THE PREDICTION OF UNIVERSITY FRESHMAN PERFORMANCE ON THE BASIS OF HIGH SCHOOL ACHIEVEMENT IN BRITISH COLUMBIA

by

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Abstract

This study was an attempt to determine the relationship at the University of British Columbia between high school achievement, as represented by grade twelve results, and university performance, as represented by first year standing. The aim of the work was to provide counsellors, both at the University of British Columbia and in the secondary schools of this province with predictive information for use in counselling.

The high school variables used were letter grade average, percentage average, standing at first attempt, recommendation, number of Departmental examinations written, and major subjects taken. The criterion of university performance used was first year standing in April.

A sample of 737 students was chosen from the Faculty of Arts and Science during the academic year of 1957-58. The students chosen had completed their final year in a public high school in British Columbia, were not repeating any first year university courses, and had had an uninterrupted secondary education. They had registered for at least fifteen units of course work, which included English 100-101, Mathematics 100 or 101, a foreign language, a science, and an elective. Results of this study can therefore be used adequately only with students of comparable high school background and with similar freshman programmes.

Literature relevant to the areas investigated in this study was reviewed.

By use of the Chi-Square technique and of a method of partitioning Chi-Square, it was determined whether the difference in freshman performance was significant among the students grouped according to the various high school variables, and where the difference lay. Contingency coefficients were calculated to show the degree of relationship between the variables and the criterion.

Most of the results of the investigation were in agreement with those reported by other authors who had conducted similar studies. It was found that there is a high positive relationship between freshman standing and grade twelve average, whether letter grade or percentage, that students who complete University Entrance standing at first attempt perform at a higher level at university than students who are required to make more than one attempt, that recommended students are better academic risks than

non-recommended students, and that students who are required to write three or more Departmental examinations are more likely to fail at university than students who write just one or two examinations.

Contrary to most studies, and agreeing rather with the exceptions, it was found that there is some relationship between major subjects taken in high school and freshman standing. Students who have included in their high school programmes Mathematics, Science, English, and Social Studies as majors are less likely to fail at university than students who take Mathematics and Science majors but omit English and Social Studies majors. Students who have taken a high school foreigh language major are more successful in first year university than those who omit a foreign language major.

A word of caution was included regarding the impossibility of perfect prediction for all students owing to the unreliability of marks, to individual differences, and to personal problems, adjustment and growth. Within the specified limitations of the results, the study indicated that high school achievement could be used effectively in prediction of performance at university.

A number of suggestions for further study were mentioned, the most strongly recommended of which were a study of the possibility of using a prediction formula including both high school achievement records and aptitude test results, and an investigation of capable students who do not proceed to university.

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CHAPTER I

INTRODUCTION AND BACKGROUND OF THE PROBLEM

A The Problem and Justification for Investigation

1. General

This study is an investigation of the relationship between achievement in high school and performance at university, in order to determine how well university success can be predicted from high school records.

Grade twelve records were used to represent high school achievement because it is in grade twelve that the final requirements for university entrance are completed. In view of the comparatively high failure rate in the first year at university and consequent enrolment attrition, first year standing was used to represent university performance.

2. Specific

Who should go to university? This is a vital question for all concerned with education. To send a poor student to university is a costly and unprofitable proposition from the taxpayer's point of view. Attrition presents a problem for the administrators, making it difficult to budget accurately. From the individual student's point of view it is not only costly and time consuming but also distressing to fail.

Scientific and industrial progress has led to a society which demands more training in both technical and social skills.

The revolution which has taken place as a result of mass education must be appreciated. More people are spending more time in school. The greater the number of individuals receiving secondary education the greater the number entering university. University attendance is no longer the privilege of the few.

According to Conway and Brown (14), the percentage of students in British Columbia remaining in school to the beginning of grade twelve has increased from 35 per cent in 1947 to 45 per cent in 1956. Approximately two-thirds of the grade twelve students are enrolled in the university programme. With a failure rate of 15 per cent in grade twelve, it is easily seen that 25 per cent of the original first grade population ultimately obtain university entrance. As attrition decreases, a change in standards is inevitably the result; university candidates are drawn from a poorer group. Are all of these candidates capable of university work?

The failure rate in first year suggests that many students are entering university who do not profit from the opportunities offered. The critical aspect of the situation is that these students have, nevertheless, successfully completed the university entrance requirements. Are there, then, borderline cases who should be discouraged from going to university where they must compete with more and better students? If so, where is the line to be drawn between poor students and potentially successful ones?

Criticism abounds. Some critics suggest raising admission requirements, sifting the applicants and rejecting the unfit. The opposing theory is to permit all to enter university where the pro-

grammes offered would be broadened to suit various levels of ability in the same way as secondary curricula have been broadened in recent years.

There are critics also of the system of accreditation in this province. They advocate that standardized entrance examinations be written by all those who wish to enter university. Others feel that "recommendation" is an adequate means of selection.

The main justification for this study lies however, not in administrative decisions but in the practical and functional aspects connected with individual counselling. Teachers and counsellors, both in the secondary school and at the university are better equipped to guide students if they have some factual and statistical evidence. A counsellor may be satisfied with his prediction of a particular student's success but he must be able to impress facts on the student and perhaps the parents.

There are two sides to this problem. One is the insistence of a student on going to university when he has little or no chance for success; the other is the hesitancy of a capable youth who could profit from further education but who lacks confidence to attempt university work. To counsel effectively, both in helping the student to lower his vocational aim and to follow more suitable pursuits in which he may be happier and more successful, and in encouraging the student to develop his academic potentialities by proceeding to university, it is necessary to have objective evidence.

How can this evidence be obtained, How and how well can success be predicted? Is the high school record a good predictor?

Specifically, the writer will attempt to answer the following questions:

(a) Is there a difference in first year standing among students grouped according to their grade twelve letter grade average?

(b) Is there a difference in first year standing among the students, who wrote three or more Departmental examinations, grouped according to their percentage average?

(c) Is there a difference in first year standing between the students who passed at first attempt and those who were required to write one supplemental or more and/or to repeat one subject or more?

(d) Of the students who attended accredited high schools, do students who were recommended in all subjects differ in first year standing from students who were not recommended in all subjects?

(e) Is there a relationship between the number of Departmental examinations that a student is required to write and his first year standing?

(f) Is there a difference in first year standing according to majors taken in high school? The following groupings of majors are considered:

(1) including Mathematics and Science but excluding English and Social Studies;

(2) including English and Social Studies but excluding Mathematics and Science;

(3) including Mathematics, Science, English and Social Studies;

(4) all other combinations of subjects.

(g) Is there a difference in first year performance between students who had a foreign language major in high school and those who did not?

B Definition of Students Used in Study

To eliminate extraneous variables and in order to obtain as homogeneous a group as possible, certain delimiting factors were observed.

The study was limited to students in first year in the Faculty of Arts and Science during the 1957-58 session. Freshman in other faculties were excluded. Of the 1883 students in first year of Arts and Science, 737 were chosen according to the following factors.

Only the students who had an uninterrupted education were considered. Students who were out of school for a year or more after completing grade twelve were excluded. Likewise excluded were students who left school prior to completing grade twelve, returning later to complete high school. Those, however, who took grade twelve in 1955-56 but who repeated courses or were making up University Programme requirements in 1956-57 were included, unless they completed, in addition, any senior matriculation subjects during that year, in which case they were excluded.

Only the students who attended a public secondary school in British Columbia during their final year were considered.

No students who were repeating first year Arts, or a part thereof, whether taken previously at U.B.C., Victoria College, or

as Senior Matriculation, were included.

Only the students who registered for at least fifteen units were included. The course taken included English 100 - 101, Mathematics 100 or 101, a foreign language, a science, and an elective, whether an additional science or a non-science.

C Sources of Data

The delimiting factors were found on students' Registration cards.

A list of accredited schools was kindly supplied by Mr. H.M. Evans, Department of Education, Victoria.

Students' high school progress, majors and performance were obtained from transcripts filed in the U.B.C. Registrar's Office. From these transcripts, averages were computed.

Students' first year standing, as determined by April results were obtained from the Registrar's Office.

Counselling files were used as a supplement when necessary, and city schools were contacted about questionable cases.

D Assumptions

The validity of this study depends on the criteria used. In this connection it was necessary to make a number of assumptions.

It was necessary to assume that the criterion of letter grades is a reliable one; that is, that the same letter grades from different schools have the same meaning. This is an unsupported assumption because there is no objective data to support it.

However, since the pattern of letter grades is strongly suggested by the Department of Education and since most schools apparently conform to this pattern, the assumption has some justification.

In addition to the use of letter grade averages, percentage averages from Departmental examinations were used with the assumption that they would provide a more reliable criterion. The marks from Departmental examinations and consequent averages are based on standardized examinations with standardized marking. In addition, the scaling technique employed by the Department of Education reportedly makes the results more reliable. Conway (13) and Conway and Brown (14) give a detailed account of the methods employed in scaling.

It was also necessary to assume that the marking of examinations at university and therefore the final standing is reliable. This is done with reservation in view of the lack of objective data to support it.

