YSIMSTE

York - Seneca Institute for Mathematics, Science and Technology Education

COLLEGE MATHEMATICS PROJECT 2007

FINAL REPORT

Laurel Schollen *(Seneca College)*
Graham Orpwood *(York University)*
Patricia Byers *(Georgian College)*
Margaret Sinclair *(York University)*
Hassan Assiri *(Seneca College)*

Table of Contents

Executive Summary

The College Mathematics Project (CMP) is a collaborative program of research and deliberation concerning mathematics achievement of first-year college students in Ontario. Its goals are:

- To analyse the mathematics achievement of first-semester college students, particularly in relation to their secondary school mathematics backgrounds;
- To deliberate with members of both college and school communities about ways to increase student success in college mathematics.

Led by a team of researchers from the York-Seneca Institute for Mathematics, Science and Technology Education (YSIMSTE), CMP 2007 included six colleges and ten district school boards from the Greater Toronto Area.

The CMP research project linked and analysed the school and college records of over 20,000 students who enrolled in all program areas of the six colleges in Fall 2006. Of these, over 10,000 took a first-semester mathematics course and the CMP research focused on their achievement in these courses, relating this to a variety of factors, including the choice of mathematics courses taken in secondary school.

Highlights of the research include the following:

- Only 66% of students achieved “good grades” (A, B or C) in first-semester mathematics in college, while 34% received grades of D or F, placing them “at risk” of not completing their chosen program.
- Four of the six CMP colleges offer preparatory (remedial) courses for students who need them and 30% of study students took these courses.
- Recent Ontario graduates (students who were under the age of 23 on December 31, 2006 *and* who had graduated from an Ontario secondary school) formed 70% of first-semester students but occupied 80% of the places in preparatory courses.
- In regular, college-level, mathematics courses, only 63% of recent Ontario graduates achieved good grades, compared with 75% of older students or those from outside Ontario.
- Significant variation was found among colleges, where “at risk” rates in Technology programs varied from less than 20% to nearly 50%.
- Choice of school mathematics courses has a major impact on first-semester college achievement. For example:
    - Over 70% of study students with Ontario Grades 9 and 10 Academic Mathematics achieved good grades but less than 50% of those with Grades 9 and 10 Applied Mathematics did so;
    - Over 40% of students taking the most common sequence of college preparation courses were found to be “at risk” when they reached the college level – this rose to over 50% in the area of Technology;

  - Course selection for Grade 11 mathematics was at least as important as that for Grade 12.
- For the first time in Ontario, CMP results provided systematic feedback to all participating school boards and every individual secondary school about the success of their graduates in first-semester college.

Following completion of the research, the CMP held a deliberative forum, in which representatives of all participating colleges and school boards, along with invited provincial organisations, discussed ways of improving student achievement, and examined a number of support initiatives that had been implemented by the institutions. From these deliberations, the CMP team concludes that there is a consensus:

- That student achievement in first-semester mathematics in Ontario colleges needs to be significantly improved;
- That the achievement of this goal requires concrete action by all stakeholders, including students and parents, school boards, schools and teachers, colleges and faculty, and the Government of Ontario.

Accordingly, CMP proposes a series of eight practical suggestions for action. For students and parents, we recommend that they become better informed about colleges and college programs, and that students select secondary school courses based on the most appropriate preparation for their desired goals. We suggest that colleges and college faculty strengthen their commitment to student retention and success by adopting initiatives found effective in other colleges. The report also proposes that schools place equal value on college destinations for their students as university destinations, and offers some ways in which this value might be demonstrated and communicated. And CMP recommends that the Government of Ontario adopt a “K-16” vision of student success and continue to support research into the interface between levels.

The cost of implementing these proposals is small in relation to the cost of not doing so. Most call for changes in attitudes on the part of all those involved. For its part, the College Mathematics Project plans to continue monitoring student mathematics achievement in the future and providing feedback to all concerned.

Chapter 1: Introduction

Success rates in first year college mathematics courses are often unacceptably low. These low success rates are usually mirrored in other subjects in which mathematics is important, and students who are unsuccessful in such key courses are often unable to complete their chosen program, resulting in unacceptably low graduation rates, particularly in certain program areas. Apart from the human cost for the students themselves, colleges throughout Ontario spend significant amounts on remedial and support programs aimed at retaining such students, taxpayers' investment in students' first year programs is wasted, and the Ontario economy continues to experience shortages of trained personnel, especially in key occupations[1].

Background

The College Mathematics Project (CMP) was developed by the York-Seneca Institute for Mathematics, Science and Technology (YSIMSTE) to research these issues and to facilitate deliberations over ways to increase student success. The project is based at Seneca College with members of the project team drawn both from Seneca and from York's Faculty of Education.

CMP is now in its third year[2]. The first year of the project (2004-05) involved a small-scale pilot study of 500 students in three schools of technology at Seneca College. In 2005-06, the project was expanded to include some 5000 students enrolled in more than 100 technology programs at six Ontario colleges. This year, the study has been broadened once again[3]. CMP 2007 examined the records of all students entering all diploma and certificate programs in Fall 2006 at six GTA colleges (Centennial, George Brown, Georgian, Humber, Seneca, and Sheridan) with a particular focus on those enrolled in first-semester mathematics.

CMP Goals and Methodology

The goals of the College Mathematics Project were:

---

[1] See, for example, the occupations facing demand pressures listed by the Ontario Government, many of which require college diploma or certificate training (*Current Labour Market Statistics*, (November 2007), 7, Research and Planning Branch, Ontario Ministry of Training, Colleges and Universities).

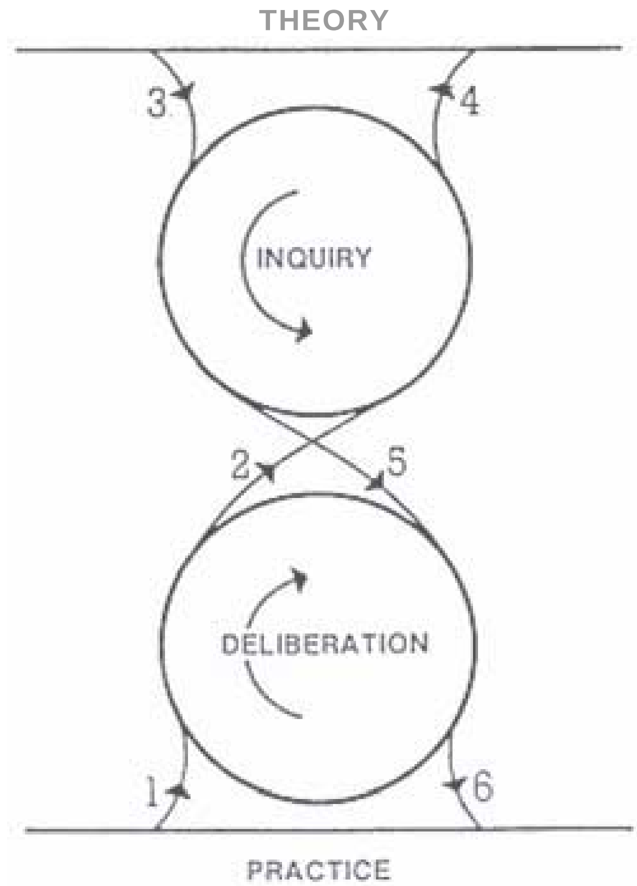
[2] The 2004-05 pilot study was supported by Seneca College of Applied Arts & Technology and the 2005-06 and 2006-07 projects by the School/College/Work Initiative (SCWI) of the Ministry of Education and the Ministry of Training, Colleges & Universities. (http://cgtat.org)

[3] Partners in CMP 2007 are listed in Appendix A.

- To analyse the mathematics achievement of first-semester college students, particularly in relation to their secondary school mathematics backgrounds;

- To deliberate with members of both college and school communities about ways to increase student success in college mathematics.

The methodology used in the College Mathematics Project was developed specifically for addressing policy research problems and is known as the Deliberative Inquiry model.



Components of Deliberative Inquiry

1. Issue Identification
2. Development of Research Questions
3. Using Theory
4. Payoff for Theory
5. Communication for Deliberation
6. Payoff for Practice

Figure 1. **The Deliberative Inquiry model[4]**

[4] Orpwood, G. (1985). Toward the Renewal of Canadian Science Education: 1. Deliberative Inquiry Model. *Science Education,* 69, 477-489.

In this model, practice drives research through issue identification while research drives deliberation over policy solutions (see Figure 1). The research questions are derived from deliberation over the issues at stake and the research results form the basis for "questions for deliberation". The model was developed originally for the Science Council of Canada 1980-84 study of science in Canadian schools and has been used successfully in several subsequent projects.

In the case of CMP, the central issue has been student performance in first-semester college mathematics. In the CMP research phase, student achievement data was gathered and analyzed in a variety of ways and the findings communicated to stakeholders in the project. The CMP Forum then brought together a wide range of stakeholders to deliberate, from their various perspectives, about potential policies and practices to achieve the goal of increasing student success.

CMP Research

The research was of two general types. The qualitative study examined grading policies, college admission practices, placement testing, student success strategies including preparatory courses, the range of programs in each participating college, and the content topics in first-semester mathematics courses. The results of this part of the research are described in chapter 2 of this report.

The quantitative study analyses the achievement patterns of students and links secondary school academic background (in mathematics) with first-semester college mathematics achievement. The results of this part of the research are described in chapter 3.

A major outcome of CMP 2007 has been the development of a CMP database and web-based display system allowing for individual queries on the data. Queries are based on the project's research questions; they provide links to the appropriate data display while maintaining confidentiality of students, school boards, and colleges. This interactivity is not just restricted to the central research team. Each participating college and school board is able to identify data pertaining to its own students within each display. In addition, this web based query system enables colleges and school boards to conduct their own analysis in relation to the aggregate data.

CMP Forum

In accordance with the Deliberative Inquiry model, CMP 2007 included a one-day deliberative forum held in October 2007 as an integral part of the study. This forum was attended by representatives of colleges, schools, and educational government panels.

The research results from CMP 2007 were first outlined. In addition, colleges and school boards reported on initiatives undertaken to support student success and on ways in which the recommendations arising from CMP 2006 had been implemented[5].

In the second part of the Forum, discussion groups met for deliberations reflecting a range of areas of responsibility: mathematics (schools and colleges); guidance; student success; and, policymakers (provincial, boards and colleges). An account of the Forum and a summary of its recommendations is presented in chapter 4. The report concludes with a summary of the results of the overall project and a look forward to 2008.

[5] See “Introduction and Past Recommendations” on the CMP 2007 Forum web site (http://cgtat.org/forum_071026_CMP_SenecaKing.html)

Chapter 2: Qualitative Research Report

In order for the College Mathematics project to reach its twin goals of analyzing students' first-semester mathematics achievement and deliberating over ways to increase their success, several qualitative research projects had to be conducted.

One group of studies focused on colleges' academic policies and programs, Since grading systems, program offerings, and mathematics courses varied considerably, a common approach was devised where necessary, to allow comparison or aggregation of student data within the CMP database.

