Perhaps in the light of such findings it is time that Ontario universities made their admission policies and procedures more stringent. It is of particular importance in limited enrolment programs to ensure that only the students likely to succeed be admitted. As increasing numbers of students apply for admission to Ontario's universities more and more programs are having to turn away "qualified" applicants. To ensure that those accepted are all likely to be able to graduate it is very important to utilize the best predictors of success in university study. It may be costly and time-consuming to identify these factors, and to process each application perhaps not utilizing the same factor; however, the cost of missed opportunities on the part of the student, and less than optimal use of resources on behalf of the universities and taxpayers, incurred by admitting the "wrong" students is undoubtedly too high.

This study examines the Ontario secondary school records of 225 students who graduated from Carleton University's Department of Geography between 1979 and 1984. Students who have not attended secondary school in Ontario may be admitted to Ontario universities, but only students with at least some senior Ontario secondary school (Grades 11-13) credits on their record are included in this study.

The intention is to determine which Grade 11-13 Ontario secondary school courses are the best predictors of a student's graduating grade-point average (GPA) in geography from Carleton University. This study differs from those cited above in that it examines student performance for the entire degree, not simply for a student's first year at university.

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SECONDARY SCHOOL PERFORMANCE
IN RELATION TO
UNIVERSITY GRADUATING PERFORMANCE:
A CASE STUDY IN GEOGRAPHY

by

© WAYNE ROWSOME, B.A. (Hons.)

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of
Master of Arts
Department of Geography

Carleton University

Ottawa, Ontario

April, 1987

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"SECONDARY SCHOOL PERFORMANCE IN RELATION TO
UNIVERSITY GRADUATING PERFORMANCE: A CASE STUDY IN GEOGRAPHY"

submitted by Wayne Rowsome, B.A. (Hons.)
in partial fulfilment of the requirements for
the degree of Master of Arts.

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ABSTRACT

Because many programs in Ontario universities have limited enrolments and do not accept all qualified applicants, it is important that those students who are accepted be the most likely to graduate. Attrition rates from Ontario universities are currently very high; most selection indicators explain little of the variance in first-year grades.

This study examines the secondary school records of students who have completed degrees in geography at Carleton University. Grade 13 averages are the best academic predictors of graduating geography grade-point average for B.Sc. and female B.A. graduates, but a better predictor for male B.A. graduates appears to be Grade 11 averages.

Broader and larger studies are needed to ascertain whether this finding for males holds true elsewhere, and whether there exist any measures other than secondary school grades which would predict more accurately students' chances of graduating from university.

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PREFACE

This study takes a particular view of the process of admitting students to Ontario universities. An attempt is made to determine if there exist secondary school-academic data which could provide a more accurate prediction of potential academic success at university than that provided by Grade 13 grades. The study always operates within the clear constraints of refining - in a mechanistic sense - the current system, leaving aside the theoretical and overtly value conscious alternatives to that system.

It is recognized that there are issues of social justice connected with an examination of the opportunity for, and acquisition of, a university education. Furthermore, universities are multi-purpose institutions which provide education, some preparation for the job market, and are engaged in research. No attempt has been made here to judge the worth of these activities, or to examine broader issues of equality of access to university or to positions of employment after university.

This research was undertaken to attempt simply to improve the selection of students for places in university programs with the goal of turning away as few qualified and interested applicants as possible (subject to space limitations), while attempting to reduce the current high attrition rates found in many university programs. It is recognized that this runs the risk of making the present system of selection more efficient without fundamentally challenging its appropriateness. This may, indeed reinforce current inequities.

CHAPTER 1

INTRODUCTION

Ontario's extensive post-secondary education system, comprising 16 universities and 22 colleges, with full-time undergraduate and graduate enrolment of 265,101 students in 1982-83 (Statistics Canada, 1983, cited in Anisef, 1986) represents a large public and private investment. Because of this investment, returns on expenditures of time and money should be maximized. One way of ensuring a good return is to select students who are, at minimum, likely to graduate, and at best, excel at university.

The results of a study conducted at McMaster University (Allan et al., 1983) show that 42.2 percent of 2466 students analysed after first-year had failed to complete the various prescribed first-year programs, and of these 48.0 percent failed their first-year program or withdrew from the university. These data suggest that perhaps as many as 20 percent of the first-year students do not begin second-year.

Data from Carleton University and the University of Ottawa show attrition rates from first-year of approximately 20 percent (Raymaker, 1986). Carleton University's Vice President (Academic), Tom Ryan has stated that "he finds it disturbing that students who actually drop out of school are the same students who gained admission on the assumption that they were able to successfully complete a university program" (Raymaker, 1986).

The criterion most often utilized by the universities to determine an applicant's suitability for undergraduate post-secondary study is secondary school performance. Ontario universities request that

students submit grades from their final three years of secondary school (Grades 11-13 in Ontario). In most cases, however, it is only the Grade 13 grades (final or interim) which are used to determine an applicant's suitability for university study. Several studies (Oksanen and Spencer, 1975; Pollock et al., 1975; Allan et al., 1983) examined this practice and found Grade 13 grades to be reasonable predictors of success (defined by completion of a first-year program) at university.

Even the best predictors of university academic success based on secondary school academic performance, as reported in published studies discussed here, are usually able to explain little more than 50 percent at best, of the variance in students' first-year university grades based on Grade 13 performance. Perhaps part of the blame for high failure and attrition rates can be placed on these imperfect predictors. The cost in human and economic terms of this imperfection could warrant further study into improving the predictors at work in deciding on university admissions. It is important to note that while a perfect predictor does not exist and therefore it is difficult to predict performance, given the importance of such predictors it is desirable to strive for the most reliable one possible.

It is felt by Anisef et al. (1986, p.3) that there is a sentiment in Canada

that significant numbers of students are now being admitted into university who lack the intellectual readiness and motivation for higher education. Although some of the responsibility for their presence in higher education may be attributed to inadequate preparation at the secondary level, open admissions policies and active recruitment of 'warm bodies' also account for a significant proportion.

Perhaps in the light of such findings it is time that Ontario universities made their admission policies and procedures more stringent. It is of particular importance in limited enrolment programs to ensure that only the students likely to succeed be admitted. As increasing numbers of students apply for admission to Ontario's universities more and more programs are having to turn away "qualified" applicants. To ensure that those accepted are all likely to be able to graduate it is very important to utilize the best predictors of success in university study. It may be costly and time-consuming to identify these factors, and to process each application perhaps not utilizing the same factor; however, the cost of missed opportunities on the part of the student, and less than optimal use of resources on behalf of the universities and taxpayers, incurred by admitting the "wrong" students is undoubtedly too high.

This study examines the Ontario secondary school records of 225 students who graduated from Carleton University's Department of Geography between 1979 and 1984. Students who have not attended secondary school in Ontario may be admitted to Ontario universities, but only students with at least some senior Ontario secondary school (Grades 11-13) credits on their record are included in this study.

The intention is to determine which Grade 11-13 Ontario secondary school courses are the best predictors of a student's graduating grade-point average (GPA) in geography from Carleton University. This study differs from those cited above in that it examines student performance for the entire degree, not simply for a student's first year at university.

The purpose of adopting this approach is that, by determining which characteristics of students' academic backgrounds permit reliable prediction of their success in acquiring a geographic education, it could allow the institution to predict which students would be expected to perform well in geography. This predictor could then be employed to ensure that only those students who are likely to be able to complete a degree in geography are encouraged or even permitted entry into a geography degree program directly from secondary school. This argument is particularly applicable if enrolment in a program is limited. This is not currently the case in geography at Carleton University.

Because many students do not apply for admission to a geography program during their final year of secondary school or before commencing first-year university, but rather apply after first-year or later, separate predictors of future academic success based on university performance (in geography or otherwise) could be developed. These latter predictors could be used on students wishing to declare a major in geography after entering the university or for those who were originally turned away from geography (on the basis of their secondary school grades), but who subsequently completed geography or other university courses. The use of either set of predictors would ensure that the future performance of all potential geography students could be evaluated using the more recent of secondary school or university grades. The use of university grades rather than secondary school grades would require the formulation of different predictor equations (which might be no more elaborate than a determination of a student's

average university grade, for comparison with the university's graduation standard). These equations are not examined in this study.

Most students who apply to university do not declare a major upon application. This study does not examine the status of an applicant upon admission to Carleton University, but rather deals only with students who graduate with geography degrees. For this reason the conclusions found in this study are not necessarily applicable to students other than those who have declared a major in geography directly from secondary school.

There are two approaches to the prediction of university academic success which are examined in this study. The first is based on the assumption that the student's terminal first degree (Pass or Honours, single or double major) is unknown; thus only the faculty in which the student has applied to study is used as a sort variable (even though it too may be subject to change). The second approach, which can only rarely be used in an operational sense, assumes that a student will choose a faculty, length of degree, and major(s) before beginning first-year university and will not change any of these components over the duration of his/her study.

There are several arguments advanced to justify the use in this study of secondary school grades as indicators of university academic performance. It is believed here that students' academic records at university will be at least as good as their records at secondary school because the interest and ability they develop during their secondary school years should carry over to, and be maintained in, university. In fact, there is reason to expect that students will

achieve higher grades at university because at university they are likely majoring in the subject which is of the most interest to them rather than taking as wide a diversity of required courses as in secondary school. It is also expected that students who would likely succeed in university geography programs would have fairly high grades in secondary school geography courses because to earn a high university average would reasonably be indicated by a high level of interest in geography.

For these reasons it was decided to examine students' academic records from Grades 11 to 13 in Ontario secondary schools. The averages for each of these years, particularly Grade 13, were examined, and individual courses, especially Grades 11-13 geography were focussed upon. Only students who had taken at least some of their Grades 11-13 courses in Ontario were examined here.

Secondary school course grades and averages are examined individually and collectively, and used in bivariate and multiple regressions and correlations to arrive at a series of predictors of graduating geography grade-point average at Carleton University. The intention of this study is to determine whether the currently used predictor of university academic success, the best six Grade 13 grades, is actually the most appropriate predictor for geography students at Carleton University, and if not, whether any other subject or average is a better predictor (on the basis of lowest standard error of estimate of predicted graduating geography grade-point average).

While it is possible that some students may perform worse at

university than at secondary school because of the different demands placed on them at each level, the various skills involved, and the varying kinds of education involved, this study does not examine the possible effects of these factors on the students. These are important issues which could be examined in a broader study.

CHAPTER 2

AN EXAMINATION OF PREDICTORS OF UNIVERSITY ACADEMIC SUCCESS

The following passage from a 1983 report by the Council of Ontario Universities illustrates the demand being placed on Ontario's universities.

Since 1960-61 full-time enrolment [in Ontario universities] has risen from 36,000 to almost 176,000, an all-time high. The participation rate in the 18-24 age group, from which traditionally the bulk of full-time students has been drawn, is 2½ times what it was in 1960-61. The percentage of Ontario secondary school graduates who go directly on to university in this province in 1982-83 reached 66.8%, also an all-time high. During this same period enrolment of persons 25 years of age and over has continued to increase. (Council of Ontario Universities, 1983, p.4)

Because of limited funding, Ontario universities have been unable to expand to meet fully the demand; thus these increasing enrolments have led to larger classes, enrolment limits being placed on courses and programs, and some otherwise eligible students being unable to gain full-time admission to a degree program at an Ontario university (Council of Ontario Universities, 1983; Davis, 1984). These enrolment pressures emphasize the importance of ensuring that each student who is admitted to an Ontario university has a high probability of graduating, and that "qualified" students not be turned away from a university education if space in a first-year program can be made available for them.

While the experience of attending university, even without graduating, can be worthwhile and rewarding for some students, the current situation in some Ontario universities whereby there are not enough places for every eligible student strongly suggests that only

those students who are expected to graduate should be admitted. This admissions policy would attempt to ensure that students who are judged capable of graduating do not lose their places at university to students unlikely to graduate. While all students who are admitted to university are judged to be capable of graduating, the fact that a sizeable minority fail to do so suggests that not all students accepted to university are prepared for the demands of their program.

Despite the importance of the university system in Ontario relatively little attention has been given to research focused on predicting academic success beyond first-year university. Most studies examine the relationship between success at Grade 13 and first-year university. The following studies of student performance in Ontario universities are all concerned with predicting first-year university academic success on the basis of factors in a university applicant's background. In these studies the term "academic success" is used to mean completion of the requirements of first-year university. There is no discussion of success beyond this bare minimum level. This study examines success at graduation, but not at the end of first-year.

2.1 First-Year University Performance Predictions Based on Grade 13 Data

Several studies conducted over the past 20 years have focused on the usefulness of Grade 13 averages in predicting students' performances in first-year university. As a result of the changing secondary school curricula over recent decades it is important to examine the utility of Grade 13 grades as a predictor of university academic success.

The first comprehensive study of this kind in Ontario was the Atkinson Study of Utilization of Student Resources. This was conducted from 1957 to 1967, a time when students were admitted to university on the basis of Grade 13 provincial examination results (Allan et al., 1983). This study found the best predictor of first-year university performance to be Grade 13 average, but Grade 12 average was also valuable. There was little use for Scholastic Aptitude Test scores and principals' ratings. It was suggested, however, that students who took more than one year to complete Grade 13 (ie. spent 6+ years in secondary school) appeared to require a Grade 13 average approximately 5 percent higher in order to have the same probability of completing first-year university as those who completed the grade in a single year. "The correlations between Grade 13 and Year 1 averages varied among programs with the highest occurring in Applied Science (Engineering) and lowest in Arts programs." (Allan et al., 1983, p.41)

The Ontario Institute for Studies in Education examined students who completed Grade 13 in 1967, 1968, and 1969, after the abolition of provincial examinations and found a higher correlation between first-year university achievement, and both provincial examinations and/or teacher-assigned marks than first-year achievement with aptitude test scores. Higher correlations were also noted for Science or Engineering disciplines than for Arts disciplines, and for females relative to males (Allan et al., 1983).

A study by Oksanen and Spencer (1975) of students enrolled in

first-year Social Science courses claimed that students' secondary school senior matriculation mean grades correlated reasonably well with their level of success in first-year courses. Students' scores on verbal and mathematical aptitude tests were also included in the analysis and were found to be relatively poor predictors of first-year university success in the case of geography (verbal aptitudes sixth best out of seven Social Science courses; mathematical aptitudes weakly negatively correlated with success in geography).

The elimination in 1967 of province-wide senior matriculation examinations appears from this study not to have eliminated the correlation of final-year secondary school course grades with first-year university performance (Oksanen and Spencer, 1975).

Studies of students entering McMaster University in 1969-70 (Borankay, 1971, cited in Allan et al., 1983) and 1974-75 (Darling, 1976, cited in Allan et al., 1983) found no significant difference in the correlation coefficients for those two years between Grade 13 grades and first-year university performance. The study by Borankay (1971, cited in Allan et al., 1983) found both Grade 13 interim and final grades to be useful predictors of university success as defined by the completion of first-year university. Students taking more than one year to complete Grade 13 (ie. 6+ years in secondary school) did not fare as well in first-year university as those who took only one year. For the 1969-70 students the Pearson correlation coefficients between Grade 13 final or interim grades and first-year university average ranged from 0.78 in Engineering to 0.52 for Social Science

students without Grade 13 mathematics.