Because transcripts do not supply information regarding reasons for writing Departmental examinations, and because it was impossible to contact each student who wrote them, it was assumed that the students who wrote four or more examinations, whose high school record prior to grade twelve was good, and whose Departmental examinations were high, wrote all examinations in order to be eligible to win a scholarship. In order to define "high", 65 per cent average or better was used. The cases in which a student was required to write perhaps one examination and wrote the rest for scholarship purposes, or for practice, would be too few to contaminate the data sufficiently to invalidate it.

Because it was impossible to contact each student or each school, it was assumed that, aside from the students who wrote Departmental examinations for scholarship purposes, the students who wrote one examination or more did so because their work during the year was below a "C" level and they were therefore not recommended. This assumption was made with some misgiving, because there is evidence to indicate that on occasion a student or even a whole class is required to write an examination, or examinations, for disciplinary reasons. On occasion, too, a student is required to write because of poor attendance. Schools vary in their regulations regarding required attendance. Since it was impossible to determine and eliminate all of these cases, the assumptions had to be made.

However, an attempt was made to check the questionable cases, through reference to Counselling files, contact with city schools by telephone, and with individual students by telephone and letter.

E Limitations of Study

The results, that is, the predictive value of this thesis, can apply only to first year Arts and Science students whose high school background and programmes at university are comparable to those of the students used as the sample in this study as defined earlier.

It is recognized that first year performance is not perfectly representative of academic success or failure. It is likely

that some students of limited academic ability might satisfactorily complete first year but due to the effort involved, decide against continuing. On the other hand, because of adjustment problems, some students who have difficulties in first year might eventually graduate.

The validity of the results depend on the reliability of the criteria used. As seen earlier, for the purposes of this study this reliability is assumed. It is, however, questionable.

In individual counselling, knowledge of high school background alone is not sufficient to predict success. It should be considered together with an evaluation of aptitude test results, of the kind used by the University of British Columbia Counselling Department, and with other data supplied by the student about himself.

CHAPTER II

REVIEW OF LITERATURE

A Introduction

The investigation of academic prediction is one of the most popular of educational studies. The number of journal articles and books on the subject is very large, especially since the 1930's during which time there was an increased interest in these matters. The subject has been studied with various methods and from various points of view. Investigations include prediction with such variables as high school performance, standard achievement tests, intelligence as measured by a single test or a battery of tests, social and economic data, personal data, interest and motivation, and combinations of variables.

Studies show that it is impossible to predict perfectly the achievement of all entrants, and that there are cases of success or failure that cannot be discovered until the student has tried to do university work. As Tribilcock (46,p.546) says;

> "While it is wasteful and otherwise undesirable to have the unfit in college, it is also wasteful and otherwise undesirable to keep the fit out of college. For many students there is no adequate test of fitness except the actual attempt to carry college work."

However, there is no doubt that it is an advantage to both the university and the students to evaluate as accurately as possible the students' chances of success or failure in university work.

Much work has been done on the evaluation of the efficiency of high school performance as a predictor of university success. One

of the arguments in favour of using such a predictor is that it is an economical one. The administration of intelligence and aptitude tests is comparatively costly. High school records are relatively easily obtainable; they require a minimum of time, effort and expense to put into practical use. Above all, it is generally agreed by authors in the field that high school performance is the best single criterion of university success. Whether used alone, or combined with other variables, such as academic aptitude test results to give a more sensitive method of prediction, high school performance should always be considered in prognosis.

The reason for the efficiency of high school marks in prediction is aptly explained by Travers (45, p.155).

> "The value of high school grades for predictive purposes is undoubtedly a result of the fact that they represent a combination of ability and motivational factors operating in much the same way as they will operate in college. The advantages of these circumstances seem to outweigh the factors that tend to reduce the validity of high school grades."

B <u>High School Marks, Average, and Rank</u>

Symonds (44,p.440) writes:

> "Of all the indices of ability to do college work, marks in the high school courses are the most significant. They are also the easiest for a college to obtain. Colleges should use the quality of work done in high school as the first index of college ability."

The predictive value of high school averages is demonstrated by Stone (43) who, in using as variables high school grade-point average, scholastic aptitude as measured by the American Council on Education Psychological Examinations, and achievement

tests, concluded that, although multiple correlations prove more efficient, the most efficient single predictor of success at university was the high school grade-point average.

In a similar study, Drake and Henmon (20) used as variables, high school rank, the A.C.E. Psychological Examinations, the Henmon-Nelson test of mental ability and the Co-operative English test. Using various combinations of the variables, they found that the combinations containing high school rank were more effective than any other combination, and that the best single variable for prediction was high school rank.

Emme (22), in his review of studies carried out in the late 1930's concluded from his data that the best method of forecasting college success is to use a formula including a combination of variables but that the best single criterion is rank in high school graduating class.

Similarly, Harris (28), in his review, concluded that although a combination of intelligence rating and high school achievement gives a higher correlation with college marks than either alone, high school grades alone show a higher correlation than intelligence rating alone.

Froelich (25), in covering all the Wisconsin research done from 1909 to 1941, came to the conclusion that a combination of high school achievement rating and intelligence rating increases the predictive efficiency of any single index, but that high school rank is the best single criterion for predicting university

success. Combinations produced multiple correlation coefficients approaching .70. High school rank alone yielded coefficients between .50 and .60.

Byrns (10), divided students into four groups according to their position in high school and compared them with their average grades in first year college. She then reversed this process, dividing freshmen into four groups according to college achievement and compared them with their high school rank. Her conclusions were that there is a tendency for students who rank high in high school to rank high in college, and for students who rank low in high school to rank low in college. She added that, since a considerable number of above-average students in high school ranked low in college, while very few poorer students in high school reached the average level in college, one can therefore be more certain that low high school average guarantees college failure than good high school average guarantees college success.

Dearborn (18,p. 192), as early as 1909, concluded that

> "If a pupil has stood in the first quarter of a large class through high school, the chances are four out of five that he will not fall below the first half of his class in university....The chances are but one in five that the student...who has been in the lowest quarter of his class will rise above the median or average of the freshman class at university, and the chances that he will prove a superior student at the university are slim indeed."

Forty years later, in 1949 Dearborn said "...rank in school performance is still one of the best criteria for predicting success in college."

Adams (1), Schmitz (39), Weintraub and Salley (49), Samenfeld (37), and Frederickson and Schrader (24), in their separate studies all agreed that high school achievement is the most efficient single instrument for predicting university performance.

Canadian studies on this subject are few, but they agree with the American findings. The Alberta Progress Report (2,p.6.), concluded, "The findings so far indicate that the best single predictor of success at the University of Alberta is the grade twelve average." They found a higher correlation between high school average and university average (r=.56) than between high school average and scholastic ability tests (r = .47).

In Ontario, the Atkinson Study of Utilization of Student Resources (4) found that, in terms of goal alone, the students who planned to go to university had definitely higher averages than others. The study has not yet progressed sufficiently far to indicate prediction of success.

In British Columbia, Wallace (48) found significantly high correlations between University Entrance examination results and average marks at Victoria College (r = between .71 and .74). However, he stated,

> "There is no passing university entrance average mark below which it is possible to say that students obtaining such average should not attempt first year college. At least one in three students obtaining even the lowest passing university entrance average" (less than 53 per cent) "can succeed in first year college.* Very likely some of the university entrance candidates who failed could, if given the opportunity, pass first year at Victoria College."

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* This is a much higher passing rate than found in the present study.

Authors in this area show that there is a significant positive correlation between high school average and college standing. Garrett (27,p.93), concluded that, "Among all the factors contributing to production of scholastic success in college, the student's average grade in high school continues to show the highest correlation with later college scholarship average." In examining thirty-two coefficients of correlation he found that they ranged from .29 to .83. Similarly, Wagner (47), in his survey of forty-seven investigations, including two of his own, found correlation coefficients ranging from .28 to .86. Seyler (40) calculated a correlation of .60. Dressel (21) calculated one of .52; and Butsch (9) found correlations ranging between .47 and .60. Among the highest correlations recorded in journals are those of Ashmore (3) which range between .83 and .89.

Among the numerous studies, only two disagree with the above conclusions. Bou and Stovall (5), came to the conclusion that although there is a positive correlation between high school and college marks, the correlation is so low that high school index is not a very reliable criterion for selecting college students. Since they also concluded that marks differed in meaning from one high school to another, particularly with respect to size of school, it may be that Puerto Rico is particularly lacking in standardization. The other disagreeing conclusion is that of the Parkyn Report (33), as reported in The Christchurch Press, which stated that there is no relation between standard of University Entrance examinations and standard of first year University results.

The article reported that causes of failure are discoverable only in university. Since this is just a newspaper article, and the quotation may be taken out of context, it is difficult to appraise its reliability.

C Recommendations

With regard to recommendation, that is, the promotion by accredited schools of students without writing formal examinations, few investigations have been conducted on the comparative success at university of recommended and non-recommended students as defined in this province. Brown and Nemzek (8), however, in a system fairly similar to the one used in this province, found a significant difference in terms of mean performance of the two groups, but concluded that although recommendation is valid for group differentiation, it is not satisfactory for individual purposes. The authors feel that the numbers of those recommended who are not successful and of those not recommended who are successful are so large that if this system is to be used as a method of selection, it should be examined for improvement.

In the local study mentioned earlier, Wallace (48,p.81) stated that the accreditation system in this province is a satisfactory one for selecting students capable of doing college work. He found that;

(1) "If a student is recommended by an accredited school in five or all six of the compulsory university entrance subjects, his chances of passing first year at Victoria College are 984 in one thousand."