A second group of studies focused on college policies and programs in relation to admissions, assessment, placement and student support. Results were used to inform Forum deliberations.

The third group of studies examined the topics in preparatory and college-level mathematics courses for both Business and Technology program clusters. An additional investigation is underway to compare the topics of introductory college mathematics courses to the topics in secondary school mathematics. The resulting gap analysis will inform curriculum renewal and development at both levels.

Comparability Studies

Colleges in Ontario operate independently and offer a wide range of programs. In preparation for data analysis CMP gathered information on program offerings, mathematics course offerings, and grading systems of the participating colleges, and developed schema for combining student data.

Clustering College Programs

CMP categorized programs according to the system of 5-digit numerical codes used by the Ministry of Training, Colleges and Universities to identify college programs and to link them to published program standards (where these exist). These "MCU Codes" provide CMP with the basis for equating programs from different colleges even when the names used locally differ.

CMP clustered all programs from all participating colleges into four major clusters, each of which is subdivided into sub-clusters, as shown in Table 1. Initially, an Apprenticeship cluster was also included, but since no student data relating to mathematics was collected from these programs, the cluster was dropped.

Table 1
CMP System of Program Clusters

Major Cluster	Sub-clusters
Applied Arts (AA)	Applied Arts Human Services Health Services Hospitality & Tourism
Business (B)	Accounting & Finance Business Administration & Management Office Administration
General (G)	General Arts & Science Pre-Health Pre-Technology
Technology (T)	Applied Science Computer Construction Electrical Mechanical

The six participating colleges offered a total of 470 programs. Of these, 247 included a first-semester mathematics course, as shown in Table 2. Sixty-three distinct mathematics courses were taught in the six colleges. Sixteen of these were in more than one program, resulting in a total of 79.

Table 2
Number of Programs and Mathematics Courses by Cluster

Program Cluster	Programs	Mathematics Courses
Applied Arts	15	6
Business	82	28
General	20	13
Technology	130	32
TOTALS	**247**	**79**

It is important to note that the relationship between programs and mathematics courses varies. In some colleges or faculties, each program or group of programs has its own mathematics course to enable the linking of mathematics concepts to program-specific contexts. In other cases, a single mathematics course serves a range of programs; this structure provides greater flexibility for staffing and timetabling and facilitates the transfer of students between programs within an institution.

Within clusters the number of programs requiring a first-semester mathematics course varies (see Figure 2).

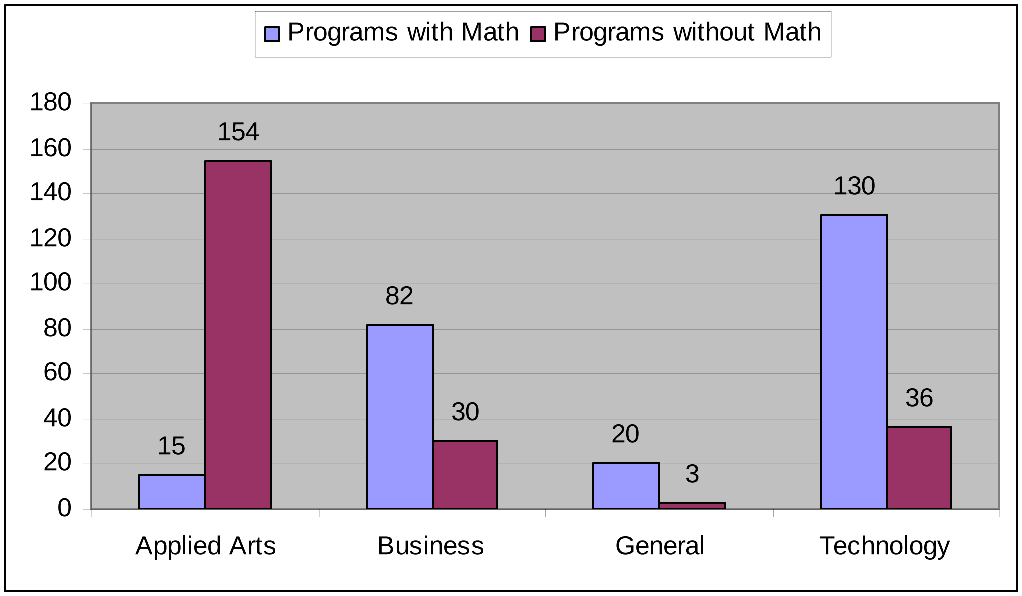


***Figure 2.* Number of programs with and without first-semester mathematics, by cluster.**

CMP found that 78% of technology programs and 73% of business programs included a first-semester mathematics course. This reflects the need for strong mathematics skills in technological and business fields.

Most general programs (87%) also required mathematics; these programs offer a broad first year preparation for other programs in college or university. Only 9% of applied arts programs required a mathematics course.

College-Level and Preparatory[6] Mathematics Courses

In addition to the 79 first-semester mathematics courses offered as part of post secondary college diploma and certificate programs, some colleges offer preparatory mathematics courses.
Usually access to a preparatory course is determined through a placement test established by the college.[7] CMP found that four of the six colleges use preparatory mathematics courses in some or all program areas as shown in Table 3.

Although preparatory courses are taken in first-semester they do not satisfy the academic requirements of the program into which students have been accepted. Thus, we separated them from regular courses in our quantitative analysis of student achievement (see Chapter 3).

---

[6] These are also known as “remedial” courses.
[7] See section on placement testing later in this chapter for more information.

Table 3
Preparatory Mathematics Courses by College and Cluster

College	Program Cluster	Preparatory Course
Centennial	Business	Math 118
	Technology	Math 140
George Brown	Business & General	Math 1027
	Technology	Math 1070
Humber	Business	BMAT 110
Seneca	Business	QNM 103
	General	MTH 159; MTH 085

Note: At the time of the study Sheridan and Georgian did not offer preparatory mathematics courses.

College Grading Systems

In order to compare and aggregate student achievement across colleges, CMP required a "common" grading system.

The simplified system developed by CMP addressed the following problems:

1. Some colleges used 'alpha' and some 'numeric' coding to report student achievement.
2. The level of achievement corresponding to a "pass" varied (e.g. among the six CMP colleges, pass marks vary from 50%, through 55% to 60%);
3. The spread of marks separating grades varied (e.g., C is 60-69%; C is 60-64%).
4. Some colleges used a Pass-Fail or a Satisfactory-Unsatisfactory system for some courses;
5. A variety of symbols and abbreviations were used on transcripts to provide additional information.

The grading systems of the six CMP colleges are summarized in Tables 4 and 5. Table 4 also contains (in column 1) the simplified common grading system developed by the CMP and the basis for its comparison with each of the other six grading systems. The CMP common grading system was first developed for the CMP study conducted in 2006, and was approved for the present study by the CMP Steering Committee at its first meeting in February 2007.

Grades representing courses that had not been completed or from which the student had withdrawn were collected under F along with grades/comments indicating failure. Pass grades (P) where used were counted separately and shown in the appropriate level for that college.

Table 4
CMP and College Grading Systems

<table>
<tr><th>CMP</th><th>Centennial</th><th>George Brown</th><th>Georgian[8]</th><th>Humber[9]</th><th>Seneca</th><th>Sheridan</th></tr>
<tr><td rowspan="3">A (80%-100%)</td><td>A+ Outstanding achievement (90%-100%)</td><td>A+ (90%-100%)</td><td rowspan="3">80% - 100%</td><td rowspan="3">80% - 100%</td><td>A+ (90-100%)</td><td>A+ Outstanding achievement (90%-100%)</td></tr>
<tr><td rowspan="2">A Excellent achievement (80%-89%)</td><td>A (86%-89%)</td><td rowspan="2">A (80%-89%)</td><td rowspan="2">A Excellent achievement (80%-89%)</td></tr>
<tr><td>A- (80%-85%)</td></tr>
<tr><td rowspan="3">B (70%-79%)</td><td>B+ Very good achievement (75%-79%)</td><td>B+ (77%-79%)</td><td rowspan="3">70% - 79%</td><td rowspan="3">70% - 79%</td><td>B+ (75%-79%)</td><td>B+ Very good achievement (75%-79%)</td></tr>
<tr><td rowspan="2">B Good achievement (70%-74%)</td><td>B (73%-76%)</td><td rowspan="2">B (70%-74%)</td><td rowspan="2">B Good achievement (70%-74%)</td></tr>
<tr><td>B- (70%-72%)</td></tr>
<tr><td rowspan="3">C (60%-69%)</td><td>C+ Satisfactory achievement (65%-69%)</td><td>C+ (67%-69%)</td><td rowspan="3">60% - 69%</td><td rowspan="3">60% - 69%</td><td>C+ (65%-69%)</td><td>C+ Satisfactory achievement (65%-69%)</td></tr>
<tr><td rowspan="2">C Acceptable achievement (60%-64%)</td><td>C (63%-66%)</td><td rowspan="2">C (60%-64%)</td><td rowspan="2">C Acceptable achievement (60%-64%)</td></tr>
<tr><td>C- (60%-62%)</td></tr>
<tr><td rowspan="2">D (50%-59%)</td><td>D+ (55%-59%)</td><td>D+ (57%-59%)</td><td rowspan="2">50%-59%*</td><td rowspan="2">50%-59%*</td><td rowspan="2">D (55%-59%)</td><td>D+ Pass (55%-59%)</td></tr>
<tr><td>D (50%-54%)</td><td>D (50%-56%)</td><td>D Pass (50%-54%)</td></tr>
<tr><td>F (0%-49%)</td><td>F (0%-49%)</td><td>F (0%-49%)</td><td>0%-49%</td><td>0%-49%</td><td>F (0%-54%)</td><td>U Unsatisfactory (0%-49%)</td></tr>
</table>

[8] Georgian College posts percentage grades. The pass grade at Georgian is 50% for a subject, the promotion grade is 60%.
[9] Humber College posts percentage grades. The pass grade at Humber is 60% for a subject.