In 1975 the Secondary-Postsecondary Interface Project found that students' performances in first-year university were as predictable as they had been almost a decade earlier when province-wide Grade 13 examinations were used (Traub et al., 1977, cited in Allan et al., 1983). This suggests that Grade 13 province-wide examinations were not necessary to determine the suitability of a student for university study.

A 1979 report by the Council of Ontario Universities found that Grade 13 grades were the best predictors of first-year university success. The study also conducted experimental testing of first-year university students in English and mathematics in 1975 and 1976 and concluded that

The addition of the test scores to high school performance data would have provided only slight gains in the efficiency of student selection. The available data suggested substantial variability in marking standards of various high schools, but the additional information provided by a single test score was not found to correct for this variation to any great extent. (Council of Ontario Universities, 1979, cited in Allan et al., 1983, p.42)

Researchers at McMaster University conducted a test using 1980-81 freshmen students to determine whether Grade 13 grades continued to be reasonable predictors of first-year university success. This test was undertaken partly in response to a decision by the University of Toronto in 1981 not to accept certain Grade 13 subjects for admission.¹ This study by Allan et al. (1983) also tested the predictive value of

¹These subjects included data processing, secretarial science, technological studies, and other business studies (Allan et al., 1983).

the final Grade 13 admission average and the interim average for first-year university performance. The coefficients were similar, with the final Grade 13 average being a slightly stronger predictor than the interim grade. The correlation between the two admission averages was 0.96. It was also found that the final average could be predicted from the interim average within 2.4 marks on a scale of 0 to 100 for 68 percent of the students (Allan et al., 1983). These values were very similar to those found by the Council of Ontario Universities in their 1979 study. This finding is important as it supports the use of interim grades rather than waiting until July for final grades.

The McMaster University study (Allan et al., 1983) was also concerned with the effect of raising admission requirements for entry to programs at McMaster University. To test the effect this could have on the selection of students the applicants were divided into quartiles based on their admission average. This analysis was performed for each of six programs. It was found that for first-year Humanities, Natural Sciences, and Physical Education there was a significant difference in first-year student performance between the bottom two quartiles for each program; however, for first-year Business, Engineering, and Social Sciences there was no such significant difference. This suggests that, particularly for the latter three programs, raising the admission average would not necessarily improve the calibre of applicant accepted and would likely eliminate many capable ones.

Allan et al. (1983) were interested in determining whether or not

there was any difference in the predictive abilities of various Grade 13 courses on first-year university performance. To test this they separated Grade 13 courses into two groups based on the criteria the University of Toronto used in examining students' records. The group of courses to be considered included English, other languages, biology, chemistry, physics, economics, geography, history, and core mathematics. These Group A courses (a term used by Allan et al., 1983) were compared with the Group B courses (family studies, music, physical education, theatre arts, social sciences, and technology subjects). It was found that the Group A courses, the only courses that the University of Toronto would accept for admission, were on balance better predictors of first-year university success than were Group B courses. This was determined using a chi square test of the difference between the percentages of non-significant subject correlations in Group A and in Group B over the six programs.

This separation of Grade 13 courses into "acceptable" and "not acceptable" university admission courses caused concern within the Ministry of Education in Ontario because of the perception that some Grade 13 courses were more appropriate pre-university courses than others. This concern was taken into account when designing new curriculum guidelines for Ontario Academic Courses (OACs) which replace Grade 13 courses beginning in 1987-88. (Although curriculum guidelines for Ontario Academic Courses are still undergoing revision, many will be in place by September 1987, and all are expected to be operational by September 1990. Therefore, no Grade 13 courses will be

available after September 1990, although some OACs may be similar or identical to the current Grade 13 courses.) University input was encouraged during the drawing-up of the OAC guidelines partly to ensure universities' satisfaction with allowing all OACs to act as admission credits to Ontario universities (Jim Rahn, Ontario Ministry of Education, personal communication, November 11, 1986). Individual universities, however, make autonomous decisions regarding courses required for admission.

2.2 University Academic Performance Indicators other than Grade 13 Grades

The situation where some universities believe there are qualitative differences between some secondary schools and Grade 13 courses has led some secondary school curriculum planners to call for standardized examinations (Jim Rahn, Ontario Ministry of Education, personal communication, November 11, 1986). The call has been frustrated so far, and such a measure should not be necessary in practice as Grade 13 courses, regardless of where they are taught, have been indicated to be acceptable predictors of university academic success (Allan et al., 1983).

Traub and McLean (1985) surveyed individuals responsible for setting undergraduate admission policies at 15 Ontario universities and found strong support for final-year provincial examinations and for utilizing their results, particularly in a first language (English or français) and mathematics, along with these and other Grade 13

teacher-assigned school marks, to assess a student's application for university study. This strong desire for provincial examinations is somewhat surprising in the light of the results found by Allan et al. (1983) suggesting that standardized test scores add little to the predictive ability of secondary school grades for university success. It is possible that few university officers know of the studies by Allan et al. (1983) and others. Thus it may be understandable that provincial examinations suggest consistency and rigour even though this may not necessarily be the case.

Pollock et al. (1975) have noted that the results of the Atkinson Study of Utilization of Student Resources (1957-67) indicated that Grade 13 was the best predictor of university academic success, but frequently explained only about 25 percent of the variance. The phased replacement of Grade 13 from Ontario secondary schools by 1990 with the new Ontario Academic Courses is designed to serve as the basis for admission to university.

Most studies of university performance focus on students' best six Grade 13 courses which have yielded six credits and an overall average of 60 percent or higher. However, in an experiment Trent University admitted in 1972-73 a group of students who had Grade 13 averages for their best six courses below 60 percent, or over 60 percent but who failed at least one of the six Grade 13 credits that they presented for admission. This study was undertaken as part of a test of various methods of determining university success. This selection procedure resulted in 101 otherwise ineligible students

being allowed to register in first-year. Of the 101 students in this situation 74 passed their first year, 9 were placed on probation, and 18 were required to withdraw by the university. While 27 percent of this group did not successfully complete their first-year course of study, 73 percent did so, and none of these 74 successful students would have been given the opportunity to register in a university degree program that year (or without replacement of poor course grades in subsequent years) if the traditional Grade 13 record requirements had been used for their admission decision (Pollock et al., 1975).

In addition to this admission procedure Pollock et al. (1975) also examined the admission of students based on: 1) open admissions (random selection of Grade 13 students who applied to Trent University), 2) interviews by a trained interviewer from the university, 3) recommendations from secondary school teachers, 4) Grade-13 interim grades equal to or greater than 60 percent on average with no failures amongst the six credits, 5) Service for Admission to Colleges and Universities (SACU) Tests of verbal and mathematical ability and, 6) traditional admission: six Grade 13 credits with an average of 60 percent or higher. The study concluded that there was no statistically-reliable difference between the first-year university academic results of the students admitted in the traditional manner and the academic results of any of the other six groups. This is an important finding as it suggests that not only may Grade 13 grades not be the best predictors of university success as they are assumed to be, but that random selection of any Grade 13 graduate may statistically yield

the same chance of selecting a student who will successfully complete a first-year university program (in a program with a 60 percent, six credit, admission requirement; ie. higher entry requirements might well have yielded different results). This study found that 81 percent of the students examined who failed to meet the normal Ontario university entrance requirements successfully completed their first year of university study at Trent University.

As Pollock et al. (1975, pp.14-15) observe

It's unlikely any university could or would justify an admissions policy which eliminates a group of students, most of whom would succeed in their program of studies. The authors are well aware that any single study in a particular university may be somewhat limited in its generalization. Nevertheless the very high percentage rate of successful completions of the academic year by this subgroup ... gives pause for serious reflection regarding traditional admission procedures and the human cost factor involved.

While the Pollock et al. (1975) study focused only on Arts and Science students at Trent University it is possible that the findings could be applicable to other Ontario universities, particularly with regard to Arts and Science students.

2.3 Predictors of University Academic Performance in the United States

The difference in educational systems between Canada and the United States results in American experiences being of lesser value in Ontario. However, evidence from the United States indicates that secondary school grades and test scores (Scholastic Aptitude Test - SAT) are the best predictors of undergraduate academic performance. Breland

(1981, cited in Klitgaard, 1985), after a review of the literature, found these measures to be the best predictors, with other material considered in admission decisions - including letters of recommendation, biodata, and essays - adding little to predictive power.

Psychologist Robyn Dawes, and colleagues (1974, 1977, cited in Klitgaard, 1985) have found that the subjective judgements of admissions officers do not predict future academic performance as well as the combination of prior grades and test scores, and if these grades and scores are known then subjective judgements contribute nothing additional to predicting undergraduate grades.

In predicting high levels of performance, important for limited enrolment programs, Willingham and Breland (1982) in a study of nine private American colleges, found a median correlation between first-year college grades and a combination of SAT scores and prior grades of 0.51. When 23 different "background measures" were added the correlation rose by only 0.04 (cited in Klitgaard, 1985). This study also found that the judgement of admissions officers when added to prior grades and SAT scores did not significantly improve the prediction of undergraduate grades.

These American studies conclude that secondary school grades and test scores are the best predictors of academic success at university. This is similar to the findings in Ontario except for the level of importance given to test scores.

2.4 An Examination of University Non-Acceptances

There are students who meet the minimum entrance requirements for university, but are unable to gain admission to the program or institution of their choice. Some students are not accepted by any university. It is important to be aware of the emphasis students may place on their education and the effect on them of failure to be accepted into their program/institution of choice.

A Council of Ontario Universities study (Davis, 1984) found that the three most important criteria used by prospective students in choosing a university were (in descending order): the interest in a particular field or career; the institution's reputation; and the reputation of a particular program. These accounted for 66.5 percent of the reasons given by applicants to Ontario universities. This report focused on students who were deemed qualified for university study but either did not receive offers of admission or turned down their offer(s). As there is no reason to believe that the reasons these students have for attending university would be different from other students it is useful to note the emphasis students claim to place on the quality of their prospective programs and institutions, as well as their interest in the field. The Davis (1984) study suggests that the students are particularly concerned with acquiring an education which they view as interesting and valuable. Thus admission policies should be designed to permit entry to all students who can reasonably be accommodated and who have a reasonably high probability of completing the degree program to which they have

applied.

The main reasons found by Davis (1984) for qualified students not attending university were (in descending order): they were undecided about their future; they were not accepted into the program of their choice; they needed a break; and they were not accepted by the institution of their choice. Each of these factors was named by more than one-quarter of the respondents. This highlights the importance that most students place on their program and institution. Thus universities should be as careful about whom they reject as to whom they grant offers of admission.

2.5 University Attrition in First and Subsequent Years: Predicting Performance

If students are to be admitted to university it is important not only that they be capable of completing their courses of study, but also that the university, in the ways over which it has control, not turn the students off their education to the extent that they withdraw from their program. It is recognized in this study that students' cognitive abilities to achieve academic success at university are assessed for admission purposes, but equally important are the students' willingness and attitudes towards high achievement. These attitudes are significantly affected by classroom experiences. It has been argued by Pascarella and Terenzini (1980) and Tinto (1982), both cited in Gomme and Gilbert (1984, p.97), that

...the importance of the impacts of faculty in both teaching and non-teaching roles upon the student both cognitively and affectively has been emphasized as crucial in the formation of decisions to withdraw or to persist.

Coupled with this is the finding that pre-enrolment traits are less important in explaining a student's decision to withdraw than are experiences the student has after enrolling in the university (Gomme and Gilbert, 1984).

These findings place some of the responsibility for reducing the attrition rates on the universities themselves, rather than on attempting to isolate factors in students' backgrounds which would indicate whether or not they were likely to succeed academically at university. This is because it has been found that there is no factor in students' backgrounds which would predict attrition, as even some "successful" students, with high grades, withdraw from their university studies (Gomme and Gilbert, 1984).

This situation calls for improvements in the affective quality of education itself to help reduce attrition. Bean (1980) and Tinto (1982), both cited in Gomme and Gilbert (1984, p.98), recommend

... assigning the most effective instructors to courses containing large numbers of first year students (among whom attrition is by far the highest), organizing classes in such a way as to ensure that professors rather than teaching assistants instruct students in settings more conducive to personal contact, and encouraging faculty to provide consistent and frequent advice to students on a formal basis.

In this sense the word "effective" could be construed to mean an instructor who teaches a course in an interesting and stimulating manner, and who is aware of the concerns of first-year students.

While it has been found (Raymaker, 1986) that first-year attrition rates at Carleton University hover around 20 percent, it has also been

estimated (using data from Rowsome, 1984; Office of Planning Analysis and Statistics, Carleton University, 1986) that close to 40 percent of all full-time students who begin a degree program at Carleton University may not graduate from the university. As there is no reason to believe that the attrition rates at other Ontario universities should differ from Carleton's, to be concerned solely with first-year attrition, when approximately half of the attrition from Ontario university degree programs may occur after first-year, ignores a substantial problem. The failure of perhaps 40 percent of Ontario's university students to achieve the degree which they pursued, at their first university, may suggest a fault with the entrance requirements or filtering procedures in Ontario's universities which should be investigated in further studies.

It is also very important for the universities in Ontario to determine the causes of attrition. Some of this attrition may be preventable by using different predictors from those currently in use to evaluate university applicants. Additionally, changes within universities may help reduce attrition rates. To reduce the current high level of attrition would likely require a clear understanding of the factors involved in students' decisions to withdraw from university. To determine these factors would require a study of those students who withdraw from university. An Ontario-wide study would be most effective in understanding university attrition.

CHAPTER 3

ANALYTICAL TECHNIQUES

In this study, which examines secondary school records and university geography graduating performance, not simply first-year university performance, the following parameters have been applied in order to ensure continuity in the treatment of the academic records under study, and to produce a result which could be useful and replicable.

3.1 Raw Data

The raw data for this study consist of the complete university admission and graduation records of those students who graduated in the five year period including Winter 1979 and Spring 1984 from Carleton University with a degree in geography (n=428). These data provide evidence of university academic success in geography, and include secondary school data which may predict this university success. This information was gathered by determining which students had received geography degrees in this period, and then retrieving the data from the University's admissions files (with the assistance of the University's Admissions Office) for each student. The degrees (and abbreviations) were: Bachelor of Arts Pass (BAP), Bachelor of Arts Combined Pass (BACP), Bachelor of Arts Honours (BAH), Bachelor of Arts Combined Honours (BACH), Bachelor of Science (B.Sc.), and Bachelor of Journalism (B.J.) with a minor in geography.

Students whose admission or graduation files were missing

(n=110/428; 25.7%) or who had no modern Ontario secondary school records in their files (n=93/428; 21.7%) were omitted from further analysis. The reduced sample was used because limiting the study to one university and one discipline would maximize the continuity in senior secondary school and university backgrounds of the students examined. The particular five year study period was chosen because it represents a sample size which was expected to be large enough to be representative of the academic characteristics of Carleton University geography students during the 1970s and 1980s.

These procedures resulted in a sample size of 225 students. The following data were drawn from each file: gender; grades (final and/or interim) if present, for Grades 11 and 12 English, French, history, geography, mathematics, science, and Grade 13 English, French, history, geography, biology, chemistry, physics, calculus, functions and relations, and algebra; Carleton University degree earned; grade-point average in geography on graduation at Carleton University as calculated by the Department of Geography; and the year the student completed Ontario Grade 13 (or equivalent).

