Method</td>
<td></td>
</tr>
<tr>
<td>B Calculation of a Regression Equation</td>
<td></td>
</tr>
</tbody>
</table>

...
# LIST OF TABLES AND FIGURES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Comparison of Final Examination Marks (1951) for First Year Arts, Agriculture, Home Economics and Physical Education Students in Two Groups</td>
<td>3</td>
</tr>
<tr>
<td>II Coefficients of Correlation Between Part and Total Scores of the A.C.E. Examination and Marks in Certain Courses of Freshmen Entering the University of Michigan in 1947</td>
<td>13</td>
</tr>
<tr>
<td>III Characteristics of the Distributions of Scores on the Three Variables and the Three Criteria</td>
<td>41</td>
</tr>
<tr>
<td>IV Pearson Product - Moment Coefficients of Correlation and Their Standard Errors Between All Psychological Tests and Academic Criteria</td>
<td>43</td>
</tr>
<tr>
<td>V Multiple Coefficients of Correlation and Their Standard Errors Between Each Academic Criterion and All Possible Pairs of Psychological Tests</td>
<td>44</td>
</tr>
<tr>
<td>VI Multiple Coefficients of Correlation and Their Standard Errors Between Each Academic Criterion and All Three Psychological Tests Taken together by the Dolittle Method</td>
<td>44</td>
</tr>
<tr>
<td>VII Expectancy Table Showing the Distribution of Class Standings of Average Final Marks Within the Quarters of the Henmon-Nelson Distribution</td>
<td>48</td>
</tr>
<tr>
<td>VIII Expectancy Table Showing the Distribution of Class Standings of English Composition Final Marks Within the Quarters of the Henmon-Nelson Distribution</td>
<td>49</td>
</tr>
<tr>
<td>IX Expectancy Table Showing the Distribution of Class Standings of Mathematics 101 Final Marks Within the Quarters of the Henmon-Nelson Distribution</td>
<td>50</td>
</tr>
<tr>
<td>X Centile Norms of the Psychological Tests Used in the Study (Including Q₁ and Q₃)</td>
<td>57</td>
</tr>
<tr>
<td>FIGURE</td>
<td>PAGE</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>1. Histogram showing the Frequency Distribution of Scores on the Henmon-Nelson Test of Mental Ability</td>
<td>38</td>
</tr>
<tr>
<td>2. Histogram showing the Frequency Distribution of Scores on the Purdue Placement Test in English</td>
<td>38</td>
</tr>
<tr>
<td>3. Histogram showing the Frequency Distribution of Scores on the &quot;J&quot; Mathematics Test</td>
<td>39</td>
</tr>
<tr>
<td>4. Histogram showing the Frequency Distribution of Average Final Marks</td>
<td>39</td>
</tr>
<tr>
<td>5. Histogram showing the Frequency Distribution of English Composition Final Marks</td>
<td>40</td>
</tr>
<tr>
<td>6. Histogram showing the Frequency Distribution of Mathematics 101 Final Marks</td>
<td>40</td>
</tr>
<tr>
<td>7. Graphical Representation of the Regression Equation for the Prediction of Average Final Marks</td>
<td>58</td>
</tr>
<tr>
<td>8. Graphical Representation of the Regression Equation for the Prediction of English Composition Final Marks</td>
<td>61</td>
</tr>
<tr>
<td>9. Graphical Representation of the Regression Equation for the Prediction of Mathematics 101 Final Marks</td>
<td>65</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION AND BACKGROUND

In October 1945, the Veterans' Counselling Bureau was established at the University of British Columbia. Veterans were interviewed shortly after arrival and, where necessary, were given guidance and assistance. Tests of academic aptitude, intelligence and interest were administered. Since then, with the decline in veteran enrolment, the service has been extended to non-veteran students and eventually may become compulsory for all incoming freshmen.

Psychological tests were included in the counselling program primarily to round-out the counsellors'
appraisal of the student. With the cumulation of cases, centile norms were developed and each student tested was thus compared with the others previously tested. Used in this manner, along with the interview and high school performance information, the tests gave the counsellor considerable help in determining academic promise. Their value in this respect cannot be underestimated since test results were frequently a large part of the factual information on which the counsellor based his counselling.

The realization of the importance of the counsell ing service has largely been due to the figures recently reported, by the Bureau, comparing success in first year for students tested and counselled and those not tested or counselled (17). These results are summarized in Table I.

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td>The differences shown between the percentages under the headings &quot;Failed Year&quot; and &quot;Passed and Above&quot; are statistically significant.</td>
</tr>
</tbody>
</table>

An analysis suggested, among other things, two major causal factors:

1. There may have been greater motivation in the group tested and counselled than in the other group. This may have been due to the manner in which the former group
TABLE I

COMPARISON OF FINAL EXAMINATION MARKS (1951) FOR FIRST YEAR ARTS, AGRICULTURE, HOME ECONOMICS AND PHYSICAL EDUCATION STUDENTS IN TWO GROUPS - THOSE TESTED AND COUNSELLED AND THOSE NEITHER TESTED NOR COUNSELLED.

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>Failed Year</th>
<th>Supplemental</th>
<th>Passed &amp; Above</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Tested and Counsellled</td>
<td>208</td>
<td>27</td>
<td>13</td>
<td>69 33.2</td>
</tr>
<tr>
<td>Not Tested or Counsellled</td>
<td>836</td>
<td>258</td>
<td>30.9</td>
<td>295 35.3</td>
</tr>
<tr>
<td>Total</td>
<td>1044</td>
<td>275</td>
<td>26.3</td>
<td>364 34.9</td>
</tr>
</tbody>
</table>
was selected. All students tested and counselled had individually sought the service, having read of it in the calendar, having heard of it, or having inquired. In other words, they sought counsel, because they were concerned about their fitness for higher education, their choice of goal, and their chances for success.

2. There is considerable value in the testing and counselling services of the counselling office, regardless of original motivation. It is possible that the counsellor may have instilled greater motivation in the student, that he may have given sound advice in the choice of courses and vocation, in the development of study habits, and in adjustment to university life, etc. The second group lacked this help.

The analysis of the findings also mentioned that the counsellors may have encouraged promising but undecided students to attend university; discouraged those not likely to be successful; and in giving vocational guidance supported the theory that students with a definite goal will work harder and tend to do better than undecided students.

A follow-up study was conducted in the fall of 1951 in which a group of incoming students were required to take the tests and be counselled by the university service (17). It indicated that there was no significant difference in the test results between this group and the
original "volunteer" group. These findings strengthen the importance of the two major causal factors described above.

A factor which could immeasurably strengthen the hand of the counsellor, and one lacking in the program of the service to date, has been any knowledge of the predictive value, in terms of academic success, of the psychological tests being used. Centile norms, based on University of British Columbia results, have been prepared, but their relationship to academic achievement is not known.

It is the intention of this study to help fill the gap.

...
CHAPTER II

REVIEW OF THE LITERATURE


Eurich (27, p. 874) once said that "no topic in educational literature has wider popular appeal than prognosis". The truth in the statement has been, more than likely, brought home vividly to many an investigator as he sought reference material for his studies. Library shelves abound with volumes of journal articles, books and pamphlets on the subject. No stone has been left unturned to find new and useful approaches to the problem, or to refine and follow up old ones.

It is intended in this chapter, to mention some of the more significant studies conducted in the field. The bibliography is indicative of the literature to be found and the additional list of references contains material which was not available to the writer, but which suggests the great variety of work being done.

In a recent review of the literature, written on prediction during the last fifty years, Eysenck (28) goes back to the days when Cattell returned to the United States from Wundt's laboratory. Cattell had written that a knowledge of intelligence is useful in selection and in counsell-
ing. Following this up, Wissler, in 1901 tried some primitive tests but failed to support Cattell. The first "success" was scored by the well-known Army Alpha Test in 1916. Since then, reports of correlation coefficients between intelligence scores and success have become extremely plentiful.

Segal (48) has prepared a very comprehensive list of correlation coefficients between numerous psychological tests and success in college. Brickman (8) supports the writer in highly recommending the Encyclopedia of Educational Research (41) and the Third Mental Measurements Year Book (14) as excellent general references.

As Stroud (56, p. 298) suggests, during the past few years there has been considerable evidence that investigators are broadening their approaches to prediction of academic success. The trend is toward measures of previous achievement and away from specific subject aptitude tests. Later sections of this chapter will be seen to support his statement.

A caution of considerable importance is put forth by Douglass (24), following a lengthy study in prediction at the University of Minnesota, that no predictor can be considered good for ALL schools and colleges. Butsch (15) stresses the importance of each school and college finding its own coefficients of correlation between academic success
and predictive factors. Berdie (4), in another study, supports Butsch and goes on to emphasize the importance of local norms. Phillips (44) writes that there is little meaning to statements in test manuals that the tests concerned were standardized on "such and such a group of, say, college freshmen". These cautions should be kept in mind constantly as the reader studies this chapter and compares its content to the findings of the study.