Table 5
Additional College Grading Policies and Symbols

Centennial	Georgian	Humber	Seneca	Sheridan
F Unsatisfactory S Satisfactory	A Performance above minimum course req. B Minimum course req. achieved F Unsatisfactory P Course req. met S Co-op successful U Co-op unsuccessful	SAT Satisfactory UNS Unsatisfactory	EXC Excellent SAT Satisfactory UNSAT Unsatisfactory	S Satisfactory
ICIP Course in progress SUB Substitution of one requirement course I Temp. grade for work not yet completed	AS Advanced standing - Credit awarded ATT Course with no evaluation factor IN I Incomplete IP Course in progress	INC Incomplete (Diploma and Certificate Studies Only	ADV Advanced standing DEF Deferred examination granted INC Work needs to be completed before grade will be assigned SUP Supplemental privilege granted (see policy for details)	CIP Course in progress SUB Substitution of one requirement course I Incomplete

Table 5 continued

Centennial		Georgian		Humber		Seneca		Sheridan	
AEG	Aegrotat standing	AEG	Aegrotat standing	AEG	Aegrotat standing	AEG	Aegrotat standing	AEG	Aegrotat standing
AUD	Audit status	AU	Course audited	AUD	Audit			AUD	Audit status
EXW	Exceptional waiver	DNA	Did not attend	DEF	Deferred (Degree Only)	ATT	Attendance Satisfactory	EXW	Exceptional waiver
GNR	Grade not reported	EX	Exemption granted based on previous credits	EXM	Exemption Grade Not	DNA	Registered but did not attend and did not officially withdraw	GNR	Grade not reported
NGR	No grade required	MT	Mid-term of course	GNE	Earned Course	DNC	Did not complete - Officially withdrew	NGR	No grade required
TCR	Transfer credit (formerly advanced standing)	NMS	No mark submitted	WTH	Withdrawal	EXM	Exemption	TCR	Transfer credit (formerly advanced standing)
WNP	Withdrew without academic penalty	WD	Withdrawal in accordance with College conditions			WD	Withdrew from subject officially before deadline (without penalty)	WNP	Withdrew without academic penalty

Note: There were no additional grading policies or transcript notations available for George Brown.

Studies into College Policies

Students applying to college must provide evidence that they can meet general and specific college and program admission criteria. Once admitted they are supported by a range of services provided by the colleges. In particular, colleges have developed specific initiatives to help students with mathematics.

Admission Policies

The following sections provide an overview of admission policies for applicants wishing to pursue post secondary studies at the diploma or certificate level with and without a secondary school diploma. Policies and procedures must adhere to the overall framework, directives and policies established by the Ministry of Training, Colleges and Universities, which has ultimate accountability for the Ontario college system.

General admission requirements. All college applicants apply through the Ontario Colleges' Application System (OCAS). In accordance with the MTCU Admissions Policy binding directives, the basic requirement for admission to post secondary programs in the Ontario college system is the Ontario Secondary School Diploma (OSSD) or equivalent. The OSSD requires that students have one senior (Grade 11 or 12) mathematics course for graduation however colleges may stipulate Grade 12.

Colleges may also publish additional admission and selection criteria if the program has particular academic focus (for example, the requirement for a senior level chemistry and biology credit for a biotechnology program), is in a specialized field (for example, the requirement for a medical examination, police reference check), or is over subscribed. For example, students may be required to submit a portfolio, résumé, or complete a questionnaire.

Mature Adult admission requirements. Colleges may admit a student under a *Mature Adult Admission* when the student lacks a secondary school diploma or equivalent, and is 19 years of age or more on or before the start of classes. Students admitted under mature status must demonstrate proficiency in meeting specific program admission requirements. Depending on the college, this may be accomplished through equivalency testing, academic upgrading courses or if the student obtained the necessary academic credits during their secondary schooling. Some colleges assess mature students on an individual basis upon admission and place them in a mathematics pathway to support their learning.

College and Program Mathematics Requirements

Each college sets its own mathematics requirements appropriate to the nature of the program. Table 6 summarises the mathematics requirements for each college and program cluster. More details are provided below.

Table 6
Mathematics[10] Requirements by College and Program Cluster

Cluster	Centennial	George Brown	Georgian	Humber	Seneca	Sheridan
Applied Arts	No math*	No math*	No math*	No math*	No math*	No math*
Business	Grade 11C, M, or U or Grade 12C or U or skills assessment or equivalent	Grade 11M or U Grade 12C or U	Grade 12C or U	Grade 12C or U	Grade 12C or U Grade 11M or U	Grade 12C or U Grade 11M or U
General	No math*	Grade 11M or U Grade 12C or U	No math*	No math*	No math*	No math*
Technology	Grade 11M or U or Grade 12C or skills assessment or equivalent	Grade 11M or U Grade 12C or U	Grade 12C or U	Grade 12C or U	MCT4C, Grade 11U or M, or any 12U	MCT4C, Grade 11 U or M or any 12U

** In the case where "no math" is required, it is understood that students will have met the OSSD requirement of one senior (Grade 11 or 12) mathematics credit.*

[10] These requirements represent the majority of the programs within the cluster at each college. Due to the breadth of programs in each cluster, there are exceptions to the requirements noted.

Applied Arts programs. In general CMP colleges do not stipulate a mathematics requirement, however there are some exceptions. This is consistent with the finding that only 9% of the programs in this cluster had a first semester mathematics course.

Business programs. All CMP colleges publish mathematics requirements for programs in the business cluster. This is consistent with the finding that 73% of the programs in this cluster had a first semester mathematics course. Centennial, George Brown, Sheridan and Seneca accept students with a Grade 11 mathematics credit (see table 6 for specific requirements). Each college has established a protocol for assessing students upon admission and placing them, if necessary, into a support program that will prepare them for their program of study. At George Brown and Centennial students may be put in a preparatory program or into a 2-semester mathematics course. At Seneca students are given a 2-semester course in mathematics.

General programs. In most cases, no specific mathematics requirement is stipulated.

Technology programs. All CMP colleges publish mathematics requirements for programs in the technology cluster. This is consistent with the finding that 78% of the programs in this cluster had a first semester mathematics course. All colleges accept students in technology programs with Grade12 U or C mathematics. Sheridan requires that students have MCT4C (Mathematics for College Technology); Seneca requires that students have MCT4C (Mathematics for College Technology) for most technology programs.

Placement Testing

As mentioned earlier, some colleges have a system of preparatory courses or other support programs to help students who lack key mathematical concepts and skills. Identification of these students is usually accomplished by a diagnostic placement test. These tests are either developed in-house or obtained commercially, as outlined in Table 7. As the Table indicates, Georgian and Sheridan have recently changed their placement testing policies and Humber and Seneca have instituted tests for specific to most technology programs.

Table 7
Instruments Used for Mathematics Placement Testing Pre and Post 2006, by college

College	Pre-2006	Post-2006
Centennial	In-house test	In-house test
George Brown	Compass® in technical programs; Accuplacer® in business programs	Compass® in technical programs; Accuplacer® in business programs
Georgian	CPT® until January 2006	None
Humber	CPT® (Business)	CPT® (Business) Pilot program (Technology)
Seneca	CPT® (Business)	CPT® (Business) CAT 3 – Level 19® (Technology)
Sheridan	CPT®	None

Student Support Strategies

Colleges provide support for mathematics students primarily through centralized subsidized tutoring, either one-on-one, or in group sessions. Tutoring is generally provided through Student Services. Tutors are college students who are usually trained by college personnel.

Program areas may schedule additional mathematics hours on student timetables; these may be formal or 'just-in-time' classes. A summary of individual college initiatives is provided below. Specific information additional initiatives that colleges use to support mathematics success, described under "Best Practices," was reported at the CMP Forum in October 2007.

Centennial College. Tutoring in most subjects (including mathematics) is provided by the college. Students need to contact the Learning Centre at each campus to apply for this service.

George Brown College. There is a *Tutoring and Learning Centre* (T.L.C.), staffed by senior students, that offers one-on-one help in mathematics. Recently, a program entitled Supplemental Instruction has been launched to provide peer support for students in mathematics. Senior students sit in classes to familiarize themselves with the mathematics being taught then hold tutorials once or twice a week for students requiring assistance. A faculty member co-ordinates the program and works with the peer tutors.

Georgian College. *The Math Lab* provides support to students for all mathematics and statistics courses at the college. It is open at various times throughout the fall and winter semesters. The college supports individual and group tutoring. For example, upon faculty request tutors are provided to assist in classes. In addition, tutors are available in program based Learning Hubs located in the Learning Commons. This service is provided at the end of the day when classes are generally over.

The business programs have adopted an on-line assessment tool (Lyryx ® by McGraw Hill) to provide students with multiple opportunities to practice mathematics skills to gain confidence and success. It is worth 20% of the final course mark.

Humber College. The college provides a drop in Math Centre for students requiring assistance. It operates from 8:30 to 6:00 Mondays to Thursdays, and 8:30 to 4:00 on Fridays. A permanent staff member oversees the centre. College and university students work as tutors in the centre. Frequently Humber will employ Waterloo co-op students in second or third year. Currently a doctoral student is working in the centre for 25 hours per week and a full-time faculty member is working 3 hours per week. There is a dedicated classroom for this centre fully equipped with computers. It is attached to Humber's writing centre, for ease of access. The drop-in centre model is in operation on both campuses. College faculty report that the centre is well used by students. In addition to the Math Drop-in Centre, the student counseling area offers peer tutoring on a one-to-one basis.

Seneca College. Student mathematics tutors are available in the *Learning Commons* (usually by appointment). This service is available to all Seneca students free of charge. The core business mathematics course QNM106 integrates an on-line assessment strategy (Lyryx ® by McGraw Hill) to increase student practice. Use of Lyryx, which is worth 20% of the student's final mark, is seen as a retention strategy since it provides students with multiple opportunities to practice mathematics and experience success.

Sheridan College. The college operates a success centre with a student, usually from University of Waterloo, available to help with math. Second or third year students are hired as tutors to help students with their specific mathematics needs.

Summary

All colleges accept students through either the OSSD or the mature adult requirement as defined by MTCU. Since mature students may lack the OSSD requirement, most colleges have implemented a testing protocol in English and mathematics as part of the mature adult admission requirement. In addition, colleges accepting students with Gr. 11 mathematics often test students for placement, provide them with a modified program of study or direct them to an academic upgrading program. Through such flexible policies the colleges meet the needs of students from a variety of educational backgrounds.

Studies of Mathematics Courses: Comparison of Topics

An analysis of preparatory mathematics courses in business and technology programs was conducted. This analysis provided a general overview of the relationship between the range of topics taught in a preparatory course and those taught in the mathematics course that is integral to the student's program of study.

The preparatory mathematics courses taught in the business and technology clusters of this study are examined below to demonstrate the relationships between concepts taught in the preparatory mathematics courses and the regular program mathematics courses.

Business Cluster

Mathematics skills considered fundamental to student success in business are: adding, subtracting, multiplying, and dividing whole numbers, signed numbers, and fractions; correctly using order of operations in calculations. These skills are essential to working with contexts such as mark-up, mark-down, simple and compound interest, annuities, and amortization schedules.

Some topics in a preparatory business course may not relate directly to the first-semester mathematics topics but are nonetheless significant to a student's success. For example, common factoring and solving systems of linear equations provide students the opportunity to develop the algebraic dexterity needed in manipulating formulas for calculating compound interest and annuities.

The relationship between other concepts taught in a preparatory mathematics course and those in first-semester mathematics of finance is more transparent. An examination of percents, fractional exponents, ratios and proportions, and percent problems has direct impact on calculating discounts, retail pricing, nominal, effective, and equivalent rates of interest.

Regardless of the topic, the concepts taught in a preparatory course are placed in a business contest. The mathematics becomes more meaningful and interesting to the adult students when teaching and learning is built around the culture of the business world. The mathematics classroom provides opportunities for students to become enculturated into their chosen career destination. Table 8 lists topics in preparatory mathematics for business and mathematics of finance. The information was derived from an examination of outlines for preparatory and business mathematics courses taught at the participating colleges.