The courses listed above were chosen because they are common academic courses offered throughout Ontario and recognized by all Ontario universities as a basis for determining whether or not a student should be admitted to a university in Ontario. By examining only records from Ontario secondary schools the commonality in curricula has been largely maintained. Graduating grade-point averages (GPAs) calculated by the Carleton University Geography

Department were used to provide a reliable grading standard for comparison consistent over the period of study.

A series of difficulties were encountered when selecting secondary school courses for the study. The courses utilized were all advanced (A-level) or enriched (E-level). No general (G-level) or basic (B-level) credits were included in the study (except in isolated cases as noted below). If both advanced and enriched credits were presented for the same course and grade then they were averaged. Some schools grant half-credits rather than full credits. In these situations the average was computed if more than a single course in a particular discipline at a single level was completed. The common Ontario Grade 11 science course is physics, and Grade 12 science course is chemistry. However, as there are other science courses, including advanced-level ones, offered in these grades it was decided for the purpose of this study to include the generic term "science" for each of the Grade 11 and Grade 12 "science" credits and permit the inclusion of any Grade 11 or 12 "science" courses under these two headings. In this situation a few general-level courses have been included either on their own or in combination with advanced-level science courses in order to provide data on students' science backgrounds. Furthermore, there are certain science courses such as Grade 11 biology and Grade 12 geology which, in some schools, are only offered at the general level. It was decided to include these courses as they do not necessarily represent a decision by a student to take a course at a general rather than an advanced level, but may represent a genuine interest that a student has

in the course which is not offered at any other level. The final problem encountered when selecting courses for this study is the interpretation of Grade 13 mathematics courses. On some records they were identified as calculus, functions and relations, and algebra, whereas on others the terms mathematics 1, 2, or 3, or pure mathematics were used. Because it was not possible to be certain which mathematics courses were implied when different schools used the terms mathematics 1, 2, or 3, or pure mathematics it was decided not to include a Grade 13 mathematics grade unless the precise branch of mathematics was specified.

3.2 Data Arrangement

The following information for each student was included in a computer file: gender (coded numerically); grade in percentage form for each secondary school credit examined; Carleton University degree obtained (coded numerically); and graduating geography grade-point average truncated to one decimal place.

Missing value codes were inserted wherever a student had not taken a course, or had not taken it in Ontario, or where the information was unavailable. The code 999 was utilized to distinguish missing values from valid grades in percentage form.

A test file was created for the purpose of selecting students who could be used as test cases to provide a guide as to the usefulness of the indicator equations. These equations were to be derived from analyses of the remaining students in the original file, to predict

graduating geography grade-point averages on the basis of certain secondary school grades. Those students who represented the last cohort to graduate from secondary school in this group were then selected. The last possible year in secondary school for these students was 1980; however, of the 225 students in the data file only five left secondary school in 1980. In order to increase the number of students in this new file it was decided to select all of those (n=23) who completed secondary school in 1979. This left 197 in the original file and 28 in the newly-created test file.

The relationships between each of the 22 secondary school subject grades versus university geography grade-point average for the 197 students in the sample were assessed using scattergrams plotted in an SPSS-X package. This allowed linearity to be roughly assessed, which gave an indication of the suitability of using each academic subject as a predictor of GPA, but it did not provide any numerical data. The fact that there appeared to be a positive relationship between secondary school grades and university geography grade-point average for each of the 22 secondary school academic subjects examined led to a decision to retain each subject for further analysis. An example of these scattergrams is shown in Appendix 1.

The intent of this study is to discover whether a certain course or group of courses, taken at secondary school, can be used to predict geography graduating grade-point averages at Carleton University.

To this end the use of individual secondary school subjects for prediction of university academic success has merit, but using averages

of a combination of various secondary school subjects could result in more accurate prediction of university success. The value of averages is that they could reduce the effects of particular teachers or curricula, and thus present a clearer evaluation of a student's potential for university studies.

The averages chosen for examination were composed of each of Grade 11, Grade 12, and Grade 13 courses on file for each student, subject to the condition that at least two marks must be present or no computation would be performed for that particular grade. Further calculations were performed to determine averages for Grades 11 and 12 combined; 12 and 13 combined; 11, 12, and 13 combined; and even more specifically, combinations of Grades 11 and 12 geography; 11 and 13 geography; 12 and 13 geography; and 11, 12, and 13 geography. In these combinations as well, a minimum of two values were required for the program to calculate an average.

The reason for choosing these particular combinations was that while universities tend to rely primarily on Grade 13 averages for admission decisions, they are also presented with students' Grade 11 and 12 course grades. An examination of the final three years of secondary school, or the final two, or all but the last one, could yield information which may predict university academic success more reliably than Grade 13 average alone. Combinations of geography courses were included because it was believed that academic performance in previous geography courses might be a better indicator of potential success in university geography than the use of other secondary school

courses, and combinations of courses could smooth the effect of any single course for the reasons mentioned above.

It is also hypothesized that the degree pursued and gender of the student could play a role in determining the best predictor course or courses because of the differences in courses taken for the various degrees, and the differing backgrounds of the students. For these reasons the 197 students were separated into gender and six degrees (BAP, BACP, BAH, BACH, B.Sc., B.J.). It was then decided to (i) eliminate the B.J. degree as there was only one student in the category, (ii) not consider female B.Sc. students on their own because there were only two such cases, and (iii) to combine the Pass degrees (BAP, BACP) into one category and the Honours degrees (BAH, BACH) into another category. These amalgamations were performed because of the similarity in courses and graduation requirements demanded of each member of the pair, plus the identical minimum or normal length of time required to complete the degree.

Finally, a further refinement was made in the study. While students pursuing Arts degrees had been separated into Pass (3 year) and Honours (4 year) degrees, it was subsequently decided that because many students are admitted as undeclared Pass degree students and some later switch to geography, and even later to Honours status, it would be best to consider them all as a single group, particularly because many first to third year courses would be common to the two levels of degree.

Separate examination of the records of students pursuing Pass and

Combined Pass degrees, and Honours and Combined Honours degrees was undertaken to determine whether there were differences in the records of these two groups of students, which, given a large sample, could be useful in predicting academic success at university. As it was not known whether the degree with which a student graduated was the one which they entered university to complete, these four degrees were combined into one for operational purposes in this study. However, this amalgamation of degrees only occurred after the two groups had been examined individually to determine if there were any noticeable differences in the senior secondary school academic records of the students who completed each degree.

3.3 Statistical Methods

3.3.1 Bivariate Correlation

After sorting the students into the groups outlined above, a Pearson's correlation coefficient (r) was calculated for each group of students, comparing grade-point average in university geography against each secondary school subject or average individually. This coefficient provided a measure of the variance in GPA which can be explained by each subject or average.

Bivariate correlations were used because they afforded the opportunity to test the usefulness of secondary school subjects/averages as indicators of graduating geography grade-point averages. The data used were also judged to meet the requirements for bivariate analyses as specified by Johnston (1980). These requirements included

linearity; normality; homoscedascity; and low autocorrelation. While certain subgroups of data may deviate somewhat from these requirements the overall sample has been judged, through visual inspection of many scattergrams of secondary school subjects versus grade-point average, to satisfy the requirements.

3.3.2 Multiple Correlation and Regression

While the bivariate correlations produce some statistically significant and high correlations, the intent of the analysis is to determine the best predictor of students' graduating grade-point averages. It is hypothesized that the combination of two or more courses and/or averages would produce a better predictor than one course or average alone. To this end multiple regression techniques were applied to the data. It was also decided not only to run multiple regressions of geography GPA on all secondary school courses and averages combined, but also to run courses as a group alone and to run averages (Grade 11, 12, and 13) as a group alone because, as averages are composed of courses, it was felt that to run courses and averages together would entail double counting. A multiple regression provides a measure of the variance in a dependent variable (in this study geography GPA) which can be accounted for by two or more independent variables (subjects or averages from secondary school in this case).

In addition to the four requirements which must be met for bivariate analyses, a fifth one, that of non-collinearity between

independent variables, is necessary for multiple regression (Johnston, 1980). The data in this study were likely collinear, but this did not cause a problem because while the subjects/averages were being used to predict GPA there was no causal relationship between the subjects/averages and GPA, therefore collinearity was not important.

The attempt to perform a multiple regression resulted in a myriad of problems because of the treatment by the SPSS-X program of the missing values in the data. It was important to ensure that missing values did not affect the calculations, but it was not possible to exclude all cases with missing values because every case included some missing values (see Appendix 2). These difficulties indicated that it was not possible within the constraints of the SPSS-X program to have the statistical package select the best predictors. Therefore it was hypothesized that courses/averages which were good predictors in a bivariate correlation would also be good predictors in multiple regression. Furthermore, it was desired to select courses/averages which had a reasonable number of observations, because of the fact that, when combined with other variables, only cases with values present for each variable are utilized. A further difficulty arose when multiple correlation (R) values were not necessarily displayed on the computer printout after the addition of each variable in a multiple regression, but rather after the inclusion of a number of variables. This made it impossible to determine the amount of additional explanation added by each variable. An adjustment of the system-set PIN value (see Appendix 3) corrected this problem.

In order to arrive at a multiple regression equation which explained an acceptable amount of the variance in GPA on the basis of secondary school grades, a series of steps were taken. Initially, several of the better predictor subjects (according to their bivariate correlations) were collectively regressed against GPA. While some of the resulting multiple R values may have been quite large, the number of students could have been small. Furthermore, to utilize less-than-frequently present courses in a predictor equation could be academically sound but not practical in developing an operational tool. These concerns resulted in the decision to regress the Grade 11, 12, and 13 averages against GPA, and to add Grade 13 geography to these three averages as this course is frequently present and has a consistently high bivariate correlation with GPA for various subgroups of the data set.

All of these tests tended to result in one or two courses/averages contributing a substantial amount to the explanation, with the additional courses/averages contributing little additional explanation probably because of multicollinearity in the independent variables. For this reason courses and averages were regressed in combination and alone against GPA to arrive at the best predictor(s) in addition to the most practical predictor in an operational sense.

3.3.3 The Basis for Determining the Best Predictor: Standard Error of the Estimate

At this juncture in the evolution of the study it was decided to concentrate on the standard error of the estimate of the regression

equation in addition to the r/R values. This decision was taken because the purpose of the study is to provide guidance as to which students should be accepted into a geography program directly from secondary school. The student's university application would state a faculty, but not necessarily the length of degree that the student might ultimately complete. This lack of knowledge regarding terminal first degree exists because many students enter university on the premise of completing a 3 year Pass B.A. or B.Sc. degree, but some of these later apply for entry into 4 year Honours B.A. or B.Sc. degrees. The decision to accept a student into the program would be based on the predicted ability of the candidate to complete the program. By using standard errors it is possible to predict, within certain confidence levels, a student's graduating grade-point average. This is because the size of the standard error of the estimate expresses the reliability of the estimate. Once a minimum standard had been set by the institution it would be possible to determine whom to accept or reject depending on how certain the institution wished to be regarding the possibility of accepting a candidate who might fail to graduate. This use of standard errors could be valuable if "open" accessibility were not the operating principle.

3.4 Testing the Predictor Equations

Having derived predictor equations for the graduating grade-point averages of the various groups of students it remained to test the accuracy and significance of the equations by predicting graduating

grade-point averages for students who have already graduated. These predictions were then compared with the actual grade-point averages of the 28 "test case" students from the original sample of 225 who began their undergraduate degrees at Carleton University in 1979 or 1980. They were separated into the same gender and academic degree groups as the initial sample of 197 and were then individually subjected to the predictor equations. However, operationally it is not possible at the time of admission, or prior to admission, to determine students' terminal degrees. Therefore, in practice, students must be assessed with the predictor equation for B.Sc. students, or B.A. males, or B.A. females, whichever is appropriate. The inclusion here of other equations is for comparative purposes only.

3.5 The Effect of Individual Courses on Graduating GPA

To attempt to assess the effect on graduating grade-point average of a certain course in a student's background versus the lack of that course, certain frequently present courses were individually selected and the graduating grade-point average of each student who took the course was selected and averaged. Then the GPA for all students who did not have the course on their record was averaged. This could provide an indication of the value of these courses as preparation for a university geography program.

3.6 Summary of Analytical Techniques

Bivariate correlations and multiple regression equations were used to predict graduating geography grade-point average on the basis

of senior secondary school course grades/averages. The goal was to explain as much of the variance in graduating GPA in geography as possible based solely on secondary school grades.

Whilst the percentage of explained variance indicated the usefulness of a course/average as a predictor it did not suggest whether or not a particular student was likely to graduate from a geography program at Carleton University. To make this judgement required the use of the standard error of the estimate of the predictor equation. The available data were analysed to arrive at a predictor equation with the smallest standard error.

An attempt was also made to determine whether the presence or absence of a certain secondary school course on students' files could influence the university grade-point average which those students received.

These techniques were all used to attempt to arrive at a method of predicting, before students enter university, whether they are likely to graduate from their chosen program.

CHAPTER 4

DETERMINATION OF PREDICTORS OF ACADEMIC SUCCESS AT UNIVERSITY

4.1 Introduction

The preceding section examined the various methods used in this study to arrive at an efficient way of predicting which applicants to Carleton University were most likely to graduate from the university with a degree in geography. In this section the available data are analysed using these methods.

4.2 Bivariate Analyses of Secondary School Data

The data file contained 197 students of both sexes and six different types of geography degrees. It was analysed in its entirety as well as in various components. Tables 1.1-4 present the bivariate correlations between grades in each of the twenty-two secondary school subjects examined as well as the ten Grade averages calculated, and each student's graduating grade-point average in geography at Carleton University.

Correlation coefficients based on the association between graduating geography grade-point average and individual secondary school subjects or averages for all 197 students are presented in Table 1.1. Pearson's r values range from 0.22 to 0.53 all of which are statistically significant (at 0.01). The complete table of all correlation coefficients which are statistically significant at 0.01 is given in Appendix 4. Tables 1.2-2.5M are treated in a similar manner. From Table 1.1 it can be seen that the best overall predictor of graduating

Table 1.1

Secondary School Grade and University Geography Grade Correlations
All Degrees (B.A., B.Sc., B.J.), All Students (Male and Female)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.53	Gr. 12+13 Geography	110	87
0.53	Gr. 11+13 Geography	114	83
0.53	Gr. 11+12 Average	169	28
0.51	Gr. 11 Average	162	35
0.51	Gr. 11+12+13 Geography	146	51
0.49	Gr. 12 Average	165	32
0.49	Gr. 11+12+13 Average	197	0
0.48	Gr. 13 Geography	155	42
0.47	Gr. 12+13 Average	195	2
0.45	Gr. 13 Average	186	11

All r values are significant at 0.01 for a one-tailed test.

geography average at Carleton University is any one of: (i) the mean average of Grade 12 and 13 geography grades ($r=0.53$), (ii) the mean average of Grade 11 and 13 geography grades ($r=0.53$), or (iii) the overall Grade 11 and 12 average ($r=0.53$). The Grade 13 average grade ($r=0.45$) is outperformed by nine predictors. Both the Grade 11 and 12 averages are more highly correlated with students' graduating geography averages than is the Grade 13 average which universities in Ontario rely upon to determine whether students should be admitted for university study. Thus for the group as a whole neither Grade 13 geography ($r=0.48$) nor Grade 13 average ($r=0.45$) are the best predictors, on their own, of geography graduating grade-point average.