(2) "If a student is recommended in four of the compulsory university entrance subjects, and has to write the other two, his chances of passing first year are 865 in one thousand."

(3) "If a student is recommended in three of the compulsory university entrance subjects and has to write the other three, his chances of passing first year college are 840 in one thousand."*

Because recommendation is on the basis of performance throughout the year as rated by each of the students' teachers, it is at least partially a subjective evaluation. In this connection it is interesting to note the results of an investigation by Prescott & Garretson (34), who distributed rating sheets to the teachers of all grade twelve students in four cities in Arizona. The rating sheets included thirteen traits: ability to learn, memory, persistence, habits of studiousness, conscientiousness, accuracy, desire to excel, ability to do independent work, ability to budget time, adaptability, social maturity, cultural background and health. At the bottom of the sheet was included a request for an estimate of the pupils' probable success in college. An arithmetic average of all rating was calculated and then correlated with first semester marks at college. The authors found a correlation

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* The very high passing rate of recommended students reported by Wallace is at least in part due to a different recommendation policy. At the time of his study a student was required to obtain C+ in a subject in order to be recommended in it, although if grades of C and C- were compensated by correspondingly high grades in other subjects, a student could be recommended in the subjects with the lower grades. Since that time the required grade for recommendation has been lowered to C.

coefficient higher than one between college marks and mental ability test score. They added that any other variable added to the rating increased the correlation so little that it did not justify the added effort or expense.

D High School Repeaters

Little work has been done on high school repeaters and their success at college. It is believed by some educators that a student gains by repeating high school courses because the review involved results in a better foundation for subsequent university work. Sarbaugh (38,p.178) discovered that analysis of data regarding repeaters negated this possibility. "It appears, then, that not only do enforced repetitions of high school courses reflect an absence of college aptitude as measured by the ACE and a lower level of high school achievement as indicated by Regents average, but they also tend to presage inferior achievement on the college level."

Coffield and Blommers (12) investigated this problem in the elementary school, with the conclusion that there is very little, if any evidence to indicate that eventual mastery of school work is enhanced by repetition. In qualifying their conclusion they stated that a slow learner who repeats eventually does no better than an equally slow learner who does not repeat. Although this conclusion was based on younger learners, it seems reasonable to assume that it would apply also to the students in the final year of secondary school.

E High School Subjects

It is a common practice among universities to demand the fulfillment of certain subject requirements by their entrants. The majority of studies dealing with the relationship between subjects taken in high school and performance at university add up to the conclusion as stated by Harris (28), that no subject or combination of subjects has any noticeable bearing on college performance. Douglass (19), Rogers (35), and Sorenson (42), in their separate studies concluded that a pattern of subjects taken in high school bears no relationship to university success. According to Darley (17), patterns of high school subjects are less valid as predictors of college achievement than high school achievement and a measure of ability.

Garrett (27) concluded that the belief that any particular pattern of secondary school subjects, especially foreign language, influences college success has been repudiated by most studies.

However, there are a few exceptions. For example, Ross (36) found a correlation between college grades and the number of social or natural science units taken in high school. Ferguson (23) found a positive relationship for Latin and a negative one for History. Bovee and Froehlich (6) found a relationship between the number of language units in high school and grades in college.

F Reliability of Criteria

How much dependence can be placed on marks or letter grades as criteria? Crawford and Burnhams (15,p.65) voiced their concern

about the reliability of marks, "A major bane of educational prognosis is the comparatively low dependence which can be placed upon such criteria as marks, whether in high school, college or graduate studies." Symonds (44,p.426) agreed that college marks must be made more reliable if prediction is to be improved. Bou and Stovall (5) offered the criticism that an A or B in one school is not necessarily equivalent to an A or B in another school. Brigham's statement (7,p.57) is relevant here:

> "I think that everyone who has worked in this field is becoming tired of assuming that the criterion - the college - is infallible and that the sources of evidences derived from the school and the examinations are in error. In many subjects of instruction the methods of teaching and examining in the college are so faulty that a perfect instrument of prediction could not correlate higher than .40 or .50 with the college result."

G Conclusions

In summary, it is found that the most efficient method of predicting university success is by the use of a prediction formula including a number of variables, one of which should be the high school average. High school average alone is the best single predictor. Correlations between high school average and university performance are positive, ranging from .28 to .89.

Accrediting high schools to permit them to recommend students capable of doing university work, is found to be a satisfactory system of selection.

Repetition of high school courses suggests inferior university achievement.

It is generally found that there is no relationship between pattern of subjects in high school and college success. However, there are a number of exceptions, showing a certain amount of relationship.

Scholastic criteria are found to be somewhat unreliable, hampering effective predictions.

CHAPTER III

METHODS OF INVESTIGATION

A Data Gathering Techniques

The sample of 737 students were chosen on the basis of the delimiting factors stipulated earlier. A card was then made out for each student. On each card was recorded the following information:

(a) name and registration number
(b) high school attended and whether accredited
(c) majors taken in high school
(d) subjects taken in grade twelve and the mark for each
(e) average letter grade and, where applicable, percentage average; whether recommended or not, and if not, the number of Departmental examinations written.
(f) whether Departmental examinations written for scholarship eligibility
(g) whether supplementals written or subjects repeated
(h) first year university standing in April

A sample card is shown in Appendix A

1. High-School Records

A letter grade average was calculated from each student's grade twelve mark. First attempt marks were used. In almost all cases these were June marks, whether in letter grade form or percentage form. If a student, however, took the course during the

summer or through correspondence, the first attempt mark recorded under August results was used.

While most marks are in letter grade form, many records include varying numbers of percentage marks which are results of Departmental examinations. The latter were converted to letter grades, using the Department of Education Scale:

86-100 = A
73-85 = B
66-72 = C+
58-65 = C
50-57 = C-
Failed = E

To obtain over-all average, the following equivalents were used:

A = 5
B = 4
C+ = 3
C = 2
C- = 1
E = 0

The closest letter grade average was used. Up to and including .5 was counted as the lower letter grade; over .5, as the upper one.

For each student who wrote three or more Departmental examinations, a mean of the percentage marks was calculated.

Practically all subjects are valued at five units of credit each. For English 40, however, two marks are given, one for language and one for literature, constituting five units. A mean

of the two marks was calculated and this weighted mark was then pooled with the other marks to calculate the over-all average, whether in terms of letter grade or percentage. In other cases, where two or three subjects in one field, such as Industrial Arts, made up a total of five units of credit the same weighting technique was used. However, because the cases in which a student took just one subject carrying less than five units were too few to contaminate the data, the mark for that subject was pooled with the rest without being weighted.

In counting the number of Departmental examinations a student was required to write, English 40 again presented a problem. However, because University Entrance standing is not complete until both parts are passed, the writer decided to count it as one Departamental examination whether one part or both were written.

Similarly, when determining whether a student was required to write supplementals or to repeat subjects, if but one part of English 40 fell into that category it was regarded as a whole.

2. University Standing

Freshman standing is given on the basis of April results and in terms of:

(a) First Class Honours (80-100 per cent)

(b) Second Class Honours (65-79 per cent)

(c) Pass (50-64 per cent)

(d) Supplemental (failure in one to six units of credit, whether or not marks sufficiently high in those courses to write supplementals)

(e) Failure (failure in more than six units of credit, thus granted no credit)

(f) Deferred (standing deferred)

(g) Withdrew

(h) Did not write exams

It is recognized that some of the students in the Supplemental category and in the Deferred category may raise their standing upon writing supplementals in August. However, for the purposes of this study April results alone were considered.

B Statistical Methods

Students were classified into groups according to grade twelve achievement and the groups were then compared in terms of freshman standing. To determine whether any significant difference existed among the groups, Chi-Square technique was employed. As an extension, to explore further where the difference lay, Kimball's (29) formula for the partition of Chi-Square was used. An example of this method of partition is shown in Appendix B. Contingency coefficients were calculated to determine the degree of relationship between the variables and the criterion.

Specifically, Chi-Square, Kimball's partition of Chi-Square and contingency coefficients were calculated in the following comparisons:

1. Averages and Standing at First Attempt

(a) Groups based on letter grade averages, A, B, C+, C, C- and E were compared in terms of first year standing.

(b) The students who wrote three or more Departmental examinations (i) because they attended non-accredited school,

(ii) because they were not recommended although attending accredited schools,

(iii) because they wished to write for scholarship eligibility, were grouped according to percentage average in June, and compared in terms of first year standing. The groups were divided as follows:

Group 1 80 to 94 per cent

Group 2 65 to 79 per cent

Group 3 50 to 64 per cent

Group 4 Below 50 per cent

In this problem, in addition to the use of the Chi-Square technique, t-tests were used to test differences between means of adjacent groups.

(c) All students were classified as either

(i) those who had a clear pass at first attempt through recommendation or by writing Departmental examinations, or

(ii) those who were required to write one supplemental or more and/or to repeat one subject or more. Their standing in first yearwas then compared.

2. Accreditation

Schools in British Columbia are accredited by the Department of Education on the basis of a number of factors. If a school

is accredited, the principal and staff have the authority to recommend students on the University Programme whose letter grade standing in a given subject is C or higher. Thus they are promoted in some or all subjects without being required to write Departmental examinations.