Table 8
Comparison of Topics in Preparatory and Regular Mathematics Courses for Business Programs

Preparatory Mathematics for Business (42 hour course)	**Mathematics of Finance (Regular Mathematics for Business)** (42 hour course)
• Arithmetic & order of operations	• Trade & cash discount
• Signed numbers	• Retail pricing
• Fractions	• Simple interest
• Integral & fractional exponents	• Compound interest including - fractional periods
• Simplification of algebraic expressions & substitution	• Equations of value at compound interest
• Ratio & proportion	• Ordinary simple annuities
• Percent problems	• Nominal, effective & equivalent rates of interest
• Linear equations, systems of linear equations & formula rearranging	• Ordinary general annuities
• Common factoring	• Amortization schedules
• Graphing	
• Problem solving	

Technology Cluster

The concepts taught in technology programs were analysed in an earlier study (see Table 9.) The 25 content areas listed were not taught in all courses at all colleges.

By analyzing the lists of topics, eight core content areas were identified as being central to a first-semester college technical mathematics course. Functions and graphs provide analytical and graphical representations for concepts taught later in these courses, i.e., systems of linear equations, quadratic equations, exponential and logarithmic functions and trigonometric functions. Fractions and factoring in algebraic form are concepts applied in quadratic equations. Working with exponents and radicals provides algebraic background for working with exponential functions.

Students in technology programs require sound algebra skills, a sense of numeracy, estimation skills, accuracy, spatial sense, the ability to manipulate formulas, and facility with using a scientific calculator. To work with applications in technical areas students also require sound reading skills, the ability to extrapolate information, and knowledge of a variety of problem solving approaches.

Table 9
Mathematics Content Topics by Number of Technical Mathematics Courses in Participating Colleges

Content	No. of Courses	Content	No. of Courses	Content	No. of Courses
Linear Functions	10	Accuracy	5	Matrices	3
Trigonometry	10	Conversions	5	Radicals	3
Exponents	9	Exponential Functions	5	Ratio & Proportion	3
Graphs	8	Logarithms	5	Variation	3
Systems of Linear Equations	8	Quadratics	5	Algebra	2
Arithmetic	7	Vectors	5	Complex Numbers	2
Geometry	6	Determinants	4		
Oblique Triangles	6	Factoring	4		
Trigonometry of any Angle	6	Trigonometric Graphs	4	Additional Topics	2

Preparatory mathematics courses therefore focus on developing and reinforcing algebraic facility and accuracy, and the ability to utilize a scientific calculator effectively (including use of the memory key, the ‘pi’ key, inverse key, and keys related to the trigonometric ratios). The concepts generally taught in preparatory mathematics courses for technical programs include arithmetic operations, conversions in measurement, ratio and proportion to facilitate formula manipulation and trigonometric ratio equations, linear functions reinforcing algebraic and graphical representations, and geometry in two- and three-dimensions including perimeter, area, and volumes. The relationship between preparatory and technical mathematics course content is shown in Table 10.

Table 10
Comparison of Topics in Preparatory and Regular Mathematics Courses for Technology Programs

Preparatory Mathematics for Technology (42 hour course)	**(Regular Program) Mathematics for Technology** (42 hour course)
• Arithmetic • Conversions • Ratio & proportion • Linear Functions • Geometry	• Functions & graphs • Systems of linear equations • Determinants • Fractions & factoring in algebraic form • Quadratic equations • Exponents & radicals • Exponential & logarithmic functions • Trigonometric functions

Chapter 3: Quantitative Research Report

The central activity of the College Mathematics Project was the quantitative analysis of mathematics achievement by college students in the first semester of their program. CMP 2007 focused on examining the records of all students entering college diploma (and some certificate) programs[11] in Fall 2006 and who took a first-semester mathematics course.

Research Questions

The research questions for the study were approved by the CMP Steering Committee and used both to define the data extraction protocols and to report the results. They focused on exploring the following four areas of interest:

- Numbers of students participating in regular college-level (diploma and certificate program) and preparatory mathematics courses;
- Distributions of grades in mathematics courses and percentages of students achieving "good grades" or being "at risk" (of not completing their chosen program) as a result of failure, near-failure or withdrawal from first-semester mathematics[12];
- Relationships between students' mathematics achievement in first semester and the mathematics courses they completed in secondary school;
- Relationships between students' mathematics achievement in first semester and the school board/secondary school from which they graduated;

Definitions

The first series of data views provides information about student enrolment, analysed by college, program cluster, gender, participation in first-semester mathematics, and age/academic background. These variables are defined as follows:

College

As noted earlier, CMP 2007 included data from six colleges. Consistent with the CMP policy on data confidentiality (Appendix B), these are represented here as C1, C2, etc, where data is considered sensitive.

[11] Degree programs and graduate certificate programs were not included.
[12] The CMP "grading system" is described in Chapter 2 and the basis for distinguishing students with "good grades" from those considered to be "at risk" later in this chapter.

Program Cluster

All college programs have been grouped into 4 major clusters (Applied Arts, Business, General and Technology) each of which is also divided into sub-clusters (as outlined in Chapter 2, table 1). For example, the Technology program cluster comprises five sub-clusters: Applied Science, Construction, Computer, Electronics and Mechanical. Programs are assigned to clusters and sub-clusters, based on their MCU codes, not on their administrative organization within each college.

Types of College Mathematics Course

Only the records of students taking a first-semester mathematics course are of interest to CMP and the overall numbers of these are shown. These are also subdivided into those whose first-semester mathematics course is a regular, *college-level* course taken by all students in their program, and those taking a *preparatory* course required of some students only.[13]

Age/Academic Background

CMP distinguishes between two groups of students, based on their age and academic background. One group (called “Recent Ontario Graduates” or “ROGs”) is made up of students who are under the age of 23 on December 31, 2006 *and* who have graduated from an Ontario secondary school. The remainder (“non-ROGs”) are those who are either older or who have graduated in another jurisdiction. This distinction is important to be able to relate achievement in college mathematics courses with achievement in secondary school mathematics.

CMP Database

The CMP database was constructed by linking the following sets of records for each student from each college:

College enrolment data:

- Student ID
- Program Code
- Birth Date
- Gender
- Student Type
- MTCU Program Code
- College Program Code
- Program Name and Description

[13] As explained in Chapter 2, “preparatory” mathematics courses (also known as “remedial” courses) are not provided by all colleges or for all programs. Readers need to bear this in mind when interpreting overall numbers in such courses.

Secondary school data:
- Student ID
- Course
- Grade
- Date
- Board ID
- School ID

1st semester College grades (Fall 2006 only):
- Student ID
- Course
- Grade

Assessment/Placement Test data:
- Student ID
- Test ID (CPT, Accuplacer, etc)
- English subset #1 e.g. reading
- English subset #2
- Math
- Flag (M for Math and E for English)

Once these four sets of records were linked, each student ID (used for linking purposes) was deleted and replaced by a unique CMP record number. Thereafter, CMP records could not be linked back to any student personally, and confidentiality is ensured. At this point, data was returned to each college for validation. Subsequently, all analyses were then carried out on this database.

One of the innovative features of CMP 2007 has been the development and use of an interactive web-based system for querying and displaying the analyses of the CMP database. The display system is organized around the four areas of research interest outlined above and enables the user to examine an analysis at an *overview* level, where data from all colleges and all programs are displayed, and also:
- to *drill down* to specific program clusters, sub-clusters, and programs,
- to compare the results of individual colleges with the aggregated results,
- to compare the results of students taking regular college-level mathematics with those taking a preparatory mathematics course, and
- to compare recent Ontario graduates (ROGs) with non-ROGs.

Thus, for example, a user could compare the percentage of students achieving a given grade in mathematics in the Technology program cluster at a given college, with comparable students in other colleges, make a similar comparison for the Applied Science sub-cluster, and for Biotechnology Technologist programs, and examine all of these for recent Ontario graduates only, and for regular college-level mathematics courses.

This interactivity makes the numbers of analyses vast and, while the interactive database provides great advantage to users with specific needs or interests, it makes the choice of which analyses to report in a document for general interest (such as this one) a difficult one.

Participation

Table 11 shows the overall enrolment of students in all six participating colleges and the four program clusters, totaling over 20,000 and Table 12 analyses this overall enrolment by gender.

Table 11
Participation of All Students by College and Program Cluster

Cluster	C1	C2	C3	C4	C5	C6	TOTAL
Applied Arts	2,601	1,564	126	3,336	51	0	**7,678**
Business	1,805	542	815	734	1,013	1046	**5,955**
General	907	319	0	470	0	371	**2,067**
Technology	1,411	517	651	961	592	590	**4,722**
TOTAL	**6,724**	**2,942**	**1,592**	**5,501**	**1,656**	**2007**	**20,422**

Table 12
Participation of All Students by Gender and Program Cluster

Cluster	Male	Female	TOTAL
Applied Arts	2,318	5,334	7,678
Business	3,026	2,915	5,955
General	851	1,205	2,067
Technology	3,961	753	4,722
TOTAL	10,156	10,207	20,422

Of course, not all college programs include mathematics as a first-semester course and Table 13 shows the enrolment of students who took first-semester mathematics, both as a number and as a percentage of the total enrolment (as in Table 11).

Table 13
Participation of First-semester Mathematics Students by College and Program Cluster

Cluster	C1	C2	C3	C4	C5	C6	TOTAL	%
Applied Arts	76	0	0	874	51	0	**1,001**	**13%**
Business	1,658	386	195	612	1,013	903	**4,767**	**80%**
General	674	216	0	353	0	201	**1,444**	**70%**
Technology	923	378	360	795	532	543	**3,531**	**75%**
TOTAL	**3,331**	**980**	**555**	**2,634**	**1,596**	**1,647**	**10,743**	**53%**

Comparison of the three tables shows that, while Applied Arts students were the most numerous in the study, fewer than one in seven took a mathematics course. By contrast, in the Business and Technology program clusters, over three-quarters of all students took a mathematics course.

From this point on in this report, the term “all students” will refer to the 10,743 students who were enrolled in first-semester mathematics. The remaining records were not examined further.

Mathematics enrolments included both recent Ontario graduates (ROGs) and those who were either mature students or who did not graduate from an Ontario secondary school (non-ROGs). The breakdown of these enrolments is shown in Tables 14 and 15 (percentages are based on total enrolments from Table 13).

Table 14
Participation of ROGs by College and Program Cluster

Cluster	C1	C2	C3	C4	C5	C6	TOTAL	%
Applied Arts	50	0	0	548	42	0	**640**	**64%**
Business	1129	246	121	408	730	710	**3,344**	**70%**
General	536	154	0	254	0	162	**1,106**	**77%**
Technology	643	251	261	539	335	419	**2,448**	**69%**
TOTAL	**2,358**	**651**	**382**	**1,749**	**1,107**	**1,291**	**7,538**	**70%**

Table 15
Participation of Non-ROGs by College and Program Cluster

Cluster	C1	C2	C3	C4	C5	C6	TOTAL	%
Applied Arts	26	0	0	326	9	0	**361**	**36%**
Business	529	140	74	204	283	193	**1,423**	**30%**
General	138	62	0	99	0	39	**338**	**23%**
Technology	280	127	99	256	197	124	**1,083**	**31%**
TOTAL	**973**	**329**	**173**	**885**	**489**	**356**	**3,205**	**30%**

Tables 14 and 15 show that about two-thirds of all students enrolled in mathematics courses in the six participating colleges had graduated from Ontario secondary schools relatively recently. These are the students whose secondary school mathematics records can be meaningfully related to their college mathematics achievement.