However, a z-test of the significance of the difference between correlation coefficients indicated no significant difference at the 0.05 level between Grade 13 average and any predictor above it in Table 1.1. Thus, while nine predictors have larger Pearson's r values

than does Grade 13 average, none are significantly different and therefore are equally useful as predictors.

The values in Table 1.1 represent all students pursuing degrees in geography. This is the crudest measure available and the differences between this table and Tables 1.2-4 indicate the value of separating students into the smallest practical homogeneous group. It can be seen that the better predictors for all 197 students grouped together often differ markedly from the predictors which are useful for subgroups of this sample. As a result of this it is prudent to use the best predictor course or average for the smallest practical homogeneous group in order to eliminate the effects of other types of students, found when examining a large, heterogeneous group of students.

The group of students analysed in Table 1.1 is subdivided into B.A. students (Table 1.2) and B.Sc. students (Table 1.5). One hundred and eighty-four of the 197 students entered the B.A. program, and for these Table 1.2 shows an r value for Grade 13 average which makes it the ninth best predictor, but a z -test again indicates no significant difference at 0.05 between the Grade 13 average correlations and that for any predictor higher in the list.

Data on 96 students who pursued Pass Bachelor of Arts degrees with a major in geography are presented in Table 1.3. Here it is found that secondary school geography courses are very good predictors of success in university geography. This finding is not surprising because of the curricular similarities between university geography

Table 1.2
Secondary School Grade and University Geography Grade Correlations
All B.A. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.51	Gr. 12+13 Geography	102	82
0.50	Gr. 11+13 Geography	105	79
0.50	Gr. 11+12 Average	156	28
0.48	Gr. 11 Average	149	35
0.47	Gr. 11+12+13 Geography	133	51
0.47	Gr. 12 Average	152	32
0.46	Gr. 13 Geography	146	38
0.45	Gr. 11+12+13 Average	184	0
0.43	Gr. 13 Average	174	10

All r values are significant at 0.01 for a one-tailed test.

Table 1.3
Secondary School Grade and University Geography Grade Correlations
All B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.58	Gr. 12+13 Geography	54	42
0.56	Gr. 11+13 Geography	52	44
0.55	Gr. 11 Average	76	20
0.55	Gr. 13 Geography	70	26
0.55	Gr. 11 Mathematics	73	23
0.53	Gr. 11+12+13 Geography	71	25
0.52	Gr. 11+12 Average	82	14
0.51	Gr. 13 Physics	28	68
0.50	Gr. 13 Functions/Rel.	37	59
0.45	Gr. 12 Average	79	17
0.42	Gr. 11+12+13 Average	96	0
0.41	Gr. 11 Geography	67	29
0.40	Gr. 11+12 Geography	57	39
0.39	Gr. 12+13 Average	94	2
0.38	Gr. 13 Average	88	8

All r values are significant at 0.01 for a one-tailed test.

and secondary school geography. High grades in secondary school geography may also reinforce interest in, and provide motivation for, university geography. Grade 11 average correlation ($r=0.55$) also ranks very high, but Grade 13 average correlation ($r=0.38$) is considerably lower at 15th out of 22. This difference is not significant at 0.05 (using a z-test), but it is significant at 0.10.

While in most statistical testing, significant differences below 0.05 are not usually reported, this study reports differences, resulting from z-tests, as low as 0.30. It was decided to report findings at the 0.30 level because even at this level there is a 70 percent probability that the results truly reflect the population and do not result from sampling error. This level of certainty is acceptable for a study of this nature.

Table 1.4 provides data on those 88 students who graduated with Honours Bachelor of Arts degrees. Here Grade 12 ($r=0.48$) and Grade 13 ($r=0.42$) averages prove to be useful predictors of university geography success, but the Grade 11 average ($r=0.31$) was 16th out of 17 courses/averages. However, a z-test indicates no significant difference (at 0.05) between any of these correlation coefficients.

The results of analyses of twelve students who received a Bachelor of Science degree in geography are shown in Table 1.5. Here the Grade 13 average ($r=0.89$) is the best predictor and the Grade 11 ($r=0.76$) and 12 ($r=0.71$) averages are well down the list. A z-test indicates no significant difference (at 0.05) between any of the 16 correlation coefficients.

Table 1.4.

Secondary School Grade and University Geography Grade Correlations
All B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.48	Gr. 12 Average	73	15
0.45	Gr. 12+13 Average	88	0
0.42	Gr. 13 Average	86	2
0.42	Gr. 11+12+13 Average	88	0
0.42	Gr. 11+12 Average	74	14
0.40	Gr. 13 History	41	47
0.40	Gr. 12 French	43	45
0.37	Gr. 12 English	72	16
0.36	Gr. 13 English	82	6
0.34	Gr. 12 Science	65	23
0.34	Gr. 12+13 Geography	48	40
0.33	Gr. 11 English	70	18
0.33	Gr. 12 Mathematics	69	19
0.32	Gr. 11+12+13 Geography	62	26
0.32	Gr. 11+13 Geography	53	35
0.31	Gr. 11 Average	73	15

All r values are significant at 0.01 for a one-tailed test.

Table 1.5

Secondary School Grade and University Geography Grade Correlations
All B.Sc. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.89	Gr. 13 Average	11	1
0.88	Gr. 13 Chemistry	10	2
0.86	Gr. 12+13 Average	12	0
0.84	Gr. 13 Geography	8	4
0.84	Gr. 11+12+13 Average	12	0
0.84	Gr. 12+13 Geography	7	5
0.81	Gr. 11+12+13 Geography	12	0
0.76	Gr. 11 Geography	12	0
0.76	Gr. 11+12 Geography	11	1
0.76	Gr. 11 Average	12	0
0.75	Gr. 11 Science	11	1
0.75	Gr. 11+12 Average	12	0
0.71	Gr. 12 Average	12	0

All r values are significant at 0.01 for a one-tailed test.

The results of analyses shown in Tables 1.2-1.5 are different from those found for all the students combined (Table 1.1). They represent a series of subgroups of the total sample. To further refine and clarify the predictive capabilities of the measured courses and averages the groups examined in Tables 1.1-1.5 were subdivided by academic degrees and by gender. These new subgroups are presented in Tables 2.1M-2.5M.

Data on all male students pursuing either B.A. or B.Sc. degrees in geography at Carleton University (Table 2.1M) indicate that the best predictor of graduating geography average is a male's Grade 11 average ($r=0.55$). While significant, the Grade 13 average ($r=0.33$) ranks 21st out of 24 courses/averages on the basis of their predictive ability. A z-test of the difference between the r value using Grade 11 average and that for Grade 13 average indicated a difference which was significant at 0.05. This clearly calls into question the use of Grade 13 averages for admitting male students to Carleton University's geography programs directly from secondary school.

Data on all female students are presented in Table 2.1F. A comparison of Table 2.1M with Table 2.1F indicates that the correlation coefficients for females are generally higher than those for males. Also evident are some very large differences in r values between the two tables for the same courses or averages. A z-test performed on the Grade 13 average in each table indicates a significant difference at the 0.01 level. This suggests that the Grade 13 average is a statistically poorer predictor for university academic success for males ($r=0.33$) than for females ($r=0.65$).

Table 2.1M
Secondary School Grade and University Geography Grade Correlations
All Male Students (B.A., B.Sc. Degrees)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.55	Gr. 11 Average	109	27
0.52	Gr. 11 French	66	70
0.52	Gr. 11+13 Geography	76	60
0.49	Gr. 11+12 Average	115	21
0.48	Gr. 12+13 Geography	76	60
0.46	Gr. 11+12+13 Geography	102	34
0.45	Gr. 11 Mathematics	106	30
0.44	Gr. 11 English	104	32
0.42	Gr. 11+12+13 Average	136	0
0.41	Gr. 11 Geography	94	42
0.41	Gr. 12 History	51	85
0.40	Gr. 11+12 Geography	80	56
0.40	Gr. 13 Geography	107	29
0.39	Gr. 12 Average	114	22
0.39	Gr. 12 French	54	82
0.38	Gr. 13 Physics	56	80
0.38	Gr. 11 Science	104	32
0.36	Gr. 12+13 Average	135	1
0.35	Gr. 12 English	111	25
0.35	Gr. 12 Geography	93	43
0.33	Gr. 13 Average	128	8

All r values are significant at 0.01 for a one-tailed test.

Data on all 61 female students who completed Arts, Science, or Journalism degrees are shown in Table 2.1F. The correlation coefficients for these students show that Grade 12 average ($r=0.68$) is the 2nd best predictor, and Grade 13 average ($r=0.65$) is the 4th best out of 24. Grade 11 average ($r=0.44$), while significant, ranks 20th overall as a predictor. A z-test indicates that there is no significant difference (at 0.05) between Grade 13 average and any of the three predictors with higher r values, but also no significant difference (at 0.05) between Grade 11 average and Grade 13 average.

Table 2.1F

Secondary School Grade and University Geography Grade Correlations
All Female Students (B.A., B.Sc., B.J. Degrees)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.75	Gr. 13 Physics	9	52
0.68	Gr. 12 Average	51	10
0.66	Gr. 12+13 Average	60	1
0.65	Gr. 13 Average	58	3
0.63	Gr. 13 Functions/Rel.	21	40
0.62	Gr. 12+13 Geography	34	27
0.61	Gr. 13 Geography	48	13
0.61	Gr. 11+12+13 Average	61	0
0.59	Gr. 11+12+13 Geography	44	17
0.58	Gr. 11+12 Average	54	7
0.55	Gr. 13 English	55	6
0.54	Gr. 11+13 Geography	38	23
0.53	Gr. 12 English	50	11
0.53	Gr. 12 Science	42	19
0.53	Gr. 12 Mathematics	47	14
0.52	Gr. 13 Chemistry	26	35
0.48	Gr. 12 Geography	41	20
0.47	Gr. 12 French	42	19
0.46	Gr. 11 Science	44	17
0.44	Gr. 11 Average	53	8

All r values are significant at 0.01 for a one-tailed test.

However, the difference between Grade 12 average ($r=0.68$) of Grade 12 and 13 average combined ($r=0.66$) is significantly different (at 0.05) from Grade 11 average ($r=0.44$). At 0.10 there is a significant difference between Grade 13 average and Grade 11 average. Thus, Grade 11 average should probably not be used as a predictor of female students' graduating geography grade-point averages.

The observed differences in predictive ability, between various academic degrees, and between males and females, using Grade 11 and 13 averages suggests that perhaps there are also differences in predictors

Table 2.2M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Students.

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.50	Gr. 11 Average	99	27
0.48	Gr. 11+13 Geography	69	57
0.46	Gr. 11 French	59	67
0.44	Gr. 11+12 Average	105	21
0.44	Gr. 12+13 Geography	70	56
0.40	Gr. 11 English	94	32
0.40	Gr. 11 Mathematics	96	30
0.40	Gr. 11+12+13 Geography	92	34
0.40	Gr. 12 History	49	77
0.37	Gr. 13 Geography	100	26
0.35	Gr. 12 English	102	24
0.35	Gr. 11+12+13 Average	126	0
0.34	Gr. 11 Geography	84	42
0.33	Gr. 12 Average	104	22
0.33	Gr. 11+12 Geography	71	55
0.32	Gr. 12 Geography	84	42
0.31	Gr. 11 Science	95	31
0.29	Gr. 12+13 Average	125	1
0.28	Gr. 13 Average	119	7

All r values are significant at 0.01 for a one-tailed test.

when academic degrees are divided into those pursued by males and females. Tables 2.2M-4 present the results of these analyses.

Information on all the male students who received Bachelor of Arts (Pass or Honours) degrees is presented in Table 2.2M. This amalgamation of Arts degrees was carried out because the purpose of the study is to determine an equation which could be applied to a student when s/he applies to university, at which point most students have not declared a major.

The students whose records are analysed in Table 2.2M form a subgroup of those examined in Table 1.2 (all B.A. students) and

Table 2.1M (all males). It is interesting to observe the difference in secondary school subjects which are statistically significant (at 0.01) in each table, and the differing Pearson's r values. This indicates that the subject/average and r value used as a predictor may vary depending on how a student is classified. It would be preferable to sort applicants into as homogeneous a group as possible for predictive purposes. This homogeneity would come about by separating students according to both gender and terminal first degree desired (if known). This sorting would eliminate the statistical influence of the other gender and various other degrees in formulating an equation to predict an applicant's graduating grade-point average.

Table 2.2M shows once more the poor predictive ability of a male student's Grade 13 average. This average ranks 19th out of 20 predictors on the basis of Pearson's r values. It is (at $r=0.28$) significantly different at 0.05 from first-ranked Grade 11 average correlation ($r=0.50$).

The records of female B.A. students are dealt with in Table 2.2F. This grouping is very similar to the group of all females (Table 2.1F) because 58 of the 61 students are common to the two tables. The fact that three non-Arts students (2 Science, 1 Journalism) can affect the results even when combined with 58 Arts students suggests the value of separating these groups, and the potential predictive value which may accrue from developing a table for female Science students when a large enough sample is acquired. A visual analysis of scattergrams for many of the individual courses listed in Table 2.1F indicates that the

Table 2.2F

Secondary School Grade and University Geography Grade Correlations
All Female B.A. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.68	Gr. 12 Average	48	10
0.66	Gr. 12+13 Average	57	1
0.65	Gr. 13 Average	55	3
0.65	Gr. 13 Functions/Rel.	18	40
0.62	Gr. 12+13 Geography	32	26
0.61	Gr. 13 Geography	46	12
0.60	Gr. 11+12+13 Average	58	0
0.59	Gr. 11+12+13 Geography	41	17
0.58	Gr. 11+12 Average	51	7
0.54	Gr. 11+13 Geography	36	22
0.54	Gr. 13 English	52	6
0.54	Gr. 12 Science	39	19
0.53	Gr. 12 English	47	11
0.50	Gr. 13 Chemistry	23	35
0.49	Gr. 12 French	39	19
0.47	Gr. 12 Geography	38	20
0.46	Gr. 11 Science	41	17
0.43	Gr. 11 Average	50	8

All r values are significant at 0.01 for a one-tailed test.

addition of the three non-Arts students does not violate any of the rules of bivariate analysis.

An examination of data on female Bachelor of Arts students in Table 2.2F shows a high r value for Grade 13 average ($r=0.65$) which is not significantly different using a z-test (at 0.05) from either of the values above it. This again suggests the value of Grade 13 average for predicting the academic performance of females at university. Significant differences can be noted between values for the female B.A. students (Table 2.2F) compared with male and female B.A. students combined (Table 1.2) with the r values being much higher for the group composed entirely of females.