2. Factors in Prediction and Their Predictive Values.

Much has been written about the factors affecting prediction and much has yet to be written. The lack of adequate measuring instruments is the greatest drawback to more comprehensive studies of a large number of these factors.

Horst (34) has written that, until adequate measures of such factors as personality, health, leisure time activities, study habits, motivation and interests are developed, it is unlikely that any significant improvements in the prediction of academic success will occur. Moore (42) adds to this list such factors as industriousness, sobriety, initiative, imagination, persistence, and social and economic status. May (40) also stresses the importance of these factors in prediction.

Scott (52) finds that background and personal data does not have enough bearing on college success to justify
their use in prediction. Harris (32), however, includes "circumstances" as an essential factor. Under this heading he lists personal, social and economic as well as academic data. Two more of this author's essential factors are ability, meaning intelligence or scholastic aptitude, and effort, meaning drive or degree of motivation. If we are going to use character or personality traits, Crawford (18) suggests that we must first be reasonably sure of the student's academic potentialities. He continues that when sound predictions of academic success are available, the other factors, equally important in selection, can then be given more careful consideration.

Motivation as a factor in prediction is a problem of special concern in this study. One of the limitations to the application of the results is that, because the students participating in the study all sought testing and counselling of their own accord, they were more highly motivated in their studies than were those who ignored the service or were told to seek it. Harris (32), Crawford (18), and Travers (59, p. 177) feel that this factor of motivation plays an important role in determining academic success. On the other hand, Schneidler and Berdie (50), in a study at the University of Minnesota, using a variety of personality inventories, achievement tests and the Strong interest test, conclude that students who volunteer for testing and counselling cannot be considered atypical.
While most authors appear to support motivation as a factor in prediction, it seems that this factor is not necessarily a distinguishing feature between students seeking and those not seeking counselling.

Reid (45), in 1938, seeking to determine the relationship between personality test scores and scholastic achievement used the Bernreuter Personality Inventory and finds no significant correlation. As a guide in choice of courses or vocation, however, he feels it is of some use. Smith (54) has discarded the Bell Adjustment Inventory, which was in her battery of tests for prediction, as being of little value. In comparison with the volume of material written on other subjects in prognosis, there has been very little on the predictive value of personality tests.

Reid (45) also finds results on the Thurstone Vocational Interest Schedule to be of little use in prediction. Douglass (24) in his comprehensive Minnesota studies has very little success to report using interest inventories. Also at the University of Minnesota, Berdie (5) conducted a study in which his results do nothing to demonstrate that interests will or will not predict curriculum satisfaction, let alone academic success. Segel (48, p.18) disagrees with these authors, writing that a measure of interests adds a lot to the predictive value of other measures.
Most of the material to be found is concerned with the value of intelligence, aptitude and achievement tests in forecasting performance in High School. These will be discussed separately below.

(a) Intelligence Tests.

Douglass (24) claims that intelligence tests are of varied and limited predictive value alone, but are useful when in combination with some other measure. Studying various summaries of results on the prognostic value of these tests, Derflinger (21) finds a median correlation between college grades and intelligence of .45. He notes, further, that intelligence tests are used in one way or another in almost every attempt to predict academic success.

By far the most frequently used test in such studies has been the American Council on Education Psychological Examination. Studies by Crawford and Burnham (19), Wallace (62), Brown (13) and Smith (54) have shown this test to be indicative of academic promise but of limited value in actual prediction.

Segel (48, p.18) writes that successive editions of the A.C.E. Examination have shown progressively higher correlations with college success. This, he says, is due to regular and careful revision of test items. Brown (13), however, finds that considerable material could be dropped for predictive purposes. In an intensive study of the pre-
dictive value of the various parts of the test, he concludes that the Linguistic parts compare more favourably with other tests than do the Quantitative. Wallace (62), in suggesting intensive evaluations by the individual institutions using the test, warns that it should not be used alone, and that great caution be used in its interpretation. These statements, he bases on the results of his studies at the University of Michigan in 1947, in which no marked differences between the predictive values of the Quantitative and Linguistic parts are revealed in their ability to foretell success in freshmen courses.

Relating A.C.E. scores to results in courses in English and mathematics and to average final marks, Wallace finds coefficients of correlation which are pertinent to this study (Table II).

| TABLE II |

Remmers, Elliott and Gage (46), at Purdue University, in a study of the battery in use there, conclude that specific subject tests, such as the Purdue Placement Tests in English, Physical Science and Mathematics, are more useful in prediction than is the A.C.E. Examination.

Studies of the predictive value of the Henmon-Nelson Tests of Mental Ability are not nearly as plentiful,
### TABLE II

**COEFFICIENTS OF CORRELATION BETWEEN PART AND TOTAL SCORES**
**OF THE A.C.E. EXAMINATION AND MARKS IN CERTAIN COURSES OF**
**FRESHMEN ENTERING THE UNIVERSITY OF MICHIGAN IN 1947.**

<table>
<thead>
<tr>
<th>Mark</th>
<th>Number</th>
<th>Quantitative Score</th>
<th>Linguistic Score</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>336</td>
<td>.285</td>
<td>.479</td>
<td>.461</td>
</tr>
<tr>
<td>Mathematics</td>
<td>72</td>
<td>.207</td>
<td>.159</td>
<td>.224</td>
</tr>
<tr>
<td>Average Final</td>
<td>323</td>
<td>.292</td>
<td>.370</td>
<td>.410</td>
</tr>
</tbody>
</table>
but those that have been conducted appear to corroborate the results of the present one. Brook (12), in a discussion of the Wisconsin High School Cooperative Testing Program, which includes the Henmon-Nelson Test, concludes that the test provides a rough evaluation of the individual's standing in the group, allowing a rough classification into broad groups. Used along with High School marks, Drake and Henmon (25) find it to be as useful as the A.C.E. (also in combination with High School marks) in prediction. In their study, these combinations prove more useful than do individual tests, including the Cooperative English Test.

Garrett (30), investigating the predictive value of the Ohio State Psychological Examination, finds a correlation of .608 between scores on it and average college marks. The correlation between high school average marks and college average marks is $r = .665$. These results are considerably better than for most other studies, and lead Garrett to conclude that either high school average marks or Ohio State test scores can be used singly and successfully in prediction. The high school average, however, provided the best single prediction.

Shaw (53) studied Thurstone's theory of primary mental abilities and their relationship to high school achievement. Using Thurstone's test, the Chicago Tests of Primary Mental Abilities, he lists the following findings:
1. Verbal Meaning Ability is highly related to every high school achievement measure he used.

2. Reasoning Ability is to be moderately high, but far behind Verbal Meaning Ability.

3. Most others exhibit little relationship to high school achievement.

(b) Aptitude and Achievement Tests.

Segel (48, p. 71) writes that the best tests for the prediction of academic success are those testing general achievement, and for the prediction of success in certain courses, tests of specific aptitudes or achievements are the best. The studies at Purdue University, by Remmers, Elliott and Gage (46), suggest that achievement tests generally show a higher correlation with academic success than do intelligence tests, as mentioned above. These authors quote results of one of Segel's investigations, in which an intelligence test correlates $r = .440$, and achievement tests $r = .545$, with college marks.

In a comparison of the predictive value of achievement tests and accumulative high school record, Derflinger (21, p. 76) says that a two hour achievement test would give a score that would be as useful in forecasting success as the high school record.

The Scholastic Aptitude Test has been one of the most widely used of its kind. Brigham (9) uses it in one
of his problems and finds its verbal score to have some correlation with college English grades. Bennet, Seashore and Wesman (3) have done a considerable amount of work on the Differential Aptitude Test and have recently published a very large number of new validity coefficients on the prediction of academic marks.

Crawford (18), studying his three factors in prediction - inherent or potential ability, opportunities for its development and seriousness of purpose or motivation, suggests that appropriate measures of each would be, in order, the Scholastic Aptitude Test, the College Entrance Board Examination and the high school record. Relating these measures to the grades of Yale University's Freshmen class of 1933, his best predictor is not the Scholastic Aptitude Test score \( r = .4070 \), or that of College Entrance Board Examination \( r = .6393 \), but the high school record \( r = .6617 \).

Much more material has been written on this type of test, but in very few instances are the results out of the ordinary. Reid (45), for example, finds the Stenquist Mechanical Aptitude Test of very little use in the prediction of academic success. Bromley and Carter (11) studying the Mathematics Proficiency Examination of the Cooperative General Achievement Tests, along with the Quantitative score of the A.C.E. Examination and rank in high school, quote a
multiple correlation coefficient with college marks of .460. Reviewing summaries of studies, Derflinger (21, p.77) finds median multiple coefficients of correlation between college scholarship and combinations of intelligence tests, achievement tests and high school grades to be within the range .60 - .70.

Eurich, Cain and Michaelis (27, p. 885) conclude that general achievement tests run a close second to high school records as a single basis for predicting college scholarship, correlations ranging from .39 to .64.

There appears to be some confusion as to the difference between achievement and aptitude tests. An analysis of references used in this section suggest, basically, a difference in purpose - a difference which is frequently quite blurred. Where an achievement test is expected to measure attainment in some specific subject, an aptitude test is concerned with the psychological processes involved. Few tests, other than those of a general nature such as the Scholastic Aptitude Test, can rigidly be classified as one or the other.