(a) Of the students who attended accredited schools, the students who were recommended in all subjects were compared with those who were required to write one Departmental examination or more, in terms of first year standing.

(b) The non-recommended students were grouped according to the number of examinations they were required to write, and observed in relation to first year standing.

3. Majors

In order to obtain University Entrance standing in British Columbia, students must obtain credit in required courses: four years of English, three years of Social Studies, two years of general Science, two years of a foreign language and three years of Health and Personal Development. In addition, they must obtain credit in at least seven optional courses, at least three of which must be taken at an advanced level, such as a fifth year of English, (English 91) or two additional years of a foreign language (91 and 92). Other possible advanced electives are Social Studies, Mathematics, Science, Commerce, Industrial Arts, Home Economics. These advanced electives are commonly called Majors.

(a) Students were grouped according to what majors they completed in high school:

(i) those completing majors which included Mathematics and Science but excluded English and Social Studies,

(ii) those completing majors which included English and Social Studies but excluded Mathematics and Science,

(iii) those completing English, Social Studies, Mathematics and Science majors, and

(iv) those completing some of the above majors and others in various combinations other than (i), (ii), or (iii).

Marks disregarded, the groups were then compared in terms of first year standing.

(b) Students were classified according to whether they had or had not a foreign language major. Marks disregarded again, the two groups were compared in terms of first year standing.

CHAPTER IV

ANALYSIS OF THE DATA

In accordance with the outline in the previous chapter, the following sections give in detail the results of the statistical analysis.

A Averages and Standing at First Attempt

1. Letter Grade Average

Considering high school letter grade averages first, Table I shows the distribution of these averages with corresponding first year university standing.

TABLE I

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL LETTER GRADE AVERAGE

Grade 12 Letter Grade Average	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With-drew	Did not Write	Totals
A	20	9		2		1	2		34
B	15	100	32	49	7	3	4	1	211
C+	1	37	63	94	56	3	13	6	273
C		2	15	57	76	2	17	3	172
C-				5	29		6	3	43
E					3		1		4*
Totals	36	148	110	207	171	9	43	13	737

* The four who failed at first attempt subsequently wrote supplementals or repeated subjects and obtained University Entrance Standing.

Examination of this table alone would lead to the conclusion that university standing is not independent of high school letter grade average.

In order to eliminate small frequencies, Table II was obtained by combining on the one hand students with no credit at university and on the other hand students with C- and E averages in high school.

TABLE II

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL LETTER GRADE AVERAGE (SMALL FREQUENCIES COMBINED)

Grade 12 Letter Grade Average	First Year University Standing					
	First Class (%)	Second Class (%)	Pass (%)	Supp (%)	No Credit (%)	Totals (%)
A	20 (58.82)	9 (26.47)		2 (5.88)	3 (8.82)	34 (4.61)
B	15 (7.11)	100 (47.39)	32 (15.17)	49 (23.22)	15 (7.11)	211 (28.63)
C+	1 (.37)	37 (13.55)	63 (23.08)	94 (34.43)	78 (28.57)	273 (37.04)
C		2 (1.16)	15 (8.72)	57 (33.14)	98 (56.98)	172 (23.34)
C-,E				5 (10.64)	42 (89.36)	47 (6.38)
Totals	36 (4.88)	148 (20.08)	110 (14.92)	207 (28.09)	236 (32.02)	737

From this table it can be seen that only about 40 per cent of the sample of students completed first year with full credit in April, 28 per cent obtained partial credit, and 32 per cent obtained no credit. Of the students with A average, about 85 per

cent obtained full credit, and this was done at honours level. Of the B students almost 70 per cent obtained full credit; of the C+ students only about 37 per cent obtained full credit. Less than nine per cent of the C students obtained full credit, and none of the C- and E students did so. Less than ten per cent of the latter group obtained partial credit.

These are but a few of the many comparisons that can be made from the table alone. All show a positive correlation, descriptively speaking, between high school letter grade average and university standing.

Statistically, testing the null hypothesis that university standing is independent of high school letter grade average, a Chi-Square of 528.14 with 16 degrees of freedom was calculated. This value is very highly significant ($P < .001$). The null hypothesis was therefore rejected in favour of the alternative hypothesis that there is a difference among the groups in a positive direction; that is, that there is a positive association between high school letter grade average and freshman standing. To ascertain the degree of relationship, a contingency coefficient was calculated, $C = .65$, which indicates a high correlation.*

To eliminate the cells with small expected frequencies,** and in order to obtain a 3 by 3 table for the partition of Chi-Square, categories were combined further to produce Table III.

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* Maximum value of C in a 5 by 5 table is .894 (26,p.390).

** In Table II there were two cells with expected frequencies of less than 5, and one cell with expected frequency of 5.07. Although the majority of statisticians would not approve, according to Cochran (11), the number of small cells is not out of proportion.

TABLE III

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL LETTER GRADE AVERAGE (REDUCED TO 3 BY 3 CONTINGENCY TABLE)

Grade 12 Letter Grade Average	Full Credit	Supp.	No Credit	Totals
A, B	176	51	18	245
C+	101	94	78	273
C, C-, E	17	62	140	219
Totals	294	207	236	737

Combining categories caused some loss of power, reducing Chi-Square to 245.66. The reduced value, with four degrees of freedom, is still very highly significant ($P < .001$).

Partitioning the above Chi-Square into its components, values were calculated to be:

Chi-Square (1) = 39.26 (difference between A, B group and C+ group in terms of obtaining full credit or just partial credit).

Chi-Square (2) = 26.72 (difference between A, B group and C+ group in terms of obtaining some credit or no credit at all).

Chi-Square (3) = 33.98 (difference between A, B, C+ groups combined and C, C-, E groups combined in terms of obtaining full credit or just partial credit).

Chi-Square (4) = 145.71 (difference between A, B, C+ groups combined and C, C-, E groups combined in terms of obtaining some credit or no credit at all).

Each single degree of freedom Chi-Square is significant at .001 level of confidence indicating that each component contributed to making the total Chi-Square significant. Chi-Square (4) provided most of the contribution.

From these statistics the following conclusions can be made.

a. There is a significant difference, in favour of the A, B group, between the performance of the A, B group and the C+ group in terms of obtaining full credit in first year or just partial credit.

b. There is a significant difference, in favour of the A, B group, between the performance of the A, B group and the C+ group in terms of obtaining some credit (full or partial) or no credit at all.

c. There is a significant difference, in favour of the A, B, C+ groups combined, between the performance of this combined group and the C, C-, E groups combined in terms of obtaining full credit or just partial credit.

d. There is a significant difference, in favour of the A, B, C+ groups combined, between the performance of this combined group and that of the C, C-, E groups combined in terms of obtaining some credit (full or partial) or no credit at all. More than half (about 59 per cent) of the total variation was contributed by this category.

2. Percentage Average

Considering only the students who wrote three or more Departmental examinations, Table IV shows the distribution of the grouped percentage averages with corresponding first year university standing.

TABLE IV

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL PERCENTAGE AVERAGE RESULTING FROM DEPARTMENTAL EXAMINATIONS

Grade 12 Percentage Average	First Year University Standing								
	First Class	Second Class	Pass	Supp.	Fail	Deferred	Withdrew	Did not Write	Totals
80-94%	29	27	2	2			1		61
65-79%	2	28	16	15	2	3	1	1	68
50-64%		1	5	25	49		11	3	94
Below 50%				2	12		4	1	19*
Totals	31	56	23	44	63	3	17	5	242

* These students subsequently wrote supplementals or repeated subjects and obtained University Entrance standing.

As before, observation of the table alone would lead one to conclude that there is a positive relationship between high school percentage average and freshman standing.

In Table V the groups with no credit are combined, and the relative proportions are shown in terms of percentages.

TABLE V

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL PERCENTAGE AVERAGE (SMALL FREQUENCIES COMBINED)

Grade 12 Percentage Average	First Year University Standing: First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
80-94%	29 (47.54)	27 (44.26)	2 (3.28)	2 (3.28)	1 (1.64)	61 (25.21)
65-79%	2 (2.94)	28 (41.18)	16 (23.53)	15 (22.06)	7 (10.29)	68 (28.10)
50-64%		1 (1.06)	5 (5.32)	25 (26.60)	63 (67.02)	94 (38.84)
Below 50%				2 (10.53)	17 (84.47)	19 (7.85
Totals	31 (12.81)	56 (23.14)	23 (9.50)	44 (18.18)	88 (36.36)	242

About 95 per cent of the top group (80-94% average) obtained full credit. Approximately 68 p er cent of the next group (65-79% average) obtained full credit; only about six per cent of the next group (50-64% average) did so, and none of the bottom group passed.

Statistically, the null hypothesis was again rejected. The calculated Chi-Square of 227.01, with twelve degrees of freedom, is highly significant (P/.001). A high degree of relationship is shown by a contingency coefficient of .70.

To eliminate cells with small expected frequencies,* and in order to obtain a 3 by 3 table for the partition of Chi-Square,

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* In Table V there were four cells with expected frequencies of less than 5. In view of this comparatively high proportion of small cells Chi-Square was computed with reservation. The following Chi-Square, with four degrees of freedom provides a more satisfactory measure.

categories were further combined to produce Table VI.