Table 2.3M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.56	Gr. 11+13 Geography	39	32
0.55	Gr. 11 Average	56	15
0.53	Gr. 12+13 Geography	40	31
0.52	Gr. 13 Geography	52	19
0.51	Gr. 11 Mathematics	54	17
0.47	Gr. 13 Physics	27	44
0.45	Gr. 11+12+13 Geography	53	18
0.44	Gr. 11+12 Average	61	10
0.41	Gr. 11 French	34	37
0.40	Gr. 11 English	54	17
0.40	Gr. 11 Geography	49	22
0.38	Gr. 11+12 Geography	42	29
0.36	Gr. 13 Average	66	5
0.36	Gr. 11+12+13 Average	71	0
0.31	Gr. 12 Average	60	11

All r values are significant at 0.01 for a one-tailed test.

An examination of Table 2.3M indicates that for males pursuing a Pass B.A. degree their Grade 13 geography average ($r=0.52$) alone, and in combination with Grade 11 ($r=0.56$) or Grade 12 ($r=0.53$) geography provides a useful predictor of success. Their Grade 11 overall average is also very useful ($r=0.55$), with Grade 12 ($r=0.31$) and 13 ($r=0.36$) averages being less valuable. As indicated by a z -test there is a significant difference between Grade 11 overall average and Grade 12 average (at 0.10), and Grade 11 and Grade 13 averages (at 0.20). While these values are not usually considered statistically significant they are nonetheless worthy of mention because they do suggest a high probability that the data are representative of the population. A comparison of Tables 2.3M and 1.3 (all B.A. Pass students) shows some

Table 2.3F
Secondary School Grade and University Geography Grade Correlations
All Female B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.82	Gr. 12 Average	19	6
0.75	Gr. 12 Mathematics	16	9
0.73	Gr. 12 Science	13	12
0.72	Gr. 11+12 Average	21	4
0.71	Gr. 11+12+13 Geography	18	7
0.68	Gr. 12+13 Geography	14	11
0.67	Gr. 11 Mathematics	19	6
0.63	Gr. 13 Geography	18	7
0.62	Gr. 12+13 Average	24	1
0.58	Gr. 11 Average	20	5

All r values are significant at 0.01 for a one-tailed test.

differences in the courses in each table as well as different r values, all of which result from the effect of female students' records present in Table 1.3, but not Table 2.3M.

Data on the same female Pass B.A. degrees is given in Table 2.3F. It is interesting to note that the Grade 13 overall average is not listed in the table because the correlation ($r=0.48$) is not significant at 0.01, although it is at 0.02 level. This contrasts with Tables 2.2F and 2.1F showing data on all female B.A. students and all females in all degrees respectively, where Grade 13 average is significant and has high r values. While it is possible that Grade 13 overall average is simply a poor predictor for female B.A. Pass students, it is possible that this small sample ($n=25$) resulted in this finding because for other groups of female students Grade 13 average is a good predictor. A z-test indicates that Grade 12 average correlation is significantly

Table 2.4M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.61	Gr. 12 French	21	34
0.51	Gr. 11+12 Average	44	11
0.50	Gr. 12 Average	44	11
0.48	Gr. 11 English	40	15
0.47	Gr. 11 French	25	30
0.46	Gr. 11 Average	43	12

All r values are significant at 0.01 for a one-tailed test.

different from Grade 13 average correlation at 0.05. Further, the Grade 12 average correlation is also significantly different from the correlation for Grade 11 average at 0.10.

The findings in this study indicate the wide range of Pearson's r values which can result when comparing graduating grade-point average against records for one secondary school subject or average using different subgroups of the total student sample. While it is possible that the results found here may be representative of much larger samples of the various groups this cannot be assumed. However, if it is true, this would be very important because of the observations of how poor a predictor Grade 13 average is for predicting graduating GPA in some cases. For this reason, studies with substantially larger sample sizes than 197 would be useful.

Male B.A. students who have graduated with Honours or Combined Honours degrees in geography are the focus of Table 2.4M. Here there are few subjects/averages, which, when analysed, result in r values

significant at 0.01. Once again, Grade 13 average is not present. Grade 12 ($r=0.50$) and 11 ($r=0.46$) averages are useful predictors for these students.

A comparison of Tables 2.2M (male B.A. students) with 2.3M (male B.A. Pass students) and 2.4M (male B.A. Honours students) shows that the predictive value and significance of courses/averages differs depending on the students included in the sample. While it is sounder to use a homogeneous sample for prediction this is only a proper approach if one can reasonably expect that students will graduate with the same degree for which they apply in December of their Grade 13 year. The limited size of the sample included in this study renders such an analysis here of questionable value, but for a larger sample this would be a valuable analysis. Speculation regarding the current sample suggests that most students who apply for entry to Carleton University to pursue a B.Sc. or B.A. Honours degree in geography likely complete this degree; however, students applying for a B.A. Pass degree may complete this or they may go on to an Honours degree. For this reason if a male Arts student applies for an Honours degree then the data in Table 2.4M could be applicable and appropriate; however, males applying for Pass degrees could be analysed by using the figures in Table 2.2M.

Table 2.4F is the counterpart to Table 2.4M in that it deals with the same academic degrees (B.A. Honours) only for females. There are very few subjects/averages which have r values significant at 0.01, but Grade 13 ($r=0.62$) and 12 ($r=0.43$) averages are present.

Table 2.4F

Secondary School Grade and University Geography Grade Correlations
All Female B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.72	Gr. 13 Chemistry	14	19
0.62	Gr. 13 Average	33	0
0.57	Gr. 13 English	32	1
0.56	Gr. 12+13 Average	33	0
0.45	Gr. 11+12+13 Average	33	0
0.43	Gr. 12 Average	29	4

All r values are significant at 0.01 for a one-tailed test.

An inspection of Tables 2.3F and 2.4F indicates the predictive ability of courses and averages for female students pursuing Pass or Honours B.A. degrees. These values differ, depending on length of degree, and are also different from those of their male counterparts. In Table 2.3F Grade 12 average ($r=0.82$) is shown to be the best predictor of graduating grade-point average for female students pursuing Pass Bachelor of Arts degrees. In Table 2.4F, which presents data on females receiving B.A. Honours degrees, the best average for predictive purposes is Grade 13 ($r=0.62$).

It is not possible to determine which courses or averages would provide the best predictor of success for women pursuing B.Sc. degrees because there were only two females in the study sample. Thus, the data on these two women were not amenable to correlation analysis.

Information on male B.Sc. students (Table 2.5M) indicates the useful predictive ability of students' Grade 13 averages ($r=0.93$). The combination of Grade 12 and 13 averages ($r=0.95$) explains even

Table 2.5M
Secondary School Grade and University Geography Grade Correlations
All Male B.Sc. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.95	Gr. 12+13 Average	10	0
0.94	Gr. 11+12+13 Average	10	0
0.93	Gr. 13 Average	9	1
0.93	Gr. 11 French	7	3
0.92	Gr. 12 French	7	3
0.91	Gr. 13 Chemistry	8	2
0.91	Gr. 11+12 Average	10	0
0.90	Gr. 12 Average	10	0
0.89	Gr. 11 Average	10	0

All r values are significant at 0.01 for a one-tailed test.

more of the variance in graduating grade-point average than does Grade 13 average alone.

A comparison with Table 1.5 (all B.Sc. students) shows that the addition of two students in Table 1.5 changes the r values and even which courses are included in the table based on their statistical significance. The value of examining subgroups of students according to degree pursued or gender is that it allows refinements to be made as more students are added to each subgroup each year. Tables 2.5M and 1.5 show that if male Science students were being analysed then the use of Grades 11 or 12 French would provide an excellent predictor; however, if male and female Science students were considered together no use would be made of Grade 11 or 12 French as they do not yield r values which are statistically significant at the 0.01 level.

An examination of scattergrams for B.Sc. students usually suggests a better fit regression line of secondary school subjects versus GPA,

than is the case for B.A. students. This occurs because in the samples used in this study the average residuals tend to be smaller when a regression line is plotted for a few points (10) than for many (60). There is no explanation for this direct relationship between number of points and size of residuals. It is simply a characteristic of this study.

The best predictors for success of males and females in various degrees are shown in Table 3. The predictors listed are those which produce the highest r value which is statistically significant at the 0.01 level and have more observations than missing values. This is because only courses that are taken by most students are valuable as independent variables in an operational setting. This table demonstrates that the choice of predictor varies depending on how a student is categorized. Moving from left to right in Table 3 increases the homogeneity of the sample groups while usually decreasing the number of students in each group.

The most appropriate way of categorizing students is to separate them into homogeneous groups according to degree and gender. This ensures that there is only one defined variable which is being examined in each analysis. While current practice dictates the use of a student's best six Grade 13 subjects to determine whether s/he should be admitted to university study, the analyses presented here, and summarized in Table 3, suggest that there exist better predictors, particularly for the various categories of male students.

This contention is examined using data from Table 4. This table examines the 14 groupings of gender and academic degree considered in

Table 3
Most Practical Predictors of University Academic Success by Degree
and Gender*

* Highest r values which are both significant at 0.01 for a one-tailed test and have more observations than missing cases.

Legend

M.P.P. = Most Practical Predictor

Gr. 11 Ave. (10) = Rank of Grade 11 Average is both best predictor

(N.S. = Not Significant at 0.01)

z at = Level of significance of difference using a z -test between top-ranked predictor and Grade 13 average

z (N.S.) = Not significantly different at 0.05

Table 4.

A Comparison of Grades 11 and 13 Averages as Predictors
of University Geography GPA for Various Groups of Students

Table	Composition of Table	Better Predictor*	Poorer Predictor*	* Statistical Significance**
1.1	All Students	Gr. 11 Ave.	Gr. 13 Ave.	0.30
1.2	B.A.	Gr. 11 Ave.	Gr. 13 Ave.	0.30
1.3	B.A. Pass	Gr. 11 Ave.	Gr. 13 Ave.	0.10
1.4	B.A. Honours	Gr. 13 Ave.	Gr. 11 Ave.	0.30
1.5	B.Sc.	Gr. 13 Ave.	Gr. 11 Ave.	0.30
2.1M	Males	Gr. 11 Ave.	Gr. 13 Ave.	0.05
2.1F	Females	Gr. 13 Ave.	Gr. 11 Ave.	0.10
2.2M	B.A. Males	Gr. 11 Ave.	Gr. 13 Ave.	0.05
2.2F	B.A. Females	Gr. 13 Ave.	Gr. 11 Ave.	0.10
2.3M	B.A. Pass Males	Gr. 11 Ave.	Gr. 13 Ave.	0.20
2.3F	B.A. Pass Females	Gr. 11 Ave.	N.S.	--
2.4M	B.A. Honours Males	Gr. 11 Ave.	N.S.	--
2.4F	B.A. Hons. Females	Gr. 13 Ave.	N.S.	--
2.5M	B.Sc. Males	Gr. 13 Ave.	Gr. 11 Ave.	N.S.

*=Better and poorer predictors considering Pearson's r values for only Grade 11 and Grade 13 averages.

**=Level at which better predictor is statistically different from poorer predictor using a z-test.

N.S.=Not significant: at 0.01 for Poorer Predictor; and 0.30 for Statistical Significance.

this study. Each grouping is examined individually, Grade 13 and Grade 11 averages are compared to determine which is the better predictor of students' graduating grade-point averages in geography, and a z-test is used to determine at what level the difference between these two averages is statistically significant.

The data show that for B.Sc. students, who in this study are predominantly male (10/12), Grade 13 average is a better predictor than Grade 11 average; however, this difference is significant only at the 0.30 level. For three of the four groups composed entirely of females, Grade 13 average was the better predictor. However, for all four of

the male-only Arts groups the Grade 11 average was the better predictor, significant at 0.05 in two cases. Furthermore, as a result of the male influence caused by more males than females being included in the sample, three of the four overall groupings including all students combined, all B.A. students, and all B.A. Pass students, exhibited a better predictor in Grade 11 average than Grade 13 average. Because this holds true for male students alone, but not female students, it adds strength to the argument that the students' records should be analysed using the smallest realistic homogeneous group of academic degree and gender.

4.2.1 Discussion of Bivariate Correlations

The preceding analyses have focused on bivariate correlations between grades in the various secondary school subjects or averages at particular grade levels and students' graduating grade-point averages in geography at Carleton University. These analyses have separated students pursuing Arts degrees into Pass and Honours degrees. Further, the tables have been designed with the r values listed in descending order within each table with no separation between groups of individual courses, geography averages, and yearly averages, and no obvious distinction between those courses which have more missing observations than present observations and vice versa. These concerns are briefly addressed here.

While it is useful to combine individual courses, geography averages, and yearly averages, into a single table for illustrative purposes there are clearly limits to the soundness and utility of such

an approach. A problem with using these bivariate correlations in an operational sense is that a substantial number of courses, including some which have very high and statistically significant r values, are not taken by a large proportion of students. To rely on one course, which a particular student may not have taken, for its predictive ability is clearly not a sound approach. However, to ignore certain courses which are very good predictors, simply because they are not taken by all students could result in poorer predictors being used and valuable information being lost. In the case of a course which exhibits an r value that is statistically significant at the 0.01 level and is the best predictor course available, then if an applicant presents this course on his/her record it could be employed as a predictor. If the course was not completed by the student then the next best predictor which the student presents could be utilized. This is the most efficient method of using bivariate correlations, but it is also very time-consuming as it entails searching for a specific course or courses rather than simply calculating the Grade 13 average. Tables 1.1-2.5M indicate the value of employing this more detailed, reliable, but time-consuming approach.

4.3 Multiple Regression

The use of bivariate correlations has the advantage of only requiring one course or average; however, operationally the use of only one independent variable does not always result in a high Pearson's r value. To improve statistical explanation a multiple

regression can be performed which would theoretically increase the total predictive value of the variables by combining two or more independent variables. The drawback to this approach is that only students who have values for every course or average included in the regression equation are considered when the multiple correlation coefficient (R value) is calculated. The nature of the data is such that regression equations may be based on small sample sizes because relatively few students will have taken every course included in the calculations. This reduction in the number of students included in the calculation may, in the case of a small subgroup, reduce it to a point where the R value is essentially meaningless. This situation places a practical limit on the number of courses which can be included in a regression equation. Furthermore, as the SPSS-X program will not select from the entire list of courses those few which produce the highest R value when collectively regressed against grade-point average, it is necessary to choose only those courses which, based on their high bivariate correlation and relatively large sample size, are expected to yield a high R value which is statistically significant (an F value significant at 0.01), has the lowest standard error, and represents a substantial number of students. This was essentially accomplished by a trial and error approach which was refined as data from various multiple regression equations were analysed.