The overall numbers for enrolment in each program cluster (shown in Table 13) can also be broken down into program sub-clusters. While we do not include this level of analysis throughout the report, we include four further tables (16 through 19) showing the relative numbers of students who were enrolled in each program area.

Table 16
Participation of Applied Arts Students by College and Program Sub-Cluster

APPLIED ARTS	C1	C2	C3	C4	C5	C6	TOTAL
Applied Arts	0	0	0	0	0	0	**0**
Health Services	75	0	0	145	0	0	**220**
Hospitality & Tourism	0	0	0	729	51	0	**780**
Human Services	1	0	0	0	0	0	**1**
TOTAL	**76**	**0**	**0**	**874**	**51**	**0**	**1,001**

Table 17
Participation of Business Students by College and Program Sub-Cluster

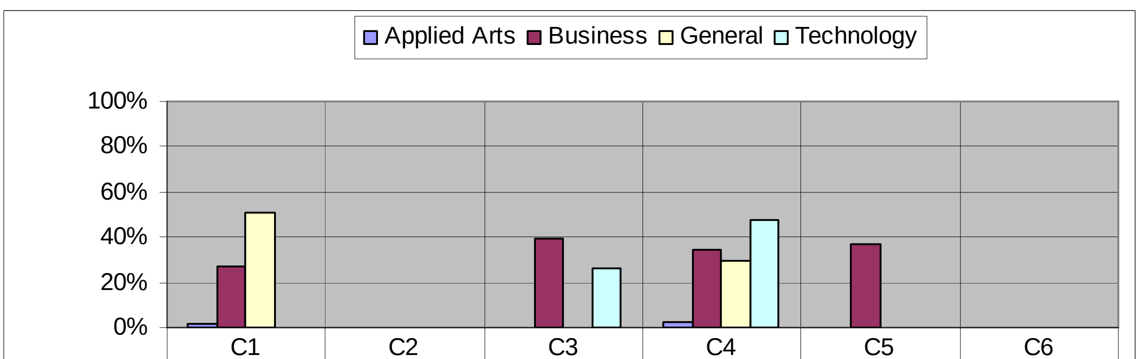
BUSINESS	C1	C2	C3	C4	C5	C6	TOTAL
Accounting	411	58	146	131	253	199	**1,198**
General Admin.	1,120	225	49	414	760	619	**3,187**
Office Admin.	127	103	0	67	0	85	**382**
TOTAL	**1,658**	**386**	**195**	**612**	**1,013**	**903**	**4,767**

Table 18
Participation of General Students by College and Program Sub-Cluster

GENERAL	C1	C2	C3	C4	C5	C6	TOTAL
Gen. Arts & Science	585	0	0	165	0	201	**951**
Preparatory Prgms.	89	216	0	188	0	0	**493**
TOTAL	**674**	**216**	**0**	**353**	**0**	**201**	**1,444**

Table 19
Participation of Technology Students by College and Program Sub-Cluster

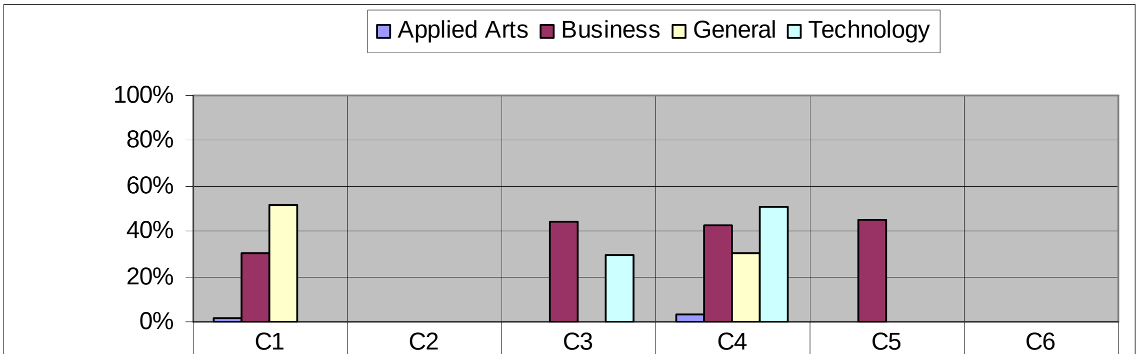
TECHNOLOGY	C1	C2	C3	C4	C5	C6	TOTAL
Applied Sciences	260	51	77	0	49	75	**512**
Computer-related	92	0	70	114	88	179	**543**
Construction	158	0	36	520	226	97	**1,037**
Electronics	112	75	39	0	110	82	**418**
Mechanical	301	252	138	161	59	110	**1,021**
TOTAL	**923**	**378**	**360**	**795**	**532**	**543**	**3,531**



	C1	C2	C3	C4	C5	C6
Applied Arts	1%			3%		
Business	27%		39%	35%	37%	
General	51%			29%		
Technology			26%	47%		

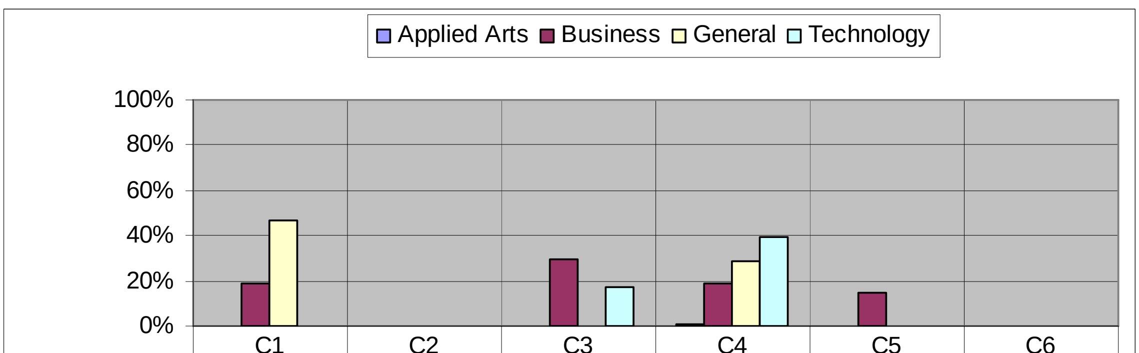
Figure 3. **Percentage of all students taking preparatory mathematics by program cluster.**

As noted earlier, some colleges have preparatory courses in mathematics (for some or all program areas), that students take when placement tests suggest that they would benefit from doing so. Because it might be misleading to equate achievement in a preparatory course with that in a regular college mathematics course, we can display enrollment data (Table 13) according to the type of course in which students were enrolled in. Figure 3 shows the percentage of students taking a preparatory mathematics course in first semester. Readers will note that colleges C2 and C6 do not have preparatory mathematics courses and that colleges C1, C3 and C5 have preparatory mathematics courses in some program areas only.



	C1	C2	C3	C4	C5	C6
Applied Arts	2%			3%		
Business	31%		45%	43%	45%	
General	52%			30%		
Technology			30%	51%		

Figure 4. **Percentage of ROGs taking preparatory mathematics by program cluster.**



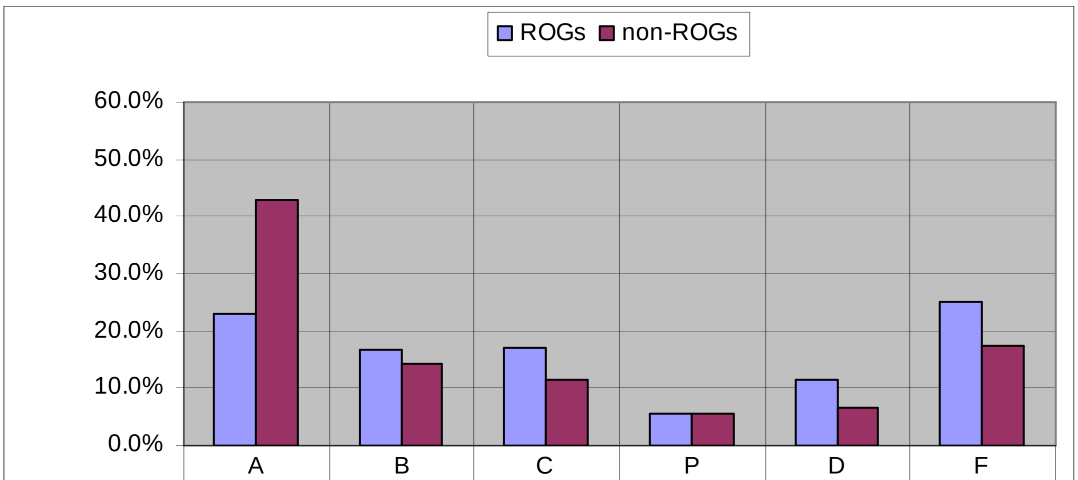
	C1	C2	C3	C4	C5	C6
Applied Arts				1%		
Business	19%		30%	19%	14%	
General	46%			28%		
Technology			17%	39%		

Figure 5. **Percentage of Non-ROGs taking preparatory mathematics by program cluster.**

Figures 4 and 5 show corresponding patterns for ROGs and non-ROGs. It is interesting to note that a higher percentage of ROGs were enrolled in preparatory mathematics than were non-ROGs. For example at C4, 43% of ROG Business students and 51% of ROG Technology students were enrolled in preparatory mathematics courses, compared with 19% and 39% for non-ROGs. A similar pattern can be observed in other clusters in which preparatory courses were offered. This could be a significant indicator to track as graduates from the newly revised Grades 11 and 12 Mathematics courses begin to enroll in colleges from 2008 onwards, since revisions have been made to college-preparation secondary school courses with a view to increasing student success in college.

Mathematics Achievement

The first analysis of achievement that the CMP team conducted is the overall distribution of grades in first-semester mathematics as shown in Figure 6.[14]



	A	B	C	P	D	F
ROGs	23.0%	16.7%	17.1%	5.7%	11.4%	25.1%
non-ROGs	42.8%	14.4%	11.4%	5.5%	6.6%	17.5%

Figure 6. **Grade distribution, ROGs & non-ROGs, all programs (n=10,743).**

Corresponding grade distributions for each program cluster (see Figures 7-10) show a consistently bimodal pattern, in which there are peaks at A and F grades.

[14] Readers will note a "P" grade is included in these distributions. This grade is awarded by one college in preparatory mathematics courses rather than the usual range of passing grades. Otherwise the grades refer to "CMP grades" as defined in Chapter 2.

