ADVANCED PLACEMENT CALCULUS

IN BRITISH COLUMBIA

by

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ADVANCED PLACEMENT CALCULUS IN BRITISH COLUMBIA

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22 July 1992
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ABSTRACT

The number of students taking Advanced Placement Calculus (AP Calculus) in British Columbia has grown very rapidly over the last six years. The purpose of this study was to trace the history of this growth, and the reasons for it. An ethnographic research method was employed in which the researcher audiotaped interviews with 65 individuals. Those interviewed included representatives of the Ministry of Education in British Columbia and of a school district, principals, counsellors, mathematics teachers, mathematics department heads, students taking the AP Calculus course, university students who had taken an AP Calculus course at school, a university student who had failed the first semester of calculus at university, a representative of the mathematics department at each of the three universities in British Columbia, and the president of the British Columbia Association of Mathematics Teachers.

The results indicate that a government initiative in making funds available to Districts for "Gifted Programs" indirectly led to the growth of the AP Calculus. The direct result of this initiative was for many districts to establish an International Baccalaureate School. This threatened to draw the top students from other schools in the district, and AP programs were established to retain students. The Advanced Placement Program was neither expensive nor difficult to establish in a school. It also met the growing demand of students to learn calculus prior to taking it at university, in response to stories about the difficulties students encountered with first year university calculus courses. The Ministry of Education, having unwittingly begun this trend, then chose to not give it recognition on students' transcripts. The universities however could not ignore it and they changed their policies, at first to give advanced placement to successful candidates, and then to give credit as well.

The philosophy behind the AP Program is that the successful student will take advanced placement and credit at university if it is possible, and move on to the next level. The reality is that despite the fact that the best students in a school take the AP Calculus
course, the students are afraid of the calculus courses at university, because of what they have heard from others, and are not taking advantage of advanced placement or credit. Teachers say that the response from the universities has been to increase the difficulty of first year courses, and that students studying first year calculus are at a distinct disadvantage if they have not had a full calculus course at school. It appears that there is a lack of communication between the Ministry and the universities and that the Mathematics 12 course as prescribed by the Ministry, may not adequately prepare students for the first year university calculus course.
ACKNOWLEDGEMENTS

I express my sincere thanks to Dr. Tom O'Shea. He has been a true mentor to me. I appreciate the time he has taken perusing my work, and his advice has been invaluable in improving the quality of this manuscript.

I thank Dr. Harvey Gerber for being a member of my committee. The time and counsel he has given me have been very valuable.

Each and every individual who was interviewed was important to the study. They all gave me their time most generously. They spoke with me frankly and honestly. I thank each of them for participating.

My final thanks go to my family, Rodney, Heidi, Jonathan and Robyn, who gave me constant and continuous support and encouragement.
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CHAPTER 1

INTRODUCTION

Advanced Placement Calculus

The Advanced Placement Program brochure, circulated with the College Board's Administration package at the Advanced Placement Conference at Simon Fraser University in 1990, describes the program as follows:

The Advanced Placement (AP) Program gives students the opportunity to pursue college-level studies while still in secondary school and to receive advanced placement or credit, or both, upon entering college. The AP Examination requires students to demonstrate that they have achieved at the college level. Both the courses and the examinations are developed for the College Board by Educational Testing Service, a private nonprofit agency in New Jersey. The AP Program is based on the belief that college-level courses can be successfully taught to motivate high school students who can then receive advanced placement and/or credit for them.

The AP course in Mathematics consists of a full academic year of work in calculus and related topics comparable to courses in colleges and universities (College Board, 1992, p. 1).

There has been a rapid increase over the past five years in the number of secondary school students choosing to take the Advanced Placement (AP) Calculus course in their Grade 12 year, and a corresponding increase in the number of schools offering such a course in British Columbia. This has happened despite the fact that the new British Columbia mathematics curriculum has included a limited calculus section in the Mathematics 12 course (BCAMT Newsletter, 1986, p. 2).
A list of the enrolment in Advanced Placement Examinations written by students in British Columbia which was circulated at the Advanced Placement Conference at Simon Fraser University in October 1990 is shown in Table 1 (College Board, 1990). The 1991 and 1992 figures and the approximate number of Calculus papers were supplied by the AP office in Canada.

Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Student Enrolment</th>
<th>AP Calculus Papers*</th>
<th>School Enrolment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>267</td>
<td>80</td>
<td>17</td>
</tr>
<tr>
<td>1988</td>
<td>758</td>
<td>200</td>
<td>41</td>
</tr>
<tr>
<td>1989</td>
<td>1380</td>
<td>376</td>
<td>68</td>
</tr>
<tr>
<td>1990</td>
<td>2228</td>
<td>678</td>
<td>85</td>
</tr>
<tr>
<td>1991</td>
<td>2851</td>
<td>895</td>
<td>101</td>
</tr>
<tr>
<td>1992</td>
<td>Approx. 3400</td>
<td>1100</td>
<td>Approx. 115</td>
</tr>
</tbody>
</table>

* The numbers for the AP Calculus papers are approximate.

Approximately 12000 students took Mathematics 12 in 1992. The number of students who took AP Calculus in 1992 represented approximately 9 percent of the students who took Mathematics 12.

A similar trend in the growth of AP Calculus occurred in the USA in the 1960s. Kenelly, et al (1985) noted a "dramatic increase in number of participants in the AP Calculus Examination in the States" (p. 166). He positively endorsed the AP calculus program by stating that it "has proved itself a cornerstone of excellence even in periods when excellence was not a major theme in education" (p. 176).
The rise in interest in AP Calculus in British Columbia has come at a time when major changes have occurred in the B.C. education system. The Royal Commission report (Sullivan, 1988) concluded that the education system as it then stood was geared to those students who would be entering post-secondary education. It also concluded that the needs of the majority of students in the system were not being met (Sullivan, 1988). The report led in 1990 to the "Year 2000" document which was based on the findings of the Sullivan Commission. The Year 2000 document is now being implemented at all levels of the education system (Year 2000, 1990).

**Personal Background**

The researcher's interest in the AP Calculus program arose in 1986. The private girls' school where the researcher taught had offered the International Baccalaureate (IB) Program, but in 1985, decided to no longer offer it. At this school approximately 90 percent of the student body continue with post-secondary education.

The researcher was the mathematics department head, and taught senior mathematics courses, including a locally developed calculus course. The researcher's initial attempt to persuade the headmistress to replace the IB Mathematics course with the AP Calculus program was unsuccessful. It was the researcher's opinion that the school should have a program that would challenge the better students. When the IB program was discontinued, the researcher tried to give the students an enriched curriculum but found that the students were not motivated to put in the effort that was necessary when they did not have an "end goal". Despite the researcher's efforts, one of the top students wrote on a course evaluation that "there was no challenge to the brighter students this year".

During the second year of teaching the locally developed calculus courses, which the school had offered for about twelve years, the researcher thought that the course was fairly comprehensive, and therefore asked four of the better students if they would attempt the AP Examination. This was a few weeks before the date of the examination. They agreed and as they were an experimental group, the school paid for the examination. If this trial was
successful, and AP Calculus introduced, the school decided that in subsequent years the cost of the examination would have to be paid by each student. The students were all quite successful, despite doing very little examination preparation. One obtained a 5 (a top score), and the other three obtained 3's (an average score).

The enrollment in the calculus class increased the following year from 10 students to 24 students, of mixed ability, some of whom could obviously manage and benefit from the AP program, and others who could not. The headmistress needed no more persuasion and agreed to offer two Calculus courses. One class would work on the AP Calculus curriculum, and be prepared for the AP examination, and the other class would do a less challenging, but comprehensive, locally developed calculus program, since there was sufficient demand for this from students.

In 1988 the researcher attended an AP Calculus workshop in Seattle. Professor Bluman of the University of British Columbia (UBC) was there and indicated that a score of 4 or 5 on the AP examination would give a student Advanced Placement in the mathematics program at UBC. This was a change in policy in that UBC had not previously given advanced placement to successful AP students. In 1991, the UBC mathematics department again changed its policy such that a student with an acceptable AP Calculus grade may acquire 1.5 units of credit for AP Calculus AB and 3 units of credit for AP Calculus BC towards her or his degree requirements. Prior to this the student had the option of taking advanced placement, but credit was not awarded. In the spring of 1987 an AP conference for all subjects was held in Kelowna, British Columbia. A similar conference was held the following year at UBC in Vancouver, British Columbia which attracted a large number of teachers. With these activities going on, the researcher became interested in the rise of AP Calculus in British Columbia and resolved to undertake a formal study of the phenomenon.
Purpose of the Study

There appear to be powerful factors driving the growth in enrolment in AP Calculus. The purpose of this thesis is to trace the history of this development in British Columbia, and to determine and illuminate those factors. In uncovering the reasons for the growth, questions will be posed which will lead stakeholders in AP Calculus to examine their programs, and the rationale behind them.

The study was designed to focus on five main stakeholders. The first was the schools, and within the schools, the districts, the principals, the mathematics teachers and the counsellors. The second was the students, including those taking AP Calculus at school and university students who had completed a calculus course at university. The third was the Universities, their policies and attitudes. The fourth was the Ministry of Education, and the fifth was the British Columbia Association of Mathematics Teachers (BCAMT).

For each of these groups the question of interest was the factors accounting for the rise of AP Calculus in British Columbia. The study looks at the manner in which the program was implemented, within individual schools and districts. It also examines how the program is implemented at a semestered school versus a non-semestered school. The study seeks to determine how the program is viewed at the district level. It analyzes the teachers' perspective, and in particular, what motivates the teachers. The effect of the AP Calculus on mathematics programs in other grades and the effect of mathematics programs in other grades on AP Calculus is also reviewed. The study investigates the reasons why students are taking AP Calculus, and the use they make of it. It attempts to ascertain whether the students taking AP Calculus are at an advantage when they complete their secondary education.

The study examines the relationship between changing attitudes of the universities in British Columbia to AP Calculus and the growth of the program.

Finally the study attempts to determine the roles and the reactions of the Ministry and of the BCAMT to AP Calculus.
Definitions of Terms

The programs described occur in secondary schools in British Columbia. The Ministry of Education of the Province of British Columbia is responsible for determining programs, and for awarding credit to students graduating from secondary schools in the province.

**Algebra 12.** Algebra 12 was the prescribed mathematics 12 curriculum that was taught during the 1980s prior to the new Mathematics 12 curriculum being implemented in September 1990 by the Ministry of Education. This was a pre-calculus curriculum. One of the major differences between the old curriculum and the new Mathematics 12 curriculum was that there was no unit of introductory calculus in the Algebra 12 curriculum.

**AP Program.** The AP Program provides "course descriptions and teaching materials as well as examinations based on these descriptions. The examination grade is sent to the colleges of the student's choice, which then grant credit, advanced placement, or both, depending on institutional policies" (College Board, 1992, p. i).

**AP Calculus.** The curriculum is provided by The College Entrance Examination Board of the United States of America, in their *Advanced Placement Course Description.*

**Mathematics Booklet.** The AP mathematics program offers two courses. They are:

**AP Calculus AB; Calculus AB: AP Calculus.** This is a curriculum for "mathematically able students" (College Board, 1992, p. 1). A very large majority of students in British Columbia who are taking AP Calculus, take the Calculus AB curriculum. This is described by the College Board and an examination based on this description is set and evaluated by the College Board in May each year. The topics include all of the prerequisites in elementary functions, and differential and integral calculus.

**AP Calculus BC; Calculus BC.** The course consists of the AP Calculus AB curriculum as well as additional topics such as infinite series. A small minority of students in British Columbia take the Calculus BC curriculum, and in many cases the students who write this examination prepare the extra sections of work independently, and not in a full classroom setting.
Bluman Report. The Bluman Report is made each year to the high schools by Dr. George Bluman. In it he shows a comparison by school of the achievements of students in first year university calculus courses at UBC in relation to their achievement in the Mathematics 12 course.

Challenge Course. This generally implies a course with a select group of students that are accelerated. This may or may not imply that the course is horizontally enriched, but because the students have been selected and identified as students able to manage the acceleration, enrichment is usually part of the course. Students in these courses complete their Mathematics 12 course at the end of their Grade 11 year at school.

Differentiation; derivative. A term used in calculus to describe the algebraic process of determining the rate at which one variable changes in relation to another variable. Differential calculus is usually dealt with in a first calculus course.

Enriched; honours. Generally this addendum to a mathematics course implies that a select group of students within a grade are completing an enriched, challenging curriculum at a particular grade level. The core curriculum is set by the Ministry, but the pace of the course is usually faster, and more in-depth material is studied. The students may, or may not, be evaluated on the enriched material depending on the school or teacher. Acceleration is not necessarily implied, but could be. If it is, students generally complete their fifth year of secondary school mathematics at the end of their fourth year in secondary school.

Euclid Contest. The Euclid Contest is an annual national mathematics contest set and organized by the University of Waterloo, Waterloo, Ontario. The contest is aimed at Grade 12 students. The contest consists of essay type questions. These are marked at the University of British Columbia (UBC) by a marking team headed by Dr. George Bluman. Over the years the questions asked have appeared to coincide more and more closely with units that are taught in the B.C. mathematics curriculum. UBC looks to the results of this contest when awarding scholarships. UBC also invites students to their honours mathematics course depending on their results in the contest.
Fermat Contest. The Fermat Contest is an annual national mathematics contest set and organized by the University of Waterloo, Waterloo, Ontario. The contest is aimed at Grade 11 students.

Integration. The process of finding the integral. The integral is a particular sum which has, as its motivation, the process of finding the area under a curve. Integration is usually dealt with towards the end of a first course in calculus, or at the beginning of a second course in calculus.

International Baccalaureate Program (IB). The program includes many subjects and a successful student must meet high standards in seven courses. The (IB) program has a European background, and has its headquarters in Switzerland. It is recognized as being a challenging program for very good students. The Ministry of Education of British Columbia gives the students enrolled in IB courses recognition on their transcript of marks. These courses have a special code which appears on the students' transcripts and is not called a "locally developed" course.

Locally Developed Calculus: Calculus LD. A course developed internally by a school. The Ministry of Education grants credit for the course as a locally developed course, but has no input into the curriculum that is taught. There is no external evaluation. The student's final grade is based on the teacher's mark.

Mathematics 11: Math 11. The mathematics course taken by students to complete their Grade 11 mathematics requirement toward their graduation. Success in this course is a pre-requisite for entry to the Mathematics 12 course. It was first implemented in the 1989-1990 school year.

Mathematics 12: Math 12. The mathematics course taken by students to gain their Mathematics 12 credit towards high school graduation requirements. The curriculum is set by the Curriculum branch of the Ministry of Education. The Mathematics 12 course is completed when the student is successful with the examination which is set and evaluated by the examinations branch of the Ministry of Education. For the student's final mark, 60 percent is based on their school mark as determined and submitted by the teacher, and 40 percent is
based on the examination. The examination may be written in January and June of each year. The curriculum is essentially pre-calculus, although it includes a unit of introductory calculus. This consists of 14 percent of the curriculum, and is intended to be covered in approximately 14 hours. This curriculum was first implemented in the 1990-1991 school year.

*Survey Mathematics 12: Math 12 Survey.* This course was established by the Ministry of Education. It was first implemented in the 1990-1991 school year. It counts as a Grade 12 credit towards a student's graduation requirements. The universities recognize it as a Grade 12 mathematics requirement in determining acceptability of courses. The curriculum is essentially finite mathematics, and is not pre-calculus.

**Overview of the Study**

The study took the form of a multi-level project in which not only the individuals responsible for initiating and implementing an advanced placement program in the schools were interviewed, but also the students involved in the programs. The levels examined were: the Ministry of Education (in Victoria), the district, and at each school, the principal, the mathematics department head (where this person was different from the teacher), a counsellor, the AP Calculus teacher, and students. Interviews were also conducted with a mathematics professor at each of the three universities in British Columbia, with the President of the BCAMT and with the executive director for Advanced Placement in Canada. Four university students were also interviewed. Pilot interviews were conducted in May and June of 1991 with students at two private schools, but the main bulk of the information in public schools was collected between October 1991 and February 1992. It was emphasized to all participants that their participation was voluntary.
Limitations of the Study

Time and finances have limited the study to schools in the Lower Mainland of British Columbia. The major limitation of the study is that schools outside this region were not contacted. However, this is mitigated by the fact that I attended two AP Conferences during 1991 and 1992, which were attended by teachers from school districts across British Columbia. Notes taken during discussions at these conferences have been incorporated into the data analysis.

Although no interviews were conducted at a "small" government school, the researcher did speak with a principal of such a school, who reported that such a school would likely have implementation problems that are unique to its situation. This situation cannot be covered by the organizational models described in the study.

Another limitation is the possibility that the students interviewed were not selected in a random manner. The choice of students was left to the mathematics teacher with the request that they be selected randomly. It was necessary to proceed in this manner so as to permit the parents/guardian of the students selected to give consent prior to the interview. It is felt, however, that specific students may on occasion have been chosen because they were the best or because they were the weakest or because they were well spoken. It is not believed, however, that this influenced the results to any significant degree.

Significance of the Study

The study will have significance for the five main stakeholders. It will be meaningful for secondary schools, not only for those involved in AP Calculus, but particularly for those not involved. Information as to the manner in which this program is being implemented will
be useful for schools not yet involved, but interested in undertaking an AP Calculus course in the future.

The study will determine how and why students make their choices and who influences them. The impact and implications to students who feel obligated to take AP Calculus and the effect of this on other elective subjects is analyzed.

The study is significant for the universities in British Columbia. It explains why the majority of students who complete the AP Calculus course nevertheless repeat the course at university. It also compares the expectations of the universities as to the mathematical background of the students with their real attainments. The study discusses the reasons for the perception that the university calculus course is particularly difficult.

The study will have significance for the Curriculum Branch of the Ministry of Education for British Columbia, particularly when it reviews and develops future secondary mathematics curricula. The study discusses the perception as to whether the mathematics courses designed by the Ministry provide the students with the required background for a first Calculus course at university. The communication between the Ministry and the universities is discussed as it pertains to the "mathematical" transition from school to university.

The BCAMT, as the largest organization of mathematics teachers in British Columbia, should be aware of trends in the schools, and the reasons for such trends. It should be in a position to act in an advisory capacity to teachers, to the Ministry and to the universities on behalf of its membership. The study analyzes the attitude of the BCAMT to the growth of AP Calculus, and discusses its position.
Chapter Organization

The study has been organized into five chapters and a set of appendices. Chapter 1 introduces the study, gives a description of the personal background that led the researcher to an interest in this topic. It describes the purpose of the study and provides a definition of terms used within the study. An overview of the study is presented. The limitations and the significance of the study are stated. The remainder of the thesis is outlined.

In Chapter 2, the literature is reviewed. This includes literature pertaining to AP Calculus in the United States of America (U.S.A.), and to AP Calculus in British Columbia.

Chapter 3 contains a description of the study; how it was conducted, the sources of information, the nature of the interviews and a description of the methods used to analyze the data.

Chapter 4 is a presentation of the results of the study.

Chapter 5 investigates, discusses and analyzes the results, focusing on the stakeholders described in Chapter 1, and draws conclusions.

The final section contains the Appendices. These include some of the questionnaires and transcripts of interviews with a principal, a teacher, a student, and three university professors. Also included is a copy of the Application for approval to conduct the study at a school in the district, sent to the districts. A List of References is attached.
CHAPTER 2

LITERATURE REVIEW

The chapter contains a review of the literature relating to Advanced Placement Calculus. It surveys the studies done in the U.S.A. and reflects on articles concerning AP Calculus in British Columbia.

AP Calculus in the U.S.A.

AP Calculus originated in the U.S.A. in the 1950s. In 1954, the College Entrance Examination Board accepted the responsibility of administering the Advanced Placement Program. This program had resulted from two studies that had investigated the transition of secondary school students to college. The first study concluded that there was a "failure of the school and college to view their jobs as part of a continuous process" in the education of a student (College Board, 1989, p. 5). The Advanced Placement program was intended to address that issue and supply the bridge that would ensure a continuum. The second study that led to the Advanced Placement Program was the Kenyon Plan, which concluded that "the best teachers of adolescent boys and girls are to be found in the secondary schools" (College Board, 1989, p. 8).

The AP Program was successful in the U.S.A. from the outset. It became recognized as a program of excellence which challenged the better students, and gave them a background that provided an easy transition from high school to college. Its success was visible in that it grew steadily: in the numbers of participating schools, the numbers of students that took the AP examinations, and also in the numbers of colleges and universities that gave it recognition. AP Calculus is one of the courses offered by the Advanced Placement Program.

The intent of the AP Program is that successful students receive and take either credit for the course or advanced placement in the subject or both when they enter university. It
was never the intent of the program that successful students repeat at university the work which they had covered in preparing for the AP examination.

However a problem arose with calculus. Successful students did not carry out the intent of the program. There appeared to be some reasons for this. The number of students enrolling in first year calculus at university grew, since calculus became a pre-requisite course for many fields of study. In 1966, Peterson suggested that "Calculus [was] a barrier that must be hurdled on the way to a lucrative professional career in medicine or engineering. Even disciplines like history sometimes require some college mathematics" (Peterson, 1986, p. 220).

Simultaneously, with the growing need for students to complete a calculus course at university, dissatisfaction with the university calculus courses arose. The dissatisfaction was twofold. The first was postulated by Peterson in 1986 namely, that for 25 years mathematics had been used as a filter for determining entry to many professions and careers (Peterson, 1986, p. 220). The second reason for dissatisfaction with university calculus courses related to the failure rate which, at many institutions, has been very high. In 1988, Cipra stated that 50 percent of the students enrolling in calculus at some universities fail or withdraw from the course (Cipra, 1988, p. 1491). Peterson also suggested that the university courses "are accused of having picked up a lot of baggage over the years, leading to weighty textbooks crammed with material that really is not essential" (Peterson, 1986, p. 221).

In 1986, at a Conference at Tulane University in New Orleans the problem of the failure rate of approximately 50 percent of students enrolled in the introductory university calculus course was addressed. Steen, the then President of the Mathematics Association of America, stated that "the teaching of (college) calculus is a national disgrace" (Peterson, 1986, p. 220).

Despite the fact that some suggestions were made with regard to curriculum, textbooks, use of calculators and computers, Peterson thought that "The reality [was] that in many universities, committees guard against and squash any radical innovations that individual faculty members may want to introduce. There is a desire to maintain a
comfortable status quo. There also appears to be an enormous inertia in the college [university] system to do anything about it" (Peterson, 1986, p. 221).

Tucker, a member of the committee setting the syllabus for the Advanced Placement program in calculus, suggested that "one place where a change may come sooner is in the high school calculus" (Peterson, 1986, p. 221). He stated that he would discuss many of the recommendations of the Tulane conference with his committee. Peterson held that

The A.P. syllabus is tightly controlled by the uniform national examination held each year. It was felt [at the conference] that if those recommendations [made at the conference] are incorporated in the Advanced Placement syllabus, then all the courses [at universities] will have to change (Peterson, 1986, p. 221).

In fact Tucker predicted that if no changes occurred in the Universities, "Calculus could end up being taught largely in high schools" (Peterson, 1987, p.317). This concern with the university calculus is obviously not a new one, as these statements echo Allen's comments made as far back as 1966. Referring to teaching of Calculus, he said that "the high schools are just beginning to do a better job [than the universities]" (Beninati, 1966, p. 29).

In response to these concerns, in October 1986, the Mathematics Association of America (the MAA), and the National Council of Teachers of Mathematics (the NCTM) in an article entitled "Calculus in the Secondary School", published a joint statement regarding their policy in which they gave their blessing to calculus being taught in high school. They recommended that the

calculus course offered in the 12th grade should be treated as a college-level course. The expectation (and subsequent recommendation) should be that a substantial majority of the students taking the course will master the material and will then not repeat the subject upon entrance to college (Steen & Dossey, 1986, p. 5).

A study by LeMay in 1985 determined that students who had taken AP courses at high school were "able, motivated, and confident to take college level course work while in high school [and] these high achievers continue to excel on the college campus" (LeMay, 1985, p. 159).
However, it appears that many students who take a high school calculus course, nevertheless repeat the work when they take a first year university calculus course. Burton concluded in 1989 that even if the Calculus course is not the AP course, "this lesser quality, watered-down course seems to have afforded the student a noticeable advantage in the standard first-year course" (Burton, 1989, p. 351). In a recent study, Ferrini-Mundy and Gaudard (1992) concurred with this conclusion. They found that "first semester college calculus students who had studied a full year of secondary school calculus, whether it be an AP course or not, are more successful in the course than those who have had either no calculus in the secondary school, or only a brief introduction" (p. 67).

Ferrini-Mundy and Gaudard (1992) found the first year calculus students to have more difficulty with procedural proficiency rather than conceptual proficiency (p. 67). Burton's study (1989) revealed that calculus courses relied heavily on the students' algebra skills that they learned in high school.

Both Wells (1985, p. 45) and Casserly (1979, p. 14) agree that students who are enrolled in enriched or accelerated programs, with the AP course as the motivating goal to work towards, are likely to develop positive attitudes towards careers in these directions.

**AP Calculus in British Columbia**

No research has been carried out regarding AP Calculus in British Columbia. However, the BCAMT published three articles in their Newsletter relating to calculus in the secondary schools. In November, 1986 they noted that the draft curriculum for Mathematics 12 included a two-week introductory unit on calculus, and that a number of schools in British Columbia had developed a one-semester course of calculus. The BCAMT stated that there was considerable interest in linking this course to the advanced placement program in the U.S.A. The article stated that the BCAMT was monitoring the extent to which calculus courses were being introduced in the province (BCAMT Newsletter, 1986, p. 2). In 1987, the BCAMT published the results of a survey conducted by the Curriculum Development Branch.
of the Ministry of Education as to the number of schools that offered a calculus course (BCAMT Newsletter, 1987, p. 2). At the same time, in its Position Paper, the BCAMT stated that "approximately 900 students are currently enrolled in a calculus course in British Columbia secondary schools" (BCAMT Position Paper, 1987).

Their figures are confirmed by the statistics shown in Table 2. These were obtained from the Information Management Branch of the Ministry of Education in the Province of British Columbia and indicate the number of students who have been awarded a LD Calculus credit towards graduation requirements by the Ministry since 1985.

<table>
<thead>
<tr>
<th>Year</th>
<th>Provincial Total</th>
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<tbody>
<tr>
<td>1985</td>
<td>22</td>
</tr>
<tr>
<td>1986</td>
<td>723</td>
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<td>962</td>
</tr>
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<td>1106</td>
</tr>
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<td>1989</td>
<td>1580</td>
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<tr>
<td>1991</td>
<td>2435</td>
</tr>
<tr>
<td>1992</td>
<td>3193</td>
</tr>
</tbody>
</table>

In 1992, the number of students who received a LD Calculus credit represented approximately 25 percent of the number of students who took Mathematics 12 in 1992.
In 1987, the BCAMT took a position on the topic which was very similar to that taken by the MAA and NCTM the year before. It was that they "do not support a calculus course as a part of the Mathematics curriculum in British Columbia . . . [but] to provide consistency across the province, schools offering a calculus course should offer the Advanced Placement Program" (BCAMT Position Paper, 1987).

In 1988, in an article in Vector, the journal published by the BCAMT, Walsh stated that "At U.B.C. only about 55 percent of students who enroll in first-year mathematics successfully complete both Mathematics 100 and 101 [differential calculus and integral calculus], and at Simon Fraser the failure rate [in calculus] is somewhere between 40 percent and 50 percent" (Walsh, 1988, p. 30). Walsh posed various reasons as to why schools in British Columbia had decided to offer a calculus course. Her reasons were based on what had happened in the U.S.A. but she did not research whether the same reasons applied in British Columbia. Walsh suggested a number of reasons for introducing a calculus course at a school. They included the enrichment of students and assisting students compelled to take a first year calculus course at university, prescribed for some other course which the student wished to pursue. She suggested that the teachers find a way for the students to better learn the prescribed Algebra 12 course. She suggested that the decision to introduce a calculus course may be influenced by many different people, and that a school offering the course must ensure "that they have available the appropriate staff and a capable student body" (p. 30).

AP Calculus is recognized as a program of excellence in the U.S.A. It has addressed many of the concerns and demands that have arisen in the U.S.A. in regard to the transition of students from high school to university. The implementation of the AP Calculus course in the schools in British Columbia is a relatively new phenomenon, and no research has yet been done as to the implications of its introduction. The patterns that are developing in British Columbia appear to be similar to those that arose when AP Calculus was first introduced in the U.S.A.
CHAPTER 3

DESCRIPTION OF THE STUDY

This chapter contains a detailed description of how the sources of information were selected, and who they were. It includes a description of the methodology involved in interviewing and collecting the data, and the analysis of the data. Finally there is a summary chart of the individuals interviewed.

Sources of Information

Six districts in the Lower Mainland of British Columbia were selected. A letter was sent to each district in September, 1991, requesting permission to enter a school in the district for the purpose of conducting interviews with various individuals at the school. The form of this letter is included in Appendix A. With district approval, one or two schools were named to be approached to see if they would be willing to be in the study. At each school, having obtained the principal's approval, the mathematics department head (if that person was different from the AP Calculus teacher) was contacted, and then the AP Calculus teacher to obtain their agreement to participate in the study. Having obtained that approval, appointments were arranged through the AP Calculus teacher with the various individuals involved in the study at the school. Consent of parents and of students was also obtained prior to interviewing the students. There was no occasion that this consent was refused.

At most of the schools, all of the interviews were completed in one visit. For two of the schools the researcher had to return in March to interview the students, as the AP Calculus program did not commence until the beginning of March, 1992, (i.e. in the second semester).
The Districts

The approach used in six school districts in the Lower Mainland of British Columbia is described in the last section. In an additional district, however, a representative of the district was not approached since the interview was conducted only with the calculus teacher. Since no students in this district were enrolled in AP Calculus, none were interviewed. The Mathematics/Science Consultant in one of the districts was interviewed by the researcher, who also met with the mathematics curriculum coordinator in another district.

Two private schools were involved in the study. One is the school where the researcher teaches and the other was contacted directly through the mathematics teacher and the director of studies, who was an administrator at the school.

The Schools

With one exception the district officer selected the schools to be involved in the study. The exception was approved to interview at the school which had first introduced AP Calculus in that district. A total of eight public schools and two private schools were involved in the study. In one of the districts, the school had a locally developed calculus program. Students at this school were not interviewed but the principal, the counsellor, and the two calculus teachers were contacted.

The Principals

An attempt was made to meet with the principal (in the private schools, the director of studies and the assistant-headmaster) who was at the school when AP Calculus was introduced. In only one case, the researcher was not able to meet the principal who was at the school at the time when AP Calculus was introduced.

The Counsellors

At each public school but one, a counsellor was contacted. In only one case the counsellor appeared to be not particularly interested in the study and uninformed about the
AP Calculus program. In all other instances, the counsellors were not only cooperative and helpful, but also well informed.

The Mathematics Department Heads

At only two of the schools was the mathematics department head a different person from the AP Calculus teacher. At all other schools, the AP Calculus teacher was the mathematics department head.

The Advanced Placement Calculus Teachers

Eight of the teachers taught the AP Calculus course. Two taught a locally developed calculus program with only a few students taking the AP examination. It is understood that these two teachers were essentially following the AP Calculus AB curriculum. At one of the private schools the teacher was following the AP Calculus BC curriculum. At all schools the AP Calculus teacher was a senior, highly experienced mathematics teacher who had been teaching mathematics for a considerable number of years.

The Advanced Placement Conferences

The researcher attended the Advanced Placement Conference held at the University of Victoria in October, 1991. At this conference two presentations were made pertaining to the AP Calculus course; one for experienced AP Calculus teachers and the other for AP Calculus teachers with little experience. The researcher attended the session for experienced AP Calculus teachers. This took the format of a group discussion which the researcher taped. The discussions of the AP Calculus teachers revolved around methods of implementation, textbooks used, problems that arise, and the philosophy behind the presentation of the course. The session was attended by twelve teachers from Burnaby, Nanaimo, Victoria, Prince George, Vancouver, Kamloops, West Vancouver, and Fort St. James.
A second AP conference for teachers was held at UBC in March 1992. This was a tele-conference to discuss graphic calculators. Once again there was a very interesting interchange of ideas among the teachers. Much of this discussion confirmed the information gathered during the course of data collection.

The Advanced Placement Calculus Students

Three students were interviewed individually at each public school except at one, where four students were interviewed. The pilot studies were conducted at the private schools where the researcher had time to interview six students at each school. All students were in the Grade 12 year. At one semastered school, students who were completing Mathematics 12 but had not yet started taking the Calculus were interviewed. Such interviews were unsatisfactory as the students were not able to answer many of the questions. At the two other semastered schools, the students were interviewed at the beginning of March, 1992 and they had only just started doing the AP Calculus course at the time of the interview. They had been studying Calculus for a few weeks. At three non-semestered schools, the students had been involved with the course for approximately three to four months. Some of these students were taking Mathematics 12 concurrently with the AP Calculus and some had completed Mathematics 12 at the end of their Grade 11 year. At the two private schools, students were interviewed at the end of their Grade 12 year, after they had written their AP Calculus examination in May of that year.

Prior to interviewing the students, parental consent and the consent of the students themselves was obtained. The students were informed at the beginning of the interview that they were not obliged to answer any of the questions put to them and that there would be no repercussions to them for having participated in this project. The students were also given the option of withdrawing from the project within a two-month period after the interview, but nobody withdrew.
I found the students to be articulate and eager to participate in the project. They appeared to be pleased that somebody was taking an interest in their opinion and were quite enthusiastic about participating.

The University Professors

At the University of British Columbia (UBC), Professor George Bluman was interviewed. Dr. Bluman has been involved in some of the decisions made by UBC in regard to AP Calculus. I had attended two Advanced Placement Conferences, one in Seattle and the other at UBC, at which Professor Bluman had spoken out on behalf of the university as to its attitude to AP Calculus.

At Simon Fraser University (SFU), Dr. Harvey Gerber was interviewed. Dr. Gerber is involved with the undergraduate mathematics program at SFU.

At the University of Victoria (UVic), Dr. David Leeming was interviewed. Dr. Leeming chairs the Mathematics and Statistics Department and chairs the Senate Committee on Admissions and Registration at the university.

It must be noted that each of the professors spoke to me in their personal capacities, and expressed their personal views. They were not asked to be a spokesperson on behalf of their respective universities, nor did any of them indicate at any time that the views he was expressing were anything other than his own.

The University Students

Two students were interviewed simultaneously at SFU. One student was interviewed from UBC. All three had recently successfully completed a first year calculus course at their respective university and all had also taken the AP Calculus examination. A student who took the AP Calculus credit at McGill University, in Montreal, Quebec was also interviewed. She had also completed other mathematics courses at McGill, but did not repeat the first semester of mathematics.
A student who had not taken calculus at school was interviewed. He had successfully completed the pre-calculus course at SFU but had subsequently failed the first semester of calculus at SFU.

All the contacts with the university students were chance ones. This level of students was not pursued any further, and would make an interesting study in itself. The data collected from the university students is used in the analysis.