(c) High School Record.

Some indication has been given in sections above that the high school record of a student is useful in predicting his success in college. This is borne out by numerous other investigations, and in fact, many authors, such
as Crawford (18), Bromley and Carter, (11), Smith (54), Berdie and Sutter (6), Schmitz (21), Garrett (30), and Eurich, Cain and Michaelis (27), conclude that the high school record is the best single predictor of academic success. Douglass (24), Drake and Henmon (25), and most of the authors already mentioned, agree that in multiple prediction the best combinations of tests always include high school marks.

Smith quotes a correlation as high as .707 using 125 students in a California Junior College. Comparing college and high school "grade-point averages", an index based on total hours of lectures in the year and course marks received, Garrett (30) finds a correlation of .665. Travers (59) in his searching, produces such coefficients running from $r = .5$ to $r = .7$.

Travers (59, p. 154) offers the explanation that the predictive value of high school marks lies in the fact that they are probably affected by ability and motivational factors etc., in very much the same way as these factors affect college performance. This, he said, appears to out-weight other factors tending to reduce the validity of high school marks.

The results of only one study disagree with the above conclusions. Bou and Stotall (7) said that high school marks were not very reliable; that there is a positive correlation, but that the standard error of estimate is
high; that some marks are not indicative of the required
degree of training and preparation; and that chances for
success in college are greater for those from the large
high school.

3. Criteria and Their Reliability.

Travers and Gronlund (60) write that, unless the
criterion in prediction is quite free from arbitrary elements,
predictions will be very difficult to make. Other authors
stress the frequency and importance of these arbitrary ele­
ments. Crawford and Burnham (19, p.65) are quite concerned
about the low dependence which can be placed on marks as
criteria. They go on to claim that standardized psycholo­
gical tests are more consistent in what they measure than
are the usual scholastic criteria which the tests are to
predict.

Brigham (9) finds that teaching and examination
methods in college tend to be so faulty that even perfect
predictive instruments cannot correlate better than .40 to
.50 with college marks. Marks are unreliable, Travers and
Gronlund (60) say, because of the variety of teachers mark­
ing, whether progress or achievement is the basis for mark­
ing, and various factors influencing teachers' decisions
such as, the student's work output and its quality, and his
knowledge of work presented and his skill in using it.
Williams (65) adds to this list the effect of the transition
from high school lessons to university lectures.


A large part of the most recent material written on this phase of the subject has been concerned with new techniques devised to assist and improve predictions. Marks (39), however, emphasizes the need for more discerning use of the old ones unless new problems occur demanding new techniques. It is well to recall the advice of Berdie (4) and Butsch (15) who stress the importance of each school or college developing its own norms and correlation coefficients for predictive purposes, regardless of the tests used and the statistical information provided with them.

Carrillo and Reichert (16) use a "caution factor" in a study of the predictive value of the A.C.E. Examination. This factor is the ratio of the number of correct responses to the number of responses attempted. The authors claim to have raised correlations "appreciably and consistently" using this technique. Their method does appear to have considerable merit in that it gives some credit for the student's gross effort within each test's time limit.

Sappenfield (47) proposes a ratio called the "Effort Index" which is the ratio between high school achievement scores and aptitude test scores. Using this index, he concludes that the more homogeneous a subgroup was with
respect to it, the higher would be the relationship between aptitude and college scholarship. He goes further, suggesting that out of a population of students, a subgroup can be selected using a fairly homogeneous range of "AQ's" (achievement age divided by chronological age), whose academic standing will be highly correlated with aptitude. The factor of motivation, therefore, can be held reasonably constant. In other words, the author is endeavours to illustrate that when effort, or motivation, is kept constant the higher is the relationship between aptitude test scores and high school achievement.

Drake and Henmon (25) use a technique in which standard errors of estimate calculated from the various correlations were compared with the standard deviations of high school averages. Any measure, or combination of measures, having a standard error of estimate less than the standard deviation of the criterion to any significant extent, is useful for prediction.

Horst (34, p.117) suggests an interesting approach to prediction studies. He proposes that cases which have been incorrectly predicted should be investigated by case study methods in an attempt to determine why the equation was inadequate.

Regardless of the value of test results, Williamson (66) stresses the need for clinical data and intensive
counselling for effective prediction of academic success.

The literature contains some comments on validity which are appropriate to this study. Edgerton (26, p.52) writes that validity is not determined solely within a test, but is also a function of the purpose for which it is used and the group or individual on which it is used. There are two kinds: "a priori" validity based on presumption without examination, and "empirical" validity based on the extent to which a test has been shown to discriminate in practice.

Cronbach (20, p.256) states that it has been found repeatedly that coefficients as low as .30 are of definite practical value, depending on various functions as mentioned by Edgerton, above. Cronbach (20, p. 260) continues that when a test is applied to a group with a wide range of ability, validity coefficients rise, and when applied to a restricted group they drop. It should be remembered here, as Springbett (55) concludes, that in multiple prediction, where a single numerical value is used, the assumption is that strength in one ability may compensate for weakness in another. The size of the coefficient would, therefore, depend on the relative ranges of the abilities involved.

5. Conclusions and Suggestions for Further Study.

In a review of studies conducted in the field of prediction, Moore (42) neatly summarizes the findings of this chapter. He finds that predictive instruments remain
about as effective, or ineffective as they were in the 1930's when correlations were massed in the "fifties", with a few in the "sixties" and the odd one higher. In multiple prediction the coefficients range from .70 to .85.

Measures of personality and interest, while considered to be necessary for effective prediction, are generally found unsatisfactory in their present state.

Tests of general intelligence are found to be useful in combination with other measures especially aptitude tests which in turn are second only to the high school record as the best single predictor of academic success. Eysenck (28) warns that we have not yet arrived at the point where tests will predict academic success as well as the sum total of the work done.

Willett (67) writes that individuals vary greatly in their reactions to similar situations at different times. Douglass (24) finds great differences in median scores made at different institutions on the A.C.E. Examination. These findings support those of other authors in this chapter that each institution must conduct its own evaluation of tests in use and develop its own norms to achieve the best possible prediction.

Academic criteria are found to be very unreliable, seriously hampering effective prediction.
The validity of a test has been seen to be a function of the purpose for which it is intended and of the group or individual on which it is used and is not solely an internal characteristic of the test.

Phillips (44) warns his readers of a number of common pitfalls in prediction, of which all investigators and counsellors should be aware. These include, the nature of the tests used, size of correlations, frame of reference in prediction, reliability of marks, effect of motivation, study habits and other factors, and the individuality of the students.

Williamson (66), in a few words, describes the status of prediction at the present time, writing that tests are constructed to predict academic success for the "average" student under given circumstances, but the counsellor is required to use them to predict achievement to be measured by unreliable criteria (examination marks), under greatly different conditions and for students who cannot be considered "average".

It would be well here to refer again to Eurich, Cain, and Michaelis (27, p. 892) who prepared a comprehensive list of subjects needing investigation. The list includes:
i. Measures of factors such as personality, personal history, etc.

ii. Comprehensive follow-up studies.

iii. Studies of factors in occupational success.

iv. Prognostic value of ability patterns.

v. Continuous studies of trends and changing requirements.

vi. Studies of types of composite abilities and their relationships to jobs and career plans.

vii. Analysis of and prediction by group action, skills and processes.

...
CHAPTER III

DESCRIPTION OF THE PSYCHOLOGICAL TESTS
USED IN THE STUDY

The battery of psychological tests presently in
use at the Counselling Office consists of the following:

1. The Henmon-Nelson Tests of Mental Ability - For
College Students - Form A.

2. The Purdue Placement Test in English - For Colleges
and Senior High Schools - Form A.

3. The "J" Mathematics Test, University of British
Columbia.

4. The Toronto Familial - Extraparental Scale.

5. The Thurstone Interest Schedule.

6. The University of British Columbia Occupational
Preference Rating Scale.

The first three of the above tests will be used in
this study. These were chosen for a number of reasons.
Firstly, they form the basic part of the battery and there­
fore deserve first consideration. Secondly, the literature
contains little material that encourages investigation of
the Thurstone Interest Schedule in the present setting.
Such an investigation would be most useful as part of a
study of the whole question of interests in prediction.
Thirdly, the Toronto Familial - Extrafamilial Scale is still under revision by its authors and a study of its predictive value at this time would be of little use. The last instrument listed is used only as a rough guide in initial counselling.

A short description of each of the tests used in the study follows:

1. The Henmon-Nelson Tests of Mental Ability (33).

This test is constructed "to measure the aptitude of college students for academic work" or, in other words, intelligence. Two identical forms have been prepared, each consisting of ninety items of increasing difficulty.