4.3.1 Discussion of Multiple Regressions

The results of these multiple regression calculations are shown in Table 5. Included in this table are the "best" and "most practical"

Table 5
Best and Most Practical Predictors in Multiple Regression and
Bivariate Correlation for Various Groups of Students

	Best Predictor			Most Practical Predictor			Gr. 13 Ave. ^a	
	Predictor	r	S.E.	Predictor	r	S.E.	r	S.E.
Gr. 11 Males	Gr. 13 Ave.	0.93	±0.35	9/10	Gr. 13 Ave.	0.93	±0.35	9/10
Gr. 11 Males + Females	Gr. 13 Ave.	0.89	±0.41	11/11	Gr. 13 Ave.	0.89	±0.41	11/11
Gr. 11 Males	Engl+G3+M1	0.89	±1.09	74/126	Gr. 11 Ave.	0.86	±1.13	99/126
Gr. 11 Females	Gr. 13 Ave.	0.74	±0.97	46/54	Gr. 13 Ave.	0.75	±1.01	55/58
Gr. 11 Males + Females	Engl+G3+M1	0.89	±1.11	112/126	Gr. 11 Ave.	0.88	±1.17	149/184
Gr. 11 Males	Engl+G3+M1	0.91	±1.05	81/136	Gr. 11 Ave.	0.85	±1.10	109/136
Gr. 11 Males + Females	Gr. 13 Ave.	0.74	±0.95	48/60	Gr. 13 Ave.	0.63	±0.99	57/60
Gr. 11 Males + Females	Engl+G3+M1+Gnp2	0.80	±1.08	120/194	Gr. 11 Ave.	0.51	±1.14	161/194

^a *Data on Grade 13 average are included if the Most Practical Predictor is not Gr. 13 Ave.

S.E. *Standard error of the estimate (expressed in grade points).

1 *Number of students with predictor on record/total number of students in the particular group

Eng *English

G3 *Geography

M1 *Mathematics

Gnp2 *Grades 11,12,13 respectively

†† r values are significant at 0.01 for a one-tailed test.

††† r values are significant at 0.01.

predictors. The most practical predictors represent variables used in bivariate correlations which exhibit a high, statistically significant r value and also represent a single course or average which most students possess. It is found that this is either the Grade 11 average or the Grade 13 average. The best predictor is the variable(s) which produce(s) a high $r(R)$ value and is(are) likely to have been taken by many students. This is not usually the same as the most practical predictor because if a student does not present on his/her record every variable (course/average) in the multiple regression equation then a prediction cannot be made about his/her likelihood of success. While the "best predictor" possesses a theoretical value (being of use only if the student being considered presents all of the equation's component courses/averages), it may not be practical to employ it, whereas in virtually every instance the "most practical predictor" is present in the student's admission file.

In the case where the most practical predictor is Grade 11 average, rather than Grade 13 average, the relevant information for Grade 13 average is presented for comparative purposes. This is done because Ontario universities tend to rely almost exclusively on students' Grade 13 averages to judge whether they should be admitted to university study.

Discussion here has centered upon the information which could be culled from bivariate and multiple correlation coefficients. The difficulty with this approach is that it only explains a portion of the variance in graduating grade-point averages based on secondary

school subjects/averages. The intent of this examination is to identify and predict the performance of those students who are likely to succeed (graduate) in the study of geography at university. For this reason it is prudent to focus upon the standard error of the estimate of each predictor. These values are represented in Table 5 as portions of grade points.

The analysis focused on 1 and 2 standard errors from the mean. Students' graduating grade-point averages would fall within 1 standard error on either side of their predicted graduating grade-point averages 68.27% of the time. The range would be within 2 standard errors 95.45% of the time. By using the equations in Table 6, the standard errors in Table 5, and the university's graduation requirements it would be possible, within certain confidence levels (ie. 68%, 95%), to predict whether or not a student was likely to graduate.

4.4 Testing the Predictor Equations

The bivariate correlation equations developed from the available data are shown in Table 6. Only the equations for the most practical predictors are presented. This is because in order to test the predictive value of these equations, on the sample group of 28 students (who were separated from the rest of the sample on the basis of university entrance year at the outset of the study) it is desirable to use an average which the student record is likely to contain.

The 28 students in the test file were separated into the same groupings applied to the original sample of 197 students. After

Table 6

Bivariate Correlation Equations for Various Groups of Students

Group	Equation*
B.Sc. Males	Gr. 13 Ave. (.137389) + -1.536383
B.Sc. Males + Females	Gr. 13 Ave. (.135117) + -1.486034
B.A. Males	Gr. 11 Ave. (.101579) + .438769
B.A. Females	Gr. 13 Ave. (.104286) + .314323
B.A. Males + Females	Gr. 11 Ave. (.087534) + 1.401796
B.A. + B.Sc. Males	Gr. 11 Ave. (.107163) + .113331
B.A. + B.Sc. Females	Gr. 13 Ave. (.104526) + .294748
B.A. + B.Sc. Males + Females	Gr. 11 Ave. (.090180) + 1.251319

* All equations are in the form $v = bx + a$, where these components are represented as follows.

v = predicted GPA

b = course or average in question

x = slope for b

a = y-intercept

separation into degree and gender, each student's file was analysed using the equations in Table 6. Because students' terminal degrees cannot be ascertained upon application to university, it is practical to analyse the records of the students in the test file using only the equations for B.Sc. males and females, B.A. males, and B.A. females. The results of these analyses are presented in Table 7, with the results of the analyses using the remaining equations from Table 6 found in Appendix 4. In two out of the 28 cases the relevant data were not present in the students' files to perform the required

Table 7

Analysis of Predictor Equations on Individual Students by Group

Group	Actual GPA	Predicted GPA	1 S.E. of Equation (grade-points)	Difference Between Actual and Predicted GPA (grade-points)
B.Sc. Males + Females	8.5	8.6	± 0.41	-0.1
B.A. Males	6.7	6.1	± 1.13	+0.6
	5.1	---	± 1.13	--
	6.7	7.8	± 1.13	-1.1
	8.1	6.8	± 1.13	+1.3
	6.2	6.5	± 1.13	-0.3
	8.4	8.6	± 1.13	-0.2
	7.2	8.1	± 1.13	-0.9
	6.4	7.1	± 1.13	-0.7
	6.4	5.6	± 1.13	+0.8
	9.1	7.4	± 1.13	+1.7
	5.8	6.9	± 1.13	-1.1
	7.6	7.0	± 1.13	+0.6
	6.9	---	± 1.13	--
	5.4	6.6	± 1.13	-1.2
B.A. Females	9.4	7.5	± 1.01	+1.9
	7.3	7.5	± 1.01	-0.2
	8.5	7.3	± 1.01	+1.2
	6.7	7.1	± 1.01	-0.4
	10.5	8.5	± 1.01	+2.0
	8.9	8.3	± 1.01	+0.6
	9.0	8.4	± 1.01	+0.6
	7.7	6.8	± 1.01	+0.9
	5.7	6.9	± 1.01	-1.2
	7.7	7.2	± 1.01	+0.5
	7.9	8.1	± 1.01	-0.2
	7.0	7.4	± 1.01	-0.4
	7.3	7.4	± 1.01	-0.1

-- or --- = data not available

+ = actual GPA higher than predicted GPA

- = actual GPA lower than predicted GPA

analyses. In the other 26 cases the analyses were performed and each case was examined to determine, on the basis of the data presented, the performance of each student on graduation from a geography program at Carleton University. To graduate from a B.A. Pass program a student must present a minimum grade-point average in geography of 4.0; a B.Sc. Honours program (the only B.Sc. degree offered by the Geography Department) requires at least a 6.5 GPA in geography courses be presented (Carleton University Undergraduate Calendar, 1986-87). Using these grade-point averages as minima each student's file was tested to determine their likelihood of graduating. In the sample of 26 students who were analysed it was found that all 26 would have been accepted into the university/program using the test at ± 1 standard error. At ± 2 standard errors two of the 26 students would have been rejected. These two individuals both earned B.A. Pass degrees with graduating GPAs of 6.7 and 6.4. The 6.7 individual presented Grade 11 marks in the 50% range and Grade 13 marks in the low 60s. The student who earned the 6.4 presented Grade 11, 12, and 13 averages in the 50s. Both were marginal students based on their secondary school records; however, each was able to earn a university Pass degree with a respectable grade-point average. These results indicate that if the more stringent level of certainty 95.45% (2 S.E.) was utilized rather than the less stringent level of 68.27% (1 S.E.) then two capable students would have been denied admission to Carleton University.²

²It is not necessary to use exactly 1 or 2 standard errors. They were used here for illustrative purposes. The level of certainty can be set (ie. 80%, 90%) with the standard error being adjusted accordingly.

This test study indicates that all 26 of the students whose records were examined would have been accepted to study geography at Carleton University if the records were analysed using indicators which would permit the university to be 68% certain it was not admitting students who were unlikely to graduate. If student attrition was a primary concern of the university, such that it wished to be 95% certain that students admitted were likely to graduate, 24/26 (92%) of the students in the test sample, all 26 of whom graduated, would have been admitted. The fact that two qualified students could have been denied offers of admission to Carleton University, based on their secondary school academic performance, is perhaps an argument for attempting to find more accurate predictors of academic performance at university. However, a 92 or 100% (depending on level of certainty, i.e. 95% or 68% respectively) success rate (as defined by the number of students who ultimately graduated that were offered a place in a geography program at Carleton University) could justify the use of secondary school grades as indicators of potential for academic success at Carleton University.

An analysis of the residuals in Table 7 shows that the predictor equations for male and female B.A. students tend to be poorer predictors for students who earn low grades (5-6 GPA) or high grades (8-11 GPA) relative to those students with intermediary grades. For the 25 students as a group 7/9 (78%) of the actual GPAs under 7.0 were over-predicted, while 10/16 (63%) of those actual GPAs of 7.0 or higher were underpredicted.

An examination of the largest overpredictions and underpredictions (those of 1.0 grade-point or higher), shows that: the three largest overpredictions of males belonged to the two worst and sixth worst students, out of twelve, based on actual earned GPA; the two largest underpredictions of males belonged to the best and third best students; for females the only large overprediction was linked with the worst student, out of thirteen; and finally, the three largest underpredictions were associated with the two best and fifth best students.

An underprediction of students likely to earn high grades should not be cause for concern as they would likely be admitted to university. Similarly, an overprediction of a student who was to earn low grades would not harm the student, it might only result in a student being admitted to university who should not have been accepted. The only danger to university applicants would be an underprediction of students with poor grades. This occurred in only 2/25 cases as reported above.

4.5 The Search for a Better Predictor

This study suggests that for some students, namely those males pursuing an Arts degree, a better predictor than Grade 13 average might be Grade 11 average. To test this hypothesis, those males who received Arts degrees out of the 28 students in the test sample, were selected, and their Grade 11 average was tested to determine its strength as a predictor. The equation used was the simple linear regression for the males pursuing B.A. degrees in the original sample

of 197 students. Of the 14 males in the test sample, two could not be tested using their Grade 11 average as it was not available for them. Two of the remaining twelve were rejected at the ± 2 standard error level, for university admission. When Grade 13 averages were utilized as a predictor it was found that all 14 students had a Grade 13 average on file, and when tested, none of these students was rejected at the ± 2 standard error level. While this could suggest that the use of Grade 13 averages would result in more reliable predictions than using Grade 11 averages, the standard error is larger for Grade 13 versus Grade 11 averages (1.26 : 1.13 grade-points). Furthermore, most (11/14) of the students' graduating grade-point averages are over-predicted using Grade 13 averages by 0.43 grade-points on average, compared with overprediction by only 0.04 grade-points when Grade 11 averages are used. The combination of Grade 11 and Grade 13 averages resulted in the same standard error as Grade 11 average alone, but overpredicted seven of the twelve students whose records could be tested. The difference between the actual average and predicted average was 0.075 grade-points. These factors indicated that there was no advantage to using Grade 11 and 13 averages combined instead of Grade 11 average alone to predict graduating grade-point averages. For these reasons it is prudent to utilize a male Arts student's Grade 11 average for predicting his likelihood of success in geography at Carleton University.

4.6 The Effect of Specific Courses on University Success

A recurring problem throughout this study has been the number of missing values in the students' records. While courses and averages were examined to determine the best indicator of students' likely success at university, they were not analysed to ascertain which courses best prepare students for university-level geography. This is because causality cannot be conclusively established from correlation coefficients alone, and the data examined in this study do not facilitate a discussion of causality.

Data on eight secondary school courses which most of the 197 students in the study had completed are presented in Table 8. The actual graduating geography grade-point average was determined for each student who presented a course as well as for those for whom there was no record of the course. The table demonstrates the small difference in GPA between: (1) the groups which have a specific secondary school course; (2) the groups which have not taken these specific courses; and (3) between each particular present and missing course. This strongly suggests that while some courses are better predictors of university success, none appears to be clearly better than any other as a preparation for university. The data in Table 8 show that students who have taken Grade 11 geography do better than those who do not present the course; this difference is slightly larger than the other seven differences (by 0.015 grade-points); students with this course have a higher GPA than students with any of the other courses; and students without Grade 11 geography have a lower GPA (by 0.008

Table 8

— The Effect of Selected Courses on the Mean GPA of all Geography Degree Students

Actual GPA	Cases With Course	N	Actual GPA	Cases Without Course	N	Difference in GPA
7.472	Gr. 11 English	157	7.455	Gr. 11 English	40	+0.017
7.514	Gr. 11 Geography	140	7.356	Gr. 11 Geography	57	+0.158
7.486	Gr. 11 Mathematics	157	7.400	Gr. 11 Mathematics	40	+0.086
7.417	Gr. 12 English	161	7.700	Gr. 12 English	36	-0.283
7.471	Gr. 12 Geography	134	7.463	Gr. 12 Geography	63	+0.008
7.499	Gr. 12 Mathematics	152	7.364	Gr. 12 Mathematics	45	+0.135
7.453	Gr. 13 English	175	7.591	Gr. 13 English	22	-0.138
7.485	Gr. 13 Geography	155	7.407	Gr. 13 Geography	42	+0.078

+ = mean GPA is higher for students with the course than without it

- = mean GPA is lower for students with the course than without it

For cases with a specific course the range in GPA is 0.097 grade points. For cases without a specific course the range in GPA is 0.344 grade points.

grade-points only) than students without any of the other courses.

This makes it difficult to suggest that Grade 11 geography is a good preparatory course for university geography programs.

To test the significance of the difference between the means of students who present a specific course and those of students without the course on their record a z-test was performed. Grade 12 English, the course with the largest difference in GPA between the two groups, was tested, and there was found to be no significant difference between the two means at the 0.05 level for a two-tailed test. This suggests that there is no significant difference between the GPA which a student would earn whether or not s/he took any or all of the eight courses examined above.

For these reasons it is probably wise to assume that the Carleton

University Geography Department should view all incoming geography students as possessing no specific geography (or other specific educational) background. As a result of the findings in this report that certain courses can be used to predict, but not create, success, the university should only assume that if, on the basis of the appropriate predictor equations, a student is deemed likely to succeed in a geography program that s/he should be admitted for the study of geography, but should not be viewed as bringing any specific geography knowledge to the first-year university level.

CHAPTER 5

SUMMARY AND CONCLUSION

This study has examined various methods of predicting academic success at university. Various indicators of first-year university success were considered; however, the main analysis was a comparison of graduating geography GPA from Carleton University and Grades 11-13 secondary school marks.

These analyses have confirmed the predictive value of using students' Grade 13 averages for gauging the academic performance at university for females and Science students; however, for male Arts students the best predictor appears to be Grade 11 average.

As a result of this difference in predictors a broader study using more students, and other disciplines (and universities) could be valuable to determine whether this situation is found in larger samples. It is also important, even in the light of this study, not to put too much faith in the use of a Grade 13 average as a predictor of success for male Science students in geography because this study was based on only 10 such students.