The Ministry

Contact was made with the Ministry through both the Assistant Director and the Director of Information Management. The Director was interviewed by telephone. Statistics from the Ministry were obtained as to the number of calculus credits given by the Ministry over the last eight years. Calculus credits do not reflect AP Calculus credits since the Ministry does not recognize AP Calculus. However, the calculus credits reflect locally developed calculus courses and it is understood that students who have taken the AP Calculus examination would be enrolled in a locally developed calculus course at their school and would therefore form part of these statistics. By comparing the number of calculus LD credits given by the Ministry with the number of students enrolled in the AP examination, one can determine the number of students taking calculus LD courses who did not write the AP examination.

The Director of Advanced Placement for Canada

Mr. George Ewonus who is the Director of the Advanced Placement Program for Canada, was interviewed. The AP office is situated in Kelowna, British Columbia. Mr. Ewonus has been running the AP Program for the last five years and deals with all of Canada. He is involved not only with Calculus, but also with all other disciplines offered by Advanced Placement. Mr. Ewonus gave me a detailed account of the events that led to the establishment of the Advanced Placement Office in Canada.
The President of the British Columbia Association of Mathematics Teachers.

The President of the British Columbia Association of Mathematics Teachers, in his capacity as the President was interviewed.

Others

Dr. Bert Waits of the University of Ohio, Ohio, U.S.A., was interviewed. Dr. Waits is a member of the AP Calculus development committee and is also a teacher at the University of Ohio. Dr. Waits has strong feelings about the positive role of graphic calculators in teaching calculus.

The principal of a "small school" of approximately 400 students from Grades 8 to Grade 12 was interviewed by telephone. He spoke to me of his practical problems in regard to calculus being taught in high school. His main concern was whether his students would be at a disadvantage if the school did not offer a calculus course.

The Interviews

A total of 71 interviews were conducted. The interviews with the principals and with the counsellors each took approximately 15 to 20 minutes. The teacher interviews were each completed in 45 to 60 minutes. Each student interview took approximately 15 minutes. The interviews with the university professors and with the district coordinator each took approximately one hour. The interviews with the university students took approximately 20 to 30 minutes, except for the combined interview with the two students, which took approximately one hour. The interview with the President of BCAMT took approximately 45 minutes, and the interview with Mr. Ewonus, approximately one hour. The interview with the Assistant-Director from the Ministry took approximately 30 minutes. The interview with the Director from the Ministry took approximately 15 minutes.
Interview Questionnaires

Questionnaires were used for some of the groups of individuals interviewed. Samples of some of the questionnaires are included in the Appendices as Appendix B. For others a more freeflowing form of interview took place. The conversation was permitted to flow in such a manner that discussion on ideas raised by the individual was encouraged. The researcher did have notes concerning aspects on which it was desirable for the individual to discuss, and at suitable times during the interview, would redirect the conversation to such subject matter. Using such an approach meant that there was no formal questionnaire planned for the district coordinator, the director of the AP program in Canada, the president of the BCAMT, and the representatives of the Ministry.

The questionnaires served as a guide, and the conversation was allowed to flow. Despite the form of the questions appearing on the questionnaires, the questions were not posed in such a manner as to encourage monosyllabic answers. They were posed in a conversational manner so as to allow the individual to expand on the topic. The questionnaire was also used as a checklist to see that answers had been given to the desired points. The questionnaire was more closely followed for the student interviews than for the others.

In preparing the questionnaires the researcher took note of the following comment of Beninati (1966):

Some questions need to be answered before undertaking the Advanced Placement Program. Is the school large enough? Can a careful long-range program be worked out for selecting a class of "most-gifted" pupils? Is there a member of the faculty prepared and willing to teach calculus? Will provision be made for this person to have extra preparation time? (p. 29).

The main questions asked of the students in the present study related to their reasons for taking the course, and what factors influenced them in their choice. The main questions asked of the teachers centered on why and how they were teaching the course. The main questions asked of the principals concerned why the administration offered the course, and how it had been integrated into their schedules. It was also desirable to determine how the
mathematics courses taught in the lower grades, particularly in respect to enrichment/acceleration, and to the streaming of students influenced the AP Calculus course.

The interviews were all audiotaped. The researcher often noticed that when an interview was completed and the tape recorder turned off, some very interesting conversation took place. Notes of these further discussions were made.

Data Analysis

The "clustering technique" of analyzing the data, described by Miles and Huberman (1984) was used in the study. Trends that occurred were identified under various topics and conclusions based on those trends were made.

Where individuals rather than a group were involved (for example, the interview with Mr. George Ewonus) trends were not sought. Instead notes were made on the interview, the information was ordered and the views of the individual reported.

Since time was more limited the questioning format for the student interviews was much more formal and constrained than for the teachers and others. As a result, the trends for the students could be fairly easily detected, when it came time to analyze the data. There was also a quantitative aspect to it, as the number of answers that had been the same or similar could be counted. With other groups, where the interview was more free flowing and less structured, it was not as easy to establish quantitative trends.
A summary of the contacts made is shown in Table 3.

Table 3
Details of sample.

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of districts attended</td>
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</tr>
<tr>
<td>Number of schools visited (one or two per district)</td>
<td>8</td>
</tr>
<tr>
<td>Number of private schools attended</td>
<td>2</td>
</tr>
<tr>
<td>Minimum number of AP Calculus students interviewed</td>
<td></td>
</tr>
<tr>
<td>at each school</td>
<td>3</td>
</tr>
<tr>
<td>Total number of students interviewed</td>
<td>30</td>
</tr>
<tr>
<td>Number of mathematics teachers interviewed (one per school)</td>
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</tr>
<tr>
<td>Number of mathematics department heads</td>
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</tr>
<tr>
<td>(where different to above)</td>
<td>2</td>
</tr>
<tr>
<td>Number of principals (one per school)</td>
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</tr>
<tr>
<td>Number of counsellors</td>
<td>6</td>
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<tr>
<td>Number of university students</td>
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<tr>
<td>Director of AP in Canada</td>
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<td>District coordinator</td>
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<tr>
<td>Ministry personnel</td>
<td>2</td>
</tr>
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<td>President of BCAMT</td>
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CHAPTER 4

ANALYSIS OF RESULTS

This chapter contains a description of the results of the study. There is an account of the development of the AP program in British Columbia. The data analysis continues with an examination and survey of the results determined from interviews with representatives from the Ministry, the district, the schools, the universities, the BCAMT, and a member of the AP Calculus development committee.

It must be noted that all comments and data contained in this analysis have been supplied by the informants. Any conclusions drawn by the researcher are contained in Chapter 5.

HISTORY OF ADVANCED PLACEMENT CALCULUS IN BRITISH COLUMBIA

Mr. George Ewonus is the Director for the Advanced Placement Program for all of Canada. The College Board for Advanced Placement established an office in Canada in 1989. Although at the time, AP courses were being taught in 69 countries other than the USA, the Canadian office was the first non-American office for AP. Initially, Mr. Ewonus's appointment was half-time, but in 1990, his position was upgraded to a full-time position. In 1991 he was appointed as a Director.

Prior to his appointment by the College Board as AP co-ordinator in Canada, Mr. Ewonus had been the full-time coordinator for gifted programs in Kelowna, British Columbia. Prior to that, his experience had been at all levels, including high-school and university level.
Information Obtained from the Director of Advanced Placement in Canada

The Director of AP Programs in Canada related the following to the researcher.

Historical Background of AP Programs in British Columbia

Dr. Harland P. Hanson was one of the original group of people who established the Advanced Placement Program in the U.S.A. in the 1950s. At the time, Dr. Hanson was Dean of Undergraduate Students at Harvard University in Cambridge, Massachusetts and as such, an extremely influential individual. Dr. Hanson was appointed the director, world-wide, for Advanced Placement, which under his leadership, quickly developed. At present, 60 percent of all American schools have Advanced Placement programs.

According to Mr. Ewonus, one of the schools where Advanced Placement was first introduced in Canada was at St. Michael's University School in Victoria, British Columbia. This was a private school that had been involved with the International Baccalaureate (IB) Program. The school introduced AP in the late 1970's. As a private school they were able to be selective and the introduction of AP by this school did not significantly affect education at other Canadian schools. The public schools in British Columbia certainly did not recognize what was happening at St. Michael's University School.

In 1983, the Provincial Government in British Columbia set aside money for "gifted programs". To qualify for funding, a school had to introduce "gifted programs" throughout the kindergarten to Grade 12 levels. At this time Mr. Ewonus was a teacher at a secondary school in Kelowna and the "gifted program" became the impetus for increased awareness at his school. He was then appointed coordinator for gifted programs in the Kelowna school district and although he did have experience at both high school and university, he knew nothing about Advanced Placement.

In 1983, Kelowna Secondary School, the largest high school in Kelowna, took advantage of the gifted program by introducing IB. Seven other secondary schools thought
that they had to compete, but could not afford to introduce IB into their schools, since it was expensive and each of those schools was relatively small.

Mr Doug Cunnian, a biology teacher at one of those schools (Okanagan Mission Secondary School) had previously taught in California. He suggested Advanced Placement and was the first person to raise it at the school level. Mr. Ewonus, on becoming co-ordinator for gifted programs for the district of Kelowna in June, 1984 investigated AP further. The district had some money available, and Mr. Ewonus decided to introduce AP in the Kelowna school district. In 1984, some students challenged the English examination (despite the fact that they had not prepared, as such, for the course). They were the first students from the public school system to write an AP examination. Two schools (Okanagan Mission Secondary School and Mount Boucherie Secondary School, both in Kelowna), introduced AP virtually simultaneously. It progressed with "blinding speed" from that point. Mr. Ewonus arranged for as many principals, teachers or others who he could interest to attend an AP conference (the first of which he was aware) at Roosevelt High School in Seattle. Approximately 65 individuals from British Columbia attended that conference.

In the spring of 1986, as a result of local initiatives by the schools, a meeting took place in Richmond, B. C. regarding AP. Bob Carkner, the Principal of Steveston Secondary School in Richmond and Graham Leask, the Principal of Langley Secondary School in Langley were instrumental in putting it together. It was not a conference and was not arranged by AP. Essentially, Carkner had become aware of AP and tried to determine who knew something about it. He contacted Dr. Harland Hanson, Director World-wide for AP, and asked him to attend. Carkner apparently had also become aware that there was some "AP activity" in the Okanagan, and accordingly also asked Mr. Ewonus to attend. This meeting was attended by various representatives of the provincial Ministry of Education and by principals or other representatives from approximately 30 to 40 schools in the Lower Mainland. At this meeting, Dr. Hanson gave a general overview relative to AP, Mr. Ewonus spoke about how it had been introduced in the Kelowna school district and Mr. Carkner spoke about what had been done at Richmond Secondary School.
At the meeting in Richmond, Mr. Ewonus held fairly lengthy discussions with Dr. Hanson. Mr. Ewonus wanted there to be some Canadian control within the AP organization, and agitated both for this and for some Canadian input. The College Board, apparently sensitive to this issue, took the initiative and established an office in Canada, with Mr. Ewonus as the co-ordinator, initially in a half-time position. The Kelowna school district agreed to Mr. Ewonus accepting this position. His tenure as the coordinator for the gifted program in Kelowna was coming to an end. After his appointment by the Advanced Placement organization, he suggested that if he was to be working in Canada, it would be more appropriate for him to be stationed in Canada and thus the office in Kelowna. Subsequently, in 1990 the position became a full-time position, and he was appointed as Director in 1991.

AP in Canada has a lot of autonomy in setting policy for Canada. The Canadian office runs its own conferences, has some of its own readers, and intends, within the immediate future, to have its own examinations.

In the fall of 1987 (one year after the meeting in Richmond), the first AP conference took place in Canada in Kelowna. By this time, Mr. Ewonus had observed the AP conference in Seattle and was of the view that he could duplicate it. It was hosted by the Kelowna school district and was "insanely" successful. Schools from all over B.C. attended the conference and there were even representatives from schools in Alberta. Mr. Nat Allen, the AP representative for the Western States of the USA, assisted with the speakers. Delegates had to pay a registration fee, and AP funded some of the conference expenses, including the cost of the speakers. As a result, the conference did not cost the Kelowna school district anything.

Events Leading to AP Calculus in British Columbia

Mr. Ewonus attributed the introduction of Advanced Placement Programs in British Columbia to a government initiative, namely the funding for gifted programs, referred to as the "Funds for Excellence", which commenced in 1963. As a result, the districts determined,
virtually overnight, to designate one school within their district as an "International Baccalaureate (IB) school". This resulted in the more gifted students leaving their existing schools to register at the IB school. To counter this "brain-drain", the remaining schools looked for an alternative program. Mr. Ewonus stated:

...what happened to us in British Columbia and in Canada, and I include the Territories because they are also now doing AP, is common to what has happened throughout the world. AP is a good program. I think calculus is a particularly difficult issue because of the universities, but our studies world-wide in AP have shown that it is a challenge. Kids are getting better level courses. They're more challenging. They are not bored. And that is the general reason for AP.... Generally speaking, people say this is good. It is good for our school. It does create problems, staffing problems, charges of elitism, but overall, it raises the level of academic challenge in the school, and that's the main reason people take it. We have advertised AP in Kelowna for many years as a challenge course. It did not get advanced placement [at the B.C. Universities]. There was no advanced placement [until fairly recently], and I recommend to schools today that that is not their reason for doing AP courses. If teachers ask me, "Why should we do AP?", the answer I give them is because it is a challenge.

The students must have the choice of whether they want to take the credit at university or not, and there are mitigating factors for their choosing to repeat the course. It was not the design of AP. The concept behind AP is that you cover the material and then go on.

The Ministry of Education

Ewonus thought that the initial impetus for the introduction of the AP courses in British Columbia resulted indirectly from the gifted programs introduced by the Ministry. However, with respect to accreditation, the Ministry has not been consistent. IB students have been recognized on their transcripts, but AP students have not. This is despite the fact that the IB students do not have to prove to the Ministry either that they have written the examination or indicate what mark they have received. The IB designation nevertheless appears on their transcript. Mr. Ewonus did not think that the Ministry was actively attempting to prevent this. He was of the view that "things have fallen through the cracks, and yet we keep running into this brick wall".
Mr. Ewonus's response to whether it was in AP's interests to have the Ministry recognize AP on student's transcripts was:

We at the College Board are certainly not interested in unduly influencing anybody's curriculum. We stand on our own and we certainly don't need to be on anybody's transcript, but we would adopt the position that we don't want our courses and exams to be used for Provincial requirements. It is up to the Provincial government department to credit their students. On the other hand, because of the unique situation where IB is already on the transcript, we feel that to be fair to the students that are writing AP, which outnumber the students by far that are writing IB, those courses should be on their transcripts.

The Universities

Mr. Ewonus's response to what was involved in having the universities recognize AP, give it credit and creditation and recognition was:

That was a difficult problem and the answer is complex. A lot of different things had to happen and they did. Sometimes out of sequence, but they did happen. First, there had to be some students writing AP exams. As a growing number of students started to write AP exams, the universities realized that this was an issue that had to be addressed. As usual it was the schools who first forced the issue, and the pressure of those students coming and their phone calls was creative in helping to open up the issue at the university. SFU had a better understanding of AP as they belong to some American organizations. They are more aggressive and flexible in their admissions policy. I talked with them directly and they gave limited recognition to the AP courses.

The process, especially at a larger university, is quite complex. There are various levels of the organization that have to go through the process. It really takes time. The larger the university, the more complex the process. SFU was the first university to develop an AP policy as such. That then created pressure on other universities. UBC took quite a lot more convincing. They did not see too many reasons for doing this as most students come to that university anyway.

When the new president, Dr. David Strangway, came to the university, to UBC, he created a President's Task Force on Admissions and Procedures. I was invited to be a member of this task force, together with Mr. Sugimoto [at the time the principal of Eric Hamber Secondary School]. That committee met for close to two years once a month and included many important faculty members at the university. The major issue for this committee was AP and IB. As time went on IB became a secondary issue and AP became the major issue. These were not the only issues, but the contentious issue was the AP.
After two years the University of British Columbia came out with a policy statement on AP. The process included talking with principals and coordinators of IB programs and AP programs. At this time that I was on this committee, I was not paid by the AP College Board and I had no interest in protecting the Board, but I was concerned about the students in my own school district who were getting advanced qualifications but no recognition.

This was happening in 1986 and 1987. The university policy came through in 1987 or 1988. Once UBC decided to recognize AP, albeit limited, then more things happened and the other two universities have come up with similar policies. In Manitoba very similar things were happening at approximately the same time that they were happening here in B.C. Most of the larger Provincial universities have policies and now there is not a university in Canada that does not recognize AP. Not all of the universities have policies simply because they have not written them yet. We are, however, still some ways away from getting good policies at the Ontario universities.

AP has now become an accepted program. George Bluman [at UBC] was a member of the task force on setting up the university policy. The university creates an enabling policy, an overarching policy that allows individual departments to give credit. It is then up to the department to say how they will buy into this policy. In other words, there's autonomy within the department as to what sort of credit they would give. The Math department will make a decision as a department, but I think George Bluman, on his recommendation, had a pivotal role to play in this decision. The Math department recognized AP and gave credit for Math 100 with no additional testing needed. The Mathematics department was very keen on recognizing AP at UBC.

With respect to the universities, and in particular the calculus courses, Mr. Ewonus thought that it was unfortunate that we have "this university issue".

That hurts. We have a strange system here and throughout Canada at the universities that makes students want to repeat the work so as to get better marks. So marks are key, not what you learned. That does go against our grain as teachers. Those are external pressures that we cannot control in AP. We fought hard to get credit and placement so that students would not have to repeat the work that they had already done. I would like to be able to see them go on without penalty to the next course. That, educationally, makes sense. In the case of the Calculus that's where we have the most problems. Kids are not going on. They are repeating the work or the course. That is an issue we would love to be able to address and help the schools and universities come to some resolution. It is not the ideal situation.

The Impact of Immigrants

It was Mr. Ewonus's opinion that in British Columbia, immigrants did not have a large impact on the growth of AP in Calculus. Insofar as Vancouver is concerned, he thought that it only impacted on certain geographical areas in the city where there were a concentration of
immigrants. In other areas, such as Kelowna, where this has not been a factor, AP has nevertheless grown incredibly.

Generally speaking, it has an influence where they are there. Yes, I think it does. Particularly in the Sciences. Overall in B.C., no. There are some difficulties that I face in regard to generalization and there are some astounding differences in the numbers. For example, 17 percent of Lower Mainland students will go on to university from high school, only five percent will in Kelowna. And there are other big differences demographically in income, position, etc.

Mr Ewonus's final comment on AP Calculus was that "You can't reverse the trend now because it's not a B.C. trend, it's a world-wide trend. It is established".

A Teacher's View of the Development of AP Calculus

One of the teachers explained why he initiated an AP Calculus course, and the way he had seen the program develop. This teacher frequently makes presentations at mathematics conferences, and is held in high esteem by his colleagues. He volunteered the information contained in the following transcript of an excerpt of his interview:

I organized a workshop at my school, and George Bluman attended that workshop. He was one of the movers and shakers of AP. His acceptance by [the mathematics] department of the AP Calculus before UBC had an official AP policy, made it easier for me to sell the program at my school. St. Michael's School in Victoria were at that workshop, and we used the fact that what they did, we also have to do. Also, George Bluman led me to believe that he was generally supportive of the AP Calculus.

I did a workshop on our implementation of the AP Calculus at a BCAMT summer conference about two to three years ago. I was not specifically asked to do this topic, but simply to do a workshop. As I had been getting frequent calls and outside requests for information from local teachers, I felt this topic would be of interest. I also attended the workshop in Kelowna.

It is also only since the Ministry has allowed students to finish Math 12 at the end of Grade 11, this has been for the last three years, [so] that the students can spread their examinations and scholarship examinations over a number of sessions, that has enabled us to let the students work ahead.

I also believe that there is a plateau for the number of students who are ready to take Calculus at school.
The History of the Calculus Unit in the Mathematics 12 Course

I spoke with a member of the last Mathematics Revision Committee, which developed the revised Mathematics 12 curriculum and was told that there had been long debates about calculus in the Mathematics 12 curriculum. The following is an excerpt from the interview with her:

The decisions made on the new curriculum go back to approximately five years ago, and at that time, there was not much locally developed calculus around. The schools were saying that they did not have the numbers to offer a calculus course, and it was impossible for them to do it, particularly in the 'small school' situation.

A decision was made not to create a Provincial Grade 12 calculus curriculum. The reaction of the universities was that they were opposed to the schools teaching any calculus in high school, and very strongly discouraged that from happening. They thought that it would not be done right, and they would rather have the students have a really good knowledge of functions and pre-calculus and problem solving. That sounded good in theory, and so it was decided by the Revision Committee to put a tiny bit of calculus into the curriculum to tie together many of the ideas of the polynomial function and behavior of graphs and function notation. A lot of what was being taught in Mathematics 11 and 12 was only leading towards calculus, but the students felt that this was theory that they would never use.

The idea naively was that there would be a great new curriculum, and that there would be discussion with the universities. At that time there was discussion with representatives from the universities and colleges. The hope was that the universities would re-tailor their first year calculus courses to dovetail more closely with what we were giving, and that the locally developed calculus courses would vanish because there would be no need of them.

At that time there were two types of students coming out of high school. There were those who had had a lot of calculus, and those who had not, and these differences were not being recognized at the university. They were all being treated the same.

The students who can do the calculus at university are the ones who have taken it at school, and that is who the university is presenting it to.

The university demands remain as high as ever, possibly even higher, and districts who have never taught calculus in the past, and swore that they never would, are now teaching it.

It is unfortunate that there is nobody in the curriculum branch at the Ministry to look at this problem.
I don't believe that what we are doing now is good. We are taking the best students and teaching them something that they are going to cover all over again. Pedagogically, that is not sound.

There is, however, a demand from the students, from their parents for this course, and having taken our locally developed calculus course, the students 'cruise' through the first semester at university. The students are well prepared and their 'confidence level' goes up between February and June of their Grade 12 year.

I don't see how a student from Fort St. John's, who takes Math 12 and comes down here to university, can be able to handle first year calculus. They just don't stand a chance.

It should be noted here that, in reference to an introductory unit of calculus in the Mathematics 12 curriculum, Ferrini-Mundy and Gaudard (1992) found that "the brief introduction to calculus may not be a sound investment of instructional time [at high school]" (p. 68).

DATA ANALYSIS

An analysis of the data obtained from the other people interviewed follows. The sources of information are representatives from the Ministry, a district, principals, counsellors, mathematics teachers, AP Calculus students, professors, university students, the president of the BCAMT, and an AP Calculus development committee member.

The Ministry

The information was obtained from the Assistant Director of Information Management and the Director of Information Management, both at the Ministry of Education of the Province of British Columbia. The Director had also headed the Mathematics Revision Committee which established the mathematics curriculum currently being taught in secondary schools in British Columbia.
**Background**

The Ministry of Education in British Columbia has not established its own calculus course, and nor is the establishment of such a calculus course currently being considered. The Director said that the Provincial Mathematics Revision Committee, in the most recent revision of the mathematics curriculum in British Columbia determined unanimously not to include a full year calculus course. The committee was of the view that the AP Calculus was firmly established and, therefore, the Province would not duplicate the course. It established the Survey Mathematics 12 course which it thought would be more interesting mathematics for students with a C at the Grade 11 level who did not intend continuing with the Mathematics 12 course. This would be a different cohort of students to those who might be taking AP Calculus or LD Calculus.

Another reason for not including a calculus course was the cost involved. The Ministry considered it too costly to establish a calculus course and to administer the examinations that would be necessary. It was the Ministry's understanding that when the Mathematics 12 curriculum was established calculus would be left to post-secondary institutions. Despite this, the schools wanted a calculus course for their students in the knowledge that the students taking such a course would have definite advantages at post-secondary institutions. However, it was never a Ministry requirement for schools to have a calculus course. The committee included some basic calculus (approximately 14 hours of contact time) in the new Mathematics 12 curriculum so as to give all students a consistent basic introduction to calculus prior to entering a post secondary institution.

**International Baccalaureate Program**

The Assistant Director informed the researcher that the Ministry recognizes the IB program for gifted students and uses a code to indicate IB courses on students' report cards. These are not locally developed courses; the Ministry is not concerned with how the individual school organizes its programs. Funds are made available for gifted programs and
it is left up to the districts as to how the funds are utilized. Thus, the Ministry does not concern itself with the fact that a student enrolled in an IB course may take Mathematics 12 in the same block. Two credits (Mathematics 12 and IB Mathematics) are awarded to students successful in Mathematics 12. The Ministry does not require proof of success in the IB examination.

Creditation

The Assistant Director of Information Management informed the researcher that the Ministry gave IB creditation in the following manner:

When we gave the IB creditation, we did not work with the parent company of IB at all. We simply worked with the schools that had IB programs in them. When we give a student the IB Mathematics credit, we are not interested in whether the student has actually written and passed the IB exam. We do not deal with the parent company of IB. We simply get the mark in from the school, in the same way as we get a mark for an LD course. It is the school's responsibility to give us this mark. The student gets provincially authorized credit for this course. It is not an LD credit. IB was recognized as a 'gifted program' and then we had to find a way to make it work on the transcript. We had to find a mechanism which would allow us to show this IB credit on the student transcript of grades which we agreed upon, and that's the process which we are still following on there.

Locally Developed Calculus Courses

The Ministry does not control the curriculum for a LD course. At the university level, when a student enters with a locally developed calculus credit from the Ministry, the university is cognizant of the fact that a LD Calculus course at one school does not necessarily mean the same as it does at another school. The universities therefore do not recognize the course, and do not award advanced placement or credit to the student.
The Status and Future of AP Calculus

The Assistant Director of Information Management said that the Ministry currently does not recognize AP Calculus. It has no special coding similar to that given to IB, nor is it recognized by the Ministry as a gifted program, although the school boards give it this recognition. He stated that,

The LD Calculus credit given by the Ministry may or may not be associated with AP Calculus. AP has never been 'blessed' with official recognition. I'm not sure what constitutes official recognition, but it's never been given the same sort of recognition as the IB was given. Some of the AP schools have certainly approached the Ministry requesting this recognition, and we are trying to respond to that. AP, of course, has just grown so much in the last few years in British Columbia.

The Assistant Director was not aware how the universities react to students with an AP course. He did not know whether the university gives advanced placement or gives credit for such a course. He agreed that AP Calculus was a "grass root" phenomenon and thought that it was at the district level that these courses were being created.

He suggested that the Ministry may in the future investigate the possibility of giving credit to the AP program. In such event the credit would be reflected on the student's record in a similar manner to that used for the IB courses.

It is possible that the AP may go the same route in terms of creditation, but I don't know if this is overall the best mechanism, and so this needs to be investigated. We could, obviously, do something parallel to the IB, and I have been asked to look into this. It would not be for this school year anyway. The AP has come up several times for discussion.

The Place of Calculus in the Grade 12 Program

The Ministry is not currently considering a separate calculus course. The Director argued against developing a Provincial calculus course, citing three reasons. First, in looking at other jurisdictions such as Alberta, it was apparent that once the calculus had become a provincial course, it became an extra mathematics requirement for the students. This ultimately became a high school pre-requisite for entrance to subjects such as Geography at
university. Second, she thought that mathematics was becoming very elitist at the senior levels, and preferred to see more students take and enjoy mathematics. She thought that it would be only the "elite students" who would be able to take the calculus program. Finally, the Director wanted to avoid what she considered overlap between a Grade 12 (Provincial) Course and the AP course. For example, to obtain advanced standing at university the student must attain the requisite grade in the AP course. However the student would also have to write a Provincial examination in order to receive the British Columbia Ministry creditation. If the Ministry were to establish a calculus course this could then be a duplication of the AP course.

Thus, the Director thought that if the province were to develop a Grade 12 calculus course, they would create a curriculum based on the AP Calculus curriculum so that students would not be granted duplicate credit. She would lobby for the AP examination to stand as the Provincial examination.

When I asked what the Director thought about the fact that AP is an American examination rather than a Canadian examination, she responded that the universities "have been hard minded on this score. They recognize AP despite the fact that it's an American examination".

The District

The Mathematics Co-ordinator from only one district was interviewed, although a Mathematics Co-ordinator from another district expressed great interest in the results of this study. The researcher has included this information, as the co-ordinator was a representative from a large district in the Lower Mainland. His information on the growth of the program in this district correlated with the information obtained from other informants. The researcher thought that the growth of the program in this district from this perspective would enhance the understanding of the phenomenon. However, since the information came from a single district, the results will not be generalized.
The Growth of AP Calculus in the District

Most of the growth of AP Calculus has occurred over the last two to three years. In approximately 1989, there was a mushrooming desire from the teachers to teach AP Calculus, and there was a lot of pressure from the students for such a course. Three teachers met with the co-ordinator and developed an outline for a locally developed calculus course. One of the teachers had started an AP Calculus course at his school. The course was structured so that it could be taught in one of three ways: as an AP Calculus course, as a locally developed calculus course, or as a calculus component of the Algebra 12 course. This was just prior to the new B.C. Mathematics 12 curriculum. Some schools were already offering calculus to students outside the regular timetable. The calculus course was then circularized to all department heads, and this may have had some effect in generating interest.

A series of workshops was then organized for mathematics teachers in the district. The first was on AP Calculus, in which the teachers were given a sense of what AP Calculus was and a short review of the content. There was some discussion about testing. In 1990, an in-service training session was offered in the district on AP Calculus. In 1991 an in-service training session on the Mathematics 12 Calculus component was given, in addition to three sessions of in-service training on the new Mathematics 12 curriculum itself.

There have been a lot of changes in this district in the last three to four years. Four to five years ago only two to three schools offered calculus; now almost every secondary school in this district offers calculus.

There is real pressure now for schools to offer calculus. Otherwise their students were at a distinct disadvantage. Other consultants in other districts have experienced the same as I have. There has been a ground swell of interest in AP Calculus because of what students are finding when they go to university. One of the things that we have talked about is that by offering the calculus, we are really exacerbating the problem [at university] and creating a greater need for the teaching of calculus in high school. We asked ourselves the question, "Is that what we want to do?" and the decision we came to was that as responsible educators, whether we want to do it or not, we have to. It was a Catch 22 situation.
Different Models of Implementing the AP Calculus Program

Teachers did not want the students to study Mathematics 12 and AP Calculus concurrently. In general, schools follow one of two models. In the first model, the same group of students is double-blocked for the whole year. The teacher teaches Mathematics 12 until January, and then calculus from January to June. Most of these students write their Mathematics 12 Provincial examination in January. The co-ordinator recognized that this might not be the best model, but it is necessary in some schools. One of the reasons that this is not the best model is that it is necessary to have the same group of students continue in the double block for the whole year. There are two problems with this; one is a timetabling problem, and the second is that some students do drop out at the end of January. There is then a difficulty as to what to do with those students for those two periods for the rest of the year.

The second model (which is most popular) is to accelerate students between Grades 8 through 11 so that they complete their Mathematics 12 at the end of Grade 11. This is being done in a variety of ways at different schools.

In general, the students taking the AP Calculus programs have first been through some kind of honours program. The enrollment in calculus courses is now large enough for the first model to exist. When the calculus was introduced, it had to be done as an additional block outside of normal time; and later it was done concurrently. Students still, for various reasons, have to take the courses concurrently.

In this district the principals generally recognize that calculus is here, and that it has to be fitted in, and there is also a certain amount of competition between schools. There is also fairly stiff competition for students, and when a school sees students going to another school because they do not have a calculus program, there is intense pressure to introduce one. This has been confirmed generally with regard to AP courses since students were being lost to IB schools in the district. That was one reason for a school to introduce AP courses.

In the last year or so, a group of mathematics consultants from different districts have met and AP Calculus is very much an issue at their meetings. Although the Ministry does
have representation at these meetings, it does not have a mathematics co-ordinator. As a result of discussions not only with this co-ordinator, but also with principals, teachers and counsellors at every school interviewed, it is clear that the Ministry has little input.

A number of factors account for the growth of AP Calculus in this district. The co-ordinator said that "the biggest impetus towards AP Calculus has come from reports of graduates of a school reporting to their teachers that their professors [at university] expect them to know some calculus and assume that they have had some calculus".

According to the co-ordinator, prior to the 1970s, the mathematics curriculum did include calculus. A revision was done in the 1970s and calculus was dropped as the university professors did not want calculus to be taught in the schools. This information was not researched further. With the most recent revision, a unit on calculus was introduced into the Mathematics 12 curriculum. However, many schools had continued to offer calculus as an elective, a locally developed course. Those schools that did, produced students who were able to handle calculus at university. The co-ordinator stated that

The professors began to teach to the level of the student who had calculus, so the students reported back to their high schools that the students who had calculus were doing much better. That has resulted in a ground swell of calculus courses in the high schools. This kind of experience has been reported to me frequently.

Most schools in the Lower Mainland are now offering calculus courses. In fact, in this district, 16 out of 17 schools currently have a calculus course, and next year all 17 schools will have a course. Although AP offers university students the opportunity to omit the first semester of calculus, not many students take up that option. Students are taking the first course to get a higher grade in that course at university.

Now the students see the calculus course at high school as being a necessity. They cannot compete without it. It seems that the universities are raising the level of instruction in calculus courses, and offering a preparatory course to that student who has not had calculus from school.

The co-ordinator had no idea of the proportion of first year students at university who take a calculus course, and was amazed at the figure of over 80 percent at UBC. He thought that to be very high.
Staffing and Teaching

AP Calculus programs have generally been taught by a teacher who has been selected internally at the school. In one or two instances, the co-ordinator has had to help find a teacher.

There is no district policy on a teacher being given extra time to prepare for the calculus course for the first time. Although this has occurred at a small number of schools it is not very common in any of the districts.

Textbooks

The topic of textbooks for these programs does not appear to be an issue. There is no specific budget, but the schools generally have the texts they require. Every secondary school in the district has a set of thirty graphing calculators, but this is not because of the calculus. As a pilot study, one of the schools has a set of graphing calculators for all mathematics students to use the whole year, and at another school the whole of the calculus class has graphic calculators.

The funding for the AP examinations is not done through this office. It is seen as "the responsibility of Gifted Education," although there is no specific district policy.

The Principals

I spoke with the principals at eight schools spread across six districts, including two private schools. All of these schools had an AP Calculus course in place, except for one, which had a large locally developed (LD) calculus program. A few students from the latter school wrote the AP Calculus examination, and this was organized by the person in charge of gifted students. The discussions with these principals involved the reasons for implementing the AP Calculus program, and the method of introducing it. A transcript of an interview with one of the principals is included in the appendices as Appendix C. This particular interview was chosen as not only does the information given correlate with the information given by the
Director of AP on the growth of AP, but it also is a representative sample of the interviews conducted with the principals. The principals have been related to their school by means of a school number. Schools are numbered the same for contacts from the same school in the principal and teacher section of the analysis.

Introduction of AP Calculus

The principals were asked for their reason for introducing the AP Calculus program at their school. A number of reasons were given by different principals, some of the same reasons were cited by more than one principal. Five of the principals suggested that AP Calculus would stimulate the brighter students.

The principal at School 4 thought that the AP Calculus would enhance the students' prospects of successfully undertaking the first year calculus course at university. He also felt that the university uses the calculus course to "weed people out", and that it was hard to understand their policies. He felt that the attrition rate at university is enormous and that it was not difficult at his school to implement the AP program so as to assist the students at university.