TABLE VI

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING
BASED ON HIGH SCHOOL PERCENTAGE AVERAGE
(REDUCED TO 3 BY 3 CONTINGENCY TABLE)

Grade 12 Percentage Average	First Year University Standing: Full Credit	Supp.	No Credit	Totals
80-94%	58	2	1	61
65-79%	46	15	7	68
Below 65%	6	27	80	113
Totals	110	44	88	242

Loss of power was again evident. Chi-Square with four degrees of freedom was calculated to be 160.29. Nevertheless, this reduced value is still highly significant ($P < .001$).

Partitioning this Chi-Square into its component single degree of freedom Chi-Squares, the following values were calculated:

Chi-Square (1) = 11.18 (difference between students with averages of 80-94 per cent and those with averages of 65-79 per cent in terms of obtaining full credit or just partial credit).

Chi-Square (2) = 1.04 (difference between students with averages of 80-94 per cent and those with averages of 65-79 per cent in terms of obtaining some credit or no credit at all).

Chi-Square (3) = 39.47 (difference between students with averages of 65-94 per cent and those with averages below 65 per cent in terms of obtaining full credit or just partial credit).

Chi-Square (4) = 109.37 (difference between students with averages of 65-94 per cent and those with averages below 65 per cent in terms of obtaining some credit or no credit at all).

One of these values, Chi-Square (2), is insignificant and contributed virtually nothing to the total variation. The other three are significant at .001 level of confidence.

From the foregoing statistics the following conclusions can be made.

a. There is a significant difference in freshman standing between the students with grade twelve averages of 80-94 per cent and those with averages of 65-79 per cent in terms of obtaining full credit or just partial credit. This category contributed about seven per cent to the total variation.

b. There is no significant difference in freshman standing between the students with grade twelve averages of 80-94 per cent and those with averages of 65-79 per cent in terms of obtaining some credit (full or partial) or no credit at all.

c. There is a significant difference in freshman standing between students with grade twelve averages of 65-94 per cent and those with averages below 65 per cent in terms of obtaining full credit or just partial credit. This category contributed about 25 per cent to the total variation.

d. The most significant difference in freshman standing lies between students with grade twelve averages of 65-94 per cent and those with averages below 65 per cent in terms of obtaining some credit (full or partial) or no credit at all. This category contributed about 68 per cent of the total variation.

The difference, in every case, is in favour of the group with the higher averages.

Table VII shows the grade twelve means and standard deviations of the students grouped according to freshman standing. A steady decrease in mean value is noticeable as standing drops.

TABLE VII

DEPARTMENTAL EXAMINATION MEANS AND STANDARD DEVIATIONS OF STUDENTS GROUPED ACCORDING TO FIRST YEAR UNIVERSITY STANDING

	First Year University Standing				
Means and Standard Deviations Derived from Grade 12 Departmental Exams	First Class	Second Class	Pass	Supp.	No Credit
Mean	84.68	78.41	69.78	63.07	54.57
Standard Deviation	4.10	5.69	6.67	10.08	7.72
Number	31	56	23	44	88

Adjacent means were tested with t-tests, and the following values were calculated:

a. Between first and second class honours standing:

$t = 5.40$
$d.f. = 85$

b. Between second class honours and pass standing:

$t = 5.82$
$d.f. = 77$

c. Between pass and supplemental standing:

$t = 3.26^{*}$
$d.f. = 55.7$

d. Between supplemental and fail standing:

$t = 5.42$
$d.f. = 130$

All t values but the third one are significant at .001 level of confidence, and the third one is significant at .01 level of confidence. These results substantiate the preceding conclusion that freshman standing is not independent of high school percentage average.

3. Standing at First Attempt

Comparing next the students who passed all subjects at first attempt with those who wrote Department of Education supplementals and/or repeated grade twelve subjects, Table VIII shows their distribution with corresponding first year university standing.

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* Variances of these two groups were not homogeneous and therefore Welch's (50) approximation was used.

TABLE VIII

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON FIRST ATTEMPT AND ON REPETITION

First Year University Standing

Grade 12 Performance	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With-drew	Did not Write	Totals
Passed at First Attempt	36	148	109	198	133	8	28	9	669
Wrote Supps. and/or Repeated Subjects			1	9	38	1	15	4	68
Totals	36	148	110	207	171	9	43	13	737

In Table IX the groups with no credit have been combined and the relative proportions in terms of percentages are shown.

TABLE IX

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON FIRST ATTEMPT AND ON REPETITION (SMALL FREQUENCIES COMBINED)

First Year University Standing

Grade 12 Performance	First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
Passed at First Attempt	36 (5.38)	148 (22.12)	109 (16.29)	198 (29.60)	178 (26.61)	669 (90.77)
Wrote Supps. and/or Repeated Subjects			1 (1.47)	9 (13.24)	58 (85.29)	68 (9.23)
Totals	36	148	110	207	236	737

It is interesting to note that of the total sample of 737 students, only about nine per cent entered university after having had to make more than one attempt at passing a subject or subjects. Of this group of 68 students, only one student passed first year university. It is obvious from the table alone that students who make more than one attempt at completing university entrance standing in high school are poorer students at university.

Statistically, the table, with four degrees of freedom yielded a Chi-Square of 100.10 which is highly significant ($P < .001$), indicating that the two groups differ in freshman standing. The degree of relationship, $C = .35$*, is not as high as would be expected due to the fact that only one of the categories contributed to the total variation, as is seen below.

In the partition of the total, the only single degree of freedom Chi-Square of significance was calculated in comparing the two groups in terms of whether they obtained some credit (full or partial) or no credit at all. Its value, 97.67, is about 97 per cent of the total variation and is significant at .001 level of confidence. It was not possible to partition the total further in the usual manner in view of the cells with frequencies of zero and one.**

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* Maximum values for C in a rectangular table are not known (32,p.182), but are less than 1.00, as in square tables, approaching 1.00 only as the number of cells approaches infinity.

** The very fact that there are no cases of students who made more than one attempt at completing university entrance standing in the upper categories is indicative of a difference in performance.

However, using Kimball's method in reverse, a Chi-Square of 53.88, significant at .001 level of confidence, was calculated in comparing the two groups in terms of whether they obtained partial credit or no credit at all.

It may be concluded that students who enter university with successful first attempts at completing university entrance standing obtain a higher freshman standing than those who are required to write supplementals and/or to repeat subjects.

B. Accreditation

Table X shows the distribution, with corresponding university standing, of students who attended non-accredited schools, students who attended accredited schools and who were recommended in all subjects and therefore did not write Departmental examinations, those who were recommended but wrote Departmental examinations for scholarship eligibility, and those who were not recommended.

TABLE X

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON GRADE TWELVE STATUS WITH RESPECT TO ACCREDITATION

Grade 12 Status	First Year University Standing								
	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With-drew	Did not Write	Totals
From Non-Accredited Schools	3	6	3	10	6		3	1	32
Recommended, did not write	5	82	70	100	37	3	8	4	309
Recommended, wrote for Scholarship	28	49	16	16	2	2	2		115
Not Recommended		9	18	81	125	3	30	8	274
Totals	36	146	107	207	170	8	43	13	730*

* Total number has been reduced by seven students who wrote departmentals for a variety of reasons other than the usual one and therefore could not be fitted into any of the categories in the table.

In Table XI the students obtaining no credit have been combined and the relative proportions in terms of percentages are given.

The proportion of students attending non-accredited schools was too small to perform any statistical analysis. However, it can be seen that the proportions of these students in the categories pertaining to university standing do not differ greatly from the total proportions. The proportion of first class standings is somewhat higher for the group from non-accredited schools, and the pro-

portion of pass standings is somewhat lower, but the proportion of failures is almost identical. The proportion of students from non-accredited schools obtaining full credit is also almost identical with the proportion of students from accredited schools who obtained full credit.

TABLE XI

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON GRADE TWELVE STATUS WITH RESPECT TO ACCREDITATION (SMALL FREQUENCIES COMBINED)

Grade 12 Status	First Year University Standing					
	First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
From Non-Accredited Schools	3 (9.37)	6 (18.75)	3 (9.37)	10 (31.25)	10 (31.25)	32 (4.38)
Recommended Did Not Write	5 (1.62)	82 (26.54)	70 (22.65)	100 (32.36)	52 (16.83)	309 (42.33)
Recommended Wrote for Scholarship	28 (24.35)	49 (42.61)	16 (13.91)	16 (13.91)	6 (5.22)	115 (15.75)
Not Recommended		9 (3.28)	18 (6.57)	81 (29.56)	166 (60.58)	274 (37.53)
Totals	36 (4.93)	146 (20.00)	107 (14.66)	207 (28.36)	234 (32.05)	730

As would be expected, the students who were recommended but wrote Departmental examinations for scholarship eligibility were the best students at university. Of this group approximately 67 per cent were honours students; a total of over 80 per cent obtained

full credit; only about 14 per cent had supplementals and only about five per cent obtained no credit.

The latter 19 per cent might well be considered exceptions, but should be noted. Even the best students from high school fail sometimes and may have supplementals at university. Similarly, it must be noted that about three per cent of the students who were not recommended achieved second class honours and about six per cent passed. These are small proportions, unquestionably, but they do exist.

1. Recommended and Non-recommended Subjects

In order to test the difference in freshman standing between the recommended and the non-recommended students, the non-accredited group was eliminated, producing Table XII, in which the two recommended groups were combined.