Validity of the test was originally determined in the makeup of the items. Further studies were made by determining its correlations with the American Council Psychological Examination. In three studies involving freshmen the following correlations were obtained: \[ r = .77 \pm .03; .68 \pm .02; .76 \pm .02. \] Another study using the Otis Self-Administering Tests of Mental Ability, Higher Examination, Form A revealed a correlation of \[ .79 \pm .03. \]

The reliability as determined by the correlation between Forms A and B was \[ r = .89 \pm .01. \]

The standard deviation was 10.2.
Norms for the test were based on the results of over 5,000 unselected students in various colleges in the United States.

The authors list uses for the test, such as:
(a) A partial basis for the admission of Students.
(b) A partial basis for diagnosing the cause of student failures.
(c) For selecting those of exceptional ability.
(d) For classifying students for instructional purposes.
(e) As a partial basis for guiding students in their selection of courses and vocations.
(f) As aids to appointment bureaus and employment agencies.

2. The Purdue Placement Test in English (68).

This test is intended for use in both high schools and colleges and is designed to measure the following factors:
(a) Punctuation.
(b) Grammatical Classification.
(c) Recognition of Grammatical Errors.
(d) Sentence Structure.
(e) Reading.
(f) Vocabulary.
(g) Spelling.
Reliability coefficients were determined by the split-half method from Form A for a sampling of 300 freshmen entering Purdue University in the fall of 1931. The total reliability was .950. High reliability coefficients were also found for the individual parts.

The content was chosen from frequently recurring errors of college freshmen and on the basis of other similar studies. Validity coefficients were determined by correlating total raw scores against semester marks on three random samplings of 100 students. They were .68, .69 and .72.

3. The "J" Mathematics Test.

The "J" Mathematics Test takes its name from the initial of one of its authors, Miss E. Jenkins of the University of British Columbia, Department of Mathematics, now Mrs. G. Kennedy. Faced with the need for some kind of aid in indicating which students needed extra help or more intensive instruction in first year mathematics, Dr. R. D. James, head of the department, assisted Miss Jenkins in the construction of a test consisting of five parts:

(a) Operations with signs.
(b) Indices.
(c) Simple equations.
(d) Verbal problems.
(e) Logical relations involving "greater than" and "less than".
As an aid to the Department of Mathematics, it proved extremely useful.

In the fall of 1945 the test was first used in the Counselling Office at the university as an aid in counselling, but there was no attempt to use it in a predictive manner. One revision was eventually carried out in which the times of the various sub-tests were adjusted and some items either added or deleted.

There has been no work done, as yet, to determine the reliability of the test and the only evidence regarding its validity may be found in an early study conducted by the Counselling Office. A correlation coefficient of .51 was found between marks on the "J" Mathematics test and marks on a mid-term examination in first year mathematics. This correlation compares very well with others reported in the literature. It is to be hoped that before too long considerably more research will be done on the test.
1. Statement of Problem.

As indicated in Chapter I, the counsellors in the university Counselling Office have been limited in their application of the psychological test results. To date the tests have been used to assist in determining academic promise in terms of the student's status with relation to others having taken them and to assist the counsellor in suggesting choice of courses and vocations. Their predictive value has not been known so that it has not been possible to use them to predict success with any degree of confidence.

It is the purpose of this study to determine the predictive value of the following psychological tests used in the University of British Columbia Counselling Office:

(a) The Henmon-Nelson Tests of Mental Ability - For College Students - Form A.
(b) The Purdue Placement Test in English - For Colleges and Senior High Schools - Form A.
(c) The "J" Mathematics Test.

Their predictive values will be studied in terms of their ability to foretell the students' success in the
following:

(a) Average Final mark.

(b) English 101 (Composition) Final mark. In order that the Purdue Placement Test in English be evaluated in terms of as stable a criterion as possible, the first year English Literature course mark was kept separate from the English Composition mark and is not used at all.

(c) Mathematics 101 Final mark.

Based on the predictive values obtained, regression equations will be developed where applicable and these in turn transposed to graphs for convenience in use.

If necessary, insofar as prediction is concerned, alternatives to the above tests will be suggested.

2. Limitations of the Study.

There are important limitations to be considered in solving the problem. First, it must be remembered that all subjects in the study were incoming freshmen registering in first year. Therefore, the results cannot be applied to students in any other year, even though they may be registered in one or both of the courses used as criteria in the study.
Secondly, all subjects sat for the Counselling Office tests, and received subsequent counselling, of their own accord. If and when, these tests are made compulsory for all incoming students, the predictive values determined by this thesis will not apply unless it can be proven that there is no difference between the groups, especially with regard to motivation.

Thirdly, unless a student is taking a full year's work, including the elective "Mathematics 101", the results will not apply.

Fourthly, in the matter of individual counselling, it is not sufficient to predict success in academic courses solely on the basis of psychological test results. Such results, as will be discussed in later chapters, can only be considered along with a thorough appraisal of the students' interests, personality, study habits, high school background and so on.

Finally, as will also be discussed later, the reliability of professors' and lecturers' marks in the various courses is questionable.

3. Techniques to be Employed.

(a) Sample.

The sample contains 150 freshmen students enrolled in 1950-51 first year arts, home econ-
omics, agriculture and physical education, of both sexes and eighteen and nineteen years of age. Most are from schools in the lower mainland of British Columbia and all took the battery of tests during the summer of 1950, before enrolling. All were registered as taking at least 15 units of work including compulsory English courses and Mathematics 101 (elective).

It should be noted that all students included in this study were among the group mentioned in Chapter I, which sought testing and counselling of their own accord. The implications of this selective factor have been discussed.

(b) Test Administration and Recording of Marks.

All tests were administered and scored in strict adherence to instructions given in the test manuals. Course marks are recorded as obtained from official tabulated records. Due to the variation possible in maximum marks, depending on the number of courses taken by the students, it will be necessary to record Average Final marks as a percentage.

(c) Statistical Methods.

1. Characteristics of Distributions of the tests and criteria will be tabulated.
ii. Pearson product-moment coefficients of correlation will be computed from scatter diagrams of all tests and course marks used in the study, paired in all possible combinations.

iii. Multiple coefficients of correlation will then be calculated between:

1. Each academic mark and all possible pairs of psychological test results.
2. Each academic mark and all three of the psychological test results taken together by means of the Dolittle Method (31, p. 441).

iv. From the above calculations regression equations will be prepared using the best combinations of the psychological tests to achieve the best prediction of academic marks.

v. Where useful, various estimates of reliability and significance will be calculated to corroborate the findings.

vi. Centile norms will be calculated for each psychological test.
vii. Using centile norms and raw scores of the psychological tests and the regression equations as mentioned above, graphs will be constructed to facilitate the prediction of academic marks.
CHAPTER V

ANALYSIS OF RESULTS

In accordance with the outline in the previous chapter the following sections discuss in detail the results of the statistical work.


Figures 1 to 6 and Table III show the distributions of scores and marks. In general, the distributions conform fairly closely to the normal frequency curve, certainly satisfactorily enough for studies of this type. The distribution of Mathematics 101 marks, however, is an exception. The standard deviation indicates a much greater dispersion of scores than is usually expected of a normal distribution. Later sections will deal with this particular situation more fully.

FIGURES 1 to 6

TABLE III
Figure 1. Histogram Showing the Frequency Distribution of Scores on the Henmon-Nelson Test of Mental Ability.

Figure 2. Histogram Showing the Frequency Distribution of Scores on the Purdue Placement Test in English.
Figure 3. Histogram Showing the Frequency Distribution of Scores on the "J" Mathematics Test.

Figure 4. Histogram Showing the Frequency Distribution of Average Final Marks.
Figure 5. Histogram Showing the Frequency Distribution of English Composition Final Marks.

Figure 6. Histogram Showing the Frequency Distribution of Mathematics 101 Final Marks.
<table>
<thead>
<tr>
<th>Statistic</th>
<th>Variables</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Henmon-Nelson</td>
<td>Purdue</td>
</tr>
<tr>
<td>Maximum Score</td>
<td>90</td>
<td>247</td>
</tr>
<tr>
<td>Range</td>
<td>35-74 = 40</td>
<td>81-207 = 127</td>
</tr>
<tr>
<td>Mean</td>
<td>53.9</td>
<td>158.6</td>
</tr>
<tr>
<td>Standard Error</td>
<td>.66</td>
<td>1.84</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>8.02</td>
<td>22.47</td>
</tr>
<tr>
<td>Standard Error</td>
<td>.46</td>
<td>1.3</td>
</tr>
<tr>
<td>Semi-interquartile Range</td>
<td>6.0</td>
<td>15.4</td>
</tr>
<tr>
<td>Standard Error</td>
<td>.51</td>
<td>1.44</td>
</tr>
</tbody>
</table>
2. Coefficients of Correlation Between the Variables and the Criteria.

Tables IV, V and VI show all coefficients of correlation found in the study as calculated according to the techniques outlined in Chapter IV. Although quoted in Table IV, intercorrelations of the various academic criteria are not pertinent to the solution of the problem. Correlation coefficients of the English Composition Final and the Mathematics 101 Final marks with the Average Final mark are spuriously high, since both the former marks were used in the calculation of the latter one. (Appendix A.)