The principal at School 6 felt that if he was going to make a generalization about AP to the students, it would be "do not use the AP courses to get into a second year program at university unless you are a very, very talented student. It really is not to your advantage". He also stressed that most of their students, even if successful with advanced placement, are going into the first courses at university. This principal also cited the fact that most students do not take credit at university even if they do receive a qualifying grade in the AP. They simply take it as a bonus to get a head start. What the calculus course does for his students is to lower their anxiety.

The principal at School 4 thought that in Vancouver (although not necessarily elsewhere) the AP Calculus program accommodated the rapidly increasing number of
Oriental students who, on arrival in Vancouver, were more advanced in their mathematics background than were their local contemporaries.

The principal at School 5 wanted to enable those students who would be attending universities in Ontario and Quebec to be equal to other students from those provinces who entered universities with an additional year's schooling. (This was in reference to the Grade 13 year that students have in Ontario, and the CEGEP program, which is a two year college course equivalent to Grades 12 and 13 that students have in Quebec). He believed that the AP programs served this purpose.

A number of principals believed that the first year calculus course was used by some universities (especially UBC) "to weed people out". The principal at School 6 said, "the first year calculus, as you know, is a killer, especially at UBC" On the other hand, one of these principals expressed concern that the IB and AP programs will ultimately act as screening devices for the university so that, if a student does not take such a course, he or she will not be admitted.

The principal at School 2 indicated that despite the fact that another school in their district was designated the AP school and that it was district policy for other schools not to have AP programs, mathematics became an issue and, because it was felt that it was advantageous to the students to have this program when they go to university, the AP Calculus was implemented in other schools regardless of the district policy.

The principal at School 7 initiated AP at the school as a natural growth from what was already being done. They had a calculus course at the school for some time offering about 80 percent of the first year university calculus courses for their high achieving mathematics students so as to "give them an edge" when they got there. This was a very large secondary school with 700 Grade 12 students and it was easy to find a class of very bright students who could be challenged and enriched, and to prepare them for first year university calculus. This principal felt that without really changing anything at their school, they were able to give their students a reward by involving them in the AP program as such. He thought that the AP Calculus program was immediately successful. He felt that it was not necessary to reinvent
the wheel since there was already a structure in the AP and that his students might as well do it, although they still call the course Calculus 12 LD.

The principal at School 6 did not have a large AP program in his school although the school had three locally developed calculus classes at the Grade 12 level. These were in place so that his students could get a real boost when they went to university, and so that the calculus at university would not be such a mystery to them. His feelings were that it must be difficult for the student who has come from a school where calculus is not offered when they go to university. They now have over 100 students taking the calculus course.

The principal at School 1 related that it was interesting to note that the teacher had commented to him that they had always had an advanced course in mathematics at the school, but that they could not get the students to enroll in it. However, once the AP course was introduced, the teacher immediately had a full class thereafter. This principal felt that the AP has a lot of credibility in that the top American universities recognize it, and that this was testimony to the quality of the Advanced Placement Program.

International Baccalaureate (IB)

A number of principals said that the AP program was introduced to counter those schools which were offering an I.B. program. As a result, those schools were attracting the better students at the expense of those schools which did not offer more advanced courses.

The principal at School 5 said that the AP program was initiated after consideration with the IB program. At this school, the IB program was considered to be a European import that was limited in North America. It was felt that it was difficult to establish credibility for the program and that it was not automatically recognized at Canadian and American universities. The AP programs already had recognition and it seemed more sensible to take the "homespun" product with growing acceptability at universities. Also, they had very few
students who would actually do the complete IB program since IB assumes an "early specialization".

All the principals I spoke to felt that the implementation of the IB program at a school in their district gave impetus to the rise of the AP programs at their school, since prior to initiating the AP programs, their students were applying to go into the IB schools, and that meant they were losing a number of their top students. The principal at School 4 explained this effect by saying that "essentially if some of the neighboring schools have programs, and you don't have them at your school, the students will go to the other schools, and you're talking about the top students in Math and Science. This was a definite reason for putting AP into our school".

The principal at School 1 has subsequently moved to an IB school and stated that, despite the fact that this school is an IB school, "there is no reason why we should not have AP here as well at this school. The IB program is not the same kind of thing. There may be other students at the school who would want to take an AP course". The principal at School 7 felt that if he were to be transferred to an IB school, he would "slowly change it to an AP school as I do not think there are very many kids who do the whole IB program anyway". This principal had not initiated AP in order to retain students. He did however feel that there was no question that the AP program did help them to retain their top students. He noted that "the other school near us started AP since they were losing their good kids to us [once we started the program]".

In general it was felt that AP grew in response to the implementation of the IB schools. The principal at School 1 felt that IB is a very expensive program and that the AP program is a better one. For IB there is only one school in the district and this principal objected to that. He felt that it was feasible for every school in the district to have an AP program since it is not exceedingly expensive. This principal felt that as far as quality was concerned, the AP program was as good as or even superior to IB as its orientation is North American as opposed to IB which is considered a "European import". This principal felt that you don't have to promote either IB or AP programs, that they are
...like selling a Mercedes. They are both quality programs; however, very few kids take the full IB diploma program. Most are enrolled in individual IB courses but do not go for the diploma. The beauty of AP is that it is very flexible. One can run courses for a particular year if you have enough students, and the following year not have the course if the enrollment is down. There is definitely a perception that we are, and I think in some cases we are, losing better students to other schools if we do not offer a 'challenge program.' AP is a draw card to keep the better students.

The principals did feel that the AP Calculus was a good course to have at their school. It "provides the opportunity for some students to advance their skills". The principal at School 7 stated that he "used AP as the school principal because of its success, especially in the calculus. It gives my school a reputation and I use this to keep my good kids here". When I went to interview students at this school, they had recently received their Provincial examination results and the billboard outside the school stated "Congratulations Math 12: average 86 percent".

This same principal felt that if he made a program that he wanted to implement just "a little bit exclusive", and if you have some external device for measuring it, so much the better, then the students "buy into it. It's as if someone else has to tell us that we're doing a good job".

It does not appear that parental pressure that has been one of the factors behind the initiation of these programs. The principal at School 8 stated that there had been some inquiries from students and parents prior to starting the courses, and it was from parents who were seeing the difficulties students were having at university.

**The Ministry of Education**

It would appear that the Ministry does not have much input in regard to the AP Calculus. Some comments from the principals at Schools 3, 7, 6 and 1 on this were:

There is no reaction from the Ministry. I do not think of them when I think of AP programs.

At the district level these programs are called "enriched programs" and so we get more funding from the Ministry.
But quite frankly, and rightly so, the Ministry is the last person to cause stimulus.

The principals at Schools 1 and 7 wanted the students to have the appropriate creditation from the Ministry and thought that it was unfair to the students for the Calculus AP to be called an LD course. They have lobbied the Ministry to try to get recognition for the AP courses. Initially one of these principals felt that the advanced placement and credit for the students at university was more important than the recognition, but did not realize that, even though "we were fighting for that, the kids did not want that particularly". The issue of creditation with the Ministry remains unresolved at this time, and the Calculus AP courses are called Calculus LD on the students' transcripts.

The principal at School 1 said that the AP Calculus was a "grass root" phenomenon. It started in the schools and was not initiated at Ministry level. As such it was probably better to not try to change this.

Costs

British Columbia has the greatest concentration of IB and AP courses in Canada, and this came about as a result of the provincial government's "two percent" funding for gifted programs. The external funding means the school must have two percent of its population clearly identified in order to get the funds. Courses such as IB or AP are regarded as "enrichment courses", and identifies the student.

All the principals felt that there was some cost attached to running an AP Calculus program at the school. This cost included the cost of the books and the cost to the district for the students to write the examinations. This differs per district. Some districts pay in full for the students to write. In some districts, the district pays in part for the students to write, and the student pays for the rest. In other districts, the students pay to write, and depending what grade they receive in the examination, they get reimbursed a portion of that amount, and in some districts, the student pays completely to write the examination. It would appear that
within a district there is a policy as regards the cost of the examination and that policy carries through to each school.

At School 8 the teacher was given an extra spare block for preparation during the first year or two that he taught the calculus course. At that time, the course that he was teaching was equivalent to the Mathematics 100 course at UBC.

Two principals at Schools 3 and 2 alluded to the fact that if they have a small class in one area, it impacts somewhere else. Since the staff is based on the number of students currently at a school, the contract makes it difficult to run a small class as other classes then have to become disproportionately large. The schools do not get extra staff for the AP programs.

The principal of a smaller school, and the principals at Schools 5 and 7, said that at a smaller school or if a smaller class is being run, then the "teacher's time", that is, the block of time in which the teacher teaches this class, does become a cost to the school in that the teacher cannot teach another mathematics class. At larger schools, this is not an issue as the AP Calculus classes generally run to capacity.

The principal at School 7 said that there is a small cost of in-service training for the teacher. This is not large as "I will not pick someone who cannot do the job anyway, especially when starting out".

At School 6 which is not called an "AP school" the principal had to fight to get the examinations that their students write paid for by the district, and eventually the funds came through their "learning enrichment program".

In general, the costs of the program were not exorbitant, the programs fit in with other programs that were offered at the school, and the principals thought that the districts were very supportive of the programs in terms of the cost of textbooks, teaching aids and supplies.
The Introduction of the AP Calculus Program

The principals were asked who initiated the AP Calculus program and how it was started. The principal at School 7 said that "the IB school was drawing the best students from my school and I initiated the AP program. There is no doubt that it was the 'Funds for Excellence' that created the IB schools. The first year we simply let a few students write the examination and they were successful. The following year we initiated the program".

The principal at School 6 said that despite the fact that they do not have a specific AP program, the students who are enrolled in the locally developed calculus course do have the AP examination as an option, and if they take the examination, do it through their "learning enrichment program". These students do some self-directed studies so as to be able to write the examination. The students at this school are not streamed at any stage. This is a senior high school with Grade 11 and 12 students only and any of their students may opt to take the calculus program.

The principals at Schools 5, 8, 4 and 7 had been responsible for suggesting the initiation of the AP Calculus course. At the other schools the teacher or the mathematics department head had initiated the program. A number of the principals felt that a course of this nature cannot be imposed on a teacher, and that it is doomed to failure if it is. One of the difficulties of these programs is to find the teacher who can teach it. Some teachers are philosophically opposed to the AP programs. All the principals agreed that you have to have the right person. It entails more work and is a challenge. It was not enough to just have a capable teacher. The principal at School 7 said that many teachers would prefer not to teach this course and he felt that the course "evaluated the teachers as well". He thought that many teachers do not want to teach high powered classes. This same principal also felt that IB schools and AP schools evoke "teacher resentment" from other teachers as some classes for these programs are very small.
Survey Mathematics 12

The principal at School 8 commented that schools are going to have to provide a calculus course for their students if they want to keep their better students at the school, and that a lot of the schools in B.C. now have calculus.

The principal at School 5 felt that the Survey Mathematics 12 course was introduced by the Ministry for what they regarded as "lesser mathematicians". However, at their school they feel the material is for "good mathematicians". Nevertheless, their weaker students are taking this course in lieu of Mathematics 12. The principal at School 6 felt that the Survey Mathematics 12 was for their students not taking Mathematics 12, and he implied that these students were not capable of doing reasonably well in the Mathematics 12.

The Counsellors

It was more difficult to establish patterns from the interviews with the counsellors since the questionnaire was not as tightly constrained as it had been with the students and the interviews were much more free flowing. As a consequence, the counsellors were not all asked the same questions, but simply allowed to talk. Those areas that had not been fully covered were then referred to by the researcher. Where possible, general statements have been made that have come from a number of counsellors.

Five counsellors and one person who served as both an administrator and counsellor were interviewed. Organizational difficulties prevented counsellors being interviewed at three schools.
The Manner in Which the Students are Counselling

It would appear that the counsellors start to talk to the students in Grade 10 both as to their Grade 11 and Grade 12 course selections and as to their post secondary plans. In some districts, a counsellor has a class from Grade 8 and follows the same students through to Grade 12 so that by Grade 12 they know the students well and have a good indication as to their ability and preferences. In each case, course selection is a one-to-one process and the counsellor spends time with the student on an individual basis. Counsellors from the senior secondary schools go to the feeder junior secondary schools during the students' Grade 10 year, and explain the requirements for graduation and post secondary university education. AP courses are mentioned at this time.

The counsellors know of the AP Calculus course, but it is the mathematics teachers who promote it. The counsellor's role seems to be to ensure that students who enroll for these courses are able to cope with them. The information and impetus which generally results in the student selecting a calculus course comes from the mathematics department and the encouragement of the student's mathematics teacher. One of the counsellors summed up the consensus on this point when he said, "I think that's really where the driving force comes from. I would say the mathematics teachers are the most influential by far".

At School 2, when the counsellor was asked whether there was a "ripple effect" such that when one school gives an AP course another school in the District follows suit, his response was that in that district, they have a common course selection book and that parents see what each school offers. If a school does not offer calculus the parents want to know why.

The counsellors were of the opinion that in the last few years students have been more interested in taking senior science courses. This comes more from the students than from the departments. The student sees the value of a science background and of keeping more options open. Counsellors advise those students who are thinking of Engineering or Science that they need calculus. The counsellors did not think that students who had taken
calculus adopted a "laid back" attitude at university. That had more to do with maturity, study habits and attitude. The students who return to the schools comment, without exception, that without the calculus they just could not do first year calculus at university. The counsellors suggested that the few truly gifted mathematics students (often referred to by their peers as "Math Nerds") who are at a different level, would likely cope, "but almost everybody else who succeeds without a calculus course at school squeaks through. All I know is that our kids say there's no way we could do it without it. I think it's absolutely crucial".

Counsellors encourage students to continue with mathematics at school. They do it because "math is required almost everywhere". However, although they "push" the mathematics courses, they do not do the same for calculus. Students make up their own minds, and counsellors simply make recommendations.

Counsellors thought that those students who went to university from schools where calculus is not offered were at a tremendous disadvantage. This was confirmed to them by their own students who return and comment

you ought to see the kids in the class who haven't had the calculus. They are just in real difficult straits.

Students come back to us from post secondary institutions and tell us, "boy they're sure glad they got involved in the program". They had, you might say, an 'edge' over other students in their classes.

One counsellor had a daughter take calculus at university. She did not take calculus at high school but was a very good student. She obtained 98 percent in the provincial (Mathematics) examination. Although she was able to cope, her friends who were not so good at mathematics did not have the background. Thus this counsellor advises students to take calculus.

One counsellor suggested that one of the reasons that calculus has grown recently is "because we have a different school population now, a lot of 'off-shore students' whose Math skills are advanced when they arrive here".
Another counsellor commented:

I must be frank, we have had quite an influx of oriental students in the last few years. They pretty well all lean towards the Math and Sciences, so our Science and Math numbers went up astronomically. An awful lot of those students are doing the AP Calculus. Certainly there are far more oriental kids in the Math class than Caucasian kids. I'm not sure how big a factor this is, but it is a factor in the growth of AP.

And another counsellor commented:

We've had a substantial increase in ESL students. It has tripled in the last one and a half years and students come in with varied backgrounds, especially in Math. Until one and a half years ago most of our students came from India; however, in the last one and a half years there has been a shift to other Asian countries: Taiwan, Hong Kong, Cambodia, Vietnam and Central and South America.

Parental Influence

The counsellors thought that the students were making their own informed choices as to their course selection. Parental input varied. Some parents simply sign the forms. To the extent that there is parental pressure, it is more in terms of "continue your education", rather than a specific course. It was felt that the encouragement came more from school personnel who were much more influential than parents.

Talented Students

The counsellors thought that AP Calculus does meet the need of talented students and serves as a challenge for them. Most of them are going into science or mathematics at university and all will take mathematics at university. Even the students who may not get advanced standing see the value in covering the material and getting a head start on that. One counsellor summed this up by saying, "to get into Science or Engineering, I think the competition is real keen. It's an advantage to have had the calculus at school".
Advanced Placement and Credit at University

One of the counsellors knew that some universities do give advanced standing to students who have taken AP and who have obtained a final standing of a four or a five. He said,

We mention this to them but at our school kids do not have to take the AP final. Some of the students will take the course just because they want the enrichment. They don't want the credit.

Another counsellor commented, "We recommend to students to look very carefully at exemptions from university. It may not be in their best interest to be exempted from a course. We do not necessarily encourage the students to take exemptions at university". Another counsellor actively encourages the students to not take the advanced standing, but to take the first calculus course again.

The objective in giving an AP Calculus course is to give the good students enrichment and a challenge. "It's a confidence builder too. They can take pride in taking AP".

The Impact of the Calculus Course on Other Courses at the School

Five counsellors responded that there was no impact, that the calculus did not conflict with other electives, and that the students are simply electing to take it.

In some cases the counsellors spoke of timetabling constraints, but this was a minor concern. The model of the "challenge program" schools allows the non-semestered schools to do calculus in the students' Grade 12 year. Since only 20 percent of the schools in B.C. are semestered, this model is probably being followed by many schools.

One counsellor suggested that in the first semester the mathematics teacher starts all the extra AP mathematics early before the second semester actually starts and the students do not necessarily write their Provincial examinations in January. They continue preparing their Mathematics 12 course after the AP examination in May and prepare then for the Provincial examinations. He commented: "That's why they do so well. They are really
getting a double Math 12”. This Counsellor was at the semestered school that Dr. Bluman referred to whose students do so well in the first calculus course at UBC.

At another large semestered senior high school they do not have an accelerated mathematics program, they do not begin the calculus early. They offer Calculus LD only and have a large number of students participating. The Counsellor stated that there were “so many people [students] requesting calculus this year”.

One of the counsellors commented on the fact that since they had so many students sign up for the calculus, they had to run one course concurrently with the Mathematics 12 course “but I don’t think that the calculus class has worked out very well at all. I don’t think there was much co-ordination between the two teachers”. He thought that this model could be used successfully if the same teacher taught both classes.

**Counsellor’s Awareness of University Calculus Issues**

The counsellors were quite vague about the pass rate in first year calculus courses. One counsellor suggested that they “lose 40 percent of the kids” and another counsellor felt that

they have the cream of the crop going there, yet they have a fairly high failure rate in a lot of the courses. The university is not making it hard to be hard. Science is a very difficult program. The level of thinking is very high. The students are not prepared by their high schools.

Two out of three counsellors had no idea of the proportion of first year students that take a calculus course. They were surprised when told that at UBC it was approximately 60 percent. One counsellor said, “I’m shocked. A lot of kids are not ready for the course”. Another counsellor said, “It is a very high proportion, especially when you consider the students in other faculties that are not heading into Sciences. What’s going on then? It seems like a very high figure. That surprises me”.

The counsellors thought that the driving force behind the AP starting up at the school had been the mathematics department head. They also noted that the attitude to mathematics between the girls and the boys was the same.
The Teachers

Introduction

Ten teachers were interviewed. Of these two did not teach a calculus course, but were mathematics department heads. A transcript of an interview with one of the teachers is included in the appendices as Appendix D. This interview was included to indicate the nature of the interview with a teacher. The researcher thought that this particular interview was comprehensive, and was a representative sample of the interviews conducted with the teachers. Information obtained from the teachers at the AP Calculus conferences was included in the analysis.

Different Models of Implementation of AP Calculus Courses

The models the schools use to implement the AP Calculus program differ according to whether the schools are semestered or not.

Semestered Schools

At semestered schools, students in Grade 12 complete Mathematics 12 in the first semester. The Calculus AP is covered in the second semester starting immediately after the January Provincial and Scholarship Examinations. To cover both courses, the teacher sees the student once each day for approximately one hour and fifteen minutes throughout the year. After the AP examination is completed in May, the calculus class either continues and goes on with more calculus, or since students are permitted to re-write scholarship examinations, they prepare during this time for the Mathematics Scholarship Examination.
Non-Semestered Schools

The non-semestered schools have three models for accommodating the AP Calculus.

Model 1. The Mathematics 12 and AP Calculus courses are run as if the school was semestered. The students are “double-blocked” (have two periods out of eight) for Mathematics for the whole year. Mathematics 12 is taught up until the Provincial examination in January, and the Calculus AP is taught thereafter. At two schools, because of time-tableing problems, one of the mathematics blocks was taught at 07:40 am every second day. In this situation, the time given in each period is approximately one hour. The teacher sees the students for six to seven periods per week. At one school which adopted this model, the Mathematics 11 Special class (which is the source of most of the AP Calculus students), is also double blocked for the whole year. The students complete three courses in the double block. These include the old Geometry 12 course, the old Probability and Statistics 12 course and Mathematics 11 Honours. This means that these students likely are receiving twice as much mathematics contact time in each of their Grade 11 and Grade 12 years than those students at a school without such double blocking.

Most students progressing into the AP Calculus class had been in a Mathematics Enriched or Mathematics Honours class for at least some of their high school mathematics courses. In some situations, these mathematics enriched classes were accelerated classes which enabled the students to complete Mathematics 12 at the end of Grade 11. Professor Bluman at UBC referred specifically to one such school during his interview. He commented that for a number of years the students who had come from this school did particularly well in their mathematics courses at UBC.

One of the advantages that some of the calculus teachers (and students) have, is that at the end of the AP Calculus examination in May, their mathematics classes terminate and both the teacher and the students have a spare period in that time. In the non-semestered school working on a semestered model for mathematics, this meant that from the middle of May until school ends in June, the teacher and the students had a double spare period.
Model 2. At one school at least a half the students in the AP class had come through the "Challenge" program. This is a program that accelerates students through Grades 8, 9, and 10 in two years. The other students in the class had come from Hong Kong and other countries. All the students in the class had completed Mathematics 12 in their Grade 11 year. The AP Calculus course ran for the whole year in one block.

Model 3. In this model the students have two blocks for the whole year, one for Mathematics 12 and one for AP Calculus, and the teacher runs the two courses concurrently throughout the year. In schools where this model has been used, the feeling is that it works very well so long as the same teacher teaches the same select group of students in both classes. The teacher is then able to juggle the work so that topics required in calculus are not introduced prior to dealing with them Mathematics 12. One teacher who uses this model commented that: "When you do the calculus, it helps [the students to] consolidate and remember the mathematics. It reinforces it".

At most schools where AP Calculus is taught, it is a pre-requisite that students have had an A or a B in either their Mathematics 11 course or their Mathematics 12 course. At one large school where AP Calculus is not offered, they do have a very large calculus program with many Grade 12 students enrolled in a locally developed calculus course. This school does not have a pre-requisite grade for entry into this calculus course, but the students must have passed Mathematics 12. This is a semestered school and the students start the calculus course in January. The teachers at this school felt that there would be too little time for the students to complete all the calculus by the middle of May. The LD Calculus course also permits the teacher to pursue his/her own curriculum for calculus, and not be compelled to work towards a specific examination.

At most schools that offer calculus, approximately 20 to 35 percent of the students who take Mathematics 12 also take a calculus course, either AP Calculus or locally developed calculus. There are many schools which run both courses. At those schools
which run the Calculus AP course, the students usually have a choice (towards May) as to whether they want to write the AP examination. Generally, the students are not compelled to write the AP examination.

At one school, the reason given for having no minimum mark to gain admission to the calculus course was that they cannot run classes which are too small. "In an elective course like this, the class size is a factor". However, generally good mathematics students apply to take the calculus course.

One large non-semestered school which uses the semester model for their courses runs two calculus courses on the semestered model, (an AP Calculus course, and a LD Calculus course), and a third LD Calculus course runs concurrently with Mathematics 12 for the whole year. The teacher's comment was that,

The student gets 'a real solid' calculus background and also more practice in the Mathematics 12. Furthermore the concurrent course is structured in such a way that the students receive approximately 125 percent Mathematics 12 and 75 percent calculus during the two courses for the year. The students enrolled in this program are those who intend to take one year of calculus for Commerce or something of that nature.

Textbooks

A variety of textbooks are used. After the teachers had taught the course for a few years, they would usually switch from one book to another. The various authors that were mentioned were: Del Grande, Duff; Bittenger; Anton; Dunkley; Adams; Stewart; Thomas Finney; Schaum's AP Calculus; Broadwin, Lechtner; Barron (for examination preparation). One teacher gave the students work sheets rather than using a textbook.
Reasons for Implementing the AP Calculus Course

The response to this question by the teachers at the different schools are listed individually below:

School 1. About 20 years ago the Bluman Report labelled the semestered schools "the worst in the Province". As a result, approximately two years later, a locally developed calculus course was introduced at this school. It was described as "LD Mathematics 12 Advanced" on the transcripts. Five years ago, the school became involved with the AP program. By this time, there had been 15 to 29 students on average in the locally developed calculus course. When AP Calculus was started, the numbers increased to two, and later to three classes with a total of approximately one hundred students taking Calculus AP out of 300 students taking Mathematics 12 this year. At this school, the administration provided the impetus for the AP Calculus. However once it was suggested, those who became involved were also very keen.

School 2. The Mathematics department head at this school initiated a locally developed calculus course following the guidelines of the AP curriculum. He allowed students who wanted to write the AP examination to do so.

At this school, all the Provincial Mathematics courses had traditionally been offered. However, UBC was not giving credit for the Survey Mathematics 12 course, and a lot of students requested an extra mathematics course. The department head also felt that: "There is a need for high school students going to university to have a first year calculus course as the university tends to knock them out".

The LD Calculus program was in place when a new department head came to this school. He had moved from an IB school, and he had knowledge of the IB programs and had also been to an AP conference. This teacher felt that AP Calculus could be offered at the school. He felt that such a course would "meet the needs of the students".

A number of students at this school had been accelerated and had completed the Mathematics 12 course at the end of Grade 11. The school had to have something to offer them for Grade 12. The first time they tried to initiate the Survey Mathematics 12 course "it
did not appear to be a saleable course". An insufficient number of students signed up for the course, and the course was not run. However at the same time the numbers for the calculus course were sufficient when it was introduced, and this course was run. The following year there were sufficient students to run both the Survey Mathematics 12 and the AP Calculus courses. Most of the students enrolled in the Survey Mathematics 12 course, were also taking the calculus course and the Mathematics 12 course.

**School 3.** At this school the mathematics department head first suggested the AP Calculus course to the administration. She believed that the idea may have come from a department heads' discussion on "ways to retain better students in the school". There was "some talk of excellence" at that time. The headmistress was "high profile", and encouraged something of this nature. As a result, she was "willing to start the course even though it was for only a small number of students". The students did not want to do the course for the advanced standing at university. In fact, at the time it was initiated, the universities did not give advanced standing. But, "the students had heard from others that it would help them in their first year university". The program started in 1990 with 7 students. The following year there were 18. The department head initiated the discussion to start the course.

**School 4.** This course started three years ago. At that time a large group of students had finished Mathematics 12 at the end of their Grade 11 year. That happened because there were International Students at the school. The program was initiated partly by the department head and partly by the principal who had a mathematics background. The students who had finished Mathematics 12 early were not keen on the Survey Mathematics 12. As a result the decision was made to initiate a calculus course.

**School 5.** At this school the mathematics department head initiated the course. He felt that the Algebra 12 course was not challenging enough for his students. He wanted to give them something more. This teacher also felt that he could "sell AP rather than IB as the universities recognize the AP program". He had the backing of the Director of Studies, who was an administrator at the school.
School 6. AP Calculus was not offered at this school. However, a locally developed calculus course had been part of the school's mathematics program for approximately 25 years. The nature of the course has changed considerably and any student who has completed Mathematics 12 can now enroll in it. Previously, the course was aimed only at the very best mathematics students. For the last five years, this school has had three classes of calculus, and this will soon be increased to five. They have a much "broader target audience now. It is not an elite honours type mathematics course anymore".

The Personal Background of the AP Calculus Teacher

Only two teachers teaching the course were not department heads and the teachers all were veteran mathematics teachers. Two teachers had been teaching calculus as part of a locally developed course for 12 to 17 years prior to the AP Calculus course being initiated. Others, although they had not previously taught calculus, had anywhere from 15 to 30 years experience teaching mathematics. All of these teachers indicated that at the time they started teaching calculus, a long time had passed since they had studied it.

Two teachers who started teaching AP Calculus in the last six years indicated that for the first year or two, they were given some extra preparation time. The remaining teachers were not given extra preparation time, although they did do a considerable amount of preparation for the first year. One teacher sat in on an evening Mathematics 100 class at UBC during the first year that he taught the course. He warned that a teacher going into the course the first time should be aware of the enormous amount of work. All teachers had a very strong mathematics background. Most had attended at least two AP conferences over the last few years. One district sponsored a teacher at a one week credit course specifically for teaching the AP Calculus held at the University of Oregon. The teachers' feelings about teaching calculus are captured in the following quotes:

Any teacher who does it, has to do it because [he/she] likes it. You really have to know your material. I am competitive. I like to see the kids do well. It's like coaching a team. There is pressure on the teacher too. The principal knows that I have 32 of the best students. He wants to see good results. That is a bit of a driver.
The hardest thing was that you are teaching students not lecturing to them. They come up and ask questions. I had to make sure that I could explain it in terms of the mathematics that they knew in grade 12. That was harder than actually remembering what to do with the calculus.

I took calculus as a second year course when I went to university. I had forgotten how much mathematics we had pulled down into the schools.

All the teachers responded positively when asked whether they enjoyed teaching the AP Calculus. These are some of their responses:

That is what keeps me here.

It is really nice to teach. You have highly motivated students.

Some teachers fear doing it. There is a challenge to do the course. It is not a course to 'saddle' someone with. You have to have the background.

I was given an extra spare period for my first year or two doing the course. I taught the university Mathematics 100 course, and I did all the examples I gave the students that year. I did not feel I could answer 'cold' on my feet if the student asked a question.

The Teacher’s Intention in Presenting the AP Calculus

Seven out of nine teachers said that they were not looking to replace the first year university course. "I stress to the students that it is not the advanced placement that is so important, but that they are going to make their transition to university easier". One teacher stated that, "the major reason the huge number of schools today have a calculus course of one sort or another is because of what is happening to students when they go to universities".

Three teachers thought that students would move to another school if they did not provide such a course, and they did not want to lose their better students. One teacher referred to the IB program as a program that could potentially draw students away from their school. A teacher at a private school who teaches the AP Calculus BC curriculum tells his students that if they get the credit, they should not repeat the course at university. However, some of them do anyway.
Knowledge of the Percentage of Students Taking Calculus in First Year at University

Most of the teachers when asked if they knew what percentage of first year students take calculus at university did not respond directly to the question. Instead they referred to the failure rate at the university. After this diversion one teacher responded that maybe 50 percent take a calculus course; another suggested that 30 to 40 percent take a calculus course and only one suggested about 80 percent of first year students take a calculus course at UBC. This teacher thought that the students were "hedging their bets and keeping their doors open". The one teacher who estimated that 30 to 40 percent take a calculus course, when told that the number was close to 80 percent at UBC, said "Holy, so much of this demand has come from external demands from many different faculties requiring more and more Math. This is a hurdle the students know they are going to have to climb over in life".

The teachers volunteered that they felt that the failure rate in the first calculus course at university was anywhere between 30 percent to 50 percent. Comments from some of the teachers were:

It is difficult to get that information as the universities are trying to recruit students.

In sciences, I think about two thirds of the students have done a semester of calculus at high school. I do not get it. They go there, and if two thirds of the students do not pass in the first semester, there's something wrong. There are also a lot of A and B students who have not done a semester of calculus who go there, and they should be passing too, just on their sheer ability. I think there are unrealistic expectations.

Two years ago, two of our students went into the Math Honours course at UBC and found it 'heavy going'. This included one boy who got a 100 percent on the Provincial exam. I think the expectations at university are just too high.

At university, they introduce calculus from a very theoretical base. The students have a lot of freedom at university. There are three hundred to three hundred and fifty students in a lecture. The students have complete independence. There is a very abstract theoretical presentation of the beginning of calculus by people who generally do not know how to teach, and do not understand how people learn at university. A lot of students get very confused.

The first year at university is a transition year. It is the most difficult year for students, and it is during the first one or two months that the students get lost. The universities should put their best people [teachers] in the first year, but they do not."
I asked a few teachers whether they thought that the university uses mathematics as a "filter" and a typical response was: "I don't think there is any question about that. I think that they use the Math 100 and Math 101 as a screening course". Another teacher responded: "The kids see it that way. They see it as a 'big screen', a fence, and that is how it is used, I think". There was also a feeling that the university courses must be getting more difficult, and that the teachers at university must be influenced by the fact that a number of the students have taken calculus before, and that even though they are not supposed to, they start upgrading the level of their course.

**Teachers' Reasons as to Why Students are Taking the AP Calculus Course**

Six out of the ten teachers responded to the effect that the students knew what was facing them at university.

I think the word is out. The students know that calculus is tough at university. They want to experience it prior to going to university. They want to lessen the blow. These students are good at mathematics. They enjoy mathematics.

The students are much more confident when they go to university having taken the calculus course. "The students have heard the horror stories because I've told the horror stories". Seven out of the ten teachers thought that, "not too many of them actually take the credit at university. They used their calculus course to make 'an easy transition' to university". There was also a frequent reference to the fact that the students would be able to get a first or second class mark in the university calculus course, and that the students needed this for their GPA.

The teachers thought that the students who did not have an opportunity to take a calculus course at school would be at a disadvantage at university. One teacher said: "I do not think they [these students] stand a chance". He did not know of a school that does not now offer a calculus course. The implication here was that there was an expectation that calculus almost had to be an elective at a school. Another teacher stated that
with AP Calculus, the student is learning much more than just the calculus. They are learning study skills. I give them a big taste of what it's like to take a challenging course at university. It helps them to make the transition to university. That is one of the biggest strengths of what I do for them.

The implication was that the AP Calculus course instills very good work habits which help the student with the transition to university.

The Level of Presenting the AP Calculus

There was a variety of levels at which the AP Calculus course was being presented. All teachers agreed on the fact that if they proved theorems, they did not expect the students to reproduce the proofs. One teacher, in a semestered situation, thought that the AP Calculus was mostly a "cookbook" type of question and answer approach. The researcher understood him to mean that he taught technique, and recognition of problem types and then the mechanics of solving the problems. Two teachers thought that the course they offered was at least at the level of or higher than that which was done at university. Both teachers were speaking from experience as the one had taken the Mathematics 100 course prior to teaching the course, and the other had a son who had taken the course at university.

Four teachers referred to the fact that the students are at an advantage taking the course at school and gave a number of reasons. One reason was small class size. One teacher stated that he tried to "simplify or normalize" the calculus. Another teacher said that there is some repetition in the university course but that he did not think that "the student sees it that way [as repetition] entirely because it is presented a little differently. [At university] it is very fast and the lecture presentation is different to my class". Another teacher suggested that "the style of presentation is different to university".

Two teachers referred specifically to the fact that the students found the algebra difficult. Some of the responses were:

I have shown you the calculus, now you do the algebra. That bothered them.
We hold their hand and correct their Algebra in tutorials. We have more time to correct their pre-calculus errors and misconceptions. That's the big problem.

I try to teach them to communicate. The first things they hand in is garbage. Actually writing out a sequence of steps. I hope this will improve with the Math 12 Geometry [that is the Geometry unit in the Mathematics 12 curriculum]. I have had to train them how to speak mathematically.

I do some proofs, but I try to be concrete and emphasize all the time what the meaning is of the 'derivative'. I have to keep stressing it all the time.

Discussion of Calculus at Department Head Meetings in the District

Most teachers replied that this was not really a topic of discussion. They felt however that there had been a "ripple effect". The schools do not want their students being regarded as "second class citizens" in mathematics. In the last three years, a lot of schools have "come on board". In one district the teacher noted, "I believe the deal was, one school does IB and we do AP".