TABLE XII

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON RECOMMENDATION AND NON-RECOMMENDATION (SMALL FREQUENCIES COMBINED)

Grade 12 Standing	First Year University Standing					
	First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
Recommended	33 (7.78)	131 (30.90)	86 (20.28)	116 (27.36)	58 (13.68)	424 (60.745)
Not Recommended		9 (3.29)	18 (6.57)	81 (29.56)	166 (60.58)	274 (39.255)
Totals	33 (4.73)	140 (20.06)	104 (14.90)	197 (28.22)	224 (32.09)	698

This table alone shows that recommended students perform at a higher level at university. Almost 59 per cent of this group obtained full credit, as contrasted with ten per cent of the non-recommended group. Less than 14 per cent of the recommended group as opposed to over 60 per cent of the non-recommended group obtained no credit.

Table XII with four degrees of freedom yielded a Chi-Square of 219.10, which is highly significant ($P < .001$), and a contingency coefficient of .49. The latter shows a positive and reasonably high correlation, in spite of the lack of contribution of one of the categories as explained below.

In the partition of Chi-Square, the following single degree of freedom Chi-Squares were calculated:

Chi-Square (1) = .46* (difference between recommended and non-recommended students in terms of obtaining first or second class honours standing).

Chi-Square (2) = 3.99 (difference between the two groups in terms of obtaining honours standing or just a pass standing).

Chi-Square (3) = 47.51 (difference between the two groups in terms of obtaining full credit or just partial credit).

Chi-Square (4) = 168.03 (difference between the two groups in terms of obtaining some credit or no credit at all).

Chi-Square (1) is insignificant and contributed virtually nothing to the total variation. Chi-Square (2) is significant but only at

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* Small cell frequencies are involved in this Chi-Square

.05 level of confidence, contributing only somewhat to the total. Chi-Square (3) is significant ($P < .001$), contributing about 20 per cent to the total, and Chi-Square (4) is highly significant ($P < .001$), contributing about 76 per cent to the total variation.

Thus it may be concluded that recommended students achieve higher standing at university than do non-recommended students. That is:

a. There is no significant difference between the two groups in terms of obtaining first or second class honours standing;*

b. There is a difference between the two groups in terms of obtaining honours or just a pass standing.

c. There is more difference between the two groups in terms of obtaining full credit or just partial credit.

d. Most of the difference is in terms of obtaining some credit (full or partial) or no credit at all.

In every case the difference is in favour of the recommended group.

2. Number of Departmental Examinations Written

The 274 non-recommended students were required to write from one to six Departmental examinations. Table XIII gives the distribution of the number of Departmental examinations written with the relative university standing.

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* This conclusion must be made with reservation due to the small cell frequencies involved.

TABLE XIII

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON NUMBER OF DEPARTMENTAL EXAMINATIONS WRITTEN

Number of Departmentals Written	First Year University Standing							
	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With-drew	Did not Write	Totals
1		9	12	41	48	2	12	2	126
2			4	23	22	1	6	2	58
3			1	10	28		5	1	45
4				6	19		5	2	32
5				1	6		1	1	9
6			1		2		1		4
Totals		9	18	81	125	3	30	8	274

In Table XIV categories are combined to eliminate small cells and proportions are given in terms of percentages. Proportions alone suggest that students who are required to write fewer Departmental examinations do somewhat better at university. Approximately 52 per cent of the students writing one or two examinations failed to obtain any credit, while over 78 per cent of the students writing three or more examinations did so.

TABLE XIV

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON NUMBER OF DEPARTMENTAL EXAMINATIONS WRITTEN (SMALL FREQUENCIES COMBINED)

Number of Departmentals Written	First Year University Standing			
	Full Credit (%)	Supp. (%)	No Credit (%)	Totals (%)
1	21 (16.67)	41 (32.54)	64 (50.79)	126 (45.98)
2	4 (6.90)	23 (39.65)	31 (53.45)	58 (21.17)
3 or more	2 (2.22)	17 (18.89)	71 (78.89)	90 (32.85)
Totals	27 (9.85)	81 (29.56)	166 (60.58)	274

Table XIV with four degrees of freedom yielded a Chi-Square of 24.06 which is significant at.001 level of confidence. The contingency coefficient of .28 is positive although not very high. However, its lack of magnitude may be explained by two prevailing conditions:

1. the range of the total group is extremely restricted;*
2. two of the categories fail to contribute to the total variation.

In the partition of the total variation, the following single degree of freedom Chi-Squares were calculated:

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* A high correlation cannot be found in a restricted range. Wert, Neidt and Ahmann (51,p.76).

Chi-Square (1) = 4.46 (difference between students who wrote one Departmental examination and those who wrote two in terms of obtaining full credit or just partial credit).

Chi-Square (2) = .12 (difference between students who wrote one Departmental examination and those who wrote two in terms of obtaining some credit or no credit at all).

Chi-Square (3) = 1.69 (difference between students who wrote one or two Departmental examinations and those who wrote three or more in terms of obtaining full or partial credit).

Chi-Square (4) = 18.81 (difference between students who wrote one or two Departmental examinations and those who wrote three or more in terms of obtaining some credit or no credit at all).

Chi-Square (1) is significant at .05 level of confidence and contributed about 18 per cent to the total variation. Chi-Squares (2) and (3) are not significant, while Chi-Square (4) is significant at .001 level of confidence and comprises about 72 per cent of the total variation.

From these statistics, it may be concluded that:

(a) There is some difference between the students who wrote one Departmental examination and those who wrote two in terms of obtaining full credit or just partial credit. The difference is in favour of the students who wrote just one.

(b) There is no difference between the same two groups in terms of obtaining some credit (full or partial) or no credit at all.

(c) There is no difference between the students who wrote one or two Departmental examinations and those who wrote three or more in terms of obtaining full or partial credit.

(d) The greatest variation lies between the students who wrote one or two Departmental examinations and those who wrote three or more, in terms of obtaining some credit (full or partial) or no credit at all. The difference is in favour of those who wrote fewer Departmental examinations.

C. Majors

Table XV shows the distribution of the students taking various combinations of major subjects with their relative first year standing.

TABLE XV

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL MAJORS

High School Majors	First Year University Standing								
	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With drew	Did not Write	Totals
Ma., Sc., Eng., Soc. St.	18	42	21	48	25	3	5	1	163
Ma., Sc.	4	20	22	38	46	1	17	3	151
Eng., Soc. St.	2	4	2	3	3		1		15
All other Combin-ations	12	82	65	118	97	5	20	9	408
Totals	36	148	110	207	171	9	43	13	737

It was the writer's intention, among other comparisons, to compare the freshman standing of the students who took Mathematics and Science as majors but who omitted English and Social Studies from their programmes with the students who took English and Social Studies as majors but who omitted Mathematics and Science. Owing to the small number of the latter the idea was abandoned. This group is therefore combined in Table XVI with the group containing all other combinations of majors. All those with no credit are also combined, and relative proportions are given in terms of percentages.

TABLE XVI

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON MAJORS (SMALL FREQUENCIES COMBINED)

High School Majors	First Year University Standing					
	First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
Ma., Sc., Eng., Soc. St.	18 (11.04)	42 (25.77)	21 (12.88)	48 (29.45)	34 (20.86)	163 (22.12)
Ma., Sc.	4 (2.65)	20 (13.24)	22 (14.57)	38 (25.16)	67 (44.37)	151 (20.49)
All other Combinations	14 (3.31)	86 (20.33)	67 (15.84)	121 (28.60)	135 (31.91)	423 (57.39)
Totals	36	148	110	207	236	737

From the proportions given in Table XVI, it is evident that less than half as many students fail who took not only Mathematics and Science but also English and Social Studies as majors.

Table XVI, with eight degrees of freedom yielded a Chi-Square of 37.34, which is significant at .001 level of confidence, and a contingency coefficient of .22, showing a positive correlation, although not a very high one. This again is due partly to the fact that some of the categories contributed little to the total variation.

Combining categories further to produce a 3 by 3 table, (Table XVII), with four degrees of freedom, resulted in some loss

of power, yielding a reduced Chi-Square of 21.46 which, nevertheless, is still significant at .001 level of confidence.

TABLE XVII

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HIGH SCHOOL MAJORS (REDUCED TO A 3 BY 3 CONTINGENCY TABLE)

High School Majors	First Year University Standing			
	Full Credit	Supp.	No Credit	Totals
Ma., Sc., Eng., Soc.St.	81	48	34	163
Ma., Sc.	46	38	67	151
All other Combinations	167	121	135	423
Totals	294	207	236	737

In the partition of the latter Chi-Square the following single degree of freedom Chi-Squares were calculated:

Chi-Square (1) = 1.40 (difference between students with English, Social Studies, Mathematics and Science majors and those with just Mathematics and Science majors in terms of obtaining full credit or just partial credit).

Chi-Square (2) = 19.91 (difference between students with English, Social Studies, Mathematics and Science majors and those with just Mathematics and Science majors in terms of obtaining some credit or no credit at all).

Chi-Square (3) = .14 (difference between students with English, Social Studies, Mathematics and Science majors combined with the students having just Mathematics and Science majors, and the students with any other combination of majors, in terms of obtaining full credit or just partial credit.