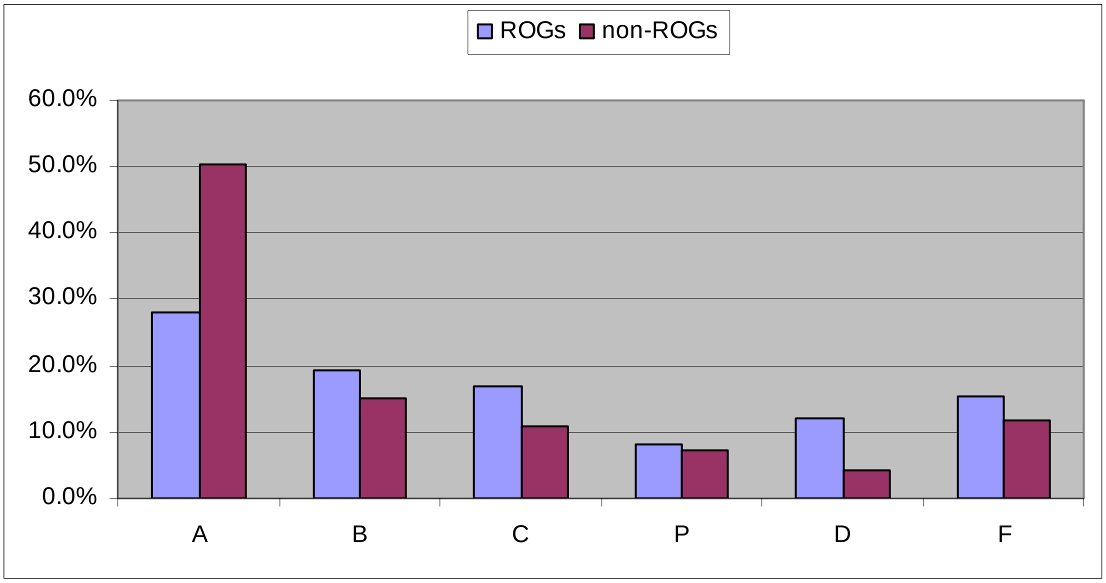


***Figure 7*. Grade distribution, ROGs & non-ROGs (Applied Arts programs, n=1,001).**

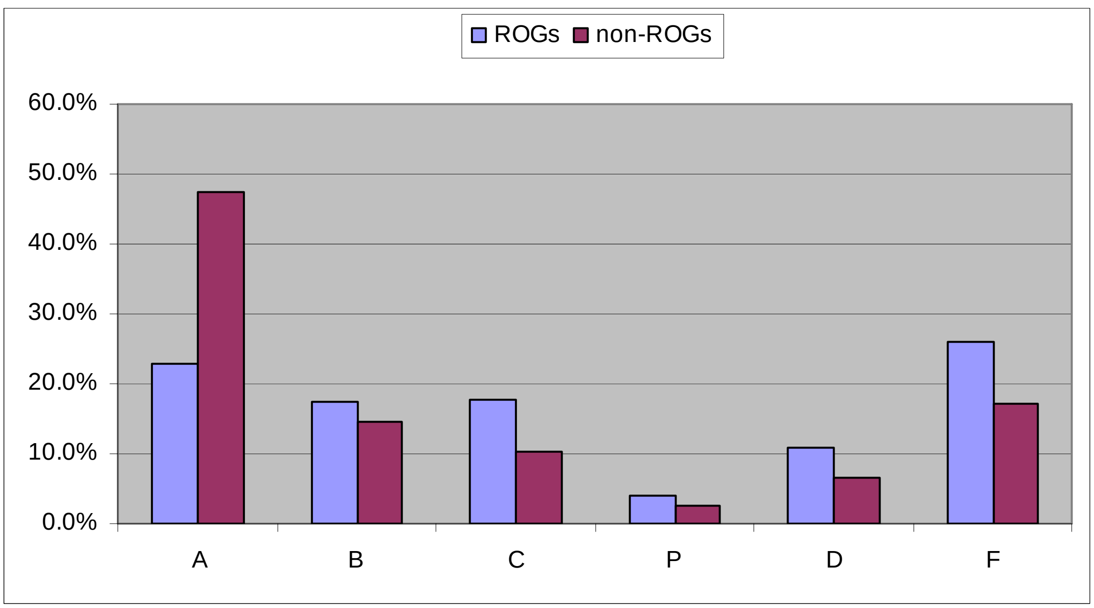


***Figure 8.* Grade distribution, ROGs & non-ROGs (Business programs, n=4,767).**

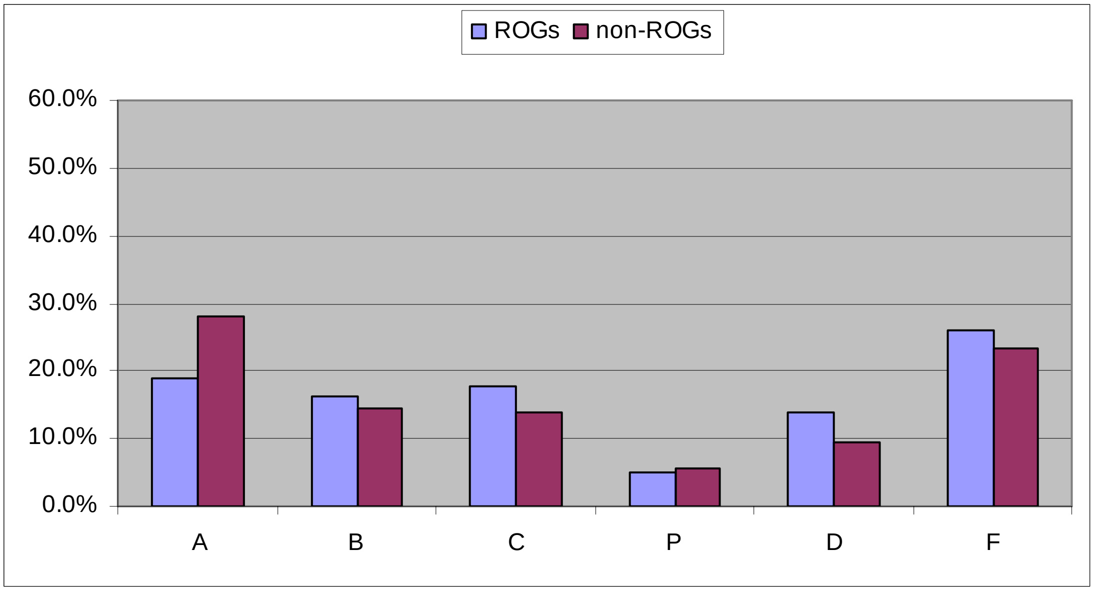


Figure 9. **Grade distribution, ROGs & non-ROGs (General programs, n=1,444).**

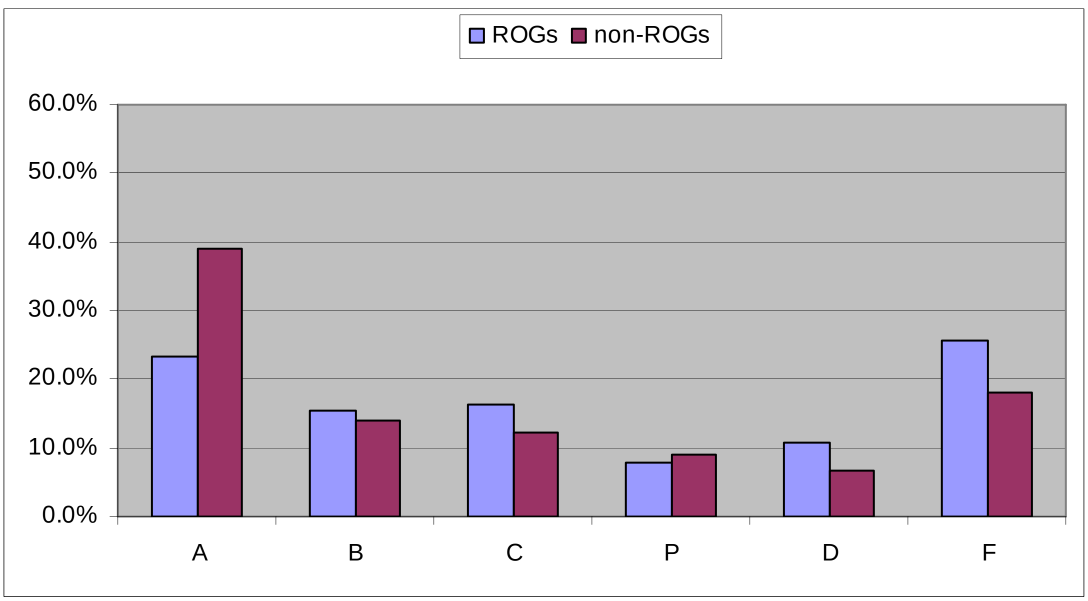
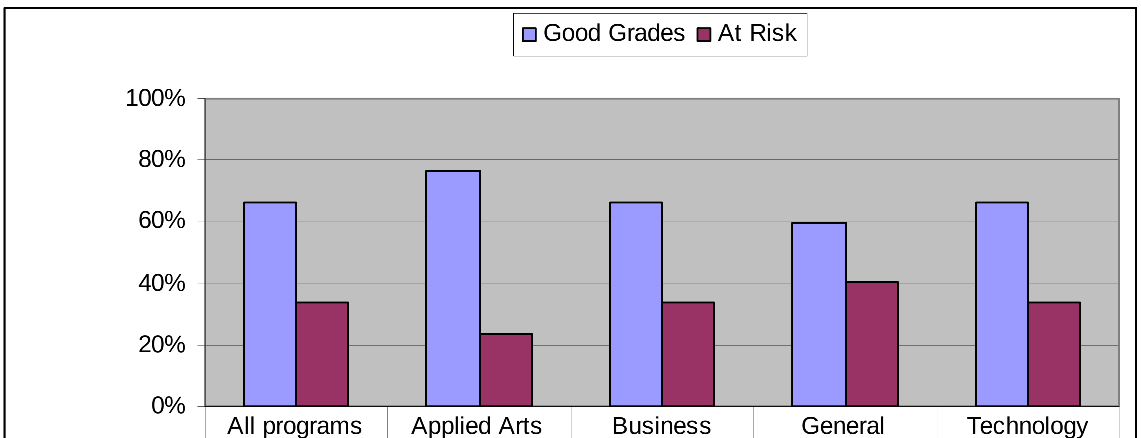


Figure 10. **Grade distribution, ROGs & non-ROGs (Technology programs, n=3,531)**

Comparison of Figures 7 through 10 also shows that in all program areas, non-ROGs consistently achieved higher proportions of A grades and lower proportions of F grades than did ROGs and that, in some areas, this result was quite pronounced. For example, over 47% of Business non-ROGs scored an A in mathematics, whereas only 23% of ROGs achieved at this level.