Teachers' Report of Feedback from Students Who Have Taken the AP Calculus

All ten teachers responded that students had reported to them that there was "no way they would have ever passed the calculus if they had not taken the course at school". Other responses from students were just a big "thank you". The students were very appreciative of having taken this course. There is a lot of competition at university, and a lot of students who have had calculus at school.

Another teacher said that the students had told him that this course helped them discover what a university course is like. It helped with their study skills, and "really having a bunch of stuff hammered at you". Another teacher stated:

Several students have returned and told me that last year's failure rate was about 50 percent at UBC. The student was appalled at some of the marks their classmates were getting. It was then they realized how much they had learned and said, "It does make a big difference". That word is percolating around. Most of the students who go to university into Math and Science say that the calculus course they took at school was the most important course they took in high school. Some of the students in their class beside them who did not have a calculus background 'were lost.'
One teacher stated that a student had said that the first term "is a breeze, but you do start to have difficulties in the second term".

A parent from my school whose daughter has just completed the second semester at university told me recently that she felt that the school had not prepared her daughter for university. This student had not taken AP Calculus at school, but an LD Calculus course, and the mother was concerned that the student had not been taught 'integration'. Although she had survived her first semester of calculus at university with a 68 percent, in her second semester, she had found the topic of integration very difficult, and the parent asked why the school had not included integration in the locally developed course.

The Effect on Students' Choice of Electives

All but one of the teachers thought that there was no reaction or backlash from other teachers at their school to the fact that students were taking another mathematics course in Grade 12. Only one teacher suggested that "usually these kids miss out on the humanity courses".

Support for the AP Program at District Level

Nine teachers stated that they have very good support at both the district and the school levels. In some cases, the teachers said that it was difficult to distinguish whether the support was from the district or from the school, but, in general, there was no difficulty having funds for textbooks. Many teachers stated that they had been to one or two or more workshops and that this had been paid for, sometimes by the district and sometimes by the school. Two teachers referred to the "funds for excellence", and felt that this in some way allowed the district to support them.
Cost of the Examination

At most schools, I was told that it is the district that pays for the AP examinations. There were three exceptions:

i) In the private schools the students have to pay.

ii) In one of the districts, the district pays one-half and the students pay the rest. Then depending on the grade that the student achieves in the examination, he or she is refunded by the school board for a portion of that amount.

iii) In another district the teacher insists that the student pays for the examination at the commencement of the course. He feels that the student in this way, makes a commitment to the course.

Teachers' view of the Counsellors' Support for the Program

All of the teachers suggested that they do the work for the counsellors in promoting the course. The students are "signed and sealed". None of the teachers indicated that the counsellors in any way attempt to talk the students out of taking calculus. One teacher said that: "we, the Math teachers, tell the students that 'they are going to have to take calculus at university for whatever they are going into. This course will make it an easier transition for them'".

Graphing Calculators

Six of the seven teachers asked responded that they either use them very little or have just started to use them this year, but that they anticipate that they will be using them more and more. Only one teacher responded that he does not believe in them, and that "it scared me a bit that AP may use graphic calculators in the future. Well, I guess I'm going to have to teach them".
Every teacher asked looked surprised when asked if the Ministry has any input into the calculus program. The response was that they have “no contact with the Ministry over this”. In some cases they elaborated, and one teacher mentioned that they have a difficult time having the Ministry put Calculus 12 LD on their students’ transcripts. For some schools the Ministry calls the course Calculus 11 LD. None of the teachers thought that the Ministry provided funds in any way, and one teacher said that the Ministry’s response was that they had put a chapter of calculus in the Mathematics 12 course. Another teacher commented:

None that I can see. The Ministry provided the Survey Math 12 course that students did not want to take. It is in our course outline book but we did not have sufficient sign-up. I suspect it’s running against the calculus class. I realize it is intended for a different group of students, but if students do not want to take Mathematics 12, they do not want to take any Math. Or else if they are taking Math 12 and are good at Math, they want to take calculus instead.

A teacher who had been the past president of the British Columbia Association of Mathematics Teachers felt that “high schools should do what we are mandated to do, properly”. He nevertheless teaches a locally developed calculus course at his school.

One teacher felt that the Ministry would not do anything as the mathematics taught in high school has to be pertinent to everyone, not just to those going to university, and that you cannot force more calculus into the program. However, another thought that the reason students are taking calculus at school is not only because they are afraid of it, but that if they want to go into a four year engineering program, they have to have it. He said:

If you want to go into Sciences in Alberta, Ontario or the States, you have to have it. We are the ones that are out of the picture. We are the ones that are not teaching it, and everywhere else in North America almost, they are.

This teacher felt that the "small school" problem could be addressed by a correspondence course. The Ministry does have a calculus correspondence course. One of the teachers also felt that the Ministry had
... better have someone there to take care of it. There is nobody home in the curriculum branch. Anything changing in the curriculum is coming out of assessment, and that is a terrible way to fix your curriculum. At the Ministry the management style is 'contract oriented'. They put a team together, do something, and then dissolve it. One of the recommendations on the last Revision Committee was that there would be an on-going review process that would keep adjusting the curriculum as one went through it.

At one of the semestered schools where extensive programs of locally developed calculus is taught, but no AP Calculus, two teachers who teach the course felt that, "The timing [of AP Calculus] is really hard since we can only start [the course] in February. But we almost feel, '...what's wrong with us?' AP Calculus is a popular movement". One of these teachers commented that she believed that "the Math teachers of B.C. should look at the situation and write a Provincial calculus curriculum, a good one semester curriculum, and forget AP. It's coming from the States anyway".
Advanced Placement Calculus Students

Thirty students were interviewed. Of these, 27 were taking the AP Calculus course and the other three had registered for it, but had not yet started the course. Of the 30 students interviewed, 10 were taking AP courses in other subjects, and 8 of the 10 were taking AP courses in at least three or more subjects.

Eighteen of the 30 students interviewed had completed Mathematics 12 before commencing the AP Calculus course. The other 12 were taking Mathematics 12 and AP Calculus concurrently. There appears to be a stronger trend to have the students complete Mathematics 12 before commencing Calculus AP. This model is discussed elsewhere.

The questionnaire was followed quite closely, but freeflowing conversation was encouraged, and there were some instances where a question was inadvertently missed. The pilot interviews at the two private schools were more constrained than the later ones where the researcher felt more experienced and allowed more freeflowing conversation to take place. At one school three students had not yet started the AP Calculus course, and so certain questions could not be put to them. These reasons account for the discrepancies in the numbers of students responding to questions.

A transcript of an interview with one of the students is included in the appendices as Appendix E. This interview was included to give an example of the nature of the student interviews and is a representative sample of the student interviews.

Feelings about Mathematics

Twenty-nine of the 30 students stated that they enjoyed mathematics. One student who came 32nd in Canada in the Fermat Mathematics contest last year said, "especially if there is no pressure to do good in tests and contests". Other responses were:

One of my favourite subjects.

Yes, sure, it's OK, I guess.
I like it. I feel the huge success when I get something right, especially if it was hard for me to understand and then I finally get it.

I love it. I once planned to major in Math, but I can’t find a decent job.

My best course, that’s what I do my best in.

Math is one of my stronger subjects. I don’t enjoy it when I fall behind.

It’s interesting.

Two students responded that they enjoyed it when they could do it. They preferred it to writing essays as there are definite answers.

Despite the fact that such an overwhelming majority of the students responded affirmatively to this question, enjoyment of the subject was not cited by a single student as a reason for taking AP Calculus.

Twelve students were asked whether they got good marks in mathematics. They all replied in the affirmative.

The Decision to Take AP Calculus as an Elective Over Another Subject

Twenty-three students were asked whether there was another elective that they had wanted to take rather than calculus. Seventeen replied that there was not another course, and that their choice was not therefore difficult. One student responded that he would have liked to have taken a “fun” course as he had a full academic load. Five students responded that they did have to make a choice because the other subject was blocked in the same block as AP Calculus.
Future Plans at University

Thirty students were invited to say what they planned to take at university. Twenty-six responded that he or she wanted to go into one of the following: Science, Engineering, Computer Engineering, Mathematics and Computer Science, Accounting or Economics, Business or Commerce. One student was planning to go into Arts and eventually into Law. One was not really decided.

Three students indicated that they may go to a university in eastern or central Canada, and two indicated that they may go east to an U.S.A. university. The other students stated that they would be going to a university in British Columbia.

All students stated that they were planning to take a calculus course at university. The one student who was planning to go into Arts and then into Law said that she did not feel that calculus was a pre-requisite for the courses that she would need at university, but, "I learned a lot of problem solving techniques doing Math, so that's why I'm taking it".

Numbers of Males and Females in the Calculus class

The question of what the relative number of male and female students in the calculus class was asked at four of the schools. The students at two of the schools responded that the numbers were approximately equal. At the other two schools the response was that there were probably a few more girls than boys.

Reasons for Taking the AP Calculus course

Nineteen students said that they were taking the course so as to make their transition to university easier. Some of the responses to this effect were:

to get a head start at university.

I've heard the first year math is really difficult and I don't want to get 20 percent.
I don't want to go through first year university not knowing anything about it.

Even if I don't get credit at university, I'll still have an advantage over the course.

It'll make university a lot easier for me. Wherever I go I can concentrate on my other studies.

Calculus nowadays is part of mathematics. I'll have a background when I go to university. Lots of public schools have the course so it'll be a benefit if I know something about it.

I felt that for university I need calculus. I need a strong math backing.

Seven students said that one of their reasons for taking AP Calculus was that they had finished Mathematics 12 the year before and did not want to spend a year without a mathematics course.

Six students gave as one of the reasons for taking the AP Calculus the fact that it was a challenge. By taking the AP test they would be able to assess their ability; AP Calculus was the "highest course in school".

Three students stated that they were taking AP Calculus in order to get advanced placement and credit at university. One student intended to go to a British Columbia university. The other two were planning to go to university in the U.S.A. One student was taking AP Calculus BC and was also writing AP examinations in Economics, Chemistry, Physics and English. This student was planning to go to Princeton University and hoped that by taking the AP courses, he would save himself one year of studies and $25,000 in university fees.

The researcher's impression was that these students were, in general, the top students at the school. They enjoyed mathematics and did well in mathematics; and yet, despite this, they expressed a fear of the mathematics courses at university. It was clear that the single most important reason for their taking AP Calculus was to assist them with their first university course.
Suggestion to Take Calculus

Thirteen students cited a mathematics teacher, either currently or in Grade 11, as the person who had suggested that they take calculus. Some even were influenced by the teachers they had in Grades 8, 9 and 10, but that could have been the same teacher for all three years.

Twelve students responded that the person who had suggested they take calculus was either an older sibling or a friend who had completed AP Calculus and then gone on to university. One student said: "My sister said, 'It is useful and if you take it in university without first having it at school, you may get lost.'"

Only one student said that a counsellor had suggested that she take the course. This student did not fit into the norm in that she came to British Columbia from Quebec for one year in order to learn English, and, on arriving, had to determine her course selection. The counselor spoke with her about AP Calculus.

The data support that the students were influenced not by the counsellors to take the AP Calculus, but rather by the mathematics teachers and older siblings and friends. This was also confirmed in discussions with the counsellors.

The Students' Decision to Take Calculus

Twenty-seven students stated that they had made their own decision to take calculus. Each of these said that they had parental support and encouragement, but most of them were surprised at the question of whether their parents had played a role in the decision.

Comments from students were:

My parents played no part. They don't really know what AP courses are about.

My parents sort of expected me to take calculus, just like another level of mathematics.

My Math teacher had encouraged me. He said, "If you plan to go to university, you should take calculus because you will be learning calculus in your first year university too. It will be a lot easier if you learn the stuff. Calculus is really useful".
Students' Mathematical Background

The researcher tried to ascertain the extent to which the students interviewed had previously been in Enriched or Honours Mathematics classes, and, if so, how this had influenced their decisions regarding AP Calculus.

Virtually all the students who had completed the major portion of their high schooling in British Columbia, had been in an Enriched/ Honours/Accelerated class for some period of their secondary education. Some had started at the Grade 8 level, some at Grade 9, some at Grade 10, and some at the Grade 11 level.

Four students had immigrated from Hong Kong and one from Singapore. All five of these students thought that the levels of mathematics in their former countries were higher than that in Canada. One student stated that: "In Hong Kong the standards are very, very high. I learned Grade 10 Math in Grade 8. I was a lot ahead when I came here".

A number of the students had been in some type of challenge or mini-school program where they had accelerated from the Grade 8 level and had subsequently completed their Mathematics 12 at the end of their Grade 11 year.

Influence of the Students' Mathematics Background

Eight students responded that before they went into the enriched class, the pace was very slow and they were being "held back". They were bored with the slow pace and did not work as hard.

Fourteen responded that they were a lot more challenged in an enriched class. Some of their comments were:

The Honours class was so much more challenging and interesting. I may as well learn something in depth and learn as much as possible about it.

I find it more satisfying to move at a faster pace.

It has been positive for me. It would have been very monotonous if I had been in a regular class. In elementary school I was frustrated.
Streaming had a lot to do with my progress in Math. It got me interested in Math, kept me on my toes. The best thing, I did not stagnate.

In the AP class the students are more hard working, have high standards, and are really ambitious, so I enjoy working with them. The teaching is good quality teaching too.

Two students stated that if they had not been in an enriched class, they would not have had enough confidence to do the AP Calculus. However, there was one student who felt that "the enriched environment had actually lowered my feelings for mathematics. I enjoyed Math before that, but then everything piled up. There was so much stuff. I haven't enjoyed the Math 12 at all". The student was in the semestered school. He had completed Mathematics 12 between September and January, being double block so as to be able to do the calculus from February to May, also in a double block.

Reaction to the Calculus Course

The three students who had not yet started the AP Calculus course are not included among these responses. There are therefore only 27 responses.

Thirteen students responded that they did spend more time on calculus than on other subjects. None felt that this would cause any difficulty for their other courses.

Ten students estimated that they were devoting the same amount of time to calculus as to their other subjects, although a few of these did say that they should be spending more time on calculus than they were.

One student said that she had spent a bit more time on calculus at the beginning of the year, but not later on in the year.

Three students felt that the calculus was very difficult. One student explained it as follows:
It's like you're in Math 11 taking a Math 12 course. The level of difficulty is high. There is a lot of pressure to do well. The class average is 83 percent. It's a lot more difficult to understand. It's easier to make mistakes. Once you understand it, it's not so hard. There are lots of steps.

Six students said they felt that the calculus was "confusing until you understand it".

The teacher just does examples on the board. There is no concept first, but then, when you do a lot of examples, you understand it and then it's easy.

I have to understand and have to think harder.

It's really important that you understand the concept because else you'll be left behind and never [be] able to catch up again.

**Comparison of AP Calculus with Mathematics 12**

Seven students replied that calculus was easier than Mathematics 12. One of these, who was taking Mathematics 12 and calculus concurrently, explained that for her, calculus was easier than Mathematics 12 possibly because she had different teachers whose teaching styles were different.

One student commented that she "usually [did] better in calculus than in algebra. Algebra is broader, but calculus, I just differentiate and integrate. It's not as broad as algebra. It's easier".

For seven students, calculus was as difficult as Mathematics 12. One student stated: "I had already done some calculus in Math 12. It's easy because of my background".

Another said: "Calculus goes into more detail".

Eight students found calculus more difficult than Mathematics 12. In fact, for them, it was the most difficult course. One of these students "found it was not really hard but it needed time".
Most students who had completed Mathematics 12 first thought that it would be quite
difficult to do Mathematics 12 and calculus concurrently. However, the students at the two
schools who were actually taking the two courses concurrently did not think it necessary to
finish the Mathematics 12 first.

It didn’t matter that I had not finished Math 12 first. You just had to know the basic
algebra to do calculus.

It helped to do calculus and Math 12 concurrently, and that I had the same teacher for
the two courses. It would be difficult if I had two different teachers.

I should know more trig. first and then do calculus.

Effect of AP Calculus on the Students’ Mathematics 12 Course

I spoke with a number of students in a semestered school who had completed the
Provincial examination in January. Despite the fact that they had all done extremely well,
they all said that they would, in all likelihood, rewrite both the Provincial and the Scholarship
examinations in the coming June session. The students thought that they would be able to
improve their grade in the Mathematics 12 examination after having taken the AP Calculus.

Students’ Perception of the Universities’ Policies Regarding AP Calculus

Nineteen students were asked this question. Seven responded that they were aware
that the university gives credit for AP Calculus or that the university recognizes AP Calculus.
One student responded that if you get a four or a five on AP, you have the option of taking a
credit at university. One of the students who had responded that they do know that the
university gives credit commented that “I found out after I registered for the course. I was
not really informed here at school. I found out from the university myself”.

Eight students were unsure; they thought the university might give some credit, but really did not know what it was, and did not seem to have given this issue any consideration.

Four students responded that they did not know how the university viewed the AP Calculus.

The hypothetical situation was posed to the students, of the university giving them credit for the first calculus course if they were successful with the AP examination, and then they were asked if they would take this credit or not. Sixteen students responded that they would not take the credit. They would take the calculus course again at university. The comments were:

I will use it as a preparation so I don’t have to work as hard next year. Skipping a year at university just sounds like too much. I’d rather have the knowledge of calculus so I can go in and do well in the first year. University is a big jump.

I’m not worried about being bored with repeating as I’ll have other things to worry about.

I’m not sure if calculus at school is the same as at university. I want to consolidate and be sure of all I’ve learned here and to get better grades. I don’t think I will be bored if I repeat the course as university Math is more complicated. The calculus course will make the transition to university easier.

I’ve heard when people get into university their marks usually drop. I’m afraid that will happen to me, so I will need that mark to pull my GPA up. I will be repeating because I just want the mark. I want the high mark.

I will be confident that I know the information and could spend that time adjusting to that course and to other courses.

I’m going to a new place and, at least, I know there is a course that I won’t be struggling in so it gives me more confidence.

My sister repeated and felt it was a good thing.

Four students responded that they were not sure whether they would take the calculus credit or not. One of these students commented:
I was planning to take the credit until I heard recommendations that lots of people
took the course over again to get a good mark, so I’m not sure. I was originally
considering skipping a year to save time, but now I’m reconsidering this.

Nine students said that they would take the credit if they qualified. Some of these
qualified this remark by saying they would do this if the grade they obtained was good
enough and, also, depending on which university they went to. Five students were at private
schools and of these four were following the AP Calculus BC curriculum. Two students gave
financial considerations as a reason because they are planning to go to Harvard and to
Princeton Universities. They are each taking numerous AP courses, and are hoping to save
themselves, in the one case $22,000, and in the other $25,000.

One student stated that he would take the credit because

I want a high GPA at university and calculus is not one of my stronger subjects, so
then I won’t have to take it at university. My perception of the number of the students
in a calculus class and the failure rate was part of my reason for taking calculus at
school because I’m not good at mathematics or at calculus, so I want to take it in this
environment. I wanted to get it over with and didn’t want it to give me problems at
university mark wise.

Another student who was also planning to go to a university in the U.S.A. said that
she would take the credit as the rules at that university prevent her from repeating the same
course. The only alternative would be to not let them know that she had successfully
completed the AP exam.

One student said that he would take the credit as he felt prepared, and “I’ve kept in
touch with UBC and seen what they’re doing, so I’m confident that I’m up to date”.

Knowledge of Mathematics Courses at University

Eighteen students were asked who had told them about the university mathematics
courses. Sixteen responded that he or she had heard from either a friend, a family member,
a cousin, or a previous graduate from their school. In all cases, the comment was similar to
the following:
Yes, a lot of people say it's really difficult and they've taken the AP and it's really helped them.

School calculus helps a bit, but it only helps for a while until you get going.

I heard that the entire year of calculus that I'm doing now is covered in the first month at university, so it helps for a bit but not for the entire year.

It's so hard at university. It's just a killer. A friend who was here last year who took the locally developed calculus, but wrote the AP exam and got a three on it, and is now in the easy calculus class for Arts students, says, "I should 'ace' this class". Other friends who got a five on AP and went to the advanced calculus class at UBC, they're saying that "they're dying in it".

I've heard that without school calculus, university calculus is really difficult and they have lots of problems.

Both my brothers were at UBC and one of my brothers did the calculus. He failed it. It was a class of four hundred students, I think.

Only two students referred to their teacher when asked this question the one saying that:

the teacher has said a lot about students who have taken the course. He has a famous saying that they come back and say that they "used to think that he went real fast, but then when they got to university they said, boy, you went slow".

**Prestige Attached to Taking the AP Calculus Course**

Seventeen students were asked if there was any prestige attached to taking the AP Calculus course. All the students responded that they had not really thought about it. On reflection eight then responded negatively and four responded positively. The researcher surmised that the students had not thought of this matter prior to being asked the question. Most asked the researcher to explain what was meant. Some of the responses included:

I want to take it so I don't feel so stupid when I'm with a bunch of people that do know how to do it.
Nerd actually, but there is a certain amount of pride outside of school too. That's not really part of my reason for choosing the course.

Some students are scared of it.

A little bit ... at Grade 10 it sounded good.

The Pass Rate in First Year University Calculus Courses

Eleven students were asked if they knew what the pass rate was in first year calculus courses at university. Five students said that they had no idea as to the pass rate. Six said that they had heard that the pass rate in first year calculus courses at UBC was pretty low. A few students thought that the pass rate was:

Something like 50 percent?

About 40 percent fail in sciences.

Quite a high number fail, but it depends on the professor.

I think at UBC it's over a 50 percent failure rate, something terrible, with a class size of four hundred, one professor and a few T.A.'s.

General Comments

At the end of the interview the students were asked if they would like to add any more to the discussion. Twenty-four students responded. The rest of the miscellaneous comments are individual, not relating to any specific question. They have been included as they give a broader understanding of the students views.

Calculus is really different from 'normal' Math.

The AP Calculus gives me a head start over other students at university.
There's more competition now than, say, ten years ago, so it does not feel so special to take these courses anymore. I think I'll be at a disadvantage at university if I was not taking calculus this year.

It was a good decision to take it because now I understand what's going on. I would advise a Grade 11 student to take it.

I'm glad I took it. I was scared. There are three white people in the class. The rest are Asian and do not speak a lot of English. If that wasn't the case, I doubt we would have a calculus course. Caucasians don't take it, fear partly, and also, there are not that many Caucasian students at the school.

I'm glad they finally actually have it because if I went straight to university without it, I'd probably be doing it again at university and it's more expensive then. I just thought I had to take it otherwise I'm going to be 'lost' in university.

It's better to get poorer grades this year and pass at university than to get good grades and fail at university.

I took calculus because I've heard so many horror stories about university being so hard and all, and so when I heard that you'll breeze through the first year at university Math section, I took it to make it easier for me. AP Calculus is a really good course I'd recommend to anyone: "Take it because it will really help you".

I highly recommend the AP course. I really enjoy it. I guess it has to do with the students in my class. They are more hard working, have high standards and are really ambitious, so I enjoy working with them and the teaching is good quality teaching too. The teacher is inspiring. He almost scares us into working, but it works. Calculus was a very good course. It was a challenge, an experience. I want a high GPA. I'm quite worried about what university will be like.

The teacher makes a big difference. I did calculus and Math 12 concurrently. They felt like really different courses to me.

I saw the extra effort that I had to put into the course as a good training for university. The AP Calculus class is more challenging than a locally developed Calculus. The AP exam is a good experience on its own. I would tell an able Math student from Grade 11 to take AP Calculus. There is no point in not getting into it properly.

I will find calculus easy next year and I think I need that break because my other courses will be challenging.

I like courses that are logical. I liked the fact that AP exam is a month before the other exams as I could concentrate on it.
I'll take my school notes with me to university.

I made mistakes this year and got behind and that experience will help me next year. I will know not to get behind.

**The University Professors**

Three university professors were interviewed, one from each of the three universities in British Columbia. The information from each of them was unique and diverse. I thought therefore, that a general analysis would not be possible, and that the actual transcripts would be more useful. Transcripts of their interviews are included in the appendices as Appendix F, Appendix G and Appendix H.

A discussion of their comments and a synthesis of their ideas with the rest of the data is included in Chapter 5.

**The University Students**

The researcher's emphasis in this study was at the secondary school level. Nevertheless five university students were interviewed. The researcher was interested in determining whether their responses were consistent with responses from students at school. The researcher thought that a comprehensive study of this group would constitute a study in itself. The students interviewed were chosen by chance meetings, and the researcher was not attempting to determine a representative sample. The researcher thought that the information provided by these students was consistent with information obtained from other groups, and was relevant, and could be included here on these grounds.
The University Students who had Completed AP Calculus and a First Year University Calculus Course

Of the four university students interviewed, two students (hereafter referred to as S1 and S2) had taken Mathematics 12 concurrently with AP Calculus. One student (S3) had taken Mathematics 12 at a semestered school in the first semester of Grade 12 and AP Calculus the semester thereafter, and the fourth student (S4) had completed Mathematics 12 at the end of Grade 11 as a result of a challenge program at her school. She then took calculus in a non-semestered school for the whole year during her Grade 12 year.

The students interviewed were from three universities: S1 and S2 went to SFU, S3 went to UBC and S4 went to McGill University in Quebec. S1, S2 and S3 had completed the first semester of calculus at a university in B.C., and S3 had started with a second semester of calculus. S4 had obtained a five on the AP Calculus exam, and had taken credit at McGill for the first semester of calculus. She had proceeded to take two more calculus courses and one course in Linear Algebra. She had just completed her first semester of her second year at McGill. S1, S2 and S3 had not received qualifying marks in the AP examination for credit at university, but all three indicated that they would not have taken credit if they had the choice. They expanded on this by saying,

If I had got credit, I probably would have been thrown into something too deep. It would have been more difficult and made my first year at university tougher.

I took calculus at school so I would have an easy course in the first term.

S4 did Calculus 2 in the first semester at McGill. She found that 75% of what she did in Calculus 2 had already been covered in the AP curriculum, and only the last 25%, parametric equations, was new. "I found it really easy". This student was disappointed that at McGill, the AP grade does not count towards your GPA. They give credit, but the grade is not recorded. She did not take Calculus 1 at McGill as "I thought it would be a boring course. To take the course over just to get a high mark is pointless".
The students were asked how they would compare what they did in AP Calculus at school with their first calculus course at university. The consensus was that "the calculus course at university paralleled almost exactly what we did in AP".

However, at university, I felt I was just a number, not like a person. At high school, you trust your Math teacher just to get the basics and understand everything, and at university, you just learn 'at a very fast clip' how everything was proved so you know it [what your high school teacher taught you] was true.

S4 took Calculus 2 in the first semester at McGill, and was in a smaller class of about 80 to 100 students. Approximately half of these students were repeating the class. However, she was very successful in this calculus course at university.

She then did a course on Linear Algebra. She commented,

I had not done this in high school. I think this was neglected in B.C. high schools. You should have some. I really think it's very important when you go to university. The Linear Algebra is required for engineering, I think, and also for management. I think it's something that has practical applications. It's one of the few things where you can really see results.

When asked if she was referring to vectors and matrices, the response was,

Yes, they should be in the B.C. curriculum because I had no exposure to them when they started talking about them, and I did not know what they were about. It was very difficult to start thinking in that fashion. I had not been exposed to it before.

These topics are in the Survey Mathematics 12 Course that was initiated the year after this student completed high school.

The students were asked whether the material in the first calculus course was a repetition of the AP Calculus material. Their responses were

Yes it was repetition, but it was good. I did not find it boring because the pace was fast, and there were lots of examples, so you could start to work it out yourself and see if you got the right answer.

I found when everyone was learning, I was reviewing. A lot of people felt frustrated. I was definitely pleased I had taken it at school. It was going a lot faster. I think that was the main factor. Everyone was struggling.

They felt that the students in the class who had not taken calculus before "[were] at a disadvantage".
S3 said that at UBC "AP has definitely helped towards the second semester as well".

**Decision to Take Calculus in Grade 12**

Three students responded that their mathematics teacher had "really convinced them". One student also said that the assistant head who organized timetables had suggested to him that even if he does not get credit for the AP, "It will surely help me, and be most beneficial to me to take it".

S4 had completed Mathematics 12 at the end of Grade 11, and did not want to be without a mathematics course in her final year at school. She also thought that it would be beneficial to get credit for the course at university. This student had never intended to study Sciences at university. She would have liked to take other AP courses at school, but they were not offered. She thought it was advantageous having extra credits at university as it means you do not have to take "a full load" all the time.

**General Comments**

S4 was asked what the most difficult part of AP Calculus had been for her. Her response was:

I think the very first part where you had to learn what the concepts were. In the beginning the concepts were difficult. Once you got the concepts, everything else followed. That is the most difficult part ... conceptually. It really helps if you get it right at the beginning. You can do much better than if you only get it a long time after everybody else has because, after you have the concept, it is very easy to apply.

The students were asked whether the AP Calculus had helped them. There was consensus that it had helped. One of them said

Even if you don't pass the exam or even write it, coming into university the first three weeks when they really go through stuff quickly to try to weed people out who are not sure about being there, you feel quite comfortable with the material.

One student said that it would have been much tougher if he had not taken AP.

I am sure the difference would have been fairly substantial. It helped me settle into university. It took some pressure off. I was not under the gun.
It was definitely good to take calculus at school. The professor never went over specific questions in class. He never assigned homework. In school we were constantly going over our homework, and it was much better. The slower pace at school also makes a difference. For sure, it gives you more time to go over stuff.

The students were asked whether their knowledge of calculus from school had affected their attitude to the calculus course at university. S1 responded that he was a bit relaxed, and did not study as much as he should have. S2 said that

for the first two weeks I was so overwhelmed in Physics, so it just helped. The other classes in the first two weeks were so overwhelming. When you got to be able to handle what was going on in the other classes, then everything went smoothly.

S1's response to whether he thought he understood calculus after completing the AP Calculus course was

Yes, more so than I had anticipated. I had heard horror stories about it. One's marks do drop in first year university. You catch the curve that they grade you on. You go from being a straight A in high school to a C and B student at university.

And S2 said,

I know I have not got any dumber. There are just more people [at university]. They are smarter, and maybe you have to get used to university and studying on your own. There is no time at university. You almost do not have time to read the material. It is quite a shock. They go at a really good clip. Last year, the teacher gave lots of extensive notes. I did not read the calculus book either last year or this year. If you kept up with the work at university regularly, it was manageable.

The students were asked about their mathematics background at school. S4 said that she had been in the challenge class for a few years, and

it made a big difference. I only noticed it once I got out of that environment. For the next two years the school did not have an honours class. The original honours classes had been part of a challenge program. I went to the regular class, and the pace was much slower. I was one of the top students in the class. Although we did easier work in the regular class, there were not other good students there to stimulate the discussion. I would prefer to take the more challenging environment though it is nice to be top of the class. In the more challenging environment, you are more stimulated and you learn more, and it is faster. The regular class was boring.
When asked if everybody in their AP class had written the AP examination, the responses differed. One student stated that everyone had the option and the ability to write the AP examination, but a lot of students chose not to. Another student responded that everyone who took the course wrote the AP examination. "You had nothing to lose by not writing it. The school paid for the examination".

When asked whether the students enjoyed mathematics, all responded that they did.

The University Student who was Unsuccessful with the First Calculus Course at University

This student had completed Grade 11 mathematics without too much trouble, but then experienced trouble with his Grade 12 mathematics which was the Algebra 12 course. He obtained a C in the Mathematics 12 Provincial examination, and did well in his other subjects. This student wanted to study Business Administration and needed a minimum of a B in Algebra 12 in order to take the required calculus course at university. The student worked for six months after completing school, and started university in the second semester. At this time he took the pre-calculus course, and although it went at a "blistering pace", he managed to keep up and got a C+. A student merely had to pass the pre-calculus course to be admitted to the calculus course. The student thought that he understood the concepts, and started the calculus course the following semester. The student was taking five courses at the beginning of this semester, but, soon after the semester started, dropped one of the courses as he realized that the work load was too great. The student's experience with the calculus course was that,

I got behind a bit in calculus. I found the more I tried to catch up, the further behind I got. The more I tried to really understand the concepts that I lacked on, the more I got behind in the ones being taught, and before I knew it, I was lost. I cannot put my finger on when it happened. For me it went very fast. I needed a lot more time to get familiar with each of the concepts they gave us. You had to have the previous
concepts down pat so you could understand the next one. Eventually the links in the chain grew weaker and weaker. By exam time, I did not know where to start. The professor was an ESL person. His English was very poor, and I had 'a hell of a time' understanding him. He knew his Mathematics. He was clear and concise. I copied all his notes, but when he was explaining what he had done, I would not understand a word. I went to the open labs. The teaching assistants were there to keep you on track. The teaching assistants told me to try the problems first. Well, I would try them for an hour, and "I'm stuck", and I ask him to tell me what to do next, and he goes, "well, you have to do something with that. Go and do it again". I would be working for one, two, three hours on the same problem. They only gave you assistance when you had attempted a question and they could point out your mistakes. My problem was trying to get to the next step. I did not know how to get to the next step, and they were not willing to show me until I had tried, but I couldn't try because I did not have the know-how.

A lot of the time I would say, 'Why?' and he [the Professor] would say, 'Because.' He did proofs. Sometimes I did not follow one of the steps in the proofs. I did not know what he did and how he got to the next step, and then he would go, 'I did not multiply this. I did it in my head.' I needed every little minute detail, and they do not have room or time for this. He left out a lot of the algebra assuming that we would see it and know how to get there.

The course was evenly spread out, but it was a constant barrage of information. The amount of procedures he spewed out week after week, it was really difficult for me. In trying to do the assignments, there were really long equations. I would work it out and get an answer which was incorrect, and not know where I went wrong. I could not understand what I did wrong. It was just the concepts I had such problems with. I could not understand how he got certain numbers. A lot of the students in the class were there for the second or third time, and had learned tricks from previous teachers. They were scoring high marks, and I was frustrated. They were coping with him. I must say he was a great teacher. He knew his Math and was very fair on the exam. I saw some harder exams from other professors.

There were some students in the class who had an A or a B on the Algebra 12, and, therefore, did not have to take the pre-calculus and came straight into this course. They were wishing that they had taken pre-calculus.

By the end of October I had given up on the open labs. They were not helping me, and I was spending much too much time there. I realized at that time that the best I could do was to get a C- or a D, and I would have to take the course over again anyway for my GPA. My other subjects were suffering. I realized I had to give up on the course. Then the marks [in my other subjects] went up. However, I stuck with the course and took notes at every lecture so that it will sound familiar when I take it again, so that I have seen it before. I will take this course again in the summer where I will be taking only this course. I can concentrate on it only. This time I'm confident I will do all right on it. It is an abuse on my GPA. I really want to give this thing a pounding. I need the calculus to get into Business, but I need an A or a B on it as I have to have at least a 3.00 on my GPA.
When asked whether the student thought that calculus was a "weeder" course, he responded,

There are a lot of weeder courses, Economics, Physics, Chemistry. The thing is, those who go to university who succeed are serious. So any course is a weeder course if you go there and fool around. If you’re serious and you need the calculus, you should succeed. It is a weeder course in the fact that it is a very difficult course and it has a high failure rate, but, unfortunately, it is one of those courses which are mandatory if you want to get into other areas, and if the student is determined to get through it no matter how many tries, he will eventually pass calculus. He may fail a few times. The students work hard. They hate it. I do not know any student who likes calculus. They realize it needs to be done, and grit their teeth, and grin and bear it. I would not rate the "university atmosphere" as opposed to a "school atmosphere" as a factor for my problems with calculus.