Chi-Square (4) = .01 (difference between students with English, Social Studies, Mathematics and Science majors combined with the students having just Mathematics and Science majors and the students with any other combination of majors, in terms of obtaining some credit or no credit at all).

These results indicate that only one of the categories caused the total variation to be significant. Chi-Square (2) is significant at .001 level of confidence and comprises about 93 per cent of the total variation. That is, the only difference of significance is between the group with English, Social Studies, Mathematics and Science majors and the group with just Mathematics and Science majors in terms of obtaining some credit (full or partial) or no credit at all. There is no difference between these two groups in terms of obtaining full credit or just partial credit. There is also no difference, on any basis, between the combined group of students taking English, Social Studies, Mathematics and Science and just Mathematics and Science and the group taking all other combinations of majors.

It may be concluded then that the students who have included in their high school programmes both the sciences and the humanities as majors are somewhat better students at university than the students who have taken the science majors without the humanities, in that fewer of the former fail.

Table XVIII shows the distribution of students who had a foreign language major in high school and students who did not, with corresponding freshman standing.

TABLE XVIII

FREQUENCIES OF UNIVERSITY FRESHMAN STANDING BASED ON HAVING A HIGH SCHOOL FOREIGN LANGUAGE MAJOR AND NOT HAVING ONE

High School Majors	First Year University Standing								
	First Class	Second Class	Pass	Supp.	Fail	De-ferred	With drew	Did not Write	Totals
Foreign Lang. Major	21	65	32	47	18	4	1	3	191
No foreign Lang. Major	15	83	78	160	153	5	42	10	546
Totals	36	148	110	207	171	9	43	13	737

Again all those with no credit are combined in Table XIX, and relative proportions in terms of percentages are given. As can be seen only about 26 per cent of the students took a foreign language major.

TABLE XIX

FREQUENCIES (PERCENTAGES IN PARENTHESES) OF UNIVERSITY FRESHMAN STANDING BASED ON HAVING A HIGH SCHOOL FOREIGN LANGUAGE MAJOR AND NOT HAVING ONE (SMALL FREQUENCIES COMBINED)

High School Majors	First Year University Standing					
	First Class (%)	Second Class (%)	Pass (%)	Supp. (%)	No Credit (%)	Totals (%)
Foreign Lang.Maj.	21 (10.99)	65 (34.03)	32 (16.75)	47 (24.61)	26 (13.61)	191 (25.92)
No Foreign Lang. Maj.	15 (2.75)	83 (15.20)	78 (14.29)	160 (29.30)	210 (38.46)	546 (74.08)
Totals	36	148	110	207	236	737

From the proportions in this table it appears that the students who included a foreign language major in their programmes achieve higher standing at university. About 61 per cent of students with foreign language majors as contrasted with about 32 per cent of those with no foreign language major obtained full credit. Less than 14 per cent of the former as contrasted with over 38 per cent of the latter obtained no credit.

To test whether the difference is significant, Chi-Square with four degrees of freedom was calculated to be 73.67. This value is highly significant ($P < .001$). The degree of relationship is moderately high, the contingency coefficient being .30, with one of the categories making no contribution to the total variation, as seen below.

In the partition of the above Chi-Square, the following single degree of freedom Chi-Squares were calculated:

Chi-Square (1) = 3.13 (difference between students with a foreign language major and those without one in terms of obtaining first or second class honours standing).

Chi-Square (2) = 11.17 (difference between the two groups in terms of obtaining honours or just a pass standing).

Chi-Square (3) = 19.22 (difference between the two groups in terms of obtaining full credit or just partial credit).

Chi-Square (4) = 40.14 (difference between the two groups in terms of obtaining some credit or no credit at all).

The first of these four values is insignificant; the other three are significant at .001 level of confidence. Chi-Square (4) contributes more than half (54 per cent) to the total variation.

From these statistics, it may be concluded that:

a. There is no significant difference between students with a foreign language major from high school and those without one in terms of obtaining first or second class honours standing.

b. There is a significant difference between the two groups in terms of obtaining honours or just a pass standing.

c. There is a significant difference between the two groups in terms of obtaining full credit or just partial credit.

d. The most significant difference between the two groups is in terms of obtaining some credit (full or partial) or no credit at all.

In each of the last three cases above, the difference was in favour of the group with a foreign language major.

CHAPTER V

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

A Conclusions

1. General

In keeping with other studies in this field, results obtained in this study show that there is a definite positive relationship between high school achievement and university performance. Better students in high school are better students at university.

2. Specific

From the statistics employed, certain specific conclusions have been reached.

(a) There is a high positive relationship between grade twelve letter grade average and freshman standing. Students with a higher letter grade average have a better chance of achieving a higher standing at university. In particular, students with C+ average or better are less likely to fail than students with C average or lower.

(b) There is an equally high positive relationship between grade twelve percentage average, resulting from Departmental examinations, and freshman standing, particularly when the division point is at 65 per cent on one side and between pass and fail on the other. That is, the higher the percentage average a student

has on Departmental examinations, the better he does at university, and in particular, a student whose high school average is over 65 per cent has a much better chance of passing at university than one whose average is below 65 per cent.

(c) Students who successfully pass all grade twelve subjects at first attempt achieve a higher freshman standing than students who are required to write supplementals and/or to repeat subjects. Repeaters are poorer academic risks.

(d) Recommended students obtain higher first year standing than non-recommended students. The difference is particularly noticeable when the division point is between obtaining some credit and failing. That is, there is less chance of a recommended student failing than of a non-recommended student failing.

Although the number of students from non-accredited schools was too small for statistical comparison with those from accredited schools, in proportions alone they do not differ in standing from the students from accredited schools.

(e) In spite of a very restricted range, there is some relationship between the number of Departmental examinations a student is required to write and his freshman standing. Students who write three or more Departmental examinations are more likely to fail than are those who write just one or two.

(f) There is some relationship between major subjects taken in high school and subsequent freshman standing, but only in a limited way. Fewer of the students fail who include in their high school programmes both the humanities and the sciences as

majors (English, Social Studies, Mathematics, Science) than of those who take just the sciences (Mathematics and Science), omitting the humanities. There is no relationship evident in other comparisons.

(g) Students who include a foreign language major in their high school programmes obtain a higher freshman standing than those with no foreign language major, except when the comparison is made in terms of first or second class honours standing, in which case there is no difference.

The latter two conclusions are not in agreement with the majority of studies which find that university success is independent of previous pattern of subjects. It is possible that students who take all four of the more academic majors and those who take a foreign language major in addition or in lieu of one of the other four are students with higher ability, and are not necessarily better prepared for university work as a result of having taken these majors. Students with higher academic ability may choose to take these majors or may be encouraged to do so by their teachers or counsellors. In any case, the situation is indicative of a higher degree of success, and cannot be overlooked.

In conclusion, it should be noted that although positive relationships are evident throughout the problems presented, they are by no means perfect. Very few categories are incompatible with successful first year standing or guarantee success. A survey of the tables alone reveals deviations.

B Implications

It is reasonable to expect in any educational system that the better students in high school have a good chance of being successful at university, while the poorer students are likely to have difficulties. Most of the findings of this study, therefore, confirm those of other investigations, and are not unusual. The conclusions, however, regarding recommended and non-recommended students are most pertinent to British Columbia, and should therefore be emphasized. They are important not only in prediction but also because they provide a strong argument in favour of the system of recommendation used in this province.

Also pertinent to this province are the conclusions concerning high school majors, both the positive conclusion with regard to a foreign language major and the negative one with regard to the sciences. The student's choice and completion of certain majors can be used in prediction, regardless of whether academic ability plays a part in his choice.

Keeping in mind the limitations of this study, it may be said with a reasonable degree of conclusiveness that university success can be predicted from high school records. These records should therefore be examined carefully by counsellors when discussing with students their future academic plans.

Because individual prediction cannot be as accurate as group prediction, some caution must be exercised in the former. It should be kept in mind that there will always be exceptional cases that do more poorly or much better than expected because of growth and emotional factors which cannot be measured or controlled.

The remarks of Dr. J.A.B. McLeish (31,p.14 and p.16) are pertinent here:

> "The standing of the young high school graduate in matriculation examinations is obviously a selective factor of great importance. Authorities in testing have underrated the predictive value of a student's high school record. But again it is not easy to settle upon a minimum cut-off percentage below which one can confidently predict that the incoming student would fail." .... "The girl who appears rather immature at entrance may be just the one who will mature most quickly in the new climate of the university. The boy who seemed to be thoroughly stable and ready for college work, in the eyes of his former principal, may have a rough and perhaps failing first year if he is unable to contend with loneliness, or with an excess of college activities, or with the nagging worry of financial problems. Perhaps the best that the university can do is to make ample room in its admissions plans for the merely 'good', or at least, 'reasonably good', youngster at the gate, and then within the gate provide as ample counselling facilities and financial assistance as it possibly can."

Not only do individual differences and personal problems interfere with perfect prediction, but also does the unreliability of both school marks and university marks. In this connection Dale (16, p.198) comments:

> "Even if all students have been correctly selected, not all will pass. It is inherent in the nature of examinations that some must fail. It is also inherent in the nature of man that some professors will set a standard which is higher than it should be, just as others will set a standard which is too low."