Table IV shows a low correlation between the "J" Mathematics Test score and the Purdue Test score. Each, however, correlate much better with the academic criteria. Since both tests are expected to measure different things, this was desirable and is considered to be a necessary requirement for useful prediction by a battery of tests.
TABLE IV
PEARSON PRODUCT-MOMENT COEFFICIENTS OF CORRELATION AND THEIR STANDARD ERRORS BETWEEN ALL PSYCHOLOGICAL TESTS AND ACADEMIC CRITERIA

<table>
<thead>
<tr>
<th>Tests and Criteria</th>
<th>Purdue-English</th>
<th>&quot;J&quot; Mathematics</th>
<th>Average Final</th>
<th>English Composition</th>
<th>Mathematics 101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henmon-Nelson</td>
<td>.49 ± .06</td>
<td>.49 ± .06</td>
<td>.31 ± .07</td>
<td>.34 ± .07</td>
<td>.21 ± .08*</td>
</tr>
<tr>
<td>Purdue English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.16 ± .08#</td>
</tr>
<tr>
<td>&quot;J&quot; Mathematics</td>
<td>.29 ± .08</td>
<td>.37 ± .07</td>
<td>.70 ± .04</td>
<td></td>
<td>.54 ± .06</td>
</tr>
<tr>
<td>Average Final</td>
<td></td>
<td></td>
<td></td>
<td>.55 ± .06</td>
<td>.24 ± .08</td>
</tr>
<tr>
<td>English Composition</td>
<td></td>
<td></td>
<td></td>
<td>.76 ± .03</td>
<td></td>
</tr>
</tbody>
</table>

Note: All r values are significant at the .01 level of confidence with the following exceptions: * significant at .05 level of confidence
# not significant at .05 level of confidence.
### TABLE V
MULTIPLE COEFFICIENTS OF CORRELATION AND THEIR STANDARD ERRORS BETWEEN EACH ACADEMIC CRITERION AND ALL POSSIBLE PAIRS OF PSYCHOLOGICAL TESTS

<table>
<thead>
<tr>
<th>Academic criteria</th>
<th>Tests</th>
<th>Average</th>
<th>Final</th>
<th>English Composition</th>
<th>Mathematics 101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Henmon-Nelson and Purdue English</td>
<td>.48 ± .06</td>
<td>.80 ± .03</td>
<td>.27 ± .08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Henmon-Nelson and &quot;J&quot; Mathematics</td>
<td>.52 ± .07</td>
<td>.39 ± .06</td>
<td>.60 ± .05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Purdue English and &quot;J&quot; Mathematics</td>
<td>.54 ± .06</td>
<td>.73 ± .04</td>
<td>.56 ± .06</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE VI
MULTIPLE COEFFICIENTS OF CORRELATION AND THEIR STANDARD ERRORS BETWEEN EACH ACADEMIC CRITERION AND ALL THREE PSYCHOLOGICAL TESTS TAKEN TOGETHER BY THE DOLITTLE METHOD

<table>
<thead>
<tr>
<th>Academic Criteria</th>
<th>Tests</th>
<th>Average</th>
<th>Final</th>
<th>English Composition</th>
<th>Mathematics 101</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Henmon-Nelson Purdue English and &quot;J&quot; Mathematics Tests</td>
<td>.49 ± .06</td>
<td>.70 ± .04</td>
<td>.54 ± .06</td>
<td></td>
</tr>
</tbody>
</table>

The Henmon-Nelson Test, on the other hand, correlates much better with the other two tests than it does with the academic criteria. This situation is probably due to its construction, which, by its very nature as a test of general intelligence, includes many items typical of both the Purdue English and the "J" Mathematics Tests.

Using the Wallace-Snedecor tables (31, p. 211) all coefficients of correlation shown in the following sections are significant at the one percent level of confidence, with three exceptions: (a) That between the Henmon-Nelson Test and Mathematics 101 Final, which is significant at the five percent level, (b) That between the Purdue Test and Mathematics Final, and (c) The "J" Mathematics Test and English Composition Final, which is not significant at either level. (Cited text).


(a) The Henmon-Nelson Tests of Mental Ability.

As was pointed out by a number of authors cited in Chapter III, tests of general intelligence have rarely been successfully used in regression equations predicting academic success. The results of this study are no exception. Correlations of the Henmon-Nelson Test with the academic criteria are not as high as they are with the other psychological tests. In studies of this sort the reverse is desirable, since, as mentioned earlier, tests in a bat-
tery should ideally measure different things.

It is interesting to note, that when the Henmon-Nelson test is used along with one or the other of the remaining psychological tests, to predict the various academic marks, the multiple coefficients of correlation obtained are increased (Tables V, VI). When regression equations are calculated, the intelligence test adds virtually nothing to the slope of the line. When predicting the English Composition Final mark, for example, the beta coefficient for the Henmon-Nelson is .002 as compared with .308 for the Purdue Test. Again, in predicting the Mathematics 101 Final mark, the weighting of the intelligence test is about one-eighth that of the Mathematics Test, influencing the slope only slightly.

When predicting the Average Final mark, in no combination with other tests does the Henmon-Nelson Test produce a multiple correlation coefficient sufficient to better that of the Purdue and "J" Mathematics Tests used together.

We may conclude, that on the basis of coefficients of correlation, insofar as the results of this study may be applied, the Henmon-Nelson Test, in comparison with the other tests, has some predictive value but most of that is in combination with the "J" Mathematics Test in predicting the Mathematics 101 Final mark.
Another approach will be now discussed. This is a study of the predictive value of parts of the distribution of Henmon-Nelson Test scores, for example, the lowest and highest quarters. To this end, the expectancy tables shown in Tables VII, VIII, and IX have been constructed.

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**TABLE VII**

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**TABLE VIII**

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**TABLE IX**

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An important limitation to the interpretation of the results presents itself, due to the breakdown of the 150 cases into 20 categories. The confidence enjoyed is less than for measures based on larger numbers of cases, although the expectancy table permits of clearer interpretation than does the correlation coefficient. This is due to the method of organizing the data. While the correlation coefficient is concerned with the distribution as a whole in one mathematical figure, the expectancy table allows consideration of the data in various parts of the distribution.
<table>
<thead>
<tr>
<th>Quarter of H-N Distribution</th>
<th>Fail</th>
<th>Supp'l.</th>
<th>Pass</th>
<th>Second</th>
<th>First</th>
<th>Total Cases</th>
<th>Fail</th>
<th>Supp'l.</th>
<th>Pass</th>
<th>Second</th>
<th>First</th>
<th>Total Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>6</td>
<td>31</td>
<td>46</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>5</td>
<td>13</td>
<td>12</td>
<td>7</td>
<td>38</td>
<td>3</td>
<td>13</td>
<td>34</td>
<td>32</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>3</td>
<td>18</td>
<td>15</td>
<td>1</td>
<td>41</td>
<td>10</td>
<td>7</td>
<td>44</td>
<td>39</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Lowest</td>
<td>4</td>
<td>2</td>
<td>25</td>
<td>7</td>
<td>0</td>
<td>38</td>
<td>11</td>
<td>5</td>
<td>66</td>
<td>18</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>12</td>
<td>66</td>
<td>49</td>
<td>14</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE VII

EXPECTANCY TABLE SHOWING THE DISTRIBUTION OF CLASS STANDINGS OF AVERAGE FINAL MARKS WITHIN THE QUARTERS OF THE HENMON-NELSON DISTRIBUTION.
### TABLE VIII

**EXPECTANCY TABLE SHOWING THE DISTRIBUTION OF CLASS STANDINGS OF ENGLISH COMPOSITION FINAL MARKS WITHIN THE QUARTERS OF THE HENMON-NELSON DISTRIBUTION**

<table>
<thead>
<tr>
<th>Quarter of H-N Distribution</th>
<th>Number Receiving Each Standing</th>
<th>Percent Receiving Each Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fail Supp'1. Pass Second First Total Cases</td>
<td>Fail Supp'1. Pass Second First Total Percent</td>
</tr>
<tr>
<td>Highest</td>
<td>0 0 13 17 3 33 0 0 39 52 9 100</td>
<td></td>
</tr>
<tr>
<td>High Middle</td>
<td>0 2 18 16 2 38 0 5 47 43 5 100</td>
<td></td>
</tr>
<tr>
<td>Low Middle</td>
<td>1 5 26 9 0 41 2 12 64 22 0 100</td>
<td></td>
</tr>
<tr>
<td>Lowest</td>
<td>0 5 25 8 0 38 0 13 66 21 0 100</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1 12 82 50 5 150</td>
<td></td>
</tr>
<tr>
<td>Quarter of H-N Distribution</td>
<td>Fail Supp'l</td>
<td>Pass</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>Highest</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>High Middle</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Low Middle</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Lowest</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>22</td>
</tr>
</tbody>
</table>
The tables throw some light on the predictive ability of the Henmon-Nelson Test. In general, it may be said that the only useful information arises out of the extremes of the distribution - the lowest and highest quarters.

It is unlikely that students scoring in the highest quarter of the test would fail their year and there are about six chances in one hundred that they would not receive a pass standing at least. Students scoring in this quarter are unlikely to receive less than a pass standing in English Composition and have only fifteen chances in one hundred of not passing in Mathematics 101.