This was the student’s second semester at university. He had already had a chance to settle in, and had made the social contacts that he felt he needed to assist him with his work. He was not, at the time that he started taking calculus, overwhelmed by the university atmosphere.

There had been a calculus course at the school that this student attended in his Grade 12 year, but he did not really know about it. He thought it only applied to "challenge students". He had been in the regular program, and so never really looked into it. When asked what advice he would give to a student who was going into Grade 12, in regard to calculus, his response was,

Make sure you know you are going to need the calculus. If you do not need it, it is a waste of time. If you do need it at university, I would say, yes, for sure, definitely take calculus at school. Your university average takes a beating when it does not need to.

The British Columbia Association of Mathematics Teachers (BCAMT)

The British Columbia Association of Mathematics Teachers (BCAMT) is a professional organization that comprises approximately 1200 secondary and elementary mathematics teachers in British Columbia. Membership is voluntary and the function of the BCAMT is to "provide quality conferences, quality publications, strong representation to the Ministry of
Education regarding issues in mathematical education, connections with the larger community of mathematics teachers nationally and internationally" (BCAMT Newsletter, 1992).

The BCAMT considers global issues for mathematics. It makes representations to the provincial Ministry of Education relative to matters pertaining to mathematics education in British Columbia.

In 1987 the BCAMT published a clear position statement against Calculus being taught at the high school level, in response to calls for comments on a proposed revised school mathematics curriculum.

The BCAMT does not support a calculus course as a part of the mathematics curriculum in British Columbia. The primary goal in the secondary school should be to teach the prescribed British Columbia curriculum. The proposed new curriculum includes a short calculus unit in Grade 12. ... The calculus course should not be a component of the B.C. prescribed mathematics curriculum. There is no intent to prescribe a calculus course for all secondary schools.

To provide consistency across the province, schools offering a calculus course should offer the Advanced Placement Program. Every effort should be made to encourage most of the calculus students to prepare for and write the Advanced Placement examination. The rationale is to have students recognize that calculus is a comprehensive course and that their full attention and application are required. It naturally follows that the post secondary institutions must recognize that their students have done the Advanced Placement course, and appropriate placement should follow (BCAMT Position Paper, 1987).

The information that follows was obtained from the current President of the BCAMT, and represents his views at all times. According to the President that statement was withdrawn (albeit not officially, or in writing to its membership) later, apparently because it was so obviously contradictory to the then state of affairs in the high schools where a substantial number of schools were offering calculus. Furthermore, the new Mathematics 12 curriculum included a calculus component in direct contradiction to the position statement. However, the President stated that "a lot of us still believed in it [the position statement]", and it was accordingly difficult to withdraw.

The President stated that the BCAMT did not make a formal presentation to the Revision Committee which was working on the new Mathematics 12 curriculum. However,
the BCAMT's presence before that committee was felt by reason of the fact that some of the members of the Revision Committee were also executive members of the BCAMT. Nevertheless, a unit of introductory calculus was incorporated into the new Mathematics 12 curriculum.

The BCAMT is currently seeking a total review of the mathematics program, and a meeting of the BCAMT is scheduled for June 1992 at which this topic will be considered. The President is personally in favour of "reinstating a policy and negotiating with the Ministry not to accept calculus in addition to Mathematics 12". In his opinion, the Ministry is not currently looking at the mathematics program.

In regard to the difficulties that students appear to have had with calculus at university the President is of the view that many schools are offering calculus so the students can survive the first year [at university] at the expense of the students who do not survive. There is not an even playing field in first year. My feeling is that just because the universities are 'doing a lousy job' of teaching calculus that does not mean that we should be assisting them by teaching it in Grade 12. Calculus is a first year university course everywhere except where high schools respond to the poor job the universities are doing in the first year calculus courses. Their high failure rate is turning women off from Mathematics which they do. The dropout rate [from mathematics programs] for women after first year calculus is way higher than for men.

Their record is deplorable, and I do not think we should be covering for them to improve their failure rate. The result will be that the universities will 'up the level'. We have one of the highest retention rates in the world in grade 12 for mathematics students, also one of the highest participation rates for females in grade 12. After the first year of university, this is blown out of the water. Instead of forcing the universities to address their problem, we are trying to band-aid it for them. The worst teaching I ever encountered was at the university level, and particularly in mathematics.

**Small Schools**

The President was concerned about the problems of a small school. The economical aspect of running a class with very few students in a school with a small enrolment is different from that of a large school. The President stated that:

There is an actual cost of an AP Calculus course to a small school, the major cost being the cost of a block of teachers' teaching time plus the textbooks and the AP examination. You are probably looking at about ten thousand dollars for fifteen
students. I was not able to reassure the principal of such a school that his students
would not be at a disadvantage if they did not take calculus. He wanted some
evidence that students did not do significantly better in first year calculus if they’d had
AP Calculus, and I referred him to the article by Ferrini-Mundy and Gaudard. As
BCAMT president, I have to be responsible to all mathematics teachers in the
Province, and my sense now is that there is a terrible inequity in the Province due to
access.

There are some serious implications in offering calculus in schools that can afford to
offer it, whereas there are a number of schools that cannot offer it, particularly in rural
areas and particularly small schools. Our organization has to think of the global
issues for mathematics, and our organization is necessary to produce some equity in
this situation.

We have to speak out against any system which clearly discriminates against
students from small towns. In point of fact, the students who do the AP Calculus,
even if they do get a qualifying mark, do not take advanced placement, but use it to
have a “jump” on other students in first year. Educationally, we have to ask
ourselves, “Is this right?”

The President of BCAMT was of the opinion that the Survey Mathematics 12 course is
a far better course for students than calculus, and that the AP Calculus courses will detract
from Survey Mathematics 12.

There are schools who do not teach Survey Math 12, but have two blocks of calculus.
Every school in my district now has a calculus program. It is insidious. Once one
school has it, all the schools have to otherwise the students who plan to go on to
Math and Science would go to the school that has it.

When asked whether AP was offered to hold good students at a school in a district
where the IB program had been implemented, the response was,

I know that the school in my district that had IB ‘bridled’ when they heard that AP
Calculus was being offered because they felt that now they would not get the best
students coming to them.

The President of the BCAMT expressed the view that he felt that calculus was
redundant with Mathematics 12, since the Mathematics 12 course has a calculus section in it,
whereas Survey Mathematics 12 was not. “They should do a really good job of the calculus
within the Math 12 curriculum”. He thought that the BCAMT needs to talk about this issue
and come up with a position statement and “hopes that the Ministry will listen to us”.

The President's immediate response to the reason AP Calculus had grown so rapidly over the last few years was because of the high failure rate in first year university. When asked whether the changing population of Vancouver was a factor, he replied: "Especially the Asian students who are really motivated to do well at school, and are very competitive at the university level. If they think there's anything that will give them an edge, they will take it. It is definitely a factor".

A Member of the AP Calculus Development Committee

Dr. Bert Waits, a member of the AP Calculus Development Committee, and a Professor at the Ohio State University spoke at the BCAMT's Mathematics Conference in 1991. The topic of his presentation was the "Calculus Reform Movement in College Calculus". His address was directed to the power of using graphic calculators to teach and learn calculus.

He stated as a fact that most college (university) calculus teachers, in the U.S.A. do not make use of the available technology. They teach calculus at university in the same manner as it has been taught for the last "20 to 50 years". Waits thought that it would be the students who would motivate the change in the manner of teaching calculus at university. He also expressed the opinion that in the U.S.A., some of the best teaching of calculus occurs at the high school level.

Dr. Waits said that the purpose of AP Calculus in high school is to mirror good college level calculus so universities are comfortable giving credit to students with AP Calculus. He implied that scientific and graphic calculators were not currently being extensively used in calculus courses at the universities. However, the AP Calculus program is assisting the calculus reform movement by permitting scientific calculators to be used for the 1993 examination. It is also anticipated that graphic calculators will be permitted in the examination by 1995. The dilemma is that AP Calculus is intended to reflect and not lead the college curriculum.
Dr. Waits thought that AP Calculus had grown in recent years in British Columbia because it is a challenge to the good students who see a need for it. He also commented that "A good AP [Calculus] course is often the best calculus a kid will ever get. And that's a fact because the AP Calculus teachers are by and large the top high school teachers in the school[s]".
CHAPTER 5

DISCUSSION AND CONCLUSIONS

The discussion and conclusions made in this chapter are based on the analysis of the data in Chapter 4. An attempt has been made to synthesize information obtained from all the different stakeholders involved in the study. Conclusions are drawn as to the factors that have contributed to the introduction and growth of AP Calculus in British Columbia. Inequities that have arisen as a result are examined. The views of the Advanced Placement calculus teachers and students are looked at, and some conclusions are drawn as to where the students' difficulties with calculus may lie. The current position of the universities is then reviewed together with the perceptions of the various stakeholders concerning the universities. The positions of the Ministry of Education and the BCAMT are set out.

The Factors Contributing to the introduction and Growth of AP Calculus

There is consensus that indirectly it was the Provincial Government's initiative in the form of the "Funds for Excellence" program that gave AP Calculus its start. Districts had to identify "gifted students", so as to qualify for this money, and as a result, a number of districts designated one International Baccalaureate (IB) school in the district. As a result, the IB school became a threat to other schools in the district as it was drawing the better students. The other schools sought an alternative program to counteract this "brain drain". AP Calculus, which had existed in the U.S.A. for more than 25 years, but was relatively unknown in Canada, became a program that was very inviting. This would not have been the case if the AP program did not have substance, and was not a quality program. The introduction of AP Calculus had a ripple effect. As one school introduced an AP Calculus course, there was
pressure on other schools to introduce the course so as to compete with the former. The students were demanding a program of excellence.

The Advanced Placement Calculus Program was a relatively easy program for a school to implement. Since the existing Algebra 12 mathematics course was a pre-calculus course, AP Calculus progressed naturally from it. The AP Program was also relatively inexpensive to implement. The schools’ only financial commitment to the College Board occurred at the time of the examination and was to ensure that the examination fee was paid.

Teachers were willing to make the effort required to teach the course. Some of them had taught locally developed calculus courses for a number of years and the change to AP Calculus was relatively easy. Many students had completed Algebra 12 at the end of the Grade 11 year, and it was logical to teach them calculus, particularly in view of the reports of former students regarding the difficulty of calculus at university.

AP Calculus grew prior to the implementation of the new Mathematics 12 curriculum as a result of the desire of teachers and the pressure from students for a calculus course. Immigrants have contributed to the introduction of AP Calculus in those geographical areas where they have settled. Many immigrants had an advanced mathematical background, and were ready to move on. While this may have been a factor in the large urban areas, AP Calculus nevertheless also developed in other areas.

The initiative of the schools prompted the universities to develop a policy of granting credit for AP, and giving it recognized status. Despite this most students do not select either the credit or the advanced placement choosing instead to take the university calculus course.

Advanced Placement is a well run organization and communication between the school and the College Board is straightforward. Advanced Placement has a high profile and an excellent reputation. The Program has existed in the U.S.A. since 1955, and many universities recognize it. AP promotes its program through conferences in various locations. The College Board responded positively to the initial approach of teachers and principals in British Columbia.
Having discovered a market in British Columbia, and indeed now in Canada, the College Board established an office in British Columbia, appointed a Director, and promises Canadian input to its Program in the near future.

Inequities

There is inequity between the larger and smaller schools. A large school will have sufficient students who will enrol in the program and it will be treated no differently from an economic perspective, to any other elective. If the AP class size is initially small, this will be offset by slightly larger class sizes for other electives. As a result, teachers’ time is not a factor. In small schools however, that offsetting does not happen and the cost of a very small AP Calculus class may be prohibitive. In that event, the students at the smaller school will not have the opportunity to take a calculus course at high school. Principals, counsellors, teachers and students believe that students who have had an AP Calculus course (or a LD Calculus course) at school are at a significant advantage over those who have not when they enter the first year calculus course at university. As one of the teachers expressed it: "[the students who have not had a calculus course at school] do not stand a chance".

There is further inequity in that some districts pay the examination fee for their AP students whereas others require the student to pay the examination fee or a part of it. On the other hand no one interviewed appeared to be concerned about this.

There is inequity in that the Ministry recognizes IB courses but not AP Calculus courses. Although teachers and principals think that the AP students should get this recognition particularly as the universities now recognize the AP Calculus the Ministry has resisted such a move.
Global Perspectives

The mathematics coordinator, the Mathematics Revision Committee member, and the President of the BCAMT look at the mathematics curriculum from a global perspective. They are concerned about meeting the needs of all students, and from that perspective, a broader curriculum would probably provide a sounder basis for mathematics education. They are also concerned about the inequality of the small school situation.

At present, the Mathematics 12 curriculum focuses on pre-calculus mathematics. However, students proceeding to university seem to need not only a sound pre-calculus background, but also a calculus background. In theory, the philosophy of a broader based curriculum is appealing. However, in practice, students proceeding to university are demanding both pre-calculus and calculus.

The Mathematics 12 curriculum is the pre-requisite course for calculus at university. The implication of this is that the expectation of the university is that it is a preparatory course for the calculus course at university. The present "global curriculum" does not appear to fulfill this need. This topic will again be discussed in the section headed "The Ministry". A discussion of the conflict with the Survey Mathematics 12 course will also be dealt with under that heading.

The Advanced Placement Calculus Teacher

All of the AP Calculus teachers interviewed were senior "master mathematics teachers". They had taught mathematics for between 15 to 30 years. They all referred to the amount of work necessary to teach the course, particularly in the first year. The majority of the teachers enjoy teaching the course; one of the factors is that the students are "the cream of the crop".

The teachers' perception is that without AP Calculus, many students will not succeed in the first calculus course at university. This is what former students tell their teachers. This
was best expressed by the unsuccessful university student who said: "If you do need it at university, I would say, yes, for sure, definitely take calculus at school. Your university average takes a beating when it does not need to".

The language used by teachers and students to describe what happens in first year calculus courses was emotive. Expressions like: "It will kill you", "I'll die", "I don't want to drown", were frequently used in describing the perception of what would happen to the student if he or she took a calculus course at university without having taken it at school.

The teachers believe that as a result of the larger number of students taking AP Calculus at high school, the university courses have already become more difficult and that this may continue. If this is so, the students who have not had calculus at high school will be at an even greater disadvantage than is presently the case.

The AP Calculus or the LD Calculus teacher believes that he or she has had to shoulder the responsibility of ensuring that his or her students will succeed with calculus at University. For the teacher, it is the AP Calculus course and not the Mathematics 12 curriculum which gives them the means to do so. It is also a prestigious course. Dr. Leeming referred to the fact that high school teachers had, on occasion, been blamed by their former students who had not succeeded in the first calculus course at university. He thought this to be harsh.

The AP Calculus course encourages and challenges the good student. It is manageable and stimulates the teacher. The process of working through the curriculum and preparing for the examination is more important than attaining a successful score on the AP examination. This is best exemplified by the fact that the students are generally not interested in obtaining Advanced Placement or credit at university. The teachers nevertheless think that recognition of the achievements of the students by the Ministry would be appropriate.

Most teachers thought that they presented the AP Calculus course at a level different from that presented at a university calculus course. One teacher commented: "I had to make sure that I could explain it in terms of the Math that they knew in Grade 12". Another
teacher's perspective of the university calculus course was: "There is a very abstract theoretical presentation of the beginning of calculus by people who generally do not know how to teach, and do not understand how people learn. A lot of students get very confused". Two teachers thought that their course was at the same level as a university course. The benefit to their students was that they were in a much smaller class.

Both teachers and principals agreed that it was essential for the teacher to be willing and able to teach the course. They also agreed that the teachers needed, and had, the support of the principals.

The Use of Graphic Calculators

With one exception, all the teachers used graphic calculators to a varying degree. Class sets of calculators had been provided by the districts prior to the implementation of AP Calculus. Most of the students had learned to use the calculator during their regular mathematics program.

The attitude of the universities to graphic calculators varied. At Simon Fraser University and the University of Victoria graphic calculators are not used. Dr. Gerber of Simon Fraser University thought that it would be unfair if one student had a more powerful calculator than another, and therefore did not permit graphic calculators. Dr. Leeming of the University of Victoria said that there were no incentives for innovative change in this regard. He commented: "I think that there is a basic inertia to [change]". Dr. Bluman of the University of British Columbia said that each lecturer had autonomy and could do whatever he or she prefers. Dr. Bluman allowed his students to use any calculator. He did not elaborate on what other lecturers at UBC do.

All three university professors appeared to me to be much less willing to introduce the graphic calculator than are the teachers. In fact, the schools all had class sets which apparently were being used not only in calculus courses, but also in the senior mathematics courses. Only one teacher expressed a reluctance to use them. The cost factor should no longer be relevant since a graphic calculator is not much more expensive than a textbook.
The Advanced Placement Calculus Student

The majority of the students have either been in a mathematics honours program, or in a mathematics challenge program at some time in their high school career. Teachers, counsellors and principals all agree that the "best students" were taking the AP Calculus course. They also agree that the course is a "confidence builder". The students thought that the AP Calculus course would make their transition to university easier. It would also give them an indication of what to expect from a university course.

For most of the students, the university policy regarding AP Calculus had not been a factor in their decision to take AP Calculus at school. Students are not generally taking the AP Calculus to gain credit or advanced placement at university. Many did not even know the policies of the universities. They are taking the course for other reasons. Similarly, teachers do not teach the course for this purpose.

Despite the fact that the students were among the best at the school, and enjoyed doing Mathematics, none gave this as a reason for choosing AP Calculus. Rather, the reason they gave was that they were afraid of the calculus course at university. They have heard that the calculus course is "a killer" at university. Sixteen out of 18 students said that they had heard this from a friend, sibling or ex-graduate. However about half of the students had heard about the calculus course at their school from their mathematics teacher. This supported the views of the teachers and counsellors who overwhelmingly thought that it was the mathematics teacher who provided the students with the information about the AP Calculus course. The latter position was also supported by the university students who all said that they had received their information from the mathematics teacher. The students thought that their parents encouraged them to take AP Calculus even though they did not really know what it was that the students were taking.

AP Calculus gives the student an idea of what a university course is like, and the effort that is expected. It does so in a much more nurturing and protective atmosphere. This allows the student to make the transition to university more easily.
The teachers and students did not think that taking AP Calculus caused a problem for their other subjects. Only one teacher said that "Usually these kids miss out on the humanity courses".

Whether the student is male or female does not appear to be significant. Often the schools are blamed for not encouraging females to pursue mathematics. The teachers and counsellors at schools were very positive about mathematics being an important subject for all to continue with, and that there was no distinction between the sexes at schools. The females certainly appear to be keeping their options open in their Grade 12 year at school.

Students' Difficulties with Calculus

The students found that the initial section dealing with the concepts of calculus, was difficult. Once having understood the concepts, what followed (the application) fell into place more easily. They thought that it was necessary to understand the concepts from the outset as it would be difficult to do the calculus before having an understanding of the underlying concepts. One student summed it up as follows: "It's really important that you understand the concept because else you'll be left behind and never be able to catch up again".

A common comment of the students was that they do better in calculus than in Mathematics 12. Their impression was that Algebra was a broader topic. Calculus was described by one student as: "just differentiating and integrating".

Three key individuals referred to the fact that students difficulties with calculus lie, not in calculus itself, but with algebra and trigonometry. Dr. Leeming suggested that one student in three who failed at university was failing not because of the calculus concepts, but because of their poor algebra and trigonometry skills. The Mathematics Revision Committee member spoke of the LD Calculus course at her school which included teaching the student how to communicate mathematically, and how to work through a number of algebraic steps in a problem. She commented that this was something that the students did not learn in the Mathematics 12 course. The unsuccessful university student stated that he needed every
minute detail explained to him, and that the university lecturer did not have time for this. As a result, he did not know what the lecturer did or how he got to the next step. The lecturer left out a lot of the algebra assuming that the students would understand, but he did not.

It would therefore appear that the students find the algebra, which is what they learn in their Mathematics 12 course, difficult. The Curriculum Development Branch of the Ministry of Education, and also the Evaluation and Assessment Branch, which sets the Provincial Examinations, both need to be aware of these difficulties. According to the university student who failed, and to Dr. Leeming, some students are unprepared for the university lecturer who does not explain every step of a problem. Many of the problems in the AP Calculus curriculum require calculus concepts for the first step of the problem, followed by simplification techniques which are algebraic in nature. This is probably true of the first year university courses as well.

The students need time to properly understand and absorb the calculus concepts. One teacher stated that AP Calculus helped students with their study skills, which in turn prepared them for university. One of his students told him that at university "[you] really have a bunch of stuff hammered at you". Dr. Gerber noted that the calculus course at university "had become packed" and that some of the course should be removed. Based on the results of this study, the universities need to consider the issue.

A number of questions arise out of the above discussion. The Ministry sets the curriculum for Mathematics 12 which is a pre-requisite course for university calculus. The secondary school teacher teaches the Mathematics 12 course to the students. Is this course deficient? Is there a total mismatch between the pre-calculus course at school and the calculus course at university? Judging from the number of students desiring to take calculus at school, it would appear so.
Calculus at University Level

Prior to the introduction of the new Mathematics 12 curriculum, a student reported back to his school as follows: "Our professors expect us to know some calculus. The professors assume that we've had some calculus".

Dr. Bluman noted that the overall results of first year UBC calculus students have improved over the past three or four years. He attributed this to the greater involvement of students in the Euclid contest and the calculus component in the new Mathematics 12 curriculum.

With regard to the Euclid contest, it must be noted that despite the fact that all of the schools included in this study participated in the Euclid contest, it was never once referred to by any of the other informants as being a factor that contributed in assisting the students with their first calculus courses at university, or in any other way. Bluman disagreed with the suggestion that the Euclid contest was not a primary focus for the students, and that it was a relatively insignificant factor.

With regard to the calculus component of the Mathematics 12 curriculum, Bluman suggests that it is this that has contributed to the improvement. In his interview Bluman himself contradicts this argument when he states that "We were [against] having that [the calculus unit] in the course [the Mathematics 12 course]. We much prefer the students to have had either no calculus or a full [course], like an AP course. We do not think of something in between as a healthy thing". One teacher thought that, "the calculus section in the Mathematics 12 curriculum is an embarrassment". Also, since only the 1991 school graduates studied the new curriculum, only they could have been influenced by it. Bluman noted that the improvement had been noticed over the last three years.

When it was suggested that many more students were now taking a full semester, or a full year of calculus at high school, Bluman did not think that this was the reason for the improvement. Dr. Bluman pointed out that close to one-quarter of the students had taken the AP Calculus prior to entering university. This does not include students with LD Calculus. He
stated that most of the AP students did not move on to the next course, or into the Honours course at UBC, which he said meant that most all of them were repeating the same work. This supports my contention that one of the reasons for the improvement is the fact that calculus courses are being taught in the high schools.

In a subsequent discussion with Dr. Gerber it was pointed out that the admission standards for students entering universities in British Columbia had been raised, as had the grades for students being accepted into the first calculus courses at university. He noted that since the majority of students who fail likely are those at the bottom end of the spectrum of all students entering the university, these higher admission standards would necessarily reduce the failure rate.

The universities in British Columbia do recognize AP Calculus and those students who so desire, may attain advanced placement and credit. At UBC, an Honours course was established and students who were very successful with the Euclid contest, or who had a four or five on the AP Calculus AB or BC, were invited to take this course. Dr. Leeming's perception of the UBC Honours course is that it is very successful. Dr. Bluman noted however, that to a certain extent the AP Calculus was a failure because there was very little follow through. Very few students were enrolling in the university Honours course. Most of the students were repeating at university the calculus they had learnt at school in the AP Calculus course. The students admitted to the Honours course are among the very best mathematics students entering the University. A teacher reported that one of his students who had attained 100 percent on the Provincial examination, found the Honours course at UBC "heavy going".

Most of the teachers, counsellors and principals had no idea of the large proportion of first year university students who take calculus. They expressed surprise when told that Dr. Bluman had said that it was 87 percent. It was not possible to ascertain the percentage at the other universities. Nevertheless, calculus is obviously a very important subject at the university level.
Dr. Gerber and Dr. Leeming do believe that calculus is used by other faculties as a "weeder" course, and are not particularly happy about this. Dr. Bluman, in response to the question of whether calculus is used as a "weeder" course by the university, said that if calculus is a pre-requisite for any particular course at UBC, it is subsequently used in that course.

A number of principals thought that the first year calculus course was used by some Universities (especially UBC) "to weed people out". One principal expressed concern that the IB and AP programs would ultimately be used as screening devices for the university so that a student will be admitted to the university only with such a course. Mr. Ewonus was concerned that the universities may already be using AP Calculus to screen students for scholarships awards.

Both the university professors and the College Board were concerned that students with AP Calculus were essentially repeating in their first year university calculus course that which they had learned at school. Both would prefer the students to accept the advanced placement. However, as long as the students perceive that calculus at university is a course which causes difficulty to many students, they will likely choose to repeat the course.

For many students, the only university mathematics course that they need is the first calculus course. Once they have successfully completed that course, they can proceed with their program. Research shows that for those students who continue with calculus, their "settling in" period will have been completed after the first university course, and that AP Calculus will not have a significant effect on their performance in the next calculus course.
Perceptions of the Failure Rate in First Year Calculus Courses

The teachers and students all believe that the failure rate in first year calculus courses at university is high. The perception of the percentage varied from 30 percent to 50 percent for UBC. They also believe that students will not succeed in the first calculus course at university if they do not take calculus at school. The counsellors were not able to comment in this regard. The principals thought that the failure rate was between 40 percent and 50 percent. The President of BCAMT referred to the "deplorable record" at university. With this attitude, it is therefore not surprising that the schools have attempted, if possible, to rectify the perceived problem.

Dr. Bluman did not quote a figure for the failure rate. Dr. Gerber thought that the failure rate at UBC was 50 percent, and that at SFU it was 30 percent. When he subsequently looked into these figures, he said that Dr. Bluman had reported a failure rate (including withdrawals) at UBC of approximately 15 percent. Dr. Gerber also found that at SFU the failure rate (including withdrawals) is approximately 10 percent. Dr. Leeming said that the failure rate (without withdrawals) at UVic was between 20 percent and 25 percent. There appears to be a disparity between perceptions and reality relative to the failure rate.

The failure rate at UVic appears to have remained constant. In 1988, Walsh reported failure rates in first year calculus courses at UBC and at SFU of approximately 40 percent to 50 percent. (Walsh, 1988, p. 30) However the failure rate at UBC and SFU appears to have dropped substantially in the last few years. These figures were not researched more thoroughly, as the researcher was more interested in the perceptions of the participants. If this is so, the researcher, based on the discussions under "Calculus at University Level" above, attributes it mainly to the higher entrance requirements of the universities and to the fact that AP Calculus and LD Calculus courses are being taught in high schools. It is probably too soon to assess the impact of the Mathematics 12 curriculum.
The Ministry of Education

Despite the initial input of the Ministry regarding the "Funds for Excellence", none of the principals, district coordinators, teachers or counsellors considered the Ministry to have any input with regard to AP Calculus. Both the principals and the teachers think that it is unfair to the students that the Ministry does not recognize the efforts of the AP Calculus students.

The Assistant Director of Information Management at the Ministry had very little knowledge about the development of AP Calculus. He thought it was being initiated at the district level. There are 3193 students registered with the Ministry this year for a LD Calculus credit of whom approximately 1100 wrote the AP Calculus examination. This represents approximately one-quarter of the students registered for Mathematics 12. According to the Assistant Director, calculus is not a priority for the Ministry at this time.

The researcher believes that the Mathematics 12 curriculum does not adequately prepare the students for what is expected of them in a first calculus course at University, and that there should be an evaluation of the curriculum. The Ministry must be aware of the extent to which calculus is being taught in the high schools, and should be asking "Why?"

If the Mathematics 12 course is the pre-requisite course for university calculus, should it not in itself be sufficient to prepare students for university calculus. The schools are feeling an obligation to present a calculus course so that their students can be successful with calculus at university.

The Survey Mathematics 12 course is in competition with the calculus courses at the schools at this time. Contrary to original intentions it is the better students who probably would like to take Survey Mathematics 12, and not necessarily the students who have decided not to take Mathematics 12. These students are taking calculus. The Survey Mathematics 12 course needs to be assessed in light of the students' and mathematics teachers' decisions to be involved in a Grade 12 calculus course.
The British Columbia Association of Mathematics Teachers

The president of the BCAMT thought because Mathematics 12 has a calculus component, a calculus course was redundant. Survey Math 12 on the other hand, was not. He argued that the teachers "should do a really good job of the calculus within the Math 12 curriculum". I do not think that a comparison can be made between the calculus that is taught in a full AP Calculus course with that taught in 12 hours in the Math 12 curriculum. The president was also concerned with the inequity of those students who are at small schools where it is impossible to offer a full calculus course.

The president of the BCAMT also thought that the Survey Mathematics 12 course was a far better one for students to be involved in at school than AP Calculus. He thought that the Survey Mathematics 12 course was more in keeping with the philosophy of the BCAMT which has a global perspective of the mathematics education in British Columbia.

The president of BCAMT apparently did not know of the extent to which calculus is being offered in the schools. He believed that it was the university's job to teach calculus, and that the schools should not have to cover for the university's "deplorable record" by doing their work for them. He would favour a position statement that would attempt to turn the tide of the AP Calculus courses being offered. It was his view that the Ministry may adopt a recommendation to this effect. However, in the light of the extent to which AP Calculus is now entrenched in the system, and the extent to which the AP Calculus teachers are involved with the course, this seems unrealistic.
**Conclusion**

My research has led me to believe that there is a problem of communication among the major stakeholders in this area. There should be ongoing and formalized communication between the Ministry and the university mathematics departments; between the Ministry and the school districts; between the school districts and the universities; between the BCAMT and the Ministry; and between the BCAMT and its members.

One means of communication would be for a high school mathematics teacher and a university calculus teacher to carefully examine each other's programs so as to learn the expectations of the other. The provincial examination also needs to be reviewed. It is this assessment device that sets the standard for what the students achieve when they complete Mathematics 12. There should be ongoing assessment and updating by both the Ministry and the university mathematics departments of their programs and curriculum, so as to ensure that the programs are appropriate for the needs of the students.

With so many students entering the universities now with a full year calculus course, perhaps the universities could look to Dr. Leeming's suggestion of having different calculus classes in the first year. They would recognize the various backgrounds that students entering university have in the same way as the Physics and Chemistry courses do. Students who have had some calculus might take a shorter course, and those who have not could take a course that involves more hours per week. At the end of the two courses, both groups of students would be at the same level.

Such communication, assessment and updating by all of the stakeholders would enable students to make a reasonable, educationally sound transition from the prescribed course at high school to the university course.

The current research study was directed at AP Calculus. However, it is clear that LD Calculus is being taught in the schools to a significant extent. A further study on this would, it is suspected, reveal very similar results to those which found in the current study.
AP Calculus will certainly continue to grow in British Columbia in the foreseeable future. Those who have a more global perspective of mathematics issues need to realize that this has been a movement that has grown from a basic need. Unless that need is met by some other means, AP Calculus will fulfill this roll. Only a change in the B.C. mathematics curriculum or in the manner in which the universities present their courses could change the position.

AP Calculus is clearly a program recognized by the students as a quality program which will not only prepare them for university calculus, but also for the demands required of them at university. They therefore view AP Calculus as a course that will ease their transition to university. Furthermore, the students perceive that university calculus is extremely difficult. The AP Calculus course gives them "mathematical" confidence.

The image of calculus needs to be improved so that it becomes viewed as "a pump and not a filter". Students should be enabled to appreciate calculus and use its power, rather than viewing calculus as a hurdle that stands in the way of a career. The current research has determined as stated by the university students that Advanced Placement Calculus assists the students in their transition from high school to university. This was one of the reasons for the original introduction of the AP programs in the U.S.A.. In addition, it has hopefully, also enabled students to appreciate the power of calculus.
APPENDIX A

APPLICATION TO SCHOOL BOARD TO CONDUCT RESEARCH

AT A SCHOOL IN THE DISTRICT
APPLICATION TO SCHOOL BOARD TO CONDUCT RESEARCH

AT A SCHOOL IN THE DISTRICT

TITLE OF STUDY:

ADVANCED PLACEMENT CALCULUS IN BRITISH COLUMBIA

Purpose of the Study

In the past five years there has been a rapid increase in the number of Grade 12 students taking the Advanced Placement Calculus course, and a corresponding increase in the number of schools offering this course in British Columbia.

A list of the enrolment which was circulated at the Advanced Placement Conference at Simon Fraser University in October 1990 is shown below.

Advanced Placement Examination Enrolment Numbers

<table>
<thead>
<tr>
<th>Year</th>
<th>Student enrolment</th>
<th>Approximate number AP Calculus Papers</th>
<th>School enrolment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>267</td>
<td>80</td>
<td>17</td>
</tr>
<tr>
<td>1988</td>
<td>758</td>
<td>200</td>
<td>41</td>
</tr>
<tr>
<td>1989</td>
<td>1380</td>
<td>376</td>
<td>68</td>
</tr>
<tr>
<td>1990</td>
<td>2228</td>
<td>678</td>
<td>85</td>
</tr>
<tr>
<td>1991</td>
<td>2851</td>
<td>895</td>
<td>101</td>
</tr>
</tbody>
</table>

(The 1991 figures and the approximate number of Calculus papers were supplied by the AP office in Canada)

It is noteworthy that the rise in interest in Advanced Placement Calculus in British Columbia has come at a time when fairly major changes have occurred in both the British Columbia Education System, and in the new Mathematics Curriculum.)
This research will examine:

1) the factors accounting for the rise of Advanced Placement Calculus in British Columbia.
2) how the course has been implemented
3) the effect of the Advanced Placement Calculus on Mathematics programs in other grades.

Significance of Study

This study will review the following:

1) It will examine the interaction between changing attitudes of the universities in British Columbia to Advanced Placement Calculus and the growth of the program. It will examine whether the rise of Advanced Placement Calculus has impacted on the mathematics programs at the universities, and if so what the effect has been.
2) Are the students who take the Advanced Placement Calculus at an advantage when they complete their secondary education, and are those who do not at a disadvantage?
3) How the program is viewed at District level.
4) How the program is being implemented at a semestered school versus a non-semestered school.
5) The program from the teacher's perspective. It will examine what motivates the teachers.

The findings on all the above points will be interrelated so as to give an understanding of the phenomenon which has occurred over the last six years.
Methodology

The following is a brief outline of my research methodology.

Population Size: (Taken from 1990 figures)

<table>
<thead>
<tr>
<th></th>
<th>Per District</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Number of students</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Number of teachers</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Number of Math Dept Heads</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>(if different person to above)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Administrators</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Number of Counsellors</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>University Mathematics Departments:</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Original Informants in Kelowna, B.C.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>District Personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.C.A.M.T.</td>
<td>The President</td>
<td></td>
</tr>
</tbody>
</table>

At each school that I visit, I would like to interview

1) at least three students in the AP Calculus class (The interviews to take approximately 15-20 minutes, and to be conducted during the school day, most probably at the time the student would be having an A.P. class, or during a students “preparation” period if this could be arranged).