The use of additional data acquired from the files of students who have graduated with a degree in geography from Carleton University, but not included in this study, will help to refine the predictive value of each of these measures. When new equations, based on larger samples, are created, this will reduce the effect which occurs when adding additional variables to the formulation of the predictor equations. This refinement could continue to occur until the first students from

Ontario's new secondary school curriculum (which requires 30 credits for secondary school graduation, rather than 27 credits for a Secondary School Graduation Diploma and 6 credits for a Secondary School Honour Graduation Diploma) apply for entry to university. At this point there may occur a 3-4 year lag before new predictor equations could be calculated, based on the new secondary school curriculum and the university experience of these students. It is not possible to determine how much difference there could be between the predictor equations based on Ontario Academic Courses and those based on Grade 13 subjects because of the potential differences in curricula.

If the best predictor of university academic success for males in other disciplines, or other universities, or in a broader, longer-range study of geography students at Carleton University is Grade 11 average, or any subject/average other than Grade 13 average, then perhaps, depending on how relatively poor a predictor Grade 13 average actually is, some re-evaluation of the current procedure for determining who should be admitted to university should be undertaken.

This study has only considered a limited number of variables which could have a bearing on a student's level of success at university. There are many other variables which could be investigated in a broader study. These include all courses taken in Grades 11-13 and best (indeterminate) number of courses taken at each of these three levels. The reason for examining these variables is that an examination of all courses or only a selection of specific courses or

choosing students' best courses could yield more reliable predictors than the best six Grade 13 courses as is current practice, or all selected courses presented as was the case in this study.

Age of the applicant could be an important determinant of university performance because of the differences in maturity, employment, and life experiences, which may partially result from age.

The secondary school attended by the applicant could play an important role in predicting university academic success because of the differences in grading standards, curricula, and teachers, between schools.

Sociological factors such as one or two parent family, occupation of parent(s), family income, and socio-economic status of student could play a significant role in determining the nature of courses/programs selected at secondary school as well as for post-secondary education. The method of predicting university academic success could vary depending on these sociological factors.

Another consideration could be whether the student has a part-time job during the academic year at secondary school, and if so, the number of hours worked per week. This, in addition to extracurricular activities (sports, social activities, etc.) could have an impact on a student's grades and his/her likelihood of academic success at university. This could result in different predictor equations being used for these students.

In addition, academic factors such as Carleton University's place in the student's university selection order; place of the major in the

student's program selection order; the reason for selecting Carleton University; and the reason for selecting a specific major could be important in determining how well a student is likely to perform academically in a geography program at Carleton University. This is because attitude towards a program or institution could influence performance, and reasons for selection; and selection order could reflect attitudes.

When students attend university many aspects of their lives change. They are also faced with a change in the style of classes and education. These factors could affect their academic performance, and as such, would be worthy of further study.

It is also important to note that this study only examined students with a senior secondary school background from Ontario. It is very likely that out-of-province applicants would not be analysed with the same predictor equations as Ontario applicants.

Viewing this study in a wider perspective several observations can be made.

- 1) There are a greater number of "qualified" students applying to university than there are places in many of the programs to which they apply.
- 2) Attrition rates at university range up to 40%.
- 3) Some students who are not accepted into the program or university to which they apply do not attend university.
- 4) There appears to be no tool available to predict university performance for large numbers of students which is more effective

than Grade 13 or Grade 11 averages.

- 5) Province-wide examinations or standardized tests are no more able to predict university performance than are Grade 13 grades.
- 6) Some students who enter university with relatively mediocre secondary school grades perform well at university while others who excel at secondary school do not graduate from university.

These findings suggest that demand exceeds supply for university spaces, many "qualified" students never graduate, and there is no efficient predictor of students' performance at university. There is a need to ensure that, in limited enrolment programs, only those students most likely to graduate be accepted into the program; however, there appears to be no reliable pre-university predictor of how well a student is likely to perform at university.

The value of arriving at the best predictor of an individual's success at university cannot be underestimated. It would be unfair, unless space limitations exist in the program, to exclude from university study students who possess the ability to graduate from the program to which they have applied. On the other hand it is clearly in the best pedagogic interest of the university to ensure that it does not admit an individual who is unlikely to graduate. The challenge is to find a predictor or predictors which are able to predict reliably the outcome of students' attempts at university study. If the results of this study are any indication this predictor is likely to be both an imperfect tool and one which varies from one applicant to another according to gender, and degree pursued.

One possible solution to this dilemma would be to allow as many students as is realistically possible to enter first-year university, and then use their performance during first-year as a determinant of their capability to succeed at university. In this way, first-year university, not secondary school, would be the filter for upper level university. This has the advantage of evaluating students under the system which they have applied to rather than the one which they have left. A disadvantage is that for many students first-year university represents a major change from the education they are familiar with, as well as an adjustment to a different lifestyle. Both of these factors could result in an academic performance which might be considerably poorer than that which they could achieve in their second year, if given the chance. However, this could be dealt with by placing on academic probation, students who perform poorly in their first-year. They could then be given a second year to demonstrate their academic worth. A further disadvantage of this proposal for open admissions is that it would likely result in a significant increase in the enrolment, and thus the cost, of the first-year programs, with the size of the second-year class being no different from the current one, although perhaps composed of different individuals. Given the costs and benefits involved though, this could be the most effective method of dealing with the problem of matching students to places in university programs.

University Geography Grade-Point Average (12 point scale)

APPENDIX 1 THE RELATIONSHIP BETWEEN GRADE 13 GEOGRAPHY GRADES AND UNIVERSITY GEOGRAPHY GRADE-POINT AVERAGES FOR THE 197 STUDENTS IN THE SAMPLE

APPENDIX 2

THE PROBLEM OF MISSING VALUES IN MULTIPLE REGRESSION EQUATIONS

It was not possible, using SPSS-X, for the multiple regression equations to have all missing values excluded without excluding all samples, when specifying MISSING LISTWISE, or excluding all samples which did not have all common values present, when specifying MISSING PAIRWISE. To use the command MISSING MEANSUBSTITUTION results in the mean for a variable being substituted for all missing values for that variable. As this could result in a different finding than that which might occur if the data were not missing or if the students with missing data for that variable were excluded, it was decided not to use MEANSUBSTITUTION. The final option for handling missing values, that of the designation MISSING INCLUDE was, throughout most of the study, thought to be appropriate as it claimed to,

Include cases with user-missing values. If you specify INCLUDE, REGRESSION treats all user-missing values (but not system-missing values) as valid, [and] cases are not excluded because of user-missing values (SPSS Inc., 1986, p.681).

On this basis many runs were executed using INCLUDE and varying the number and type of courses/averages included as well as the gender/degree combinations examined.

Whilst initially the results appeared reasonable, further investigation indicated that the missing values were not being excluded from the calculations, and very small subgroups of the total sample were appearing to explain more variance in grade-point average than one might expect, again as a result of the treatment of missing values.

These problems forced an abandonment of the MISSING INCLUDE command in favour of a total abolition of the MISSING command. This process invoked the default for missing values, which resulted in the data being treated as they would under the MISSING LISTWISE command. This results in all cases that have missing values for the variables specified being eliminated from the ensuing calculations. For this reason the inclusion of five or six variables would usually result in a small sample size or no students at all being included. As a result of this, it was necessary to select a few courses and/or averages which were suspected, on the basis of their bivariate correlations, of making a significant contribution to the ability to predict graduating grade-point average.

APPENDIX 3
ADJUSTMENT OF THE SPSS-X PIN AND POUT VALUES

Early in the analysis it was discovered that the use of the system-set PIN value of .050 was inappropriate for this study as it frequently entered very few variables in a stepwise manner and then forced the rest in using its ENTER command. This was deemed inappropriate because, while during the STEPWISE entry process each variable is entered in sequence with a multiple R value being calculated for each entry, when the remaining variables which were not added during the STEPWISE process are added during the ENTER step, the total multiple R value for all variables used is given. This makes it impossible for the value of each variable added to be assessed. To overcome this difficulty the PIN value is increased to .500 and the POUT value increased to a value greater than .500 (in this study .600 was used). This allows for the individual, sequential entry of enough values to raise the multiple R value to a high value without resulting in an unwieldy number of variables being utilized.

APPENDIX 4

COMPLETE TABLES OF BIVARIATE CORRELATIONS BETWEEN SECONDARY SCHOOL GRADES AND UNIVERSITY GEOGRAPHY GRADES

Following are the complete versions of Tables 1.1-2.5M, and 7. In most cases abridged versions of these tables were included earlier in this study. The abridged tables contained data which were discussed in an operational sense, whereas this appendix presents all of the data acquired through the research performed in this study.

Table 1.1

Secondary School Grade and University Geography Grade Correlations
All Degrees (B.A., B.Sc., B.J.), All Students (Male and Female)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.53	Gr. 12+13 Geography	110	87
0.53	Gr. 11+13 Geography	114	83
0.53	Gr. 11+12 Average	169	28
0.51	Gr. 11 Average	162	35
0.51	Gr. 11+12+13 Geography	146	51
0.49	Gr. 12 Average	165	32
0.49	Gr. 11+12+13 Average	197	0
0.48	Gr. 13 Geography	155	42
0.47	Gr. 12+13 Average	195	2
0.45	Gr. 13 Average	186	11
0.44	Gr. 13 Physics	65	132
0.44	Gr. 11 Mathematics	157	40
0.42	Gr. 12 English	161	36
0.41	Gr. 11 Science	148	49
0.40	Gr. 12 History	69	128
0.40	Gr. 11 English	157	40
0.40	Gr. 11+12 Geography	116	81
0.39	Gr. 12 Geography	134	63
0.39	Gr. 12 French	96	101
0.39	Gr. 11 Geography	140	57
0.39	Gr. 11 French	113	84
0.36	Gr. 13 Functions/Rel.	84	113
0.36	Gr. 13 History	79	118
0.35	Gr. 12 Science	142	55
0.34	Gr. 13 English	175	22
0.33	Gr. 12 Mathematics	152	45
0.31	Gr. 13 Chemistry	94	103
0.28	Gr. 11 History	91	106.
0.22	Gr. 13 Biology	107	90

All r values are significant at 0.01 for a one-tailed test.

Table 1.2
Secondary School Grade and University Geography Grade Correlations
All B.A. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.51	Gr. 12+13 Geography	102	82
0.50	Gr. 11+13 Geography	105	79
0.50	Gr. 11+12 Average	156	28
0.48	Gr. 11 Average	149	35
0.47	Gr. 11+12+13 Geography	133	51
0.47	Gr. 12 Average	152	32
0.46	Gr. 13 Geography	146	38
0.45	Gr. 11+12+13 Average	184	0
0.43	Gr. 13 Average	174	10
0.43	Gr. 12+13 Average	182	2
0.42	Gr. 12 English	149	35
0.41	Gr. 11 Mathematics	144	40
0.39	Gr. 12 History	67	117
0.39	Gr. 13 Physics	55	129
0.38	Gr. 12 French	86	98
0.38	Gr. 11 English	144	40
0.37	Gr. 12 Geography	122	62
0.36	Gr. 11 Science	136	48
0.36	Gr. 13 Functions/Rel.	77	107
0.34	Gr. 11+12 Geography	104	80
0.34	Gr. 13 History	77	107
0.34	Gr. 13 English	166	18
0.34	Gr. 11 French	103	81
0.34	Gr. 11 Geography	127	57
0.30	Gr. 12 Science	130	54
0.28	Gr. 12 Mathematics	139	45

All r values are significant at 0.01 for a one-tailed test.

Table 1.3
Secondary School Grade and University Geography Grade Correlations
All B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.58	Gr. 12+13 Geography	54	42
0.56	Gr. 11+13 Geography	52	44
0.55	Gr. 11 Average	76	20
0.55	Gr. 13 Geography	70	26
0.55	Gr. 11 Mathematics	73	23
0.53	Gr. 11+12+13 Geography	71	25
0.52	Gr. 11+12 Average	82	14
0.51	Gr. 13 Physics	28	68
0.50	Gr. 13 Functions/Rel.	37	59
0.45	Gr. 12 Average	79	17
0.42	Gr. 11+12+13 Average	96	0
0.41	Gr. 11 Geography	67	29
0.40	Gr. 11+12 Geography	57	39
0.39	Gr. 12+13 Average	94	2
0.38	Gr. 13 Average	88	8
0.38	Gr. 12 English	77	19
0.38	Gr. 11 French	51	45
0.38	Gr. 11 English	74	22
0.37	Gr. 12 Geography	68	28
0.36	Gr. 12 Science	65	31
0.35	Gr. 11 Science	70	26
0.30	Gr. 12 Mathematics	70	26

All r values are significant at 0.01 for a one-tailed test.

Table 1.4
 Secondary School Grade and University Geography Grade Correlations
 All B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.48	Gr. 12 Average	73	15
0.45	Gr. 12+13 Average	88	0
0.42	Gr. 13 Average	86	2
0.42	Gr. 11+12+13 Average	88	0
0.42	Gr. 11+12 Average	74	14
0.40	Gr. 13 History	41	47
0.40	Gr. 12 French	43	45
0.37	Gr. 12 English	72	16
0.36	Gr. 13 English	82	6
0.34	Gr. 12 Science	65	23
0.34	Gr. 12+13 Geography	48	40
0.33	Gr. 11 English	70	18
0.33	Gr. 12 Mathematics	69	19
0.32	Gr. 11+12+13 Geography	62	26
0.32	Gr. 11+13 Geography	53	35
0.31	Gr. 11 Average	73	15
0.29	Gr. 13 Geography	76	12

All r values are significant at 0.01 for a one-tailed test.

Table 2.3M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.56	Gr. 11+13 Geography	39	32
0.55	Gr. 11 Average	56	15
0.53	Gr. 12+13 Geography	40	31
0.52	Gr. 13 Geography	52	19
0.51	Gr. 11 Mathematics	54	17
0.47	Gr. 13 Physics	27	44
0.45	Gr. 11+12+13 Geography	53	18
0.44	Gr. 11+12 Average	61	10
0.41	Gr. 11 French	34	37
0.40	Gr. 11 English	54	17
0.40	Gr. 11 Geography	49	22
0.38	Gr. 11+12 Geography	42	29
0.36	Gr. 13 Average	66	5
0.36	Gr. 11+12+13 Average	71	0
0.31	Gr. 12 Average	60	11
0.30	Gr. 12 English	58	13
0.30	Gr. 12+13 Average	70	1

All r values are significant at 0.01 for a one-tailed test.

Table 1.5
 Secondary School Grade and University Geography Grade Correlations
 All B.Sc. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.89	Gr. 13 Average	11	1
0.88	Gr. 13 Chemistry	10	2
0.86	Gr. 12+13 Average	12	0
0.84	Gr. 13 Geography	8	4
0.84	Gr. 11+12+13 Average	12	0
0.84	Gr. 12+13 Geography	7	5
0.81	Gr. 11+12+13 Geography	12	0
0.76	Gr. 11 Geography	12	0
0.76	Gr. 11+12 Geography	11	1
0.76	Gr. 11 Average	12	0
0.75	Gr. 11 Science	11	1
0.75	Gr. 11+12 Average	12	0
0.71	Gr. 12 Average	12	0
0.69	Gr. 12 Science	11	1
0.67	Gr. 12 Mathematics	12	0
0.67	Gr. 11 Mathematics	12	0

All r values are significant at 0.01 for a one-tailed test.