Few, if any, first class Average Final and English Composition marks are likely to be obtained by students scoring below the median on the Henmon-Nelson Test. There are eleven chances in one hundred that a student scoring in the lowest quarter will receive a first class standing in Mathematics 101.

The expectancy table for the Mathematics 101 Final marks is in no way as decisive in the extremes as are the other criteria, due probably, to the unreliability of the mark itself. This will be discussed in a later section.

Finally, it may be concluded that the Henmon-Nelson is in no way as effective in prediction as are the Purdue Placement and "J" Mathematics Tests. As a rough guide in
isolating some of the extremes, it has some value as shown in the expectancy tables.

(b) The Purdue Placement Test in English.

Referring again to Table IV, we find a correlation coefficient of \( r = .70 \pm .04 \) between the Purdue Test and the English Composition Final, better than any others involving the individual psychological tests. Adding the Henmon-Nelson Test, a multiple coefficient of \( R = .80 \pm .03 \) is produced. As was discussed in the previous section, there is almost no difference between the regression equations constructed on the basis of these coefficients.

Very close to the correlation .70, mentioned above, are two others, both multiple coefficients, one \( (R = .73 \pm .04) \) being that between the Purdue English with the "J" Mathematics Test and the English Composition Final, and the other \( (R = .70 \pm .04) \) being that between all psychological tests taken together and the English mark. It is apparent that these combinations can add very little, if anything, to the predictive value of the Purdue Test alone predicting success in the English Composition course.

Taken alone, the Purdue Test predicts the Average Final mark better than the Henmon-Nelson Test, but not as well as does the "J" Mathematics Test (Table IV). A multiple correlation coefficient, using both the Purdue Test and the "J" Mathematics Test in predicting the Average
Final mark, of $R = .54 \pm .06$ appears to be the most useful one.

In the prediction of the Mathematics Final mark, the Purdue Test adds little to the total picture.

To sum up, the Purdue Placement Test is most useful (as might be expected) in the prediction of the English Composition Final mark and, with the "J" Mathematics Test, in the prediction of the Average Final mark.

(c) The "J" Mathematics Test.

The "J" Mathematics Test alone is most effective in the prediction of the Mathematics 101 Final, with a correlation coefficient of $r = .54 \pm .06$. It also is the best single predictor of the Average Final mark, and is of no use at all as a predictor of the English Composition Final.

Taken along with the Purdue Test, it is the best predictor of the Average Final mark. Using the Henmon-Nelson Test with it reduces its predictive value considerably. In combination with the Purdue Test, it is a very good predictor of the English Composition Final ($R = .56 \pm .06$), and with the Henmon-Nelson its value in predicting the Mathematics 101 mark is increased to $R = .60 \pm .05$.

The full value of the "J" Mathematics Test will not be known until the Mathematics 101 course has been effectively revised and the results become more reliable.
On the basis of the foregoing evidence, however, the "J" Mathematics Test is a good predictor of the Mathematics 101 Final and this prediction is improved when the Henmon-Nelson is added. This test is also useful along with the Purdue English Test in the prediction of the Average Final mark.

4. Selection of "Best Predictors" of the Various Academic Criteria.

(a) Prediction of the Average Final Mark.

The highest correlation of a psychological test with Average Final marks is that of the "J" Mathematics Test ($r = .41 \pm .07$), and the lowest is that of the Henmon-Nelson Test ($r = .31 \pm .07$). Furthermore, as tabulated in Table V, a combination of the Purdue Placement Test and the "J" Mathematics Test produces a correlation coefficient of $R = .54 \pm .06$. However, a three way combination adding the Henmon-Nelson Test yields a lower one ($R = .49 \pm .06$) (Table VI).

It is concluded, therefore, that the best prediction of the average Final mark is by a combination of the Purdue Placement Test and the "J" Mathematics Test ($R = .54 \pm .06$). Calculated on this basis the resultant regression equation reads:

$$X_4 = 17.9 + .154X_2 + .556X_3$$

(Appendix - B)

where $X_4 =$ Average Final mark.

$X_2 =$ Purdue Placement Test in English score.

$X_3 =$ "J" Mathematics Test score.
The Standard Error of Estimate of the correlation is 10.83, indicating that two-thirds of all obtained scores should fall within approximately 11 points of the predicted score.

The contribution of knowledge of variance on the psychological tests associated with the variability of the Average Final mark is indicated by the coefficient of multiple determination, which, in this case, is .2872 or approximately 29 percent. The remaining 71 percent is associated with other factors which might include motivation, study habits, adjustment to university life, variety of courses taken, etc.

These results are encouraging when one considers the make-up of the Average Final mark more carefully. It is composed of the results on fifteen or eighteen units of course work, ordinarily five or six subjects, of which, in the sample used in this study, only two are known to be common throughout - English and Mathematics.

Using the centile norms calculated (Table X) and raw scores, the regression equation is represented graphically for practical use in Figure 7. The Purdue Test was placed along the ordinate and the "J" Mathematics along the abscissa, the predicted score to be read off according to the diagonal lines which were chosen to indicate divisions between class groupings. On this basis, using either cen-
tiles or raw scores, an approximation of the Average Final mark can be read off or interpolated on the graph, or a more reliable estimation can be had if the class standing, only, is desired.

TABLE X

FIGURE 7.

(b) Prediction of the English Composition Final Mark.

The English Composition course is a compulsory course in first year and is taught along with one in English Literature. Referring to Table IV, it may be seen that the best correlation with the English Composition course is that of the Purdue English Test ($r = .701 \pm .041$).

The best prediction, however, appears to be that achieved by a combination of the Henmon-Nelson and the Purdue English ($R = .805 \pm .029$).

The next step is to prepare a regression equation:

$$X_5 = 12.05 + .002X_1 + .308X_2$$

where $X_5 = $ English Composition Final mark.

$X_1 = $ Henmon-Nelson score.

$X_2 = $ Purdue Placement Test in English score.
TABLE X

CENTILE NORMS OF THE PSYCHOLOGICAL TESTS USED IN THE STUDY
(INCLUDING $Q_1$ AND $Q_3$)

<table>
<thead>
<tr>
<th>Centile Points</th>
<th>Henmon-Nelson</th>
<th>Purdue English</th>
<th>&quot;J&quot; Mathematics</th>
<th>Centile Points</th>
</tr>
</thead>
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<tr>
<td>99</td>
<td>73.0</td>
<td>204.5</td>
<td>57.3</td>
<td>99</td>
</tr>
<tr>
<td>90</td>
<td>64.5</td>
<td>189.5</td>
<td>44.7</td>
<td>90</td>
</tr>
<tr>
<td>80</td>
<td>61.6</td>
<td>178.5</td>
<td>41.5</td>
<td>80</td>
</tr>
<tr>
<td>(Q3) 75</td>
<td>60.4</td>
<td>175.6</td>
<td>40.3</td>
<td>75 (Q3)</td>
</tr>
<tr>
<td>70</td>
<td>58.9</td>
<td>171.4</td>
<td>39.1</td>
<td>70</td>
</tr>
<tr>
<td>60</td>
<td>56.2</td>
<td>163.7</td>
<td>36.3</td>
<td>60</td>
</tr>
<tr>
<td>50</td>
<td>54.4</td>
<td>157.4</td>
<td>34.4</td>
<td>50</td>
</tr>
<tr>
<td>40</td>
<td>52.2</td>
<td>153.0</td>
<td>32.9</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>49.6</td>
<td>148.2</td>
<td>30.9</td>
<td>30</td>
</tr>
<tr>
<td>(Q1) 25</td>
<td>48.4</td>
<td>144.9</td>
<td>29.9</td>
<td>25 (Q1)</td>
</tr>
<tr>
<td>20</td>
<td>47.2</td>
<td>141.7</td>
<td>28.7</td>
<td>20</td>
</tr>
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<td>10</td>
<td>44.95</td>
<td>131.2</td>
<td>26.0</td>
<td>10</td>
</tr>
<tr>
<td>01</td>
<td>34.8</td>
<td>111.2</td>
<td>20.9</td>
<td>01</td>
</tr>
</tbody>
</table>
Then $X_4 = 65.71$

Example:
$X_2 = 160$
$X_3 = 40$
Then
$X_4 = 65.71$

Figure 7. Graphical Representation of the Regression Equation for the Prediction of Average Final Marks ($X_4$).

$X_4 = 17.9 + .154X_2 + .856X_3$

$SE_{est} = 11$
It will be noted, that in this equation the beta coefficient of the Henmon-Nelson Test, for all practical purposes, eliminates the influence of the test. The equation is therefore discarded, and other combinations of tests will be considered.

Tables IV, V and VI list the following correlation coefficients and Standard Errors between various test combinations and the English Composition Final mark:

i Purdue Test with the English Composition Final: $r = .70 \pm .04$

ii Purdue Test and "J" Mathematics Test with the English Composition Final: $R = .73 \pm .04$

iii Purdue Test, "J" Mathematics Test and Henmon-Nelson Test with the English Composition Final: $R = .70 \pm .04$

The differences between these coefficients are insufficient to warrant selecting any particular one solely on the basis of its size. For simplicity in use it would be most advantageous to use the first coefficient listed, that between the English Composition Final mark and the Purdue Placement Test in English score ($r = .70 \pm .04$).