2) the teacher teaching the A.P. Calculus course (the interview to take approximately an hour, and to be arranged at a mutually convenient time).

3) the Mathematics Department Head (if different from the teacher).
4) the Administrator at the school who was responsible for introducing the course. I expect this interview would take approximately half an hour.

5) a Counsellor responsible for assisting students in their course selection

I would prefer to conduct all the interviews at any one school on one particular day. In the __________ District, I request permission to conduct interviews at one school of your choosing. I would speak briefly to the teacher involved to set up the interview day. I would request the teacher to select the three students for me at random, by drawing lots. I would request the teacher to do this prior to the interview day, as the students need to be given the option to participate, and parental consent forms need to be sent home and signed. A copy of the questions that will be put to the students is enclosed. The nature of an interview is such that although this will be followed as closely as possible, other points may arise which could be pursued. It is not my intention to ask questions which are in any way invasive of the students privacy. The students will be informed that they are under no obligation to answer any questions, and that there will be no repercussions as a result of the interview. Although I will need the students names for my record keeping purposes, the student will not be identified either with the information obtained from the student or, in fact, at all. The only other persons who will have access to the information will be my immediate Supervisors at Simon Fraser University. I have also enclosed the interview form for the teacher. I again would foresee that I may diverge from this if other issues arise.

PARENT CONSENT

My name is Lynne Massel. I am a senior Mathematics teacher at a Vancouver School. I am also a graduate student at Simon Fraser University conducting research towards a Masters degree in Mathematics Education. The topic of my research is the Advanced Placement Calculus in British Columbia. I anticipate completing the project by the summer of 1992.

The School Board has given me permission to conduct student interviews in accordance with the standard procedures which require that I first obtain the consent of the parents/guardians of the students to be interviewed. I would like to interview your son/daughter for the purpose of my research. Your son/daughter's participation is entirely voluntary.
The interview is expected to take approximately 20 minutes, at a mutually convenient
time and at the student's school. The student will not be under any obligation to answer any
question. I will ask the student for his/her name, but this will be for my record keeping only
and his/her identity will be kept confidential. The interview will be tape recorded, but neither
the recording nor the content of the interview will be disclosed to anyone other than to my
immediate supervisor, Dr. Tom O'Shea, of the Department of Education at Simon Fraser
University, and possibly also to my examining committee at Simon Fraser University if such a
request is made. After completion of my degree, the tapes will be destroyed.

If, within two months after the interview, the student decides that he/she does not
want me to use the information provided during his/her interview, I will delete that portion of
the tape on which the interview was recorded and will not make use of the information
obtained. The student can make this request either to his/her mathematics teacher or by
telephoning me directly at 733-1012.

Any complaints that you or the student may have concerning the interview may be
made to my supervisor, Dr. Tom O'Shea.

Please will you give me permission to interview your son/daughter by signing this form
at the appropriate place. PLEASE PRINT.

I, ________________________________ (parent/guardian/teacher)
of (students full name) ________________________________

have read and understood the above and consent to LYNNE MASSEL conducting an
interview with my son/daughter/ward.

SIGNATURE: : ________________________________
NAME : ________________________________
DATE : ________________________________
INFORMED CONSENT BY SUBJECTS TO PARTICIPATE IN A RESEARCH PROJECT

Preamble to the interview:

I am writing a thesis towards the completion of a Master's Degree at Simon Fraser University. My research topic is: Advanced Placement Calculus in British Columbia.

I will be asking you some questions. You are under no obligation to answer any of the questions I put to you. I foresee that I will complete this research project by the summer of 1992. Should you decide within the next two months to withdraw the interview we are about to do from this study, contact me at 733-1012, or ask your teacher to contact me, and the data collected during your interview will not be used.

I will ask you for your name, but it will not be used in the write-up, it is for my record keeping purposes only. This tape will be kept in a secure position in my home. The only other persons who will have access to it will be my immediate Supervisors, and possibly the examining committee, if they deem it necessary. (Once the research is completed, the tapes will continue to be held in a secure position in my home, and eventually destroyed).

Having been asked by LYNNE MASSEL, a Graduate student of the Faculty of Education at Simon Fraser University to participate in the Research Project as outlined above,

I (please print) __________________________________________ a student at

____________________________________________________ School,

state that I have read the Preamble to the interview above.

I understand I am under no obligation to answer any questions. I understand I can withdraw my interview from the research project within the next two months.

I understand I can register any complaint I have about the interview with Dr Tom O'Shea, Dept of Education, Simon Fraser University. (Dr O'Shea is the Senior Supervisor for this project).

I agree to participate. SIGNATURE: __________________________________

DATE: ___________________________________________________________
AP Calculus Student Interview Questionnaire

Preamble to the questionnaire is that I am trying to determine why students are taking AP Calculus at your school. I would like to know how you made your choice to take the course and what your thoughts are about the program.

1) Why are you taking a calculus course this year?
2) Are you planning to take calculus at university?
3) Do you know if university calculus is a pre-requisite for any future choice of courses you may want to take?
4) Do you feel that there was another elective that you really wanted to take this year, but could not, because of the calculus?
5) Who suggested you take the calculus?
6) Did you need persuading?
7) What role did your parent/s play in your decision?
8) Did you spend any more time on the calculus course than on other courses this year?
9) If 'Yes' - why? Was this a problem for your other subjects?
10) How would you rate this calculus course in terms of 'very easy' to 'very difficult'
a) in regard to the course material itself, and
b) in comparison with your other courses this year?
11) Do you enjoy doing mathematics?
12) a) Do you think there is some prestige attached to being in the Advanced Placement Calculus class?
b) If "yes", do you think this influenced your decision to take the course?
13) What was the primary motivating factor that decided you to take Calculus this year?
14) Did you complete the B.C. Provincial Grade 12 course prior to starting a calculus course?
15) If 'no', - do you feel that this influenced your understanding of the Calculus?
16) If the University you are proceeding to gives you credit for their first Calculus course, will you take the credit, or take the course?
17) If you take the credit, is "saving time at university" a factor in your decision?
18) Do you think that mathematics will play a role in your future career?
19) Have you been in a "streamed" mathematics class?
20) If "yes", at what grade level/s were you streamed?
21) How do you think the "streaming" experience affected your decision to take Advanced Placement Calculus?
22) Is there anything I have not asked you about that you would like me to know in regard to this topic, or are there answers on which you would like to expand?
APPENDIX B

INTERVIEW QUESTIONNAIRES
INTERVIEW QUESTIONNAIRES

The questionnaires below were used for the following groups of individuals:

The Principal

Preamble to the questionnaire is that I am trying to determine why you initiated an AP calculus program at your school, how it has been implemented, and what your thoughts are about the program.

1) Why did you initiate the AP Calculus program?
2) Who first proposed the AP Calculus program at your school?
3) How was the program implemented, and what impact did this have on other programs at the school?
4) How does the AP program relate to the IB program in your district?
5) How was the teacher selected, and were there any problems in this regard?
6) Could you tell me about the school population here?
7) Is there any parental pressure for this type of program?
8) What are the financial implications of the AP Calculus program to the school?
9) Do you have district support for the program?
10) In what way does the Ministry have input to the AP Calculus?

The Counsellor

Preamble to the questionnaire is that I am trying to determine why students are taking the AP Calculus and, in particular, what sort of influence the counsellors have on the students in their making their decisions to take this course, and so I'd like to know how the students do their course selection and what sort of information they are receiving from you.

1) Do you have students who have left your school, been to university, and come back to the school to talk with you about their programs?
2) And, if so, what sort of feedback do you get from these students in regard to their mathematical experience at university?
3) Is there more stress on the students at your school who are enrolled in the AP Calculus program because of pressures of that class on their time?
4) How does having the AP Calculus as one of the elective subjects impact on other electives at the school?
5) Is the attitude, in general, to encourage students to go as far as they can with mathematics?
6) When you have course selection, who is giving the students the information about the calculus course?
7) What are your perceptions as to how much mathematics a student needs to know when they enter university?
8) Who gives the students information about the mathematics courses at the school?
9) Do you have a lot of kids who drop out of the calculus course soon after it starts?
10) Will the school offer other AP courses in the future if this is the only one offered at this time?
11) Who was the driving force behind the AP Calculus starting up at your school?
12) Do you see the AP Calculus meeting the needs of the more talented mathematics students?
13) Is this a challenge course for these students?
14) Do you have any idea yourself of what the university pass/fail rate is like in first year calculus courses?
15) Do you think calculus is used as a "weeder" course at university?
16) Do you foresee more students per year taking the AP Calculus in the future at your school?
17) Do you know what proportion of students take first year calculus at university?
18) In what manner would you consider students coming into a first year calculus course at university from a school where calculus was not offered?
19) Do you think there is a "ceiling" to the number of students taking the course based on the demands of the course?
20) Do you think there is a "ripple effect"? In other words, when one school gives a calculus course, do others follow suit? Do other schools feel obliged to give the course, otherwise their students would be at a disadvantage?
21) Is there any parental influence exerted on your school to offer such courses? In other words, are the parents looking at what's happening in other schools and demanding that the school offers like courses?
22) In what way are the parents involved in the student's decisions to take this course?
23) Could you tell me about the student population, and has this impacted on the students' course selections?
24) What sort of district support does this school have for the AP Calculus course?
25) Is there anything further that I have not asked you that you'd like to add to this discussion?
The Advanced Placement Calculus Teacher and The Math Department Head

Preamble to the questionnaire is that I am trying to determine who initiated an AP calculus program at your school and why. I would like to know how it has been implemented, and what your thoughts are about the program.

1) How long have you been teaching this course?
2) How were you selected to teach this course, as opposed to another mathematics teacher at the school?
3) Do you enjoy teaching the course?
4) If 'Yes' - why? If 'No' - why not?
5) Is it a more difficult course for you to teach than, say, the Mathematics 12 course?
6) What preparation did you have to do prior to teaching the course the first time around?
7) What is your philosophy behind the 'level' at which you present the material in this course?
8) Have you been able to obtain suitable textbooks?
9) Do you feel that your course could comfortably replace a course given at university to first year calculus students?
10) Do you have this in mind as one of your objectives when you present this course?
11) Do you know what percentage of your students take the first year calculus course at University?
12) Do you believe that course to be, more or less, a repetition of what you are teaching these students?
13) Do your students write the A.P. Calculus Examination, or is your course "Locally Developed"? Discuss.
14) If "Yes" to A.P. - what benefits are there to the student taking this examination?
15) Do you regard your course as 'challenging' to the students?
16) What are your motivations for giving a high school student a calculus course?
17) Have all, or most, of the students in the course completed Mathematics 12 prior to starting your calculus course?
18) If "Yes", how was this accomplished?
19) What impact does this have on the way the mathematics courses are structured in the lower grades at the school?
20) If "No" to (9) above - do you teach the Mathematics 12 course in the same school year as you are teaching the Calculus?
21) How do you combine the two courses?
22) What support do you have from the administration for the calculus course?
23) Who was most instrumental in providing the impetus for this school to have a calculus course as an elective?
24) What do you read the attitude of teachers at the school in other disciplines to an "extra" mathematics elective being offered?
25) Have you attended any workshops or conferences on this topic?
26) Has the Ministry, or District, provided you, or the program, with any support?
27) Is there anything I have not asked you about that you would like me to know in regard to this topic, or are there answers you would like to expand on?

The Advanced Placement Student

See Appendix A, page 128

The University Professor

Preamble to the questionnaire is that I am looking into the AP Calculus program in British Columbia, and trying to determine how the universities regard the program and why the universities made their decisions regarding students entering university with a successful AP Calculus grade. I would like to know what your thoughts are about the program. I am trying to determine what effect the AP Calculus in the schools has on the students further education.

1) What is your opinion on Advanced Placement Calculus?
2) What made the university change it's policy on the AP Calculus?
3) What proportion of first year students come into your university with an AP Calculus credit?
4) Was there any influence on your decision regarding AP Calculus in terms of what universities like McGill or the University of Toronto do? (And for SFU and UVic. that changed to: How did the decision that UBC made influence your decision?)
5) To what extent is the university mathematics department involved with setting the B.C. mathematics curriculum for secondary schools?
6) How do you feel about calculus students using graphic calculators?
7) Do you have any statistics on how students who have an AP Calculus credit do in the first semester courses at your university?
8) How many of these students take honours calculus programs?
9) Is calculus used as a "weeder subject" at your university?
10) What is the pass rate in first year calculus courses at your university?
11) What do you think about high school teachers teaching calculus at high school?
12) What is the size of the first year calculus classes at your university?
13) Is there anything I have not asked you about that you would like me to know in regard to this topic, or are there answers on which you would like to expand?

The University Student

Preamble to the questionnaire is that I am looking into the AP Calculus program, and I would like to determine how you made your choices to take the course, and how this has affected your subsequent calculus course and what your thoughts are about the program.

1) What was your motivation for taking calculus at high school?
2) What benefit, or otherwise, do you feel your calculus course taken at high school has had for you?
3) How do you think your high school calculus course effected your understanding of and performance in your university calculus course?
4) Was there repetition of material in the university course?
5) If 'yes' above, was the material covered in the same manner and tackled at the same level?
6) Were you bored in the university course as a result of taking the course at school?
7) Do you think you became lackadaisical in the university course because you felt you had already mastered the material?
8) Have you regretted taking calculus at high school?
9) If "Yes" - why?
10) If a Grade 11 student were to ask you for advice, and intended taking calculus at high school, and had an opportunity to take it in Grade 12, what advise would you give that student?
11) Is there anything I have not asked you about that you would like me to know in regard to this topic, or are there answers on which you would like to expand?
First Year Calculus Student who did not Take Calculus in Grade 12 and was Unsuccessful with the First Calculus Course at University

Preamble to the questionnaire is that I am looking into the AP Calculus program. I am interested to know your experiences in the first calculus course at university, because I understand you were unsuccessful with it. I am interested to know of your mathematics background at school.

1) How did you find your calculus course this year?
2) What grade did you obtain?
3) How did you do in your mathematics courses at school, in general?
4) Did you find this course to be similar or different to your school mathematics?
5) Why did you take a calculus course at university?
6) What do you plan to major in at university?
7) Which faculty are you in now?
8) Which faculty would you like to eventually be in?
9) Do you need this calculus course to get into that faculty?
10) Did you have an opportunity to take a calculus course while in Grade 12?
11) If ‘Yes’ above - why did you not take it?
12) Do you regret not taking it?
13) Why?
14) If ‘No’ in (10) above, would you have taken it if you had the opportunity?
15) If a Grade 11 student were to ask you for advice, and intended taking calculus at high school, and had an opportunity to take it in Grade 12, what advise would you give that student?
16) Is there anything I have not asked you about that you would like me to know in regard to this topic, or are there answers on which you would like to expand?
APPENDIX C

TRANSCRIPT OF EXTRACTS FROM
AN INTERVIEW WITH A PRINCIPAL
The following is an extract from an interview with a Principal who was responsible for introducing AP Calculus into his school.

Massel: Let me just tell you what I'm coming from. I'm a Math teacher and I've been teaching for about, close to twenty years now and I'm starting doing my Master's Degree through Simon Fraser University. I'm writing my thesis right now. So I was interested in looking into what's happening in Calculus in High Schools. I'm going to eight different districts and I am doing a multi-level study, speaking to Administrators, Teachers, Counsellors, Students and also to the Universities. One of the schools I went to was [name of school]

Principal: That's where I was. I was there for seven years.

Massel: I'd really like to know, well, just lots of things from you.

Principal: I hope I can be of some help because the specifics, I think [the mathematics teacher], as I told you, was absolutely the right person to be speaking with ... he is in my estimation, really. He is a standout, exceptional master teacher - top of the best of the best. So whatever he says, I believe.

Massel: He gave me a tremendous amount of information about the program and what they do there. I guess, what I'd like to ask you is why AP? Why did you get involved with AP and why did you introduce it at the school at the time as opposed to the LD Calculus?

Principal: Well, it's interesting how it all unfolded, but briefly, it went like this. I was in the junior high schools and then was moved to [the school] in April of 1983 and then I came in there and started getting a handle on the school. As a year or so unfolded two things happened. On the one hand, in the beginning of the early eighties and what you had was a lot of people around saying, "What are we doing for highly motivated kids academically?" Are we having special programs to encourage them, etc. In the junior high school we weren't so concerned about that ...it wasn't a problem. There was nobody expressing any sort of, "what have you got?" Whereas, as soon as I walked in the door there, there was the question. And it came from a whole lot of directions. It came from parents. It came from the central office. Anyway, immediately, just on my appointment there, somebody said to me that I should get the International Baccalaureate program into [the school]. That would just be a flagship...how wonderful that would be. Well, I don't miss out on many things. I was a little slow at moving on this. I guess maybe something was telling me not to, I don't know, but, anyway, in '83, I went to [the school] and a principal at another school just went and wrote a letter and next thing I knew IB was into his school almost the year after he was in.

Massel: That's in [name of the other school]?
Principal: [Yes]. So then the pressure really came to task and it was like this. I'm a very competitive person so ... right away we had thirty kids who we discovered were coming over [to the other school] for the IB program. Well, my attitude, you know, you really want to have good staff moral and that was tough for the teachers involved. [The mathematics teacher], and there were some other superstars over there, who were just losing the best kids. So during that year, the '84 year, I went to [another] senior high school. [The principal at this school] and I checked around and he initiated his own program. .... I even had the junior high where I had just left saying to me, what have you got. It was coming in all directions. And, somebody said, a teacher in the school said to me that up in the Okanagan they had initiated an Advanced Placement program in a couple of courses, and they were pleased with it. He gave me the name of the fellow to contact and that is the whole thing from there. That was history from there. So what happened was we both decided fine to go on. The way I went about it was; I just said to the teachers in the school "listen we're losing kids and we want to talk to someone." We got this fellow from Kelowna, we flew him down here, paid his way, an excellent man. He didn't come on strong about it, but obviously he'd been doing it in the States, the Advanced Placement in the States in California and that's how he brought it up.

Massel: This was a teacher?

Principal: At the school in Okanagan.

Massel: It was just a teacher?

Principal: A teacher. He had a lot of experience. He wasn't just a rookie. He knew what he was talking about. He spoke well. Anyway I had about fifteen teachers at this meeting who I had invited. We went back from that meeting and I talked and heard and I said I liked what I heard and they liked it ... and I always trusted the professional. Again, people like [the mathematics teacher], some really solid academic teachers at that school ... I listened and heard what they were saying. They liked what he was saying, so I liked what they were saying, because they're the experts. From that I went on a twofold front. That was in the Fall. What we did was, in the Spring, we had ten kids ... we hand picked ten kids and coaxed them to write the exam without any preparation other than [the mathematics teacher] and teachers preparing them.

Massel: Just based on the Calculus that they'd been taking?

Principal: We did that. That was in the Spring of the '84 year and so ten kids wrote twelve exams, some students wrote two. We got the results back and they got four's and five's. Five is the top score. So right away we knew we had something. The teachers liked it. They had the outline and they did lunch hour and after school prep sessions. So the following year we initiated the program at the school. I'm very public relations oriented so I got parents in and I talked to the newspaper and I got all the literature I could on it and really did a number on it. We had about sixty kids apply and we offered it in Mathematics, in
English Literature and Chemistry and French. Away it went. It went from sixty up and of course the second year, I mean the '85 ... '86 years we absolutely clicked. Two top students in the province were at our school and they were going around saying the AP was partly the reason why they did so well. I mean we were lucky to have these two boys in the school, but we were getting all kinds of feedback. And then I would get the kids coming back as the years went on. Seven years later, the kids would come back and say that "the AP was absolutely wonderful. When I went into university ...away I went." Anyway, the thing flew. I just listened to the teachers and I listened to the kids and the kids were saying that when you go into your second year at university, your marks [in first year] determine whether you get into your [chosen] faculty or not. And they [the students] weren't caring about advanced placement or credit. It was just the preparation for the first year of university.

Massel: I was going to ask you, do you know how many of them actually take that credit because from what I understand there's very few who actually take the credit.

Principal: Yes.

Massel: They go to university and they still do first semester.

Principal: Yes, so the program is one of...

Massel: So your motivation wasn't really to get them advanced placement, it was just to put some kind of program of excellence in place for the better students.

Principal: How do you mean?

Massel: Well, if they get fours and fives on the AP in those days the universities didn't give any credit at all and today UBC does give them credit and advanced placement. Well, very few if them appear to take that.

Principal: That's right.

Massel: So, your motivation was really just a program of excellence in your school for those better students ... to enrich the students?

Principal: Yup. It was interesting. I did it in the school but I also had other colleagues around the province [expressing interest]. Even though they had it up in the Okanagan, they hadn't shared it. I formed an advisory group of colleagues, four or five of us, for the province. Our annoyance at the beginning was that the university wouldn't recognize it. We talked about how the universities could work with this new program. Of course their attitude, which was fair, was saying, you've got to prove this thing to us ... that it's a quality program, before we're going to buy into it and give you advanced placement and credit. We wanted the recognition, but more importantly, the placement and credit. But we didn't realize that even though we were fighting for that, the kids didn't really want that particularly. They wanted to do well in their studies.

Massel: But still, it came from you people that the University even found out about it, as it were.

Principal: Yes.
Massel: Which is interesting.
Principal: So we had a meeting [with some key people] and they did listen. They understood, but at that time, [their attitude was] "what is this program?" Well, of course, as it unfolded it proved to be [excellent]. They came on board because we were able to deliver the kids, you know, no problem at all.
Massel: How does the Ministry view this program?
Principal: Well it came from the schools. It was hard to argue with the schools because they were demonstrating that it worked, that it had quality, etc. The other thing I'll just throw in before I forget is that it is really important for you to go back to [the mathematics teacher] again. He said to me, ....and I never knew ... I wish I had known it earlier because I would have used it ... his comment was that there had always been the opportunity to have an advanced course in Mathematics in the school. The Ministry had that for the top kids. But [the teacher] found, each year, year in and year out, that he'd have only five or six kids enroll in the course. He could not get kids in the course. And as soon as we had the advanced placement and had that brought into the school, he immediately had a full class every year after that. I don't know how many he has now, but he had at least two [classes] all the year that I was there. Now, you're talking sixty kids or more.
Massel: So as soon as you have a course that's a little bit exclusive, then the kids will buy into it?
Principal: Well, the course was there ... there was a course there, and he says the kids wouldn't go for it at all.
Massel: So what made the difference?
Principal: As soon as we called it "Advanced Placement". There's a lot of credibility to advanced placement which people didn't know. I mean that program is recognized by your top universities in the United States. Lots of kids don't just hang around here, they are off looking at Harvard or Stanford or wherever and so the credibility with advanced placement in the American universities is right up there. But it was interesting because he couldn't get the kids in the group. As soon as we had advanced placement we were just flooded with kids. Again, it was a testimony to the sort of quality of the program. If the program is not of high quality, the kids won't be there. They just won't go.
Massel: Do you think the fact that so many kids, I mean there's a tremendous amount of either locally developed calculus or advanced placement Calculus happening now in the schools. Do you think that this is something that the Ministry should be taking note of? Should they have their own kind of program for this? You know they have bought into an American program essentially.
Principal: I think the way it has gone is the right way because it's grass roots oriented. The schools have seen a need. The program is available. I don't think you want to tamper with a railroad track. It's just been wonderful and, of course, it outdoes ... the advanced
placement outdoes IB because IB is very, very expensive. We only have one [IB] school in
the district, which I object to. I was really annoyed over that. The one school had it and we
couldn’t have access to it. The fact that every school can have an advanced placement
program is wonderful. It’s not exceedingly costly and yet can stand right beside [IB] quality
wise. I would say [AP is] even superior to IB, from my personal view, because it’s more North
American oriented.

Massel: Did the IB come in because of the funding that became available for
excellence, or programs of excellence?

Principal: Yes, it was. Back in the early 80’s they put out some seed money to the
school district to promote the highly motivated academic kids. What happened was that
money was given out to the school district for the whole district. But what happened was the
IB program[was initiated at one school in the district]. One school got it all. Of all the things
that I’ve been involved in, it [the AP program] certainly has been of the highest quality. As
I’ve said so many times when we were talking to people about it is that it’s like selling a
Mercedes. The program is first rate. The IB program is too. They’re quality programs so you
don’t have to promote them with anybody. Very interestingly, I just had a call from a fellow
from the Ministry and he was investigating how the Ministry could recognize IB and AP in
their new graduation program. They’re doing some work for the new graduation program.

Massel: Yes, at some stage I want to go to the Ministry and ask where this stands with
them?

Principal: Yes, and really you know, for the kids it’s really important for it to be
recognized on their transcripts ... identified. AP hasn’t been and we’ve been sort of fighting
a battle on that one. It was really unreasonable because the universities are recognizing it,
we’re using it and the Ministry isn’t showing it on the kids transcripts. So I think they’re going
to swing all that around.

Massel: You don’t see the AP Calculus at the schools as being something that the
regular math student who knows that they’re going to have to take Calculus at university
because they want to get into such and such a faculty should be taking at high school level to
help them when they get to university?

Principal: You would have to ask the [teacher]. I think I can speak for him because he
tended to really let any kid who wanted to take on the challenge do so. It was sort of a
challenge program but I don’t think he ever cut too many kids out. If they wanted to have a
go at it [he would let them]. I guess he would talk with them and recommend it. But he was
not the sort of teacher [who made a] decision that you were in or out. You talked to the kid
about it and the kid would think it over and either buy in or buy out. I think the reality is that
it’s a rigorous program ... in a sense it’s also an enriching sort of program [so] if you’re really
that keen [you would be allowed to take it]. That’s the beauty of AP. [At the IB school] there
are over a hundred kids involved with single programs in the International Baccalaureate.
There are only about six or seven or eight in a full program. [The full program is very demanding], you can't do anything else in your life. For the kids who have special interests and talents in whatever the subject area, these programs offer [enrichment and a challenge].

Massel: Yes, we had IB at our school for quite a long time. It served a very small number of students. We've only got fifty in our graduation class. So you can imagine. In all the years we had it only two or three students took the full diploma. The kids work [very] hard. So the AP certainly suited us better.

Principal: The other neat thing about AP is that it doesn't matter what the school size is. You can have only a couple of courses. Very few pull out. With French ... some years we had it and some years we didn't have the numbers [to warrant running the course]. I was very careful with the initiation of it. I said to the whole teaching staff that it's going to keep kids in the schools. It's going to provide jobs for everybody in a sense. Also with French we only had about ten or twelve kids sign up [one year] and we didn't have it, and then it came back [the following year]. So that's the beauty of it, the flexibility of it too.

Massel: Well the major expense of it as I see is the block of time for the teacher. I guess in terms of other expenses, your textbooks are one shot.

Principal: You need some resource stuff but for AP, I mean, it's not...

Massel: It's not that much.

Principal: For the IB, there are megabucks involved. They're a very big bureaucracy.

Massel: Well, I sure appreciate it.

Principal: You can always phone me if you think of anything else and George Ewonus is a real expert. He's got all his facts and figures. He'd be the right person for it because when we all started out, I mean he was just in the one district and then they approached him and he was the right man for the job because he knows it upside down and backwards. Your investigation is a good idea because it's been sitting there and I think people should know more about it.
APPENDIX D

TRANSCRIPT OF EXTRACTS OF AN INTERVIEW

WITH AN AP CALCULUS TEACHER
TRANSCRIPT OF EXTRACTS OF AN INTERVIEW WITH AN AP CALCULUS TEACHER

The following is a transcript of the interview held with an AP Calculus teacher. This teacher taught at a large non-semestered senior secondary school.

Teacher: In this school here, like, we have about 700 Grade 11s. It's a senior secondary school, so in two years, with seven hundred students, we're supposed to...it takes a year just to find who the good students are because some of them have an opinion of themselves that's not quite accurate. It takes a year to find them, and we really only have two years to develop them. Lord knows what happens at the junior high level. I'll tell you, we get some bright kids obviously because we've got so many students here, but a lot of them are bright, but being bright is one thing, but developing your ability is certainly another, and a lot of them haven't developed at all. It's just raw material, and you try to do something in two years.

Massel: Now, your school is semestered, so...

Teacher: Well, no it's not. It's year long, but we run the math, for the brighter students, we run it in semesters.

Massel: Oh, I see, so you get them through the Math 12...

Teacher: At the end of January.

Massel: And they write the Provincial exam.

Teacher: Yes.

Massel: And then you take that same group into the AP Calculus.

Teacher: Yes. In 67 hours.

Massel: 67 hours for the AP Calculus by the time they write the exam.

Teacher: You know what the prep schools on the Atlantic Coast get? A 130 to 135 hours. Last year I did it in 68.

Massel: What size is the class?

Teacher: This year I've got 32.

Massel: Just one group?

Teacher: I had two. Well, what we've done, I just can't do it, you know, like I've, for the last seven years I've taken both groups, and even though one group was maybe a little bit stronger than the other, I had them all write the exam anyway, but it's just too much. It's too much...

Massel: Too much for you.

Teacher: Too much for me. I just can't do it, so we have another teacher on staff that, you know, kind of.... He teaches more or less the same. We use the same book, but he maybe doesn't take the same quality level of questions, and he goes a little bit slower too,
and those students, they’re very good students too, very good, but they’re just not able to handle the real fast pace that...you can appreciate the kind of pace. And they get a good calculus background.

**Massel:** Do they write the AP exam or not? ... No? So you give them just a locally developed exam.

**Teacher:** Yes. It’s essentially the same, you know.

**Massel:** So we’re looking at what? About 60,70 students out of a graduating class of 700?

**Teacher:** No, no, I said we had seven hundred grade elevens. I didn’t say we had seven hundred grade twelves. We lose a lot here. We lose 200 students.

**Massel:** So it’s only out of 500?

**Teacher:** Maybe 550, 500 or 550, and we have about, yes, it’s about 70.

**Massel:** So, that’s still a fair number.

**Teacher:** Yes, you’ve got to understand what we’ve got here. We’ve got everything in this area here. We have the very, very high academic student to extremely low, and I mean extremely low, and lots of in between, lots of diversification.

**Massel:** How many of your Grade 12s are taking Math 12? What sort of numbers in Math 12?

**Teacher:** Quite a few, we have much higher than the Provincial average, and I’ve been talking to the principal about that. We have about 35 percent, 36 percent of our population goes through Math 12 out of Grade 12s.

**Massel:** And you have a mixture of girls and boys? Is it the same proportion of fifty percent girls and boys?

**Teacher:** Yes, and surprising enough in the AP Calculus sometimes it’s just a girls’ year.

**Massel:** Oh, really?

**Teacher:** Oh, yes, I’ve had years, where, Jees, I’ve had some just great girls. Take the top ten and eight of them would be girls. Not so much this year. This year is a boys’ year.

**Massel:** Can you tell me how you kind of got involved in AP Calculus, what your background was?

**Teacher:** Well, we’ve taught the calculus here for 17 years. At one time we were the only school that did do a calculus course. I think [name of other school in district] has always done it, not many, I’d say maybe two to three schools gave a real calculus course, I mean, maybe some people offered calculus, but that’s in name only. For 17 years at this school anyway, we’ve taught first year university Math.

**Massel:** And for all of that time, did you do it on the same basis? Did you finish the Math 12 or the Algebra 12 first?

**Teacher:** Well, at one time this was a semester school so that’s no problem. Then when the principal, this is back about now eleven years ago, ten, eleven years ago, I guess,
changed the school from semestered to non-semestered, then, regardless we need two blocks to do the two courses so we just double block them. Double blocks and then have them write in January.

Massel: So that's what you do now, you double block them in the first term?
Teacher: In the first five months.
Massel: Right, throughout they are double blocked then.
Teacher: Well, yes, because they need two courses year long anyway, so.
Massel: So, how many times a week are you seeing that particular Math class that's taking AP Calculus?
Teacher: Well, it depends on how the cycle goes because we work on a five by eight, so at least six, sometimes seven, sometimes eight. It depends on what the sequence is.
Massel: And that's for what length of time?
Teacher: Wait, I'm thinking back when we truly were semestered. Now, no, this year is really unique in that we have a teacher come in from [name of another school], and he wanted to do the Physics AP. Well, the principal in his wisdom with the timetable somehow [messed] it up and put the AP Physics in the same block, because I need two blocks for Math and for calculus, he put the Physics in one of those blocks, so this year I'm not really truly double blocked. I teach a class starting at 20 to eight in the morning every second day. So I get, that's only 50 minutes, and then the other block runs throughout the five by eight system that we have in the school, so I meet them still six seven times but I don't get the same number of minutes, because I lose at least 30 or 40 minutes a week by going in the morning because I don't get the full hour, and I don't get that extra block either.
Massel: You don't have problems with getting students here at that time of the morning.
Teacher: Well again these are the top 32 out of 550. Even the good students have to be motivated, and sometimes not literally, but figuratively have to be kicked too. But all in all they're pretty good.
Massel: The normal school block here is what? An hour or an hour and ten minutes?
Teacher: An hour.
Massel: So when you started doing the AP Calculus did you go down to Oregon at that time to do the course?
Teacher: No, I guess I didn't really finish off what we were talking about before. We've done calculus here for seventeen years, at least I've done it for seventeen years, then when the new principal came in, the principal currently, he came in six years ago, five, six years ago, and he said, well, look at, if you are in fact doing the calculus course, why not have them write the AP exam. AP just started up at that time in B.C. [British Columbia]. In B.C. anyway, it's been going on for years in the States, but in B.C., and I said, yes, that's a good idea, so I talked to the students at that time too, and that very first year the school board wouldn't pay
for the exam. The kids paid for it, 75 bucks Canadian for a 45 dollar test, so that's how it started. Then after that first year, I didn't really know exactly what was on the curriculum even though I had a little booklet but I didn't really know what the exams looked like or anything, so that first year was kind of a tough year for me. The kids did well. I mean we used to get about 75, 80 percent get fives. 80 percent get fives and we had a couple of threes, but mostly fours or fives. And then I heard about this thing going down at the University of Oregon. I can't remember the guy's name. His first name was Dick. He was the department head of Mathematics at the University of Oregon. They put it on for a week, Monday to Friday.

**Massel:** Do they do this every summer?

**Teacher:** I don't know if they do or not, but it was a prep course too. It was good. I mean anybody that's teaching the calculus or AP Calculus ought to really go down and spend a week with these guys. They're very good.

**Massel:** So it's just a five day course.

**Teacher:** Well, they run through the course. They tell you how the exams are set up and how they're marked and this and this and this. Very good. Not even comparable to these one day things.

**Massel:** I think they do still do it. I remember reading about it somewhere that the course was good.

**Teacher:** Yes, it's very good. I'd strongly recommend it to anybody.

**Massel:** But you had a calculus background at the time already because you'd been teaching it before.

**Teacher:** Well, I took four years of calculus at university too, but, of course, I have to admit that first year when I started doing the Calculus AP at that kind of pace and the difficulty level of the question, Jeez, I had a bit of a tough time. I did my homework too.