CMP draws another important conclusion from these bimodal grade distributions. Mathematics is such a fundamental subject for many program areas in college that, rather than contrasting “pass rates” (which would group A, B, C, P and D grades together) with “failure rates” (F grades only), CMP prefers to contrast achievement of “good grades” (A, B, C & P) with achievement that places students “at risk” of not completing their chosen program (D and F). (There is empirical support for the use of the term “at risk”: an earlier CMP pilot study found that, of technology students receiving a D grade in first-semester mathematics, over 50% had left the college within a year and only 9% completed their program on the normal schedule.)

Accordingly, in the analyses that follow, we describe student achievement in terms of the two categories, “Good Grades” and “At Risk”. Figure 11 shows the achievement of all students analysed by program cluster. It shows that overall, while about two-thirds of all students were achieving good grades, as much as one in three were considered to be at risk, based on their first-semester mathematics. These figures are quite consistent for both Business and Technology clusters which together account for more than three-quarters of all students in the CMP sample.



	All programs	Applied Arts	Business	General	Technology
Good Grades	66%	77%	66%	59%	66%
At Risk	34%	23%	34%	41%	34%

Figure 11. **Achievement by program cluster.**

Figure 12 presents mathematics achievement, by student type (ROGs and non-ROGs) and by course type (regular college-level math and preparatory math). The patterns here show that ROGs were more likely to be at risk than non-ROGs, and that this was equally true for preparatory mathematics courses as for regular college-level mathematics courses.

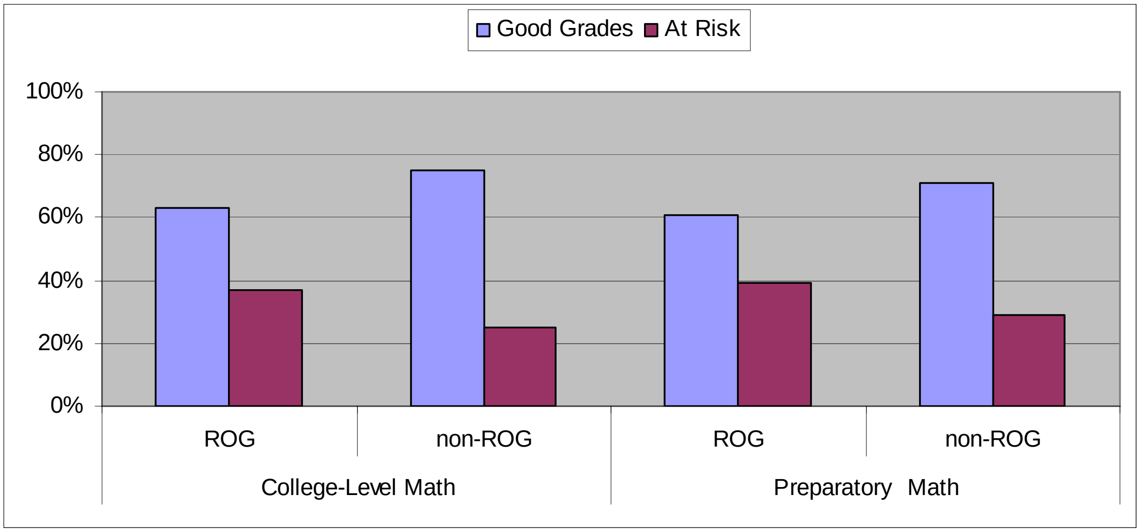


Figure 12. **Achievement by course type and student type.**

Figure 13 presents overall mathematics achievement by college. It should be noted that to maintain confidentiality, the colleges are sequenced and identified differently than in earlier charts. The patterns here show that there was significant variation among colleges with “at risk” levels varying from a low of 21% in College B to a high of 39% in College F.

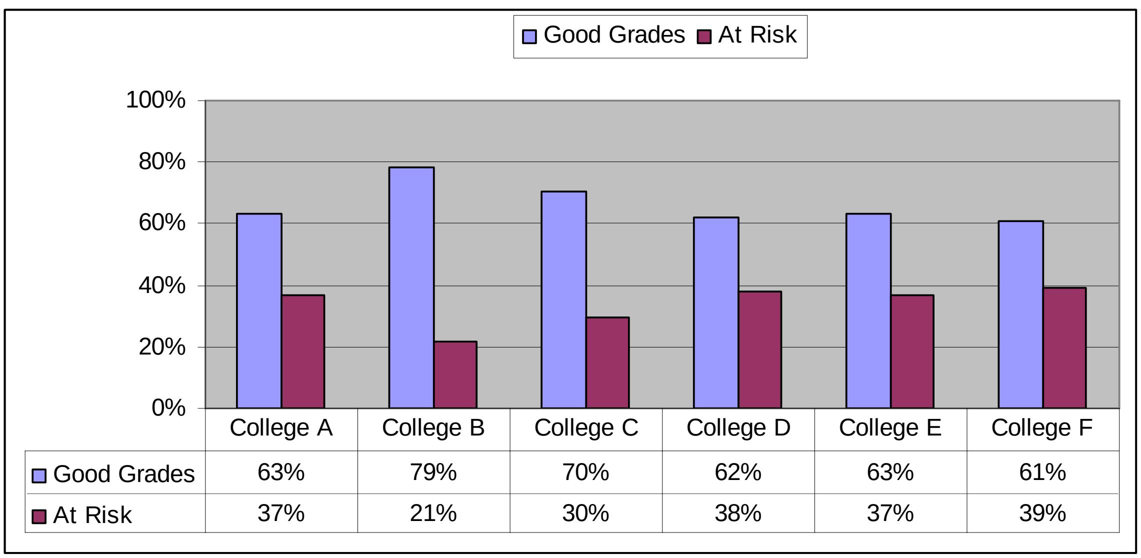


Figure 13. **Achievement by college.**

The pattern shown in Figure 13 can be further analysed by program cluster and student type. Figures 14 and 15 present data from this perspective for Business and Technology students respectively; the graphs show that the variation among colleges noted earlier was even more pronounced for specific program clusters.

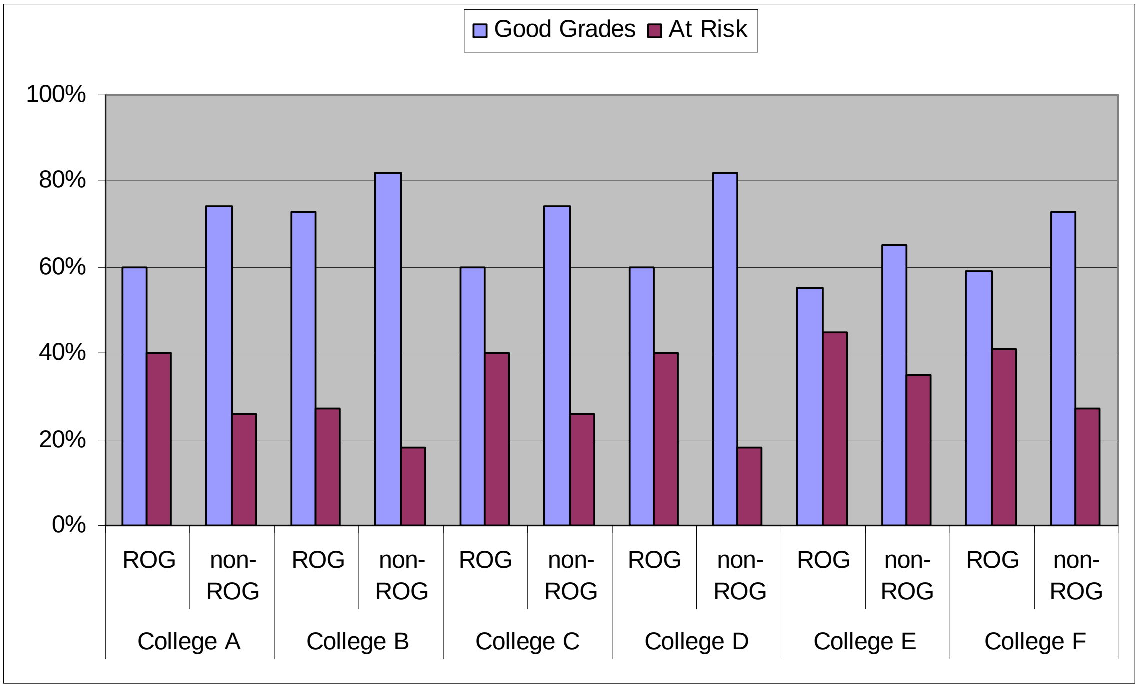


Figure 14. **Achievement by college and student type (Business programs, n=4,753)**

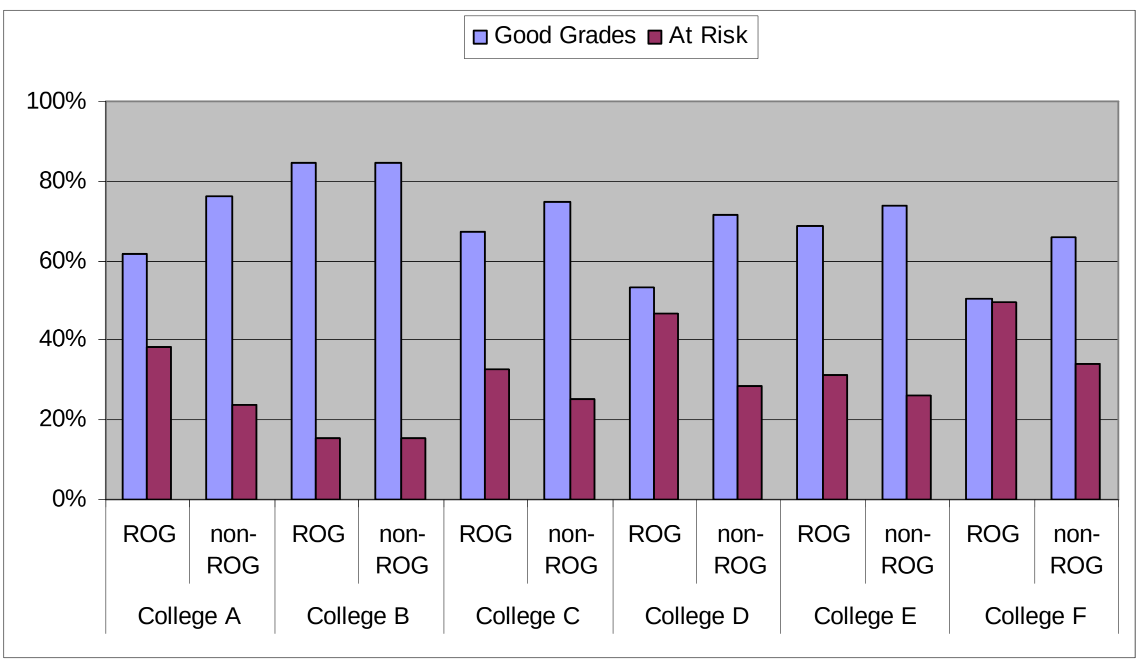


Figure 15. **Achievement by college and student type (Technology programs, n=3,641).**

Since the achievement data is available in much more detail on the interactive CMP database, each participating college has the opportunity of examining its own data in more detail and of identifying programs with the highest proportion of at risk students and this process has already begun.