A second regression equation reads:

$$X_5 = 12 + .309X_2$$

where $X_5$ = English Composition Final mark.

$X_2$ = Purdue Placement Test in English.
The Standard Error of Estimate in this case is 7.06, indicating that within plus or minus seven points of the predicted mark two-thirds of all obtained scores should fall. The coefficient of determination is .4914, or approximately forty-nine percent. The remaining fifty-one percent of the variance is probably associated with various factors other than the variance in the Purdue Placement Test.

Using the centile norms, calculated in Table X and raw scores, Figure 8, shows the regression line and its limits of accuracy (Figure 4). As in the prediction of the Average Final mark, class groupings are indicated as well as actual marks.

---

(c) Prediction of the Mathematics 101 Final Mark.

Because of the nature of the distribution of Mathematics 101 Final marks, prediction will be difficult regardless of the predictive value of the "J" Mathematics Test. Within a maximum score of 150 there is a range of 105, with a standard deviation of 27 points (Table III).

The significance of this size of standard deviation insofar as this study is concerned will be seen later.
Figure 3. Graphical Representation of the Regression Equation for the Prediction of English Composition Final Marks, \( X_5 = 12 + 0.309X_2 \) \( SE_{est} = 7 \)
Referring to Table IV, and disregarding its high correlation with the Average Final mark, the Mathematics 101 mark correlates best with the "J" Mathematics Test \( r = .54 \pm .06 \). When the Henmon-Nelson Test is combined with the "J" Mathematics the multiple coefficient of correlation is \( R = .60 \pm .05 \). This is better than a three-way combination of all the psychological tests, which yields a correlation of \( R = .54 \pm .06 \).

The most effective combination which can be used, therefore, is that of the Henmon-Nelson and the "J" Mathematics Tests. The regression equation, calculated on this basis, reads:

\[
X_6 = 15.2 + .238X_1 + 2.012X_3
\]

where \( X_6 \) = Mathematics 101 mark,
\( X_1 \) = Henmon-Nelson Test score.
\( X_3 \) = "J" Mathematics Test score.

Again, the Henmon-Nelson Test is not shown to be a very important aid to prediction, but this equation will be used, however. Due to the large standard deviation of the Mathematics 101 distribution, the standard error of estimate of the above equation is also high, since the formula for this statistic depends largely on the former.

The standard error of estimate is 21.57 meaning that two-thirds of all obtained final mathematics marks will fall between \( \pm 21.57 \) points of the predicted mark. This situation seriously hampers all but the very roughest of predictions.
Had the distribution been more normal, the standard deviation would have been reduced to about 17 and the standard error to 15, which would have been a slight improvement. The fault appears to be in the construction or the marking of the Mathematics 101 course and examination. (It has been announced that the whole mathematics course of first year studies is to be revised for the session 1952-53, which means that this section of the problem will have to be redone in its entirety, sometime in the future).

The coefficient of multiple determination is .3660 or 36.6 percent, meaning that the variance in psychological test results is associated with 36.6 percent of the variance in the Mathematics 101 Final mark.

The equation is transposed to a graph in Figure 9, using centile norms and raw scores. The reader must be warned of the unreliability of this prediction chart, due to the very large standard error of estimate. An illustration will be useful here. Assuming that a student receives a score of 50 on the Henmon-Nelson Test and a score of 30 on the "J" Mathematics Test, his predicted final mark in Mathematics 101 is approximately 85, a pass standing. Due to the large standard error of estimate, (21.57) there are 66 chances in 100 that the student's true mark will be somewhere within the limits 63, a supplemental standing, and 107, a second class standing.
5. Summary and Conclusions.

(a) The Henmon-Nelson Test shows higher correlations with the other psychological tests than it does with the academic criteria, while the latter tests correlate low with each other and much better with the criteria.

(b) The Henmon-Nelson Test, although it tends to increase correlations when combined with either the Purdue Test or the "J" Mathematics Test, adds very little weight to regression equations for the prediction of academic marks. On this basis it is of no use in predicting the Average Final mark or the English Composition Final mark, and of limited use in predicting the Mathematics 101 Final mark. On the basis of expectancy tables, it is of some use in predicting failures and first class standings in the criteria.

(c) The Purdue Placement Test in English is very effective alone in the prediction of the English Composition Final mark. In combination with the "J" Mathematics Test, it effectively predicts Average Final marks, also with a reasonable standard error of estimate.

(d) The "J" Mathematics Test is most useful in the prediction of the Mathematics 101 mark in conjunction with the Henmon-Nelson Test. As mentioned in (c) above, the
Figure 9. Graphical Representation of the Regression Equation for the Prediction of Mathematics 101 Final Marks \( (X_6) \). \[ X_6 = 15.2 + 0.23X_1 + 2.012X_3 \] \( SE_{est} = 22 \)
Purdue and "J" Mathematics Tests make the best combination for the prediction of the Average Final mark.

(e) Coefficients of correlation are very reliable in terms of their standard errors. Standard errors of estimate are low, with the exception of that for the prediction of the Mathematics 101 Final mark. This is directly due to the high standard deviation of that distribution.

In conclusion, it may be said, keeping in mind the limitations of the study, that the battery of psychological tests used by the Counselling Office at the University of British Columbia can be used effectively in the prediction of success in first year, in terms of the average final mark and certain course marks.
CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS
FOR FURTHER STUDY

This study is designed to determine the predictive value of three psychological tests used by the Counselling Office of the University of British Columbia. It is further intended that the results be used to provide a graphic means of prediction for actual use by the counsellors in their work. A search for relevant investigations in psychological and educational literature has been conducted and the results reported.

A number of important conclusions have been drawn, but it would be well to briefly summarize the results of the investigation and the review of the literature before discussing them.

1. Summary.

(a) Relative Predictive Values of the Psychological Tests.

1. The Henmon-Nelson Test of Mental Ability-Form A.

In keeping with the findings of most investigators concerning the predictive value of intelligence tests, the Henmon-Nelson
Test is of some use in combination with the other tests. This is particularly so when it is paired with the "J" Mathematics Test in the prediction of the Mathematics 101 Final mark. The coefficient of correlation between the English Composition mark and the Purdue Placement Test score is boosted from .70 to .80 when the Henmon-Nelson is added to the latter, but no difference occurs in the regression equation. In the prediction of the Average Final mark, the test again fails to be of any use. On an individual basis, it cannot compare with the effectiveness of the others.

Expectancy tables indicate that this test can be used to isolate the extreme cases in all academic criteria but Mathematics 101.

Were economy of time in the administration and marking of a test not important factors in its selection, a good many authors would suggest using the A.C.E. Examination. The majority of investigators, however, find no special merit in the test, nor in fact in most intelligence tests, and recommend that any measure of intelligence
be very cautiously used in prediction - for, at best, such tests serve as a very rough guide.

ii. The Purdue Placement Test in English - For Schools and Colleges - Form A.

This test proves to be the best single predictor of an academic criterion, having a coefficient of correlation of .70 with the English Composition Final. The addition of the Henmon-Nelson Test raises the figure to .80 but, as mentioned above, little change is produced in the slope of the regression line.

Together with the "J" Mathematics Test the Purdue Test is the best predictor of Average Final marks.

iii. The "J" Mathematics Test.

With a coefficient of correlation of .54 the "J" Mathematics Test is the best single predictor of the Mathematics 101 Final mark and also excels the other tests in the prediction of the Average Final mark. As mentioned above, in the multiple prediction of the Average Final mark and the Mathematics 101 Final, the "J" Mathematics Test is part of both the most use-
ful combinations, in the former with the Purdue Placement Test, and in the latter with the Henmon-Nelson Test.

An adequate analysis of this test will not be possible until a more reliable criterion is constructed. As was described earlier, a revision of the Mathematics 101 course is expected for the session 1952-53.

Measures of specific aptitudes for the prediction of success in individual courses are reported, throughout the literature, to be the most useful psychological tests in prediction (p.14). In spite of the scientific construction of these tests, they are found to be second in value to the high school record.

(b) Selection of the "Best Predictors" of the Various Academic Criteria.

The literature stresses the unreliability of academic criteria. This appears to be mainly due to the variety of lecturers marking, frame of reference adopted in marking, various other factors influencing the markers' decisions, and to the lack of standardization in
examinations used. Until such arbitrary elements are removed prediction will be difficult.

1. The Average Final Mark.

   The best prediction of this mark is achieved by a combination of the Purdue Placement and the "J" Mathematics tests (R = .54). The standard error of estimate is 10.83 and the coefficient of multiple determination was .2872. Considering the possible variety in components of the Average Final mark, of which the Mathematics 101 and English Composition Finals are the only common ones throughout the study, these results are very encouraging. Used with discretion, they should be very useful in practice.