**Massel:** But you were motivated to do that yourself. Do you enjoy teaching the AP Calculus?

**Teacher:** That's what keeps me here.

**Massel:** And why are the kids taking it?

**Teacher:** Oh, I think they're aware of how difficult first year university is and they know the drop out and failure rate. Why are they taking it? They're taking it, obviously, for a background. But we have three calculus courses here at this school. Like, I just started a brand new one this year, and this one is, we have the AP, and that's at the top, and the LD Calculus, but then what we have is a year long calculus. Now, this runs concurrently with the Math 12. Now, there are certain topics in the calculus that require a Math 12 concept, so I've got to stop, teach that Math 12 concept, and then continue on with the calculus. So, in doing that I'm teaching Math 12 in that course, so what that does is, not only gives the student a real solid background in calculus even though we can't get as much of the material finished,
but it gives them more practice in the Math 12. So really out of two blocks now, because they're double blocked, but concurrently year long, they're getting about a 125 percent Math 12 and 75 percent calculus. And these are students that, you know, for example, just want or need one year of calculus for Commerce or something like that. And they want to go to university and they're not that strong in Math. These students are C, C+ Math 12 students, C- Math 12 students, but they're really liking the calculus. Now, why would the students take the AP rather than that, or the LD? I think it's just a challenge.

**Massel:** They're good students.

**Teacher:** Yes. They like writing tests. I mean I tell them. I recruit these people in Grade 11 and tell them that it's an honour to write the test and be in the class, and it's a challenge. It's a very well constructed test, and it's just ... something to work towards and write and see how you make out. See how they stack up against other people on a very good test. So that's really why they're doing it. I don't think too many of them actually take the credit when they go to university. They take, usually, Math 120 Honours at UBC.

**Massel:** Not that many take Math 120 Honours. UBC would like them to.

**Teacher:** I've had a lot of my students do that, but our very best students here go to Simon Fraser. Bluman, I know, Bluman tries to get the kids to go there, but it's just too hard. A lot of them take that Engineering program at SFU, a lot of them. The very best kids I've had in the last ten years have all gone to Simon Fraser. They come back, and they just ... Those kids that are going into that program, are they taking the credit? Or are they doing the calculus again?

**Teacher:** No. Well, Simon Fraser, I think, just this year now is giving credit. But they realize that by working really hard in Grade 12 when they take their five courses in their first year university, really it's only four, and it frees up a lot of time. They really realize that the more work they put into calculus in Grade 12, it's going to pay off in time, and also in preparation.

**Massel:** I've just recently got something from Simon Fraser University about their giving credit.

**Teacher:** Well, I guess it's pretty ... I guess it's fairly ... it makes it difficult for them ... the professor, to have a first year university course with half of them sitting back with their arms folded because they know it all. Maybe that's part of the rationale there, I don't know. The intent, I think the intent, our intent here at [my school] was just to give the students a real good background to really pave the way, and now it's turned into this. I myself am not really that much in favour of the AP. You know, I'd rather, you know, the intent again is to get them prepared.

**Massel:** So, when you say you're not in favour of the AP, you're not looking to replacing the first year university course?
Teacher: No, absolutely not, I mean at UBC, they have ... they'll say it's not true, but I think it is, they continue to make that course more difficult, and more difficult, and more difficult, so, therefore, in grade 12 we have to do more, and more, and more, and more to pave the way.
Massel: Do you think they are making it more difficult?
Teacher: Oh, yes I think so.
Massel: Do you think they're making Math a filter even more so than it is?
Teacher: I don't think there's any question about that. I think they use Math 100 or Math ... what is it, 101, as a screening course.
Massel: Do you know what percentage of first year university students at UBC take a calculus course?
Teacher: I don't know the percent. I know the failure rate is around 40 percent, I think. I don't know if that includes withdrawals or not.
Massel: Yes, I'm not sure about that.
Teacher: I don't know. I think it would be very difficult to get that kind of information, you see, because Simon Fraser and UBC, I think, are trying to encourage students, and they're going to try to make those figures, the bad news figures, as good as possible. I don't know.
Massel: Well, I was quite surprised because I spoke with Professor Bluman, and he told me that over 80 percent of first year students take a calculus course at some time in their first year, and I was amazed. I didn't realize it was that high.
Teacher: Wow, I don't, then, therefore, he's saying that a lot of our students must be taking calculus?
Massel: Yes, they're taking it in case they need it down the road for something because it's become a prerequisite for such a lot of things.
Teacher: The intent here, I want to make sure that any student, any good student that I've got in my course or in this school, when they go to university, I don't know what they're going to do in English or Chemistry but they're certainly going to ace the calculus course, and that's what I'm trying to do.
Massel: Do you have a high correlation between the grades the students are getting in Math 12 and the grades they're getting in calculus.
Teacher: Almost a one. An A is a first. The kids that come out of here, all of them ... I mean one year we had a hundred percent got a first class, and that's out of a large population too.
Massel: What about the kids at the lower end of the spectrum of the school, like the Grade 11s who are just sort of scraping through the Math 11. Are you encouraging them to go on with Math 12?
Teacher: Oh I tell you ... I teach a Math 11 class. As a matter of fact I just went home last night and yacked at my wife. I have a class of 28 in Math 11. I don't think there's one
that's capable of handling the Math 12, and the Math 12 is a, in my opinion, a bonehead course. I mean Math 12 prepares you for nothing. It's a terrible course, I mean, I don't see how a student can, up in Fort St. John or whatever place take Math 12 as per that textbook and come down and go to Simon Fraser or UBC or some university, and be able to handle first year. That person better be real special or they don't stand a ghost of a chance, in my opinion, not a ghost of a chance.

**Massey:** Are the kids who are not getting calculus at school, other than what's in the Math 12 curriculum...

**Teacher:** That is an embarrassment.

**Massey:** Are the kids who are not getting calculus at school at a real disadvantage now when they go to university because of the numbers of kids who are having calculus?

**Teacher:** I don't think they stand a chance. I don't know of a school ... I don't know of a school that doesn't offer a calculus course now, I mean even some of the schools out here. I mean every school on the North Shore has calculus, and West Van. and Burnaby, my god.

**Massey:** So what's happened, have the universities sort of ... Is it pushing it down, saying these kids had better come up to us prepared because we are going to make it so tough. What do you think's going on there?

**Teacher:** Well, what would you do if you were a student and you knew that 50 percent of the people who take first year university calculus fail? I'd make sure I had a background, I mean I'd do it by tutorial or correspondence or something. Absolutely!

**Massey:** What are the implications of that for the Ministry courses? Is there not some onus now on the Ministry to provide a calculus course at high school?

**Teacher:** I guess that's what we're trying to do. Look at the chapter of calculus that they've got in the Math 12.

**Massey:** It's just the mechanics of having to differentiate a bit.

**Teacher:** Do you teach calculus at your place?

**Massey:** Yes.

**Teacher:** Well, I mean the product and quotient rule is optional. [Laugh] I mean unbelievable, unbelievable ...

**Massey:** Do you have a lot of support from the district for your courses, for example if you need books?

**Teacher:** Oh, yes.

**Massey:** Not a problem?

**Teacher:** Not a problem. I don't know if there was even originally, even though the kids, as I said before, had to pay for the exam the first year, but after that, no, no, the district pays for all the exams. I've had no difficulties whatsoever with books.

**Massey:** When you went down to Oregon to take that course, did they pay for you or did you do it yourself?
Teacher: Yes, they did.

Massel: And what about graphic calculators, are you using them at all?

Teacher: Well, I guess I'm the black sheep around here as far as the department heads. I don't believe in them. I think I can get, I think my kids can visualize a graph of any trigonometric function, bang, they can see it. They have their own graphic calculators in their head. And they understand exactly how it evolves from whether you're taking a model curve, a sine function, a cosine function. They know exactly the role played by every one of those variables, and they can just, bang, they've got it. They see it, and I think it's much better to teach them that way so that they can mentally see it rather than physically punching it in. I'm not a believer in them at all ... but I don't know. It scares me a bit. I was reading that AP Calculus handbook, and it scared me when I read the first couple of pages saying that in the future graphic calculators may be...

Massel: I think by 1995, they say.

Teacher: Yes, well, I don't know what I'm going to do. I guess I'm going to, if I continue to do AP Calculus, I guess I'm going to have to teach that graphic calculator.

Massel: They're not that bad once you spend a bit of time learning the calculator. I find for things like ... when I was teaching my calculus course this year I hadn't done polynomials in Math 12 because I teach the two courses concurrently.

Teacher: Calculus and Math 12?

Massel: Yes, and I was doing some curve sketching in the Calculus, and the kids had not yet learned how to factorize the higher order polynomials to find the roots [in the Math 12 course]. So I found the graphic calculator quite useful there.

Teacher: To what extent, to see what it looks like or just to see that there are three roots or two roots or whatever?

Massel: Just to see where the roots were basically, you know, just to give them that immediate visual thing. I agree with you that they need to know. And in order to use the graphic calculator they have to know what the graphs would look like pretty much before they put it on anyway so that they can set the range. So it's just, you know, just as an aid.

Teacher: Oh yes, OK, fair enough as an aid, and maybe to verify what you've ... the practical, what you've done on your paper, to verify that this is all great, as an aid, so some of the people here, some friends of mine even think that it's the gift from heaven.

Massel: No, no.

Teacher: Not for comprehending and understanding mathematics, no way.

Massel: No, just as an aid, it's a useful tool basically.

Teacher: Yes, I guess so. I guess I'm getting older.

Massel: What kind of support do you get from the counselors at the school when they come to course selection for grade 12? Are you really counseling these kids?

Teacher: I do their work for them. They're already signed, sealed.
Massel: So the kids know that this is what I should be doing.
Teacher: Not should be doing, will be doing.
Massel: Do you have to turn kids away from these courses?
Teacher: No, I started with 37. The principal asked me, look at, you want to go higher than 34. Sure, I'll take 37 then, like I said, it's down to 32 now. But those five that dropped, they're very, very good students. They dropped only because they were afraid of not getting an A. There's another bone of contention that I've got with these students that chase after marks.
Massel: You have it here too? It's a terrible problem.
Teacher: I tell you, I'm ready to ... for next year say ... there's no Math 11 special. There's no Math 11 Honours, and there's just Math 11. They'll all go in one group. That's about where I'm getting at right now, fighting with kids and fighting with parents.
Massel: Because when you have the Honours course the kids feel they've been penalized mark wise, and they don't realize that they're benefitting educationally.
Teacher: And the parents, I don't know what world the parents live on either. I have a real problem with parents. My son and daughter had an A all their life. What are you doing? I'm trying to teach them some mathematics. The standards are changing. They better get prepared for those standard changes when they get on to university. We have a Math 11 Special program here, and this is where all the good kids used to come from, well, we're down to 21, and in previous years we've had 60, and what they do is in two blocks, they're double blocked too in Grade 11, and they take three courses: the old Geometry 12, it's off the Ministry, we call it locally developed, teach the same course, Probability and Statistics 12, the old one, off the books, bang, we still do it, locally developed, then we do Math 11 Honours, and I mean Math 11 Honours. The old Dolciani [textbook that was in common usage for the Algebra 12 curriculum] type of questions, none of this...but actually the Math 11 book is pretty good ... anyways, they do three courses in two blocks, so we've got about 90 hours per course. We have about that.
Massel: We've probably got that as well.
Teacher: So multiply that by three...180, by two, sorry, the courses are 60,60,60. And what the most important thing is that they are now prepared mentally and with their work ethic in Grade 11. Boy now they're willing to work in Grade 12 other than...
Massel: Yes, and they've got the background.
Teacher: They've got the background, and then they also, they're used to working in Grade 11. It takes them awhile to get them going, and then in Grade 12 it works out very nicely.
Massel: And now you say that group this year's down to 21?
Teacher: Yes, and I went to talk to ... last year in Grade 10 class, I went into the class and talked with all these kids. They are OK, we understand this is good, but very hard!
said, yes, yes, you've got to work at it. How much homework you got to do? Well, you've got to do at least an hour, and maybe even an hour and a half depending if you get two of them in one day, a night. An hour and a half, oh no, I can't do that. I have friends that only got a C+. So what are they taking, these kids are all taking Math 11 ... Math 11, the suicide course because it goes nowhere.

**Massel:** Do you have the Math 11 A program here as well?

**Teacher:** Yes, we've got a lot of students in there, about 180.

**Massel:** Do the kids ever fall back into the mainstream from those courses?

**Teacher:** The Math 11 A?

**Massel:** And from Math 10 A too?

**Teacher:** Well, we don't have, but some of the 10 A's are taking the intro Math.

**Massel:** Do they ever come back into mainstream?

**Teacher:** Some of them. I'd say about 30 percent take Math 11 in Grade 12.

**Massel:** So they are coming back. What about the Math 12 survey?

**Teacher:** We've got one block, no, no, what we do is we put the Math 12 survey in the Math 11 Special. We give them that credit. It's still the Probabilities and Statistics course ... right.

**Massel:** You do matrices and vectors?

**Teacher:** Matrices

**Massel:** And Vectors?

**Teacher:** We used to do the vectors in the old Math 12 before the government exams. They are really important. We used to do the polar coordinates too. It's a lack of time.

**Massel:** Do you have any backlash from teachers of other disciplines here that some of these kids are maybe doing too much Math, you know, not enough arts subjects or...?

**Teacher:** Lots. [Laugh]

**Massel:** Because I get that at our school when I went around pushing Math programs, and it's true they're important.

**Teacher:** I guess I've got my own opinions.

**Massel:** What about the sort of ethnic mix in this area. Do you have a lot of...?

**Teacher:** Everything.

**Massel:** Has that influenced your programs at all?

**Teacher:** Not really, we have the white Caucasians, and Orientals and Asians and East Indian people.

**Massel:** Do you have kids coming in to Grade 11 who have a background in say Hong Kong?

**Teacher:** Yes, we get a few, but we don't get that many really. They're second generation. We get a few though. Not in the last three, not that many in the last five or six years. I remember talking to the counsellor about this fellow and he also wanted to get into
Math 11 Special. We were into the course three months already. I'm looking at him, you know he's got his Vietnamese translation book with him too. I said they're just writing the test now. Anyway, he came in 15 minutes late ... finished before the other kids, and then got the best in the class, and he had to translate for the Geometry test.

**Massel:** You said, I'll take him!

**Teacher:** So I signed him up. So we get a few of those but not really all that many. Is that it? Is that all your questions?

**Massel:** I think I've really covered all of it.

**Teacher:** What is your intent? What is your thesis here on?

**Massel:** Well, I did this course through Simon Fraser University, this Master's course for Math teachers. Now I'm at the stage where I have to do my thesis, and I was interested in the AP because I know what I did at my school to get the program off the ground. So I was just interested in looking into what's happening with Calculus in B.C. The districts were supportive since they're also interested in the results because there is a lot of calculus happening and nobody seems to, you know, have really said, this is what's happening out there.

**Teacher:** Have you been to schools like David Thompson and Templeton and Vancouver Tech?

**Massel:** No, in Vancouver I went to [two schools]. I limited myself to eight schools.

**Teacher:** Those are the schools that are just exploding mathematically, David Thompson ... Killarney ... Asian.

**Massel:** It's interesting, so many people have said to me, that's why I asked about ethnic mix, have mentioned that, and I spoke to my supervisor at Simon Fraser, and I spoke to him, and I said, you know, what about this, and he said, well it's a difficult one to get numbers and statistics too, and actually I'm going to put it in just in terms of my write up. I think that's very true. I'm sure that that has had an influence.

**Teacher:** Oh! Influence! Boy, I tell you, I certainly think so. I mean schools like Churchill, I mean they have a very good Math program there and they have a very good teacher. My god, look what they're working on, holy cow! Talk about motivated!

**Massel:** And that's what makes the other schools have to build up their programs because else their kids are disadvantaged.

**Teacher:** That's what... I give my Math 11 students, Math 12, the good kids, I give that speech to them all the time. Those kids at Churchill are going to eat you up. Killarney and Vancouver Tech, I mean you might be a big fish in a small pond here, you're going to get annihilated if you go in there with just your ability and not your work ethic, but I don't know. Doing that, I get lots of flack from counsellors, and lots of flack from parents, parents writing letters to the principal. [Teacher] is preaching the wrong thing to my little darling. [Laugh] By the same token, I get all the letters coming back, the kids coming back saying, holy cow,
you were bang on ... bang on. I said, you know, I've got the kids coming back who are sitting in their calculus class first year, and they are feeling pretty good about things, and they are looking at the faces on people and ... wow. How could I have done it, that's what a lot of them say ... how could I have done it without a background?

**Massel:** Do you have any of your kids going back East from here?

**Teacher:** Not really, again, it's the social-economic situation here. A lot of really good, good kids, they go to Kwantlen and things like that. They just don't have the resources, don't have the money. I've had a few kids go back East. A couple of students here four years ago went to McGill, one went down to California. Not that many.

[The rest of the interview included a discussion about textbooks and about organizing the random selection of students and appointments for interviewing them.]
APPENDIX E

TRANSCRIPT OF INTERVIEW WITH

AN AP CALCULUS STUDENT
TRANSCRIPT OF INTERVIEW WITH AN AP CALCULUS STUDENT

The following is a transcript of the interview held with an AP Calculus student. This student attended a large non-semestered senior secondary school.

Massel: You have read that I'm doing a thesis on the Advanced Placement Calculus. I'm a math teacher in Vancouver. I've seen the program rise rapidly in the last few years, and I'm interested in why this has happened. I'm speaking to teachers, students, headmasters, and university people to try to ascertain why. Why are you taking the Advanced Placement this year.

Student: First of all, before I went into Grade 11, I knew that I would take it because the Math 11 Special would lead into the A.P. So if I were to put that effort into the special class I might as well continue. The main reason is so that I would be prepared for university. Even though I would have to struggle a little bit in high school, it would be easier for me in university. The competition I guess. Even in my Junior High years, I took whatever enriched courses were available. My parents really encouraged me to do that. I enjoyed it because I learned more and I feel I'm being more productive.

Massel: Even though they might be a little more difficult?

Student: Yes.

Massel: What are you planning to take at university? Have you got any ideas yet?

Student: First year I'll be entering the faculty of science and then second year I'll probably move on to engineering.

Massel: So you're definitely going to be using your mathematics?

Student: Yes.

Massel: Do you enjoy mathematics?

Student: Yes, I do.

Massel: Is it one of your best subjects.

Student: I would say so but, the thing is, I'm torn between the Arts and the Sciences because I enjoy English and the Arts just as much, but I think I'm a little bit stronger in the Math.

Massel: It is a problem when you're an all-rounder

Student: Yes.

Massel: You don't know which direction to go in. A nice problem, I think. At the time when you first heard about the calculus you were still in Junior High. Was it calculus you heard about or more the enriched Grade 11 Program?

Student: It was the Math 11 Special.
Massel: The first time you really heard about calculus was when you were here at this school?
Student: They kind of explained it to us in Junior High that if we took the Math 11 Special, it would kind of move on to the A.P. I believe that it wasn't that clear to me, so I just knew that it was some sort of an enriched course.
Massel: But last year when you decided to go into the AP Calculus, who would have told you about the program at that stage?
Student: Our math teacher. We had two different teachers. We were taking the Geometry, then Algebra, then Probability and Statistics. Three courses. So we would switch between two different math teachers.
Massel: Did you have two blocks last year?
Student: Yes.
Massel: I see. That's interesting. So you have had a really heavy schedule of math for the last two years. When you decided to take the calculus was it your own decision, ultimately?
Student: Yes.
Massel: Did your parents play any part in it?
Student: I asked them for advice and they believe I'm fairly strong in math and I've always been in the top five percent of my class, in Junior High at least. I was worrying that it would be too difficult, because they kind of scared us before we went in; how difficult it would be and they really scared off most of the students. They said well, if you're too intimidated, then who is good enough to go in.
Massel: So they encouraged you basically?
Student: Yes.
Massel: Are you spending, well I know the calculus has only recently started for you, the actual course itself. Are you spending more time on that course than you were on say your math 12 or other subjects, at this time?
Student: I should be, but I find I would like to. Yes, normally I would spend more time on my calculus, I think, than on other subjects. I guess I just have to work on that. Right now I have all those other courses, plus I have a lot of extra-curricular activities that I'm putting time into, so at the moment for the past month since we began calculus I haven't been putting enough time into it.
Massel: How would you compare this calculus course with, say, the Math 12? Are you finding it pretty much the same level or more difficult, or easier?
Student: Pretty much the same level.
Massel: So its not any more difficult, as such.
Student: No.
Massel: I'm going to ask you . . . you don't have to answer this . . . how did you do in the Math 12 exam?

Student: 90 percent. But in the course, since the beginning of the year, I wasn't doing that well. I was getting a low B level. The Provincial brought me up.

Massel: Did you write the scholarship as well?

Student: Yes, I did.

Massel: How did you do in that?

Student: I got a 556. But before I wrote it I knew I had bombed it. I guess I was so drained from the Provincial, so I hope to write it again.

Massel: Are you taking other A.P. subjects this year? Will you write other A.P. exams?

Student: Physics 12 A.P., up until the beginning of this week. Our Physics 12 A.P. class, many of us were finding the pace too quick, so about half the class switched to Physics 12 regular, and I was one of those individuals.

Massel: It's not a block switch. You're just going to work on slightly different work within the same class.

Student: But then I have a Socials 11 A.P., but that's a Grade 11 course.

Massel: It's like an enriched class.

Student: Yes. I didn't take Socials 11 last year.

Massel: Will you write the English 11 A.P. exam?

Student: No.

Massel: Do you think there is some kind of prestige attached to taking calculus while you are still at high school? Some kind of honour? Would that have been a factor in your decision?

Student: Not consciously, but it probably had to do with it. When I was making my decision, I was used to being in enriched courses.

Massel: Have you spoken with students who have finished school, gone to university, taken calculus there and told you anything about the calculus course at university?

Student: Yes. I have heard that calculus is a killer. I have heard a lot of that.

Massel: Did that play a role in your decision to take it at school?

Student: Yes.

Massel: If you are successful with the calculus exam - if you get a four or a five - do you know if the university would give you credit for that?

Student: I have applied to U.B.C. - it is one of the universities that I have applied to - and they say that they do take it into consideration, but I don't know how much.

Massel: If you were to get credit for say the first calculus course at university would you take that credit, or would you do the course again?

Student: I wouldn't take it.

Massel: Why?
Student: Because, I guess essentially my marks would be, I would be struggling with the new things I'd be learning, when if had started just from first year calculus it would be much lighter for me because I would already have that base.

Massel: So you really see the calculus as helping you to make that transition to university to make it as easy as possible.

Student: Yes.

Massel: Do you know what the pass rate is at U.B.C. in the calculus courses.

Student: Our teacher mentioned this. I don't think its too high. Maybe about 30 percent?

Massel: I'm not sure what it is. I'm just trying to see if there are any ideas out there of what it is.

Student: I don't think it's too high.

Massel: So you do feel it is a potentially difficult course. Any other comments.

Student: Just that I would really recommend the A.P. course. I really enjoy it. The students in my class are really hard working and ambitious, and have high standards. I enjoy working with them. The teaching is very good.

Massel: That makes a difference. Is the teaching inspiring?

Student: Very inspiring.

Massel: He makes you want to work.

Student: Well, almost scares us into working. But it works.
APPENDIX F

TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW

WITH A MATHEMATICS PROFESSOR

AT THE UNIVERSITY OF BRITISH COLUMBIA
TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW
WITH A MATHEMATICS PROFESSOR
AT THE UNIVERSITY OF BRITISH COLUMBIA

The following is an extract from an interview with Dr. George Bluman. Dr. Bluman is a Professor of Mathematics at the University of British Columbia and is Undergraduate Chair at UBC.

This transcript was edited with Dr. Bluman's approval to enhance the readability.

Massel: Over the years it's become apparent to me that you've been fairly influential, I think, or may have been influential in terms of how AP's been recognized. I remember the very first workshop I went to just outside of Seattle. You were there and gave your views on how the university viewed AP. Over the years I've seen the way in which the acceptance of AP has changed.

Bluman: Yes, I was on the UBC committee ... a President's Advisory sub-committee which recommended the AP.

Massel: So I'm hopefully going to speak to people at each university and you're the first person I've [approached]. I hope I'm going to ask you the right kind of questions. But, I really want to know what your views are on the AP, on the whole program. I want to know things like how do you find the students who have done AP? When they come to university and take a course, how do they do? etc. And if I can use this in my...

Bluman: Sure, now...

Massel: Just before you start, I just want to tell you that I'm going to the schools. I'm going to speak to teachers. I'm going to speak to students and find out why they're taking it. And, I'm going to speak to principals to find out how and why it's been implemented, etc.

Bluman: One of the very important groups for you to speak to are those who are at university right now who took AP. [Find out] what they're doing with it and why.

Massel: I thought to do that...

Bluman: That's the most important group. Now you'll see why.

Massel: Ok, yes I'm very interested.

Bluman: After we accepted AP, I initiated in the department here a special course for the AP students - an honours Calculus 121 in the first semester, followed by another honours course, Linear Algebra. [This was] specifically for this group. And the criterion was that you had a five in the AP Calculus AB and the curriculum was catered to the AP course. They [the AP students] were missing certain things from our Calculus 120 course. In particular [they were missing] more detail on the Mean-Value Theorem, Newton's method [and] parametric
equations ... which are all in our first semester. So I spent three weeks on background material which they would have in the first course. On the other hand they had integration in the AP course. So [I cut] the time spent on the various techniques of integration and whatnot, to create three weeks. [By doing this when] they end the course, they’re at the same level as the other honours calculus students. Anyhow, in the first year, we got about 16 or so students in the course, and then [in] the second year we got about 20. This year, the third year, [we] only [got] 14. And yet there are more students who qualify for it.

**Massel:** Yes, the numbers are going up.

**Bluman:** Ok, what are the students doing? They’re repeating! They are repeating their work from AP. They need 100 or 120 and they’re just doing it all over again. They’re looking at AP as simply a way...they think it’s [a way of] just getting higher grades. In school you would not allow a student to finish Grade 11 math and repeat Grade 11 math...

**Massel:** Just to improve their grade.

**Bluman:** That’s not the intent of it! So, in that sense, the thing was a failure. I think it’s a failure.

**Massel:** And yet it’s here and it’s becoming very forceful.

**Bluman:** I realize that but the counselling is not working properly. The purpose of the AP is to allow the student, especially in Math, to [go] ahead. They can move ahead when they come into the university and take more electives. Particularly [for those] students [who] often go to other fields and haven’t enough room to take enough math in their programs. It gives them the opportunity [to do so]. So next year ... right now I’m seriously thinking of no longer providing this special course for the student.

**Massel:** Do they have the option of going into the second semester if they don’t want to go into that honours course?

**Bluman:** But they’ll have a hard time... they would have a hard time if they take the honours course, because they are missing some things from the first semester. It might be too big a jump for the students. But if they’re not doing [the honours course] in the first semester, they’re for sure not going to do it in the second semester. I wrote a letter to each student inviting them to the [honours] course and explaining the difference. [Despite these efforts] they still don’t go into the course. The students who got into the [honours] course and took it were very receptive to it. Unfortunately, many teachers are counselling students to repeat the course. That’s where the problem is. The teachers in the schools are counselling the students to repeat the calculus.

**Massel:** So they’re not encouraging the students.

**Bluman:** Not at all, quite the contrary.

**Massel:** What I heard at the AP conference sort of backs that up. There was just a small handful of teachers who were there but that was what they were basically saying.
There's a feeling outside of the university that a lot of students are going to fail first term calculus at university. Is this the case?

Bluman: No.

Massel: What is the...

Bluman: All the AP students have an A in Math 12.

Massel: What about the students who are at a school where calculus is not taught. Are they at a disadvantage?

Bluman: No, in actual fact they're not. Every school now has three or four weeks of calculus which is in the Mathematics 12 curriculum.

Massel: Yes, what do you think of that?

Bluman: We were [against] having that in the course. We much prefer the students to have had either no calculus or a full [course], like an AP course. We do not think of something in between as a healthy thing. But the facts are that psychologically the students think it's better to have three or four weeks of calculus.

Massel: Do you have any input into the development of the B.C. Math curriculum?

Bluman: No. No. No. We wrote letters opposing certain things but no attention was paid to them.

Massel: Right. I know the BCAMT came out with a statement a few years ago saying, either a whole year of calculus or no calculus.

Bluman: Yes that was our recommendation.

Massel: It seems like the curriculum people didn't follow that through at all.

Bluman: That's right, but all I can say is that the students were not performing any differently here, whether the schools they came from had calculus or not. It was their results in Math 12, and the kind of school they went to, that mattered the most. It doesn't mean the school was good because it offered a calculus course.

Massel: Is there a strong correlation between the Math 12 results and the results in the first semester calculus here?

Bluman: Yes, definitely. Clearly the A students do much better than the B students, do much better than the C+ students from any given school. The average grade at some schools [much lower] than other schools. If you just normalize the grades, certainly the A students are much better than the B students, much better than the C+ from within a given school. Except, oddly enough, the private schools, the independent schools. We did some studies on this and on a relative ordering the independent schools' grades were not nearly as reliable as the public schools, in regard to the order of the students. The order of the students from the public schools was more accurate than at the independent schools. The order was more likely to reverse from an independent school, particularly from a boy's independent school.

Massel: Well do you know why? I teach at an independent school and I think the students get a lot more attention. So the over-achievers who are really working very hard
and getting a lot of individual attention are doing very well on their Math 12. Then they come to university and they can't sustain it.

Bluman: So the poor student does better at independent schools?
Massel: I think so.
Bluman: It can happen that a poor student does better than a better student?
Massel: Yes.
Bluman: Well it's not so visible from girl's schools. It's more visible from boy's schools. If you tested the students at the beginning of the term the order that they had from the independent school was verified. Okay? [What I think happened was that the university environment affected the boys, particularly the boys.] and that's why the ordering changed.
Massel: Outside influences.
Bluman: Outside influences. I think the preparation was fine, the preparation and the grades were accurate. [A public school boy did not have to make as much adjustment to the environment at UBC.]
Massel: I see what you're getting at. Professor, what made this university...I mean I know that you were instrumental in bringing about the change in policy on AP Calculus from the university's perspective, but why did you want to do that?
Bluman: Oh, because I wanted to encourage excellence from the schools. It was clear from looking at the data and at the AP curriculum, which is a satisfactory program, that if a student can achieve a certain mark on AP they have mastered the curriculum and are ready to move ahead.
Massel: Right, so you wanted to give them credit for that?
Bluman: That's right.
Massel: Did the fact that the Eastern universities give credit for AP have any bearing on your decision?
Bluman: No, not at all. But the fact that Eastern universities and American universities in particular, were giving credit helped sell the case. For me personally, that was not the reason.
Massel: Is there a large proportion now of first year students coming into the math classes with an AP Calculus background? I know what the numbers are from the AP conference.
Bluman: I can only speak for Math. At UBC we have 131 students who submitted their grade of a four or a five on AP Calculus this year, 131.
Massel: And that's out of...but you have far more than that taking calculus courses, don't you?
Bluman: [The total number of first year students coming directly out of B.C. high schools who took calculus in their first year is about 1800. Of these 258 submitted AP Calculus
grades. 137 had a grade of four or five. 244 submitted AB Calculus grades and 20 submitted BC Calculus grades.

**Massel:** So it's about an eighth?

**Bluman:** No, no, it's about a ... seventh ... but many students don't submit their grades.

**Massel:** Oh, I see.

**Bluman:** There are 864 that wrote AP Calculus in B.C. and 238 submitted grades to UBC. Now we know that over half of the better students in the province come to UBC. We've got data on that. The better the student is, the more likely it is that they're going to come to UBC, so we can estimate...

**Massel:** As opposed to the other B.C. universities?

**Bluman:** Over half of the better students in the province who go on to post-secondary education come to UBC. The better the student, the more likely he is to come to UBC. And so I expect about 60 percent of the students that write AP attend UBC. That means that if 864 wrote the calculus ... now there are some weak ones in Math, but anyhow, I'd imagine that between 450 to 500 of those students are at UBC right now and 258 submitted their grades. So I'd estimate that probably 450 ...

**Massel:** Did the AP Calculus?

**Bluman:** Are at UBC right now. I'd estimate 450 are at UBC right now.

**Massel:** So that's close to a quarter of your students who have taken the AP Calculus prior to coming here?

**Bluman:** Yes.

**Massel:** Have you noticed an effect on the standard, you know, how can I put it, on the ... the students who are taking those courses, even those that you don't know that have taken AP courses, have you noticed an effect?

**Bluman:** It means that almost all of them are repeating.

**Massel:** Yes, I see that, so are you noticing a difference?

**Bluman:** I don't think that the numbers are such that you can notice a difference from that. But we do notice that the students are better this year at UBC and I don't think it's AP. I think it's a better curriculum in grade 12 Math. But we've noticed improvements in the last three or four years in the first year students here. At other places they've been worse, but the data does not back that up ... here.

**Massel:** That's interesting.

**Bluman:** And I think the Euclid Contest combined with the AP...there may be a connection between the two, in that getting involved with the Euclid means the students may be more confident of putting in an AP. The students can perform well.

**Massel:** Yes, certainly at my school it would be the same students, more or less, who had be taking the calculus, who would be writing the contests.
Bluman: Yes, but Euclid is written before AP. So the fact that the student maybe does well on Euclid [makes the student think that] maybe they can do the AP.

Massel: Yes, but they make their commitments, in actual fact, in practicality, they make their commitment to AP long before they think about the Euclid contest.

Bluman: No but the school itself saying that they could do the AP. They say that their students can do well. The school has to make a decision as to whether they're going to offer AP.

Massel: I see what you mean, so that their Euclid contest has influenced whether the school...

Bluman: And vice versa. The AP influences the Euclid results. I think it works both ways, in fact. One feeds on the other. Another spin off, I think, is that by doing the AP Calculus, the Math 12 [is improved]. And that's another reason to encourage the AP development. I felt that the AP would make the Math 12 teaching better in British Columbia because the teachers see beyond the level of Math 12 and [they] feed that back into the Math 12. That can only lead to better preparation of the students in general. The teacher has a better perspective on things.

Massel: What are your thoughts on the following? At my school we do the Math 12 and the AP Calculus during the same year. The students have not completed Math 12 when they start AP Calculus. I certainly got the feeling at the AP conference on Saturday, that many of the 12 teachers who were there do it the same way. [There was an interruption] I was asking what your thoughts are about doing the Math 12 concurrently...

Bluman: Okay. It's certainly preferable to have done the Math 12 before, certainly preferable. You know there's two ways you can do the Math 12. One is to do it together so whenever you have some Math 12 material [that is] needed for the AP you do it at that time. The other alternative is to do the Math 12 first in that year and then do the AP after that. I would think that in actual fact, if you're going to do it in Grade 12 probably the first model is better where you do the Math 12 and AP together but there are some overlaps, for example, functions and inverse functions.

Massel: Well, what it means the teacher must do a juggling job. You have to hold back on things like differentiating trig functions in the calculus because you maybe haven't done that in the Math 12 course, or exponents and logs ... so it's a bit of a juggle. That's the way I do it. It seems to work.

Bluman: There's one danger in that sometimes the students associate certain topics, particularly those of a geometrical nature, as belonging to calculus and they don't. They stand on their own without the calculus. That's the only thing, that they may lose perspective. But ideally, it would be better to have the students [complete] the Math 12 before [commencing calculus]. In other words you have a program that starts in Grade 8.