In conclusion, the writer feels that in spite of the hazards involved in prediction, this study provides counsellors with statistical and factual evidence concerning high school records. It is hoped that this evidence, combined with information gained from aptitude test results,* will better prepare coun-

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* Luyendyk (30) and Shirran (41) found that prediction of success can be made from results of certain tests administered by the University of British Columbia Counselling Department.

sellors to predict students' performance at university and to counsel effectively.

The results of this study may also be of interest to University administrators for admissions purposes.

C Recommendations for Further Study

This study did not include students who omit a science and/or foreign language in first year. These are, in the main, pre-Commerce students. It is suggested that this group be studied in some similar fashion.

The importance of age, sex, and other factors such as motivation, study habits, extra-curricular activities, and finances as factors in academic performance should be studied.

In an attempt to evaluate more satisfactorily the influence of certain high school subjects on university success further work might be done with the factor of intelligence controlled.

It might be worthwhile also to investigate the comparative success of students with an interrupted education, that is, those who left school for a year or more prior to entering university.

An analysis of difference in university performance between rural and urban school graduates would provide useful information, as would a study of difference between public and private school graduates.

An investigation of the reliability of marking at university would be interesting.

An investigation of the possibility of using a prediction formula including both high school achievement and aptitude test results would be most valuable.

Some research on the capable students who do not proceed to university, and the reasons for not doing so, would be very profitable. In Ontario it was found as reported by R.W.B. Jackson in a foreward to Report No. 4 of the Atkinson Study (4) that,

> "Of our most able in some aspects of aptitude and achievement, for example, little more than half go on to university; of our less able students, it is embarrassingly evident that too many do go on to university."

If the same waste of human resources exists in this province, and there is no reason to believe that British Columbia differs from Ontario in this respect, the problem should be investigated and some attempt made to correct it.

CHAPTER VI

SUMMARY OF THE PRESENT STUDY

This investigation was designed to determine the relationship between high school achievement and university performance with the primary purpose of providing information for counsellors which they could use in predicting the success or failure of university candidates.

The high school variables used were letter grade average, percentage average, standing at first attempt, recommendation, number of Departmental examinations written, and major subjects taken. The data regarding these variables were obtained from grade twelve records. The criterion of university performance used was first year standing in April.

A sample of 737 students was chosen from the Faculty of Arts and Science during the academic year of 1957-58. The students who were chosen had completed grade twelve in a public secondary school in British Columbia, were not repeating any first year university courses, and had had an uninterrupted secondary education. They had registered for at least fifteen units of course work, which included English 100-101, Mathematics 100 or 101, a foreign language, a science, and an elective.

It was noted that the predictive value of this investigation can adequately apply only to students whose high school background and university programmes are comparable to those of the students used in this study. Further limitations are imposed by

the necessity of making certain assumptions regarding the reliability of high school records and university marks.

Literature which is relevant to the areas investigated in this study was reviewed and conclusions were summarized.

In order to determine whether the difference in freshman standing was significant among students grouped according to the various high school variables, Chi-Square technique was employed. To determine further where the difference lay, a method of partitioning Chi-Square was used. Contingency coefficients were calculated to show the degree of relationship between the variables and the criterion.

From these statistics it was found that there is a high positive relationship between first year university standing and grade twelve average, whether in letter grade or percentage form, and that students who achieve University Entrance standing at first attempt obtain a higher first year standing at university than students who are required to write supplementals and/or to repeat subjects. It was also found that recommended students perform at a higher level at university than non-recommended students, and that students who are required to write three or more Departmental examinations are more likely to fail at university than students who write just one or two examinations. In addition, some relationship was found between major subjects taken in high school and first year university standing. Students who have included as majors in their high school programmes Mathematics, Science, English and Social Studies, are less likely to fail at university than

students who take Mathematics and Science majors but who omit English and Social Studies majors. Also, students who have taken a high school foreign language major perform at a higher level at university than those who omit a foreign language major.

It was concluded that, within specified limitations, the results indicated that high school records can be used effectively in predicting university performance. It was suggested that some caution be exercised in individual prediction since individual differences make perfect prediction impossible. For more sensitive prediction, it was further suggested that academic ability test results be used to supplement high school records.

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APPENDIX A

Sample of Card Used for Gathering Data

Name 1. 1957 Registration No.

2. Magee (A)

3. Ma., Sc., Eng.

4. Eng. 40 C
C
Eng. 91 57%
Ma. 91 61%
Chem. 91 C+
Phys. 91 59%
Co. 10 C

5. C
6. 59%
7. N.R. (3) 9. Fail
8. S.R.

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1. Year grade twelve completed
2. School attended (A - Accredited, N.A. - not accredited)
3. Majors completed
4. Subjects taken in grade twelve and marks
5. Letter grade average
6. Percentage average
7. Scholarship (S.S.), Recommended (R) or Not Recommended (N.R.) and number of Departmentals written
8. Supplementals written and/or subjects repeated (S.R.)
9. First Year University Standing in April.

APPENDIX B

2. Sample of Kimball's Method for the Partition of Chi-Square, 3 by 3 Contingency Table*

High School Letter Grade Average	First Year University Standing: Full Credit	Supp.	No Credit	Totals
A, B	176 (a_1)	51 (a_2)	18 (a_3)	245 (A)
C+	101 (b_1)	94 (b_2)	78 (b_3)	273 (B)
C, C-, E	17 (c_1)	62 (c_2)	140 (c_3)	219 (C)
Totals	294 (n_1)	207 (n_2)	236 (n_3)	737 (N)

$$\text{Chi-Square (1)} = \frac{N[B(n_2a_1 - n_1a_2) - A(n_2b_1 - n_1b_2)]^2}{ABn_1n_2\,(A+B)\,(n_1+n_2)}$$

$$= \frac{737\,[273(207\text{x}176 - 294\text{x}51) - 245(207\text{x}101 - 294\text{x}94)]^2}{(245)\,(273)\,(294)\,(207)\,(245+273)\,(294+207)}$$

$$= 39.26$$

$$\text{Chi-Square (2)} = \frac{N^2[b_3(a_1+a_2) - a_3(b_1+b_2)]^2}{ABn_3\,(A+B)\,(n_1+n_2)}$$

$$= \frac{737)^2\,[78(176+51) - 18(101+94)]^2}{(245)\,(273)\,(236)\,(245+273)\,(294+207)}$$

$$= 26.72$$

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* Reproduction of Table III, p. 32.

$$\text{Chi-Square (3)} = \frac{N^2[c_2(a_1+b_1) - c_1(a_2+b_2)]^2}{Cn_1n_2(A+B)\ (n_1+n_2)}$$

$$= \frac{(737)^2\ [62(176+101) - 17(51+94)]^2}{(219)\ (294)\ (207)\ (245+273)\ (294+207)}$$

$$= 33.98$$

$$\text{Chi-Square (4)} = \frac{N\ [c_3(a_1+a_2+b_1+b_2) - (a_3+b_3)\ (c_1+c_2)]^2}{Cn_3\ (A+B)\ (n_1+n_2)}$$

$$= \frac{737\ [140(176+51+101+94) - (18+78)\ (17+62)]^2}{(219)\ (236)\ (245+273)\ (294+207)}$$

$$= 145.71$$

2. Sample of Kimball's Method for the Partition of Chi-Square, 2 by 5 Contingency Table*

First Year University Standing

Grade 12 Standing	First Class	Second Class	Pass	Supp.	No Credit	Totals
Recommended	33 (a_1)	131 (a_2)	86 (a_3)	116 (a_4)	58 (a_5)	424 (A)
Not Recommended	0 (b_1)	9 (b_2)	18 (b_3)	81 (b_4)	166 (b_5)	274 (B)
Totals	33 (n_1)	140 (n_2)	104 (n_3)	197 (n_4)	224 (n_5)	698 (N)

$$\text{Chi-Square (1)} = \frac{N^2[a_1b_2 - a_2b_1]^2}{AB\, n_1n_2(n_1+n_2)}$$

$$= \frac{(698)^2\,[33x9 - 131x0]^2}{(424)\,(274)\,(33)\,(140)\,(33+140)}$$

$$= .46$$

$$\text{Chi-Square (2)} = \frac{N^2\,[b_3(a_1+a_2) - a_3(b_1+b_2)]^2}{ABn_3(n_1+n_2)\,(n_1+n_2+n_3)}$$

$$= \frac{(698)^2\,[18(33+131) - 86(0+9)]^2}{(424)\,(274)\,(104)\,(173)\,(277)}$$

$$= 3.99$$

x Reproduction of Table XII, p. 45.

$$\text{Chi-Square (3)} = \frac{N^2 [b_4(a_1+a_2+a_3) - A_4(b_1+b_2+b_3)]^2}{ABn_4(n_1+n_2+n_3)\ (n_1+n_2+\ n_3+n_4)}$$

$$= \frac{(698)^2 [81(33+131+86) - 116(0+9+18)]^2}{(424)\ (274)\ (197)\ (33+140+104)\ (33+140+104+197)}$$

$$= 47.51$$

$$\text{Chi-Square (4)} = \frac{N^2 [b_5(a_1+a_2+a_3+a_4) - a_5(b_1+b_2+b_3+b_4)]^2}{ABn_5(n_1+n_2+n_3+n_4)\ (n_1+n_2+\ n_3+n_4+n_5)}$$

$$= \frac{(698)^2 [166(366) - 58(108)]^2}{(424)\ (274)\ (224)\ (474)\ (698)}$$

$$= 168.03$$