   Based on the regression equation produced, as in all cases below, a graph facilitates determining probable marks in an easy, straightforward manner.

ii. The English Composition Final Mark.

   While a combination of the Purdue Placement Test and the Henmon-Nelson Test yields a higher correlation (R = .805) with the English Composition Final, the
former used alone \((r = .701)\) results in an almost identical regression equation. The simpler equation, because of ease in handling, is the most useful one.

The standard error of estimate is just 7.06, while the coefficient of determination is \(.4914\), the highest in the study.

iii. The Mathematics 101 Final Mark.

This part of the study was seriously hampered by the nature of the distribution of the criterion. The standard deviation is very high, influencing not only coefficients of correlation but standard errors of estimate.

The best single predictor of this mark is the "J" Mathematics Test \((r = .54)\) but the addition of the intelligence test increases it to \(R = .60\). The multiple regression equation is based on the mathematics and intelligence tests.

The unusually high standard deviation of 27 points in a range of 104 results in a standard error of estimate of 21.57, not at all practical for prediction within the scope of this thesis. As a rough guide, however, a graph showing the regression line is included to supplement the others.
2. Conclusions.

The foregoing investigation has thrown considerable light upon the predictive value of the psychological tests in use at the University of British Columbia Counselling Office.

In general, the results are very much in keeping with those of studies reported throughout the literature. Nothing unusual, or unexpected, was uncovered in the analysis. The old, frequently tried, techniques were used carefully and found highly satisfactory.

Within the limitations imposed upon their application, the results will be of great practical value to the counsellor. He will now be aware of the rather doubtful part played by intelligence tests in prediction, but, will be able to utilize the extremes of the Henmon-Nelson distribution through the use of expectancy tables. At best, he may find this test indicative of academic promise rather than probable achievement.

The specific subject aptitude tests were found to be most useful in predicting marks in the academic criteria. With the reservation that some measure of the high school record is usually the best single predictor of academic success, this finding is amply supported in the literature. The Purdue Placement Test in English was especially useful. Had the Mathematics 101 Final mark been a more reliable criterion, the "J" Mathematics test would have been judged more ade-
quately than was possible under the circumstances. However, in the prediction of the Average Final mark it measured up extremely well.

All three academic criteria can be predicted with reasonable accuracy, with the exception of the Mathematics 101 Final mark.

Whether or not students seeking counselling services can be considered atypical is the issue on which the extent of application of the results depends. While some authors disagree, most support the view that motivation is an important factor in success. If it can be assumed that those students wanting testing and counselling are more highly motivated in the performance of their academic work than those who avoid or ignore the service, then the results of this study will apply only to the former group. However, as long as the service is non-compulsory, the findings will apply to virtually all students receiving it.

There was no evidence, either as a result of the study, or in the literature, to suggest that any of the three tests should be replaced by more efficient measures. That any of the three could be replaced by better ones cannot be decided until possible alternatives are investigated in the same setting and under the same conditions as were the tests used in this study.
In conclusion, it may be said that the counsellors will now have factual information at hand concerning the three tests and the academic criteria. By using the expectancy tables and graphs provided in the text of the study, they will be greatly assisted in predicting the students' chances for success in first year, and in counselling them accordingly.

3. Recommendations For Further Study.

About the most significant contribution of the literature to the study was that a measure of high school performance usually bettered most other measures as a predictor of academic success. It is suggested, therefore, that future studies of this problem by the Counselling Office should include this factor.

In an attempt to contribute more evidence on the predictive value of interest and personality factors, the remaining tests in the battery - the Thurstone Interest Schedule and the Toronto Familiar-Extrafamilial Scale - should be thoroughly studied.

Investigations into the importance of motivation, age and sex as factors in academic performance would be highly desirable. The effect of the counselling experience on motivation, study habits, choice of courses and vocations, etc., would be another problem well worth intensive study.
An analysis of differences in motivation, personality and high school record etc., between students tested and counselled and those not tested and counselled, would provide very helpful information to assist in determining the limitations of future studies.

Consideration should be given to the possible use of some of the new statistical techniques such as the "caution factor" of Carrillo and Reichert (p. 33).

A complete reliability study of the "J" Mathematics Test is essential, and should be carried out prior to any other investigations being undertaken which would include it, so that it may be adequately revised and standardized.

A long-term study of progress through university is desirable. It would be of added benefit to the counsellor in guidance problems if such investigations were broken down into faculties or vocational fields. Moore (42) reports a dearth of such studies.

Follow-up investigations of ability patterns and their relationships to vocations and occupational success are suggested by Eurich, Cain and Michaelis (p. 36). These authors also recommend continuous studies of trends and changing requirements.
It must be remembered, however, that the value of the research suggested in this section is almost wholly dependent on the reliability of academic grades which to this date has not been encouraging and needs vast improvement.
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BIBLIOGRAPHY (Cont'd.)


68. Wykoff, G. S., McKee, J. H., and Remmers, H. H., Purdue Placement Test in English - For Colleges and Senior High Schools, Forms A, B, and C, Directions for Administering the Test, New York Psychological Corporation, 1932.
FURTHER REFERENCES

Note: The material listed below was not available to the writer but is included here to emphasize the great variety of work being done in the field.


FURTHER REFERENCES (Cont'd.)


FURTHER REFERENCES (Cont'd.)


APPENDIX
APPENDIX A

CALCULATION OF THE MULTIPLE COEFFICIENT OF CORRELATION BY THE DOLITTLE METHOD BETWEEN AVERAGE FINAL MARKS AND RESULTS ON ALL PSYCHOLOGICAL TESTS TAKEN TOGETHER

1. **Variables:**
   (a) $X_1$ = Average Final Mark
   (b) $X_2$ = Henmon-Nelson Test of Mental Ability
   (c) $X_3$ = Purdue Placement Test in English
   (d) $X_4$ = "J" Mathematics Test

2. **Work Chart:**

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<th>4</th>
<th>1</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>$X_2$</td>
<td>$X_3$</td>
<td>$X_4$</td>
<td>$X_1$</td>
<td>Sum</td>
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APPENDIX A  (Cont'd.)

Step:  
(a) Correlations with $X_2$ are entered in row A.
(b) Values in row A are summed and total is entered under "Check Sum".
(c) All values in row A are divided by -1.0000.
(d) Remaining Correlations with $X_3$ are entered in row C.
(e) Step b is repeated for this row plus value at A3.
(f) Beginning with A all values in row A3 are multiplied by value at B3.
(g) All values in rows C and D are added and sums entered in row E.
(h) All values in row E are divided by the value at E3 with sign changed.
(i) Check: $F_3 + F_4 + F_1 = \text{sum in Check Sum column}$.
(j) Remaining correlations with $X_4$ are entered in row B.
(k) Sum of remaining correlations with $X_4$ is entered in Check Sum column.
(l) All values in row A are multiplied by $B_4$ and entered in row H.
(m) Values in row E are multiplied by $F_4$ and entered in row I.
(n) Values in rows G, H and I are summed and sums entered in row J.
(o) Values in row J are divided by $-J_4$.
(p) Check: $K_4 + K_1 = \text{sum in Check Sum column}$. 
APPENDIX B

CALCULATION OF REGRESSION EQUATION FOR
THE PREDICTION OF AVERAGE FINAL MARKS

1. **Variables:**
   
   \( X_1 \) = Average Final Mark.
   
   \( X_3 \) = Purdue Placement Test in English.
   
   \( X_4 \) = "J" Mathematics Text.

2. **General Formula:**

   \[ X_1 = a + bX_3 + bX_4 \]

3. **Solution of Beta Coefficients:**

   \( \beta_{13.4} = \frac{r_{13} - r_{14}r_{34}}{1 - r_{34}^2} = .26949 \)

   \( \beta_{14.3} = \frac{r_{14} - r_{13}r_{34}}{1 - r_{34}^2} = .33238 \)

4. **Solution of Regression Weights (b):**

   \( b_{13.4} = \frac{(d_1)}{(d_3)} \beta_{13.4} = .1539 \)

   \( b_{14.3} = \frac{(d_1)}{(d_4)} \beta_{14.3} = .5557 \)

5. **Solution of the constant "a":**

   \[ a = M_1 - b_{13.4}M_3 - b_{14.3}M_4 \]

   \[ = 17.9 \]

6. **Regression Equation:**

   \[ X_1 = 17.9 + 15.4X_3 + .556X_4 \]
3. Solution of Beta Coefficients:
   (a) $\beta_{14} = -x_1 = 0.3272$
   (b) $\beta_{13} = -F_1 + B_{43} (F_4) = 0.2646$
   (c) $\beta_{12} = -B_1 + B_{43} (B_4) + B_{42} (B_3) = 0.0133$
   (d) Check: $\beta_{12} r_{13} + \beta_{13} r_{23} + \beta_{14} = r_{34}$
       $(0.0133 \times 0.499 + 0.2646 \times 0.299 + 0.3272 = 0.413)$

4. Solution of Multiple Coefficient of Correlation.

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<td>$r_{lk}$</td>
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$\text{Sum} = 0.236841$
$= R^2$
$R = 0.487$