Massel: The type of thing that Eric Hamber has.
Bluman: And other schools too.
Massel: How do you feel about calculus students using graphic calculators here at university?
Bluman: I think it's great if they use them.
Massel: Are they encouraged here?
Bluman: Ah ... it depends on the instructor.
Massel: Yes, I read something, now what was it? A little while ago. It must have been about a year ago. Somebody asked the department here about calculators and that was the answer. It depends on the instructor. I found that interesting.
Bluman: Yes, you get different points of view. My own view though is that you have to recognize the current technology and the real world. As long as the students use them properly.
Massel: I heard Bert Waits speaking on Friday at the conference. He's from Ohio and he's on the AP Calculus development committee. The topic of his talk was on the reform movement in college calculus and his presentation was about using technology in the calculus course. So I was just wondering what the university's philosophy was.
Bluman: Well what it amounts to is that it is dependent on the instructor. I mean all ways are good as long as you're enthusiastic about it. You can't say that one way is better than another way. So people tend to ... If people have been doing it successfully one way for many years [that's how they will continue to do it].
Massel: Are you aware that, I believe, 1995 is the date set, that the AP Calculus exam is going to permit graphic calculators to be used.
Bluman: No, I'm unaware of that, but I see nothing wrong with that. I allow the students in my first year calculus class to use any calculator they want, no restrictions at all.
Massel: I see. And do you like it if the students come out of school and know how to use this technology? Does it make your life easier?
Bluman: Not necessarily, but I like them [to use] whatever they feel comfortable with, you know. I don't want a student to be anxious because they haven't got the technology, you see. This is the thing.
Massel: This is possibly a little bit of a sensitive issue, but is calculus actually used...I don't know if you can even answer this...Is calculus a filter subject at university?
Bluman: Not really. In fact...what do you mean by a filter subject?
Massel: Well, it seems to be a prerequisite for so many things and students at school have tremendous anxiety because they have to take calculus, not necessarily because they want to, but they have to otherwise they can't...
Bluman: Ok, all the programs that require the calculus, follow up. That's an answer to your question. All the programs that require [calculus] ... that I [am aware of], follow up with a course [in which] Calculus is used.
Massel: So it’s necessary for that particular...?
Bluman: In science, in all the sciences calculus is necessary. And it’s required in economics. It’s required for pre-commerce. At UBC last year of all [first year] students, 87 percent took calculus in their first year.
Massel: That’s a big percentage.
Bluman: If you asked that question 15 years ago, it was 55 percent. It’s gone up ... 55 percent to 87 percent.
Massel: So there’s a tremendous need [for students to be able to do calculus]. Certainly at my school I keep impressing on the students from a very young age that math is really important for them to know these days.
Bluman: In fact I looked through all the schools. I believe it was correct to say [that for those schools which had ten or more students attend UBC, at least 80 percent of those students were taking calculus].
Massel: That’s a huge proportion. Probably the only other course that’s offered that has that sort of proportion of students is something like English.
Bluman: No. English is required by everybody, so 100 percent English.
Massel: Yes, everybody, Ok.
Bluman: In fact that’s how I get the data. A fraction of the students taking English were taking calculus. That’s the way I work it out.
Massel: I see. Is there any other subject that this is such a high proportion?
Bluman: Oh no. Oh, there’s no subject close to third place.
Massel: Do you think that might be one of the reasons why the schools are feeling that they need to offer their students a calculus course so that they’ve got that...I realize that you don’t like the fact that the students are repeating. But the sense that I get is that the students know that their marks are very important. So whether they’re good at Math or not that good at Math, they know that if they have to take calculus, they want to do as well as possible. Do you think that might be a reason why so many of them are opting to take it?
Bluman: I think so, although ... see I have seen students who have repeated and did worse and failed. They get a five in AP and fail!
Massel: Why would they do that?
Bluman: Because they were bored.
Massel: So they felt they knew it?
Bluman: They didn’t do their homework and failed the course ... visibly.
Massel: Is there a large number of such students that this happens to?
Bluman: Before it was approved, I had a class where I had three students from the same school who presented a five on the AP and one of them was excellent. In fact he became a master’s student of mine eventually. The other one who won the Euclid contest, was in the top twenty [high school students] in British Columbia and he failed. The third
student's was the weakest on the Euclid. He got a five [on the AP] and he repeated and he did abysmally. But these [last] two were the most bored students in the class. If anything one was a little bit of a trouble maker. He wasn't paying attention and talking. And the other one had the most uninterested face in the class; he had got into the top twenty in Euclid, and had a 5 [on the AP]. The third student who was also in the top twenty-five on the Euclid and was taking it over again, he enjoyed it immensely. And they were all from the same school.

Bluman: Interesting. Can you tell me what you think about the actual teaching that's happening in the schools, the teaching of calculus? Well, certainly I know when I picked up and started teaching calculus, it was for the IB program so it was a few years ago, but I had been away from calculus for a long time, from the time I left university. I had to pick it up and even now, certainly there are some parts of it that I feel very comfortable with and others that I don't. You know, it's just a matter that I've been away from it for so long. How do you feel the teaching is being handled in the schools? What sort of level?

Bluman: Ok, I [personally] think the universities are uptight about it. That was the case in the Arts faculty. The Arts faculty would not grant [credit for the AP courses]. We grant credit for the AP courses in the Science faculty. The argument [the Arts faculty gave] was that you [the high school teacher] can't do a proper job, you just can't do a proper job! My view is that there's a standard in the AP course that's monitored. However you achieve that standard is fine. That is the standard. We don't question at the university how a student gets a 65 percent or a 60 percent. It's the same with you on a course at your school. What you're [teaching] will be reflected in the results in that school. But that's not going to [impact] on the student's being given credit here. That's an internal matter for the school, not a matter for us to look at.

Bluman: Ok, so if the students are coming out with the results then you don't worry too much about how the course has been taught?

Bluman: No, the student [attains a standard]. If there is some problem in preparation, it will correct itself, just like it corrects itself in the [high school] class.

Bluman: Do you think that there is some good teaching going on out there?

Bluman: In the schools?

Bluman: Yes.

Bluman: I think there must be. [You only need to] see some of the results that some of the students have from certain schools. Certain school's students always do well and [excel]. You might say well that's because of the [area]. That's for sure not the case. But I see [a difference] when a school has a new person come on the scene, a new Math teacher or a new principal or a new combination of both. I see this fantastic change going on in just one year. So obviously the teacher is playing a very significant role in Mathematics. The administration is also very, very important. The support they give the teacher [is important].
They have the clout to say who's teaching what. No, I think [the situation] is extremely sensitive to teachers.

**Massel:** This is really off the topic, but I'm just interested from my own perspective in my own school. Do you think that it's a good idea to have streamed courses in Math? By streamed I mean that you have the better students in one group or in an enriched program.

**Bluman:** Yes, I do think so. The reason I think so is that students learn from their peers more. That's very, very important, peer learning. On the other hand, I do think that these students should not be apart from the other students. I think that they should be teaching the other students. I think they learn a lot by explaining to the poorer students what is going on. There's a strong correlation. You mentioned about [calculus being a] filter. It's interesting that they did a survey of the most reliable indicators for success. They found that for the students that went into Arts, Math 12 was a considerably more reliable indicator than English 12 of how well they do in Arts, as a single subject.

**Massel:** That's interesting.

**Bluman:** I understand that just over half the schools are offering [the AP Calculus] now in B.C.

**Massel:** There are a lot of schools. I just looked at the number of students over the last few years... and it's been growing exponentially.

Bluman then spoke about the fact that for students to maintain their scholarships at UBC they have to maintain an 80 percent average. He felt that some clause should be put into the university scholarship and the Canada scholarship [criterion] to reflect that a student in an honours course could have a lower grade than if they were in a regular course. He also thought that it would be unfair to legislate that students could not repeat a course at university if they had the AP credit at that stage. That's the end of the interview with George Bluman from UBC.
APPENDIX G

TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW

WITH A MATHEMATICS PROFESSOR

AT SIMON FRASER UNIVERSITY
TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW
WITH A MATHEMATICS PROFESSOR
AT SIMON FRASER UNIVERSITY

The following is a transcript of the interview held with Dr. Harvey Gerber. Dr. Gerber is an Associate Professor of Mathematics at Simon Fraser University, British Columbia.

Massel: What I'm speaking to you about is what your views are about, I suppose the AP Calculus, if you know anything about the course itself and also about the fact the kids are taking it at school now. Why you are now accepting it? How this came about etc.

Gerber: Well the AP Calculus course as a course itself, as a program itself, is very good. The bad part of it, of course, is that it's taught specifically for an examination which always has disadvantages. Courses are basically taught for examinations anyway so this is nothing new as far as students are concerned, but as far as a uniform examination which has very simple standards in the sense of clearly defined one, two, three, four, five and having grades four and five mean something special, it is very, very fine. The exam is very, very good, as good as or better than any one of us could do in our own courses. The material is good standard material and as far as the kind of way of looking at the calculus that we can expect in the high schools, it's very, very good. It is an excellent program. Whether or not it should be advanced placement or it should be given some credit is another question. The course explicitly was for advanced placement which technically means that the students, when they come in, that they've taken the AB Calculus which corresponds to the differential calculus, they would get credit for the first half a year of our course. They would not get credit for it but they would be allowed to go into the second course, so if they needed a hundred and twenty hours credit to graduate, they would still need a hundred and twenty hours to graduate except that they would bypass the first semester. Similarly with the BC which would be the first year. That would be advanced placement. Credit means honest to goodness credit for four units, three units, whatever it is, and instead of needing a hundred and twenty to graduate, they now need a hundred and seventeen to graduate but the grade doesn't appear on their transcript. We prefer to give them advanced placement. One, because that was the intent of the course. Two, because in our experience these are very good students in the first place and they're going to take the hundred and twenty hours and it'll do them good to take something else, and number three, it probably is a better idea to just say to them, look this is really a course that the university... because it isn't a university course. There's things that happen in the university environment that don't happen at high
school. So, the reason we did it, frankly, was because UBC did it. I for one thought that it made absolutely no difference because in our...

**Massel:** You do in fact give credit now...

**Gerber:** We just decided... this semester...

**Massel:** But the marks don't...

**Gerber:** That's right, we give credit. If they wish students will do it. I for one predict that very few students will opt to take this. The teachers get all upset and the students get all upset because they think they're getting something less from one place than the other... even though they don't take it. So UBC decided to do it and UVic. went that way, we found ourselves trying to justify what both of these universities before said was the correct policy. All of a sudden they did it. I would guess, I don't know, that UBC decided to do it because of the Engineering Faculty decided that they should do it...

**Massel:** Can I just clarify one thing. If a student comes to you and they have been successful with AP Calculus with say the AB level and they've got a four or a five, do they have to take the credit and move on?

**Gerber:** No.

**Massel:** So they can stay?

**Gerber:** They can stay if they want.

**Massel:** Ok, I heard of one kid who specifically didn't write AP because he didn't want to get credit, he wanted to do Calculus at university. Then I found out he was in a pre-calculus class. Do you have a pre-calculus class?

**Gerber:** Yes, a pre-calculus class but that's for people who haven't received grade B or better in high school.

**Massel:** Yes, that's why I said query my source because, you know, I got it from his Mom who wasn't quite sure what she was telling me, what the reasons were for that?

**Gerber:** But almost all students decide to... we ran some statistics... and it was very confusing. Some people who had gotten a four or a five in Calculus [AP], and who had taken the first semester calculus course, wound up not doing that well in the first semester calculus course, not as well as we thought they should. Almost all people who went on to the second semester calculus or where they were supposed to be if they were taking advanced placement, those people did, in fact, do very nicely. So we don't know if it's because they didn't know to take it or they went back to take it again and sometimes when you take it again, you don't pay attention, or whether or not it was a matter of... they may have gotten a four but they really didn't feel as if they knew the material, and the people who went on were people who got good honest fives and they... so we didn't know what the hell it meant, but we were willing to go along with this.

**Massel:** I guess over the last few years more and more students are coming who have had some kind of calculus background. Do you teach first year courses?
Gerber: Yes, I teach, well, I haven't taught calculus in about two years, but I taught a 100 level course this semester.

Massel: I'm just wondering if there's a sense when you're teaching a class that's got students in it who have calculus at school before, if there's a sense that they know this ... let's give them more, sort of thing. Do you think your courses have changed substantially over the last few years?

Gerber: Because of this? There is a tendency if the students do well for professors to pile it on. The course has suffered from that. It has gotten too tight, too much. If you think before it was too much, now it has gotten worse. And we're having a meeting this Thursday and one of the items on the agenda is taking care of that. We should chuck out some of it. Students can survive. They do survive but survival is ... They survive because they have to survive. And they're bright and so they do it. So whether that is a cause and effect, I don't know. What's happening is one semester of students who are very, very good, and a person (university teacher) who is supposed to, who is supposed to cut back, purposely didn't because his students were doing very, very well. They did better than they ever did before.

Massel: Yes, you don't know whether those students can handle it.

Gerber: We don't know whether or not...we have to take a hard look. But the number of people that we're talking about versus the size of the class ... approximately 350 people. We don't have ... we don't have a quarter of that.

Massel: Right.

Gerber: So, even less.

Massel: So there are other factors?

Gerber: So there are other factors. The major factor is the average thing ... [The

Grade Point Average, (GPA). The admissions office has raised the GPA for admission to

SFU]

Massel: Has gone up?

Gerber: Enormously. So you're getting students who are B students.

Massel: Yes. I've heard a couple of people, well, a couple of students that I spoke with both at high school and a couple of students from SFU who have taken the AP Calculus and they've said that the one thing that they found, the AP Calculus helped them with was the transition, making the transition from high school to university. They had heard that calculus was very difficult, but they felt confident that they could do it. And especially in the first few weeks when they were still finding their feet, they were having a course that they felt they had a handle on. And certainly the students from school are saying the same thing. Just about every single student I've spoken with, other than those from St. George's, have said that they are not taking this for university credit. They're going to be taking calculus (first semester) at university.
Gerber: I think what you were ... if I understand you correctly is that what they’re saying is that they want a course that is a university course. They want to taste university before they get to university. And in that sense it’s very, very good. But so is IB ... except that IB is a little bit of less use in the sense that it’s not ... it’s a better course in that it’s more well rounded and it’s just more interesting ... it’s far better I think ... but for a course that gives them a closer view of what they’re going to face in university ... and that’s not good ... it would be better that the university courses were like the IB courses, but talk about reality for a moment. The course that they’re taking is far closer to what they’re going to experience than anything else, and so in that sense it’s ... it is a good experience.

Massel: Well, I’ve spoken with two people at the university level and they both made the same comments to me and I have had the same comments coming out from the grade 12 students that I’ve spoken with, and that is that university students who have a difficulty with calculus are not necessarily having problems with calculus but that their Mathematics skills are weak, their Algebra skills are weak. Have you noticed that?

Gerber: When I had, when I took calculus in university, the first day, the professor said, no one here is going to fail calculus, but a third of you or half of you will fail Algebra. They have had these concepts in the past but you’re also adding something in here in that we’re assuming now that ... a quadratic equation. I can say, ok, this quadratic equation, the roots are three plus five, square root of two over six, whatever. The details of it ... leave it to the students. Now, the goal, of course, is for them to see the overall picture, but sometimes they feel they can’t see the overall picture because they can’t see the details that you’re talking about. So these are the problems that we face. It’s that level which hits them. So if they know enough of the picture beforehand, then, and I’ve seen it before, this still is a shock, but at least they feel they know what they’re doing and so that they can go and check the details. But there’s a real problem that takes place with adjustment to university ... Anything that can be done to ease that adjustment ...

Massel: Yes, I think that’s one of the, to me, one of the primary results that’s coming out of this, the fact that the students are really using this as an initiation into what university is about. And they get there and not only are they being initiated, but they’re also feel comfortable with something that they’ve heard is so terribly difficult.

Gerber: The only problem is that you’re still dealing in a high school environment and if I were to teach in a high school environment, for the first two or three years I would teach like a university teacher ... the course like calculus. This is a ... the fact that I’m in a different environment, I may have to adjust to the environment.

Massel: So that what you’re saying is that university teachers are teaching at a level that is just that much higher.

Gerber: We’re teaching with a totally different premise. Whether it’s good or bad, we teach with a different premise.
Massel: You know what's very interesting about all of this is that the kids who are taking the AP Calculus, the kids who are in the course at the school, these are not the schools that are presenting just a locally developed calculus. There was one school which had quite a different philosophy where anybody who wanted to take the course [LD] could take it. The kids who are doing the AP Calculus are the kids who are coming out from Math 11 and Math 12 with an A or a B. It's the top kids that are doing that, and then coming and repeating the course at university.

Gerber: Well, it's an elitist program. This is your honours calculus students. These are your honours Math students. Nobody's going to take it who is a poor C student.

Massel: But it's too bad that these are the kids who perhaps should have the confidence in themselves to be able to go into university without having had it before.

Gerber: But what the Sciences have done for the student is to ... it does it for students in first year, is chop out lots of good students, lots of capable students because of the way we approach the subject, the amount of material we put in the subject, the lack of support we give the students, the totally new approach we burden on the students ... so these courses have gotten a reputation so that the students who are coming in are coming in scared and they're going out angry. So it's for that reason, for example, that there's a task force at SFU in first year sciences ... A lot of good students are not even given the opportunity to show that they are bright. It's a program which is so packed that it's unreasonable to expect that ... one of the consequences of this is that we're finding that students are not taking fifteen hours of credits anymore. It's the rare exception that's taking fifteen, sixteen hours. Students are taking nine, twelve hours of credits. The hours represent credits for a semester. That's because of the course. It's gotten worse. When I was at graduate school ... no twenty years before that ... the first year at university was Algebra ... college Algebra. The second year was analytic Geometry, the third year was calculus, a year only, and the forth year was differential equations and Algebra. Analytic Geometry has now gone because we couldn't do it all and the point is we lag behind ... as you're seeing in high school, we lag behind throwing away. And we're lagging behind in the universities in the first year courses and you get a book this big and everybody wants to finish. By the time you've finished it's just chock-a-block full of stuff ... in every subject at university. We, at the university in the Math department, are trying to address this issue.

Massel: Is the marking in the first year courses done on some kind of a curve at SFU?

Gerber: It varies from professor to professor. No one in the Math department gives a fixed number of A's, B's, C's etc. It's not that kind of curve. It's done on a sort of modified curve with a sense of where an A, B, C, etc. should be. If, for example, I give an examination that I feel is good and I've got a good class and thirty percent of the students get A's ... good luck to them, then that's what they get. We have cut back the failure rate enormously. We insist now that no one go into that class without a B or better in Math 12. The others
immediately go in to make up Math classes. Secondly, there’s an open lab and those students who use it do well. They get a lot of support from each other and a lot of support from the people who are there. UBC has had, I’m told, a fifty percent failure rate. We are nowhere near it. We have maybe a thirty percent failure rate, but UBC is a killer. There is no support whatsoever ... no tutorials, no support ... just walk into class ... attend a lecture and go out. Now, I don’t know if they have the same requirement insisting on certain grades. We found out that if you have the people with B’s and above in Math, it also creates an environment where the students are better students and, therefore ... you don’t have this feeling that everybody’s failing. If you allow C’s and D’s in the room and they fail ... and this guy comes and sees that people leave, it’s demoralizing ... so you don’t even think you understand what you’re doing. The classes are approximately 350 students for the first semester. We have three different kinds of calculus: calculus for Biology students, calculus for Commerce and Economics students, Arts students and calculus for hard-nosed people, that is Computer Science, Physics, Chemistry. The class size ranges from 250 to 350 to 400 students. The courses are very different from one group to another. The Arts and Commerce students have the easiest course. It’s the easiest one but they don’t do as well because we get the worst teachers. Nobody wants to teach it.

Massel: Do you think that Math is used as a filter?
Gerber: Yes.
Massel: Is it fair? Is it just a matter that you have to get the numbers down somehow?
Gerber: I don’t think it’s fair at all. As a person who loves his subject, I think it’s an abuse of the subject. I try desperately not to get involved with that sort of process but sometimes you are forced to. I’ll give you just some indication ... calculus for Biology students. What the hell do Biology students need calculus for? If you turn to them and find out that they’ve never needed it in any one of their courses anywhere, anyplace, anytime. So one year I turned to the biologists and asked them ... years ago ... I turned to them and I said, well, have fun. I’ll make up a course for you. You tell me what you want in it and I’ll put it together, just for you, but don’t give them [the students] this stuff. They don’t need it. They don’t want it. They know they don’t need it. Who wants to teach a course where the students know they don’t need it for anything. They say, well, the students want to go on and finally become medical students and they need it for medical school. So what do they need it for Medical School? Do I know a single doctor who really uses calculus? I mean really ... who uses calculus in any way, shape or form. So, there it’s obviously a filter. In the case of Commerce students. Definitely. You can’t get into Commerce until you’re in second year there are so many people who want to be in there. So calculus is required to weed them out. We told them that UVic. has a good program that they particularly like, that the students like. We’ll move away from calculus. We’ll give you more time at Mathematics and give them something that they really can use and we’ll put together a package which is far better. Their
answer is: Do you really need it? Oh, yes, we need it for this course. We need it for that course. It's a bunch of nonsense. It's nothing more than distinguishing grades, something to make the distinction between grade one students and grade two students. I spoke to the people in Education and said, ok, you require a Math course for teachers. There were some students in the class who are getting C's and D's and they're scared to go into PDP [professional development programs]... why not just give everybody a pass in this course? That way we will remove some of the anxiety from students ... and they will enjoy it. And then they have to take an exam, and then they worry, not because they're getting a C or a B in Mathematics but because their overall average ... their GPA is so important. Yes, it's being used in that fashion [as a filter]. Craig Newell, [a graduate student in mathematics education] in talking to students who are taking the first semester of calculus, and in speaking with them says that students say that this course is stopping me from being what I want to be.

Massel: That's why the schools feel that they have to give these students a course in calculus because the students come back to the schools and say it's the best thing I ever did, or why didn't you give it to me. I had a Mom come to me at school recently, she's now in first year at UBC and she came to the school, (her other child is at school), she comes up to me, she sought me out particularly...so this Mom comes to me, she sought me out because I don't teach her other daughter, she came to me and she said, Mrs. Massel, I must tell you, she says, I'm cross with you. I said, why? She said, because my daughter took calculus here, she says,and she took it by chance, nobody insisted that she took it and, she says, my daughter's come home and said, if I hadn't taken it, I would be failing and she says, you've got to insist that the kids take it. This was the Mother telling me. This was the reaction. And this kid was ... not one of the best Math students. She was a very average Math student, nice kid, hard worker ... but the fact that she'd taken our locally developed calculus course means that she was successful at university. It is the Math teachers at the school and not the counsellors who are advising the kids to take calculus at school.

Gerber: If you want to survive, you have to take calculus.

Massel: The teachers don't even have to sell it.

Gerber: Well ... because their friends come back and tell them ... those who didn't take it and those who did.

Massel: Do you know what proportion of first year students are taking calculus at SFU?

Gerber: Of the entering class? First semester calculus about 800 students. I don't know what proportion that is to the entering first class. It's a lot of people. It's everyone who is going into Computing Science, Math, Physics, all the Sciences and Computing Science and Engineering, those going into Commerce, Economics, Biology, some students who are going into Archaeology. That's just the calculus courses.

Massel: What is the university's attitude on calculators and, in particular, graphic calculators?
Gerber: I think people would agree to using calculators if they could have everybody using the same calculator, then the field would be even for examinations. The students who have very powerful calculators are at a distinct advantage to other students. I tell the students that I will open it up to calculators provided that I give everybody all the formulas and make it an open book examination. Then I would use calculators, but then the exam will be harder ... and I politically say: well ... it will be different. This is playing games with them, but the problem is that having someone who can have a calculator that can do graphs and can integrate and differentiate and somebody whose calculator can't do this, is not fair because it's not playing the same game. Meanwhile, there is a lot of different experimentation going on. You have a lot of people to sell on that including me.
APPENDIX H

TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW

WITH A MATHEMATICS PROFESSOR

AT THE UNIVERSITY OF VICTORIA
TRANSCRIPT OF EXTRACTS FROM AN INTERVIEW
WITH A MATHEMATICS PROFESSOR
AT THE UNIVERSITY OF VICTORIA

The following is a transcript of the interview held with Dr. David Leeming. Dr. Leeming is a professor of mathematics and chairs the Mathematics and Statistics Department, and he also chairs the Senate Committee on Admissions and Registration at the University of Victoria, British Columbia.

The researchers introduction and preamble was not recorded.

Leeming: In calculus in B.C., most of it, historically, is taught through locally developed courses in the schools. At one time there were eighty schools in B.C. offering locally developed calculus courses. University of Victoria has taken the position, and I think the other universities also, that they never gave credit for those courses because there was such a different variety of levels and some of them took a whole year and some of them took a semester and they never got past the derivative. Others went into the integration techniques and so on. So we basically ignored it and put them all into the Calculus 1 and Calculus 2. But we'll always tell the students who have not had any calculus ... they always felt disadvantaged ... but we always reassure them that we start at square one and while we do move fairly quickly, we do cover everything that you need to know right from square one. Sometimes that's reassuring and sometimes it isn't ... reassuring to the students to hear that message. So we basically ignored any attempts for it, or even for advanced placement. We wouldn't give advanced placement even, let alone credit. And then AP came on and as you can see from the data here, the first student to come in with an AP course was in '87, and in '91 there are just a tremendous number of them. But the difference between '90-'91 and '91-'92 is that '91-'92 we actually gave credit for one and a half units for Mathematics 100 for those who took a Calculus AB. Now the Calculus BC we've basically ignored. We would do students on an individual basis. We almost invariably give them credit for 101 if they took it but only four of our students took the BC anyway. Very few students take it, so we're not too concerned about that ... so we didn't even make a policy for that because it didn't seem necessary, where it did for the AB. But this is not the only advanced placement course that's now receiving credit at University of Victoria; there are a variety of them and they will be listed so all the admissions people and counsellors in schools, and so on, will get that information of exactly what's required to students. But a four or a five will be the minimum for credit on any of the AP examinations.
Massel: Now is this, is the recognition of AP, is that more in response to the fact that UBC is recognizing it or is it in response to the fact that the AP curriculum does satisfy your requirements?

Leeming: Well, we were very well aware, I think, that two years ago George Bluman had allowed these students to come in. I think they got credit for the 100 at UBC. I'm sure they did actually, but you could verify that. He had about 16 students, and so he put them in the 101 in first semester. And then he gave them a Linear Algebra course in second semester and they seemed to respond to that tremendously well. In fact, I think of those 16, he said, about 13 were considering continuing with a Mathematics program. So that's a real success story ... what he set up ... and we began to look at it too. We took another look, an independent look at the AP, Calculus AB, to decide whether or not we really wanted to give credit for it and decided we would. However, we were quite aware that the AB Calculus only covers about 80 percent of our syllabus ... so there are students...because we teach four hours a week, one semester, and, so we warned the students that there are some topics they won't have covered. However, we know that if they get a four or a five they're bright enough to pick that up on their own with some assistance. Now it's too early to tell, really, how successful they're going to be. I guess that will be the next phase and, of course, if you want the information on that, well you'll probably be able to get it in May or June.

Massel: Do the students who come to you with the Calculus AP, do they take the credit for the most part?

Leeming: That's a good question. This option, they have to request it first and some of them, I guess, feel less confident than others and want to repeat it and that's ... we haven't made a hard and fast rule. Unlike transfer credit, say, from one of the colleges for a course which is automatic for every students who took it at a college. We don't make the AP credit automatic, so they have to request it.

Massel: So the students coming from college would have to take the credit if they came to UVic?

Leeming: No, I was saying that a student who took Calculus 1 at a college would already be articulated and they would automatically get transfer credit and move on to the next level.

Massel: You wouldn't allow them to stay at that level?

Leeming: No, we wouldn't allow them to stay, well, we would allow them to repeat the course but for no credit, the same as we do for our own students.

Massel: They can improve their grade?

Leeming: That's right. Actually it's interesting, you can improve your grade by taking a course. You don't get credit for it but that improved grade counts toward your grade point average for the year in which you take it, so there is an opportunity to up your grade point average, whereas you can't get additional credit.
Massel: What are the sizes of your classes at University of Victoria? Your calculus classes?

Leeming: The class sizes are not that great. The maximum would be 70, but the average would be more like 50 or 45. We've always had small sized classes. At this point it's almost too new to see how students coming in with the AP Calculus are doing. There would be data in June after the academic year is over.

Massel: What are your views about the sort of calculus teaching that's happening in high schools here?

Leeming: I have very little information. The end result is what we would look at, whether the student's got a four or a five on the AP Calculus. My experience is very limited. I get invited annually to teach calculus classes in Victoria schools. I've not been involved with any of the AP conferences.

Massel: The question that arises in my mind is what's happening with Mathematics? Is calculus being pushed down into the high schools and is it becoming the high school teacher's job to teach calculus to students?

Leeming: Well, the new Mathematics 12 curriculum contains fourteen hours of calculus and basically does an introduction. I'm not sure that it will be the mandate of all schools to teach calculus. I know that initially I and others, many others, resisted vigorously having any calculus in Mathematics 12. We came around, were converted in a sense, for two reasons. One of them was that the physicists used the derivative very early in their course, far earlier than the mathematicians teach it. The second one basically was that there would be students coming out of Mathematics 12 who would never darken the door of a post secondary institution and if they didn't see at least something, albeit a very intuitive and geometric point of view on an introduction to calculus, that they would never see it. They would never have any flavour for what calculus is all about. So I think that the syllabus ... that fourteen hours was put together quite sensibly, and they put sensible topics in there ... things that give an introduction to the subject. For the brighter kids, then, the question is, how far do you go? Do you get them to do AP and at the end they get some credit when they get to university or do you just try to take them gently through a whole year of one or two hours a week and teach them some basics? It depends, I guess, on the size of the school, where it is, how many students. And it's interesting that the Mathematics 12 grade is the most reliable predictor we have still on how students will perform at university.

Massel: How do you react to the following, that the Mathematics teachers are telling their students that they'd better take calculus at school so that they're not one of those statistics that are failing? Is this a true perception that the teachers have? Is this what is happening?

Leeming: I think it's incorrect. It's wrong. First of all, students should have Mathematics 12 behind them before they start taking a calculus course. I don't believe in giving calculus to
students who only have a Mathematics 11 background. I don't agree with the thinking that you can put the student through Mathematics 12 and calculus simultaneously. They should cement their Algebra and Trigonometry training. That's where the problem lies, the one in three that fails Calculus 1, it's not their calculus concepts, it's their Algebra and Trig. They cannot keep up because they don't know it well enough to keep up. There's another problem and that is an attitude problem ... [the students] who have a little calculus under their belts and everything they see the first three weeks of lectures is familiar. "I know this stuff. I don't have to look at this." Three weeks after that, they're in over their heads because they have developed this attitude that they know it all. Whereas the poor old student who's struggling through it, who's never seen it before, quite often is more successful. Because they're terrified and they have an attitude that makes them work. So I have a lot of problems with this calculus in high school.

Massel: The teachers are suggesting to their students that they take this because they're getting feedback from their students who are coming back to the school and reporting, "Thank heavens I took calculus, because if I hadn't I would have been lost."

Leeming: Uh-huh, I hear that message too and I think in some cases that I've heard students say that "I'm not doing well in calculus. Why didn't you make me take it in high school?" And those students are quite often blaming the schools for their failure, whereas they should be blaming themselves because they didn't prepare themselves for their Algebra and Trig. skills. If you're not really up on your Algebra and Trig. ... we'll take you through the calculus, but that's what you've got to know. We keep preaching that message. But we will not sit still and put our heads in the sand forever and pretend that nobody's teaching calculus in schools and the only thing we'll recognize is the AP with a four or a five. What will happen is that we will recognize the various backgrounds that students come to us with, in the same way as the Physics and Chemistry departments do. And those students who have had some calculus will take a course, and those who haven't will take a (different) course that involves more hours per week. So that at the end of the two courses, both sets of students will be at the same point.

Massel: What proportion of first year students at University of Victoria are taking a calculus course?

Leeming: There are approximately 1100 students who take calculus and approximately 5650 students entering the University of Victoria. About 19 percent to 20 percent.

Massel: At UBC, Professor Bluman had said that about 80 percent of first year students take calculus.

Leeming: That's not quite right. The figure I heard was that when they looked at their students who were graduating, 80 percent of those students who were graduating from UBC had taken a calculus course at some stage during the course of their degree. We are trying
to get hold of the number of students who are taking calculus in post secondary schools in British Columbia.

**Massel:** Has calculus become a filter subject for some courses?

**Leeming:** It is a screen. It has become a screen in some areas and as a Mathematics department we have very little control over that. We do offer it as a service course. I'm not sure that it's happening so much at University of Victoria. The one classical story is at UBC, foods and nutrition... Home Economics requires a calculus course, so it was perceived as a screen. I don't know if it is still in place or not.

**Massel:** What about graphic calculators?

**Leeming:** Well, we have been trying to keep up with the technology. There was a time, even five years ago, when calculators were not permitted, then we started to permit them and we started to ask questions that required the use of calculators. Of course, the calculators get more sophisticated. You can program in all your derivatives and all your integrals if you want to, so now we have a problem as to what to do with that. If they bring a calculator with an exotic memory then they'll have to show that it's cleared for an examination. Since not all of the invigilators of examinations are familiar with these calculators, with the memories... Engineering has scrapped them for examinations and so have we. As for graphing calculators, we've basically ignored their existence. We haven't used them. There are often people who are interested in this. The problem is, in insisting that students all buy an expensive calculator and we can't always get them all the necessary computer time. And also, there's the problem of - there are no rewards in the system for innovative changes in the curriculum. You do that on your own time or you spend some of your research on it. That's another problem. I think that there is a basic inertia to it. We've been doing it this way for so many years and it seems to have worked... failing one third of the students... and we've done it for ten years. Why change now? We have an assistance center for students, there is a drop-in center that is open for 36 hours a week. We use senior undergraduate students and graduate students and this is kept very busy, particularly at mid-term and exam time.

**Massel:** I attended Bert Waits' talk about the graphic calculator and he said that AP Calculus is going to be using graphic calculators by 1995.

**Leeming:** Yes, I agree. We're going to have that thrust upon us too.

**Massel:** Is a failure rate for the last ten years of one third of your students realistic?

**Leeming:** When you look at the failure rates, you look at the drop failure rates. You have a lot of drops before the final exam. The failure rate, I think, if I recall, was between 20 and 25 percent.

[There was some discussion as to methods of awarding grades that was not relevant, and has been excluded.]
Leeming: I'll tell you an anecdote about the first student who came to the university and insisted on getting credit for having received a four or a five on the AP, this was in the summer of '89. This student is now in her third year and is majoring in Mathematics at University of Victoria. After having been given the credit by the university at that time and being permitted to go into the second course, she was really turned on. And this is what George Bluman was saying. You have to give them something. You don't have to give them very much. Show them that you're interested and reward them for their past success, and that you want them enough to give them something. Advance them. Give them a little credit. Advance them on and it works ... I think it works. For a few years at University of Victoria we had an honours section in Calculus 1 and we based the selection just on the Algebra 12 marks ... but it didn't work. It was a small class of seven students and some of them even failed. We gave them some theoretical calculus that we wouldn't normally do and they wrote the same exam at the end of the year, but some of them just didn't want it, and some of those who wanted it just weren't good enough. So we gave it up. There's an attitude out there that you're never going to make it if you don't see calculus before you go into university. I don't know how you counteract that. The transition for students ... particularly the students that go away to university ... residence life and all the distractions and a new place to live and having to worry about laundry and all these other things that you never had to worry about before ... and it's a tough transition for students who are just barely getting into maturity.
LIST OF REFERENCES