Table 2.1M

Secondary School Grade and University Geography Grade Correlations
All Male Students (B.A., B.Sc. Degrees)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.55	Gr. 11 Average	109	27
0.52	Gr. 11 French	66	70
0.52	Gr. 11+13 Geography	76	60
0.49	Gr. 11+12 Average	115	21
0.48	Gr. 12+13 Geography	76	60
0.46	Gr. 11+12+13 Geography	102	34
0.45	Gr. 11 Mathematics	106	30
0.44	Gr. 11 English	104	32
0.42	Gr. 11+12+13 Average	136	0
0.41	Gr. 11 Geography	94	42
0.41	Gr. 12 History	51	85
0.40	Gr. 11+12 Geography	80	56
0.40	Gr. 13 Geography	107	29
0.39	Gr. 12 Average	114	22
0.39	Gr. 12 French	54	82
0.38	Gr. 13 Physics	56	80
0.38	Gr. 11 Science	104	32
0.36	Gr. 12+13 Average	135	1
0.35	Gr. 12 English	111	25
0.35	Gr. 12 Geography	93	43
0.33	Gr. 13 Average	128	8
0.31	Gr. 11 History	63	73
0.26	Gr. 12 Science	100	36
0.23	Gr. 13 English	120	16

All r values are significant at 0.01 for a one-tailed test.

Table 2.1F

Secondary School Grade and University Geography Grade Correlations
All Female Students (B.A., B.Sc., B.J. Degrees)

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.75	Gr. 13 Physics	9	52
0.68	Gr. 12 Average	51	10
0.66	Gr. 12+13 Average	60	1
0.65	Gr. 13 Average	58	3
0.63	Gr. 13 Functions/Rel.	21	40
0.62	Gr. 12+13 Geography	34	27
0.61	Gr. 13 Geography	48	13
0.61	Gr. 11+12+13 Average	61	0
0.59	Gr. 11+12+13 Geography	44	17
0.58	Gr. 11+12 Average	54	7
0.55	Gr. 13 English	55	6
0.54	Gr. 11+13 Geography	38	23
0.53	Gr. 12 English	50	11
0.53	Gr. 12 Science	42	19
0.53	Gr. 12 Mathematics	47	14
0.52	Gr. 13 Chemistry	26	35
0.48	Gr. 12 Geography	41	20
0.47	Gr. 12 French	42	19
0.46	Gr. 11 Science	44	17
0.44	Gr. 11 Average	53	8
0.42	Gr. 11 Mathematics	51	10
0.39	Gr. 11+12 Geography	36	25
0.36	Gr. 11 Geography	46	15
0.32	Gr. 11 English	53	8

All r values are significant at 0.01 for a one-tailed test.

Table 2.2M
 Secondary School Grade and University Geography Grade Correlations
 All Male B.A. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.50	Gr. 11 Average	99	27
0.48	Gr. 11+13 Geography	69	57
0.46	Gr. 11 French	59	67
0.44	Gr. 11+12 Average	105	21
0.44	Gr. 12+13 Geography	70	56
0.40	Gr. 11 English	94	32
0.40	Gr. 11 Mathematics	96	30
0.40	Gr. 11+12+13 Geography	92	34
0.40	Gr. 12 History	49	77
0.37	Gr. 13 Geography	100	26
0.35	Gr. 12 English	102	24
0.35	Gr. 11+12+13 Average	126	0
0.34	Gr. 11 Geography	84	42
0.33	Gr. 12 Average	104	22
0.33	Gr. 11+12 Geography/	71	55
0.32	Gr. 12 Geography	84	42
0.31	Gr. 11 Science	95	31
0.29	Gr. 12+13 Average	125	1
0.28	Gr. 13 Average	119	7
0.24	Gr. 13 English	114	12

All r values are significant at 0.01 for a one-tailed test.

Table 2.2F

Secondary School Grade and University Geography Grade Correlations
All Female B.A. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.68	Gr. 12 Average	48	10
0.66	Gr. 12+13 Average	57	1
0.65	Gr. 13 Average	55	3
0.65	Gr. 13 Functions/Rel.	18	40
0.62	Gr. 12+13 Geography	32	26
0.61	Gr. 13 Geography	46	12
0.60	Gr. 11+12+13 Average	58	0
0.59	Gr. 11+12+13 Geography	41	17
0.58	Gr. 11+12 Average	51	7
0.54	Gr. 11+13 Geography	36	22
0.54	Gr. 13 English	52	6
0.54	Gr. 12 Science	39	19
0.53	Gr. 12 English	47	11
0.50	Gr. 13 Chemistry	23	35
0.49	Gr. 12 French	39	19
0.47	Gr. 12 Geography	38	20
0.46	Gr. 11 Science	41	17
0.43	Gr. 11 Average	50	8
0.40	Gr. 11 Mathematics	48	10

All r values are significant at 0.01 for a one-tailed test.

Table 2.3M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.56	Gr. 11+13 Geography	39	32
0.55	Gr. 11 Average	56	15
0.53	Gr. 12+13 Geography	40	31
0.52	Gr. 13 Geography	52	19
0.51	Gr. 11 Mathematics	54	17
0.47	Gr. 13 Physics	27	44
0.45	Gr. 11+12+13 Geography	53	18
0.44	Gr. 11+12 Average	61	10
0.41	Gr. 11 French	34	37
0.40	Gr. 11 English	54	17
0.40	Gr. 11 Geography	49	22
0.38	Gr. 11+12 Geography	42	29
0.36	Gr. 13 Average	66	5
0.36	Gr. 11+12+13 Average	71	0
0.31	Gr. 12 Average	60	11
0.30	Gr. 12 English	58	13
0.30	Gr. 12+13 Average	70	1

All r values are significant at 0.01 for a one-tailed test.

Table 2.3F

Secondary School Grade and University Geography Grade Correlations
All Female B.A. Pass Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.82	Gr. 12 Average	19	6
0.75	Gr. 12 Mathematics	16	9
0.73	Gr. 12 Science	13	12
0.72	Gr. 11+12 Average	21	4
0.71	Gr. 11+12+13 Geography	18	7
0.68	Gr. 12+13 Geography	14	11
0.67	Gr. 11 Mathematics	19	6
0.63	Gr. 13 Geography	18	7
0.62	Gr. 12+13 Average	24	1
0.58	Gr. 11 Average	20	5
0.58	Gr. 11+12+13 Average	25	0
0.57	Gr. 12 English	19	6
0.56	Gr. 12 Geography	18	7

All r values are significant at 0.01 for a one-tailed test.

Table 2.4M

Secondary School Grade and University Geography Grade Correlations
All Male B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.61	Gr. 12 French	21	34
0.51	Gr. 11+12 Average	44	11
0.50	Gr. 12 Average	44	11
0.48	Gr. 11 English	40	15
0.47	Gr. 11 French	25	30
0.46	Gr. 11 Average	43	12
0.42	Gr. 12 English	44	11
0.41	Gr. 11+12+13 Average	55	0
0.38	Gr. 12+13 Average	55	0

All r values are significant at 0.01 for a one-tailed test.

Table 2.4F

Secondary School Grade and University Geography Grade Correlations
All Female B.A. Honours Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.72	Gr. 13 Chemistry	14	19
0.62	Gr. 13 Average	33	0
0.57	Gr. 13 English	32	1
0.56	Gr. 12+13 Average	33	0
0.45	Gr. 11+12+13 Average	33	0
0.43	Gr. 12 Average	29	4

All r values are significant at 0.01 for a one-tailed test.

Table 2.5M

Secondary School Grade and University Geography Grade Correlations
All Male B.Sc. Students

Pearson's r	Secondary School Subject/Year Average	Cases	Missing Cases
0.95	Gr. 12+13 Average	10	0
0.94	Gr. 11+12+13 Average	10	0
0.93	Gr. 13 Average	9	1
0.93	Gr. 11 French	7	3
0.92	Gr. 12 French	7	3
0.91	Gr. 13 Chemistry	8	2
0.91	Gr. 11+12 Average	10	0
0.90	Gr. 12 Average	10	0
0.89	Gr. 11 Average	10	0
0.88	Gr. 12+13 Geography	6	4
0.87	Gr. 12 Science	9	1
0.86	Gr. 11+12+13 Geography	10	0
0.85	Gr. 12 Mathematics	10	0
0.85	Gr. 11+13 Geography	7	3
0.85	Gr. 13 Geography	7	3
0.83	Gr. 11 Science	9	1
0.83	Gr. 11+12 Geography	9	1
0.83	Gr. 11 Geography	10	0
0.79	Gr. 11 Mathematics	10	0
0.78	Gr. 11 English	10	0

All r values are significant at 0.01 for a one-tailed test.

Table 7

Analysis of Predictor Equations on Individual Students by Group

Group	Actual GPA	Predicted GPA	1 S.E. of Equation (grade-points)	Difference Between Actual and Predicted GPA (grade-points)
B.Sc. Males + Females	8.5	8.6	± 0.41	-0.1
B.A. Males	6.7	6.1	± 1.13	+0.6
	5.1	---	± 1.13	--
	6.7	7.8	± 1.13	-1.1
	8.1	6.8	± 1.13	+1.3
	6.2	6.5	± 1.13	-0.3
	8.4	8.6	± 1.13	-0.2
	7.2	8.1	± 1.13	-0.9
	6.4	7.1	± 1.13	-0.7
	6.4	5.6	± 1.13	+0.8
	9.1	7.4	± 1.13	+1.7
	5.8	6.9	± 1.13	-1.1
	7.6	7.0	± 1.13	+0.6
	6.9	---	± 1.13	--
	5.4	6.6	± 1.13	-1.2
B.A. Females	9.4	7.5	± 1.01	+1.9
	7.3	7.5	± 1.01	-0.2
	8.5	7.3	± 1.01	+1.2
	6.7	7.1	± 1.01	-0.4
	10.5	8.5	± 1.01	+2.0
	8.9	8.3	± 1.01	+0.6
	9.0	8.4	± 1.01	+0.6
	7.7	6.8	± 1.01	+0.9
	5.7	6.9	± 1.01	-1.2
	7.7	7.2	± 1.01	+0.5
	7.9	8.1	± 1.01	-0.2
	7.0	7.4	± 1.01	-0.4
	7.3	7.4	± 1.01	-0.1
B.A. Males + Females	9.4	7.5	± 1.17	+1.9
	6.7	6.2	± 1.17	+0.5
	5.1	---	± 1.17	--
	6.7	7.8	± 1.17	-1.1
	7.3	7.8	± 1.17	-0.5

Table 7 (continued)

Analysis of Predictor Equations on Individual Students by Group

Group	Actual GPA	Predicted GPA	1 S.E. of Equation (grade-points)	Difference Between Actual and Predicted GPA (grade-points)
B.A.				
Males +				
Females				
	8.1	6.9	± 1.17	+1.2
	8.5	7.9	± 1.17	+0.6
	6.2	6.6	± 1.17	-0.4
	6.7	6.8	± 1.17	-0.1
	10.5	8.7	± 1.17	+1.8
	8.4	8.4	± 1.17	0
	7.2	8.0	± 1.17	-0.8
	8.9	8.2	± 1.17	+0.7
	9.0	8.1	± 1.17	+0.9
	6.4	7.1	± 1.17	-0.7
	6.4	5.8	± 1.17	+0.6
	9.1	7.4	± 1.17	+1.7
	5.8	7.0	± 1.17	-1.2
	7.6	7.1	± 1.17	+0.5
	7.7	6.8	± 1.17	+0.9
	5.7	7.5	± 1.17	-1.8
	7.7	---	± 1.17	--
	7.9	7.5	± 1.17	+0.4
	6.9	---	± 1.17	--
	5.4	6.7	± 1.17	-1.3
	7.0	7.4	± 1.17	-0.4
	7.3	---	± 1.17	--
B.A. + B.Sc.				
Males				
	6.7	6.0	± 1.10	+0.7
	5.1	---	± 1.10	--
	6.7	7.9	± 1.10	-1.2
	8.1	6.8	± 1.10	+1.3
	6.2	6.5	± 1.10	-0.3
	8.4	8.7	± 1.10	-0.3
	7.2	8.2	± 1.10	-1.0
	6.4	7.1	± 1.10	-0.7
	6.4	5.5	± 1.10	+0.9
	9.1	7.4	± 1.10	+1.7
	5.8	7.0	± 1.10	-1.2
	7.6	7.1	± 1.10	+0.5
	6.9	---	± 1.10	--
	5.4	6.6	± 1.10	-1.2

Table 7 (continued)

Analysis of Predictor Equations on Individual Students by Group

Group	Actual GPA	Predicted GPA	1 S.E. of Equation (grade-points)	Difference Between Actual and Predicted GPA (grade-points)
B.A. + B.Sc.				
Females	9.4	7.4	± 0.99	+2.0
	8.5	8.1	± 0.99	+0.4
	7.3	7.5	± 0.99	-0.2
	8.5	7.3	± 0.99	+1.2
	6.7	7.1	± 0.99	-0.4
	10.5	8.5	± 0.99	+2.0
	8.9	8.3	± 0.99	+0.6
	9.0	8.4	± 0.99	+0.6
	7.7	6.8	± 0.99	+0.9
	5.7	6.9	± 0.99	-1.2
	7.7	7.2	± 0.99	+0.5
	7.9	8.1	± 0.99	-0.2
	7.0	7.4	± 0.99	-0.4
	7.3	7.4	± 0.99	-0.1
B.A. + B.Sc.				
Males + Females	9.4	7.6	± 1.14	+1.8
	6.7	6.2	± 1.14	+0.5
	5.1	---	± 1.14	---
	6.7	7.8	± 1.14	-1.1
	8.5	8.2	± 1.14	+0.3
	7.3	7.9	± 1.14	-0.6
	8.1	6.9	± 1.14	+1.2
	8.5	8.0	± 1.14	+0.5
	6.2	6.6	± 1.14	-0.4
	6.7	6.8	± 1.14	-0.1
	10.5	8.8	± 1.14	+1.7
	8.4	8.5	± 1.14	-0.1
	7.2	8.0	± 1.14	-0.8
	8.9	8.2	± 1.14	+0.7
	9.0	8.1	± 1.14	+0.9
	6.4	7.2	± 1.14	-0.8
	6.4	5.8	± 1.14	+0.6
	9.1	7.4	± 1.14	+1.7
	5.8	7.0	± 1.14	-1.2
	7.6	7.1	± 1.14	+0.5
	7.7	6.8	± 1.14	+0.9
	5.7	7.5	± 1.14	-1.8
	7.7	---	± 1.14	---
	7.9	7.6	± 1.14	+0.3

Table 7 (continued)

Analysis of Predictor Equations on Individual Students by Group

Group	Actual GPA	Predicted GPA	1 S.E. of Equation (grade-points)	Difference Between Actual and Predicted GPA (grade-points)
B.A. + B.Sc.				
Males +				
Females	6.9	---	± 1.14	--
	5.4	6.7	± 1.14	-1.3
	7.0	7.5	± 1.14	-0.5
	7.3	---	± 1.14	--

--- or --- = data not available

+ = actual GPA higher than predicted GPA

- = actual GPA lower than predicted GPA

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