Mathematics "Pathways" Through Secondary School

Requirements for graduation from Ontario secondary schools with an Ontario Secondary School Diploma (OSSD) include the completion of three mathematics courses, one of which is at the senior (Grades 11-12) level. In practice, many students complete more than this minimum number of mathematics courses. Indeed, as the analysis in Chapter 2 shows, admission requirements for many college programs include the completion of four courses.

Being able to compare the college-level achievement of students with varying secondary school mathematics backgrounds is of great interest to colleges, school boards, and the Ministry of Education and CMP has provided the first step towards a systematic analysis. When the records of all ROGs were analysed, CMP found that a very wide variety of mathematics "pathways" was followed by students whose records were examined.[15]

Altogether, 7,727 students were found to have followed 252 different pathways. Many of these pathways were followed by a very small number of students. If those followed by fewer than 10 students are discarded, the number of pathways is reduced to 102, while the number of students is reduced by less than 15% (see Table 20). In addition, 17 of these pathways were found to be based on the former OSIS (Ontario Schools-Intermediate/Senior) curriculum, which was superseded in 2000 by *The Ontario Curriculum.* These pathways were also discarded, reducing the number of pathways to 85 and the number of student records to 5,912 (76.5% of the total).

Table 20
Mathematics Pathways Followed by CMP Students

	Number of Pathways	Number of Students	Percentage of Total
All Pathways	253	7,727	100%
Pathways followed by 10 or more students	102	6,612	85.6%
Pathways based on Ontario Curriculum (2000)	85	5,912	76.5%

[15] A mathematics "pathway" is the sequence of mathematics courses taken by a student though secondary school.

Figure 16 shows that the distortion of the achievement data resulting from this reduction in the number of pathways analysed is minimal. The percentage of all students having "good grades" in the full 253 pathways was 64.4% and, when only 85 pathways were analysed, this was reduced to 63.5%, less than a 1% change. The CMP team therefore concluded that the reduction to 85 pathways was justified; thus the remaining analyses are based on the records of students following these pathways.

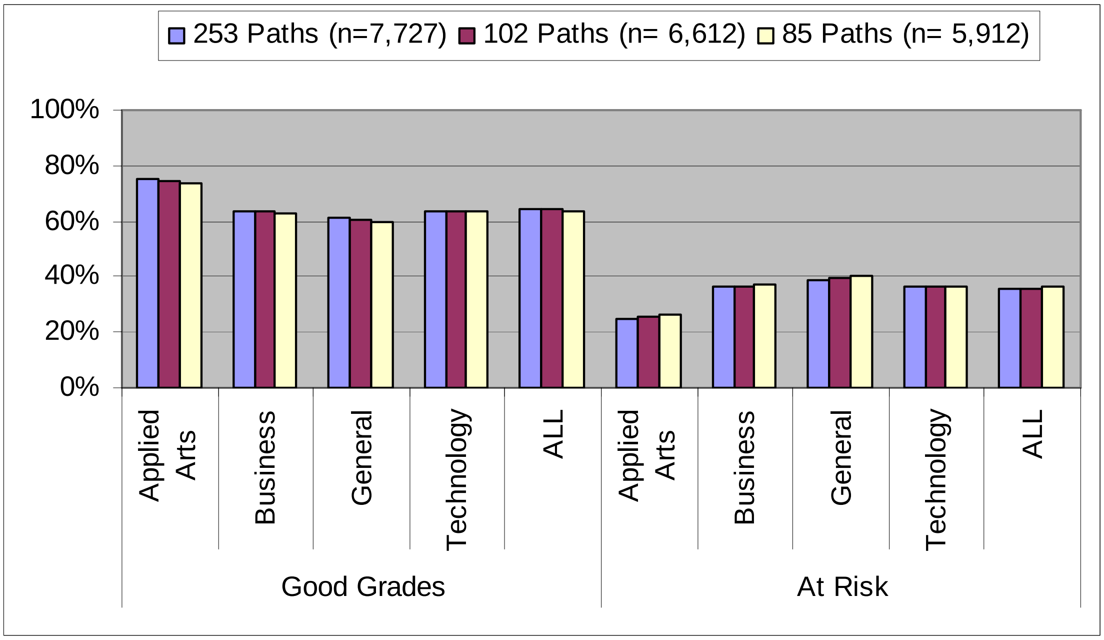


Figure 16. **Comparison of analyses of achievement by pathways.**

Students' selection of mathematics courses in secondary school can be seen to be a very important factor in relation to achievement in college mathematics. The charts that follow illustrate the differences in achievement of students who have made different selections of courses in secondary school.

Impact of Grade 9/10 Course Selection[16]

Figure 17 shows the impact of students choosing Grades 9 and 10 Academic or Applied Mathematics courses. Most students (71.7%) who followed the Academic pathway through Grades 9 and 10 received good grades in college; that number dropped to 48.7% when the corresponding Applied courses were selected. And this difference is even more pronounced for Technology students, where 72.6% of students with Grades 9 and 10 Academic but only 38.7% of

[16] These analyses are based on the mathematics courses and pathways described in *The Ontario Curriculum, Grades 11 and 12 Mathematics (2000)*. While this policy document was superseded in 2007, students whose data is examined by CMP 2007 took mathematics courses when the former document was still in force. Relevant excerpts from the 2000 policy document are contained in Appendix C.

those with Grades 9 and 10 Applied received good grades in first-semester college mathematics.

.

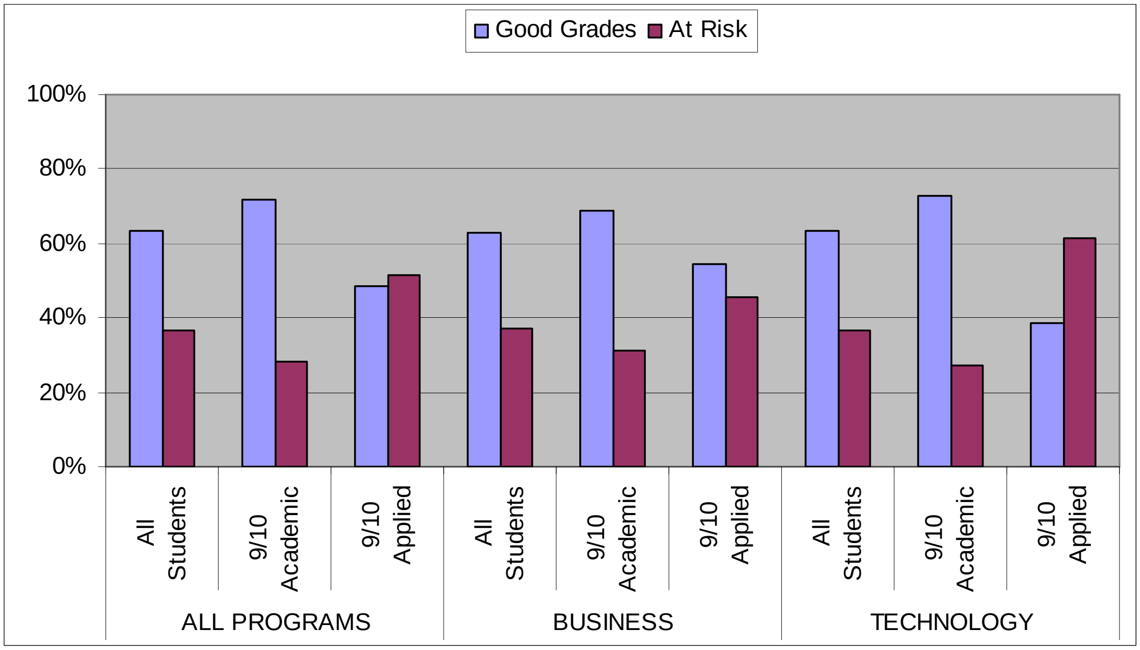


Figure 17. **Achievement of students with Grade 9/10 Academic and Applied courses.**

Impact of Grade 12 Course Selection

Figures 18 and 19 show the achievement of students having the most common Grade 12 “college preparation” courses, MAP4C (College and Apprenticeship Mathematics) and MCT4C (Mathematics for College Technology). In each figure, the first set of columns corresponds to all pathways that included MAP4C and the second set the most commonly followed pathway (MFM1P, MFM2P, MBF3C and MAP4C). These first and second sets of columns represent all program clusters; correspondingly, the next two sets represent the Business program cluster and the last two the Technology cluster.

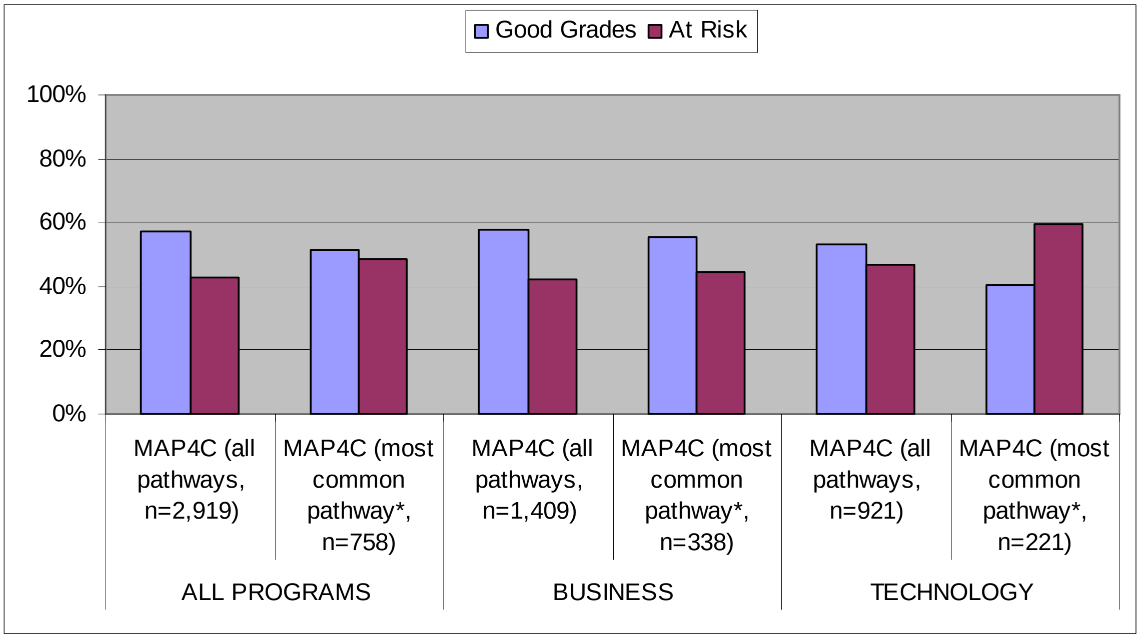


***Figure 18*. Achievement of students with MAP4C. (*Most common pathway = MFM1P, MFM2P, MBF3C, MAP4C).**

Figure 18 indicates that over 40% of students who took MAP4C were "at risk" after first semester, and that this number rose to 60% in the case of Technology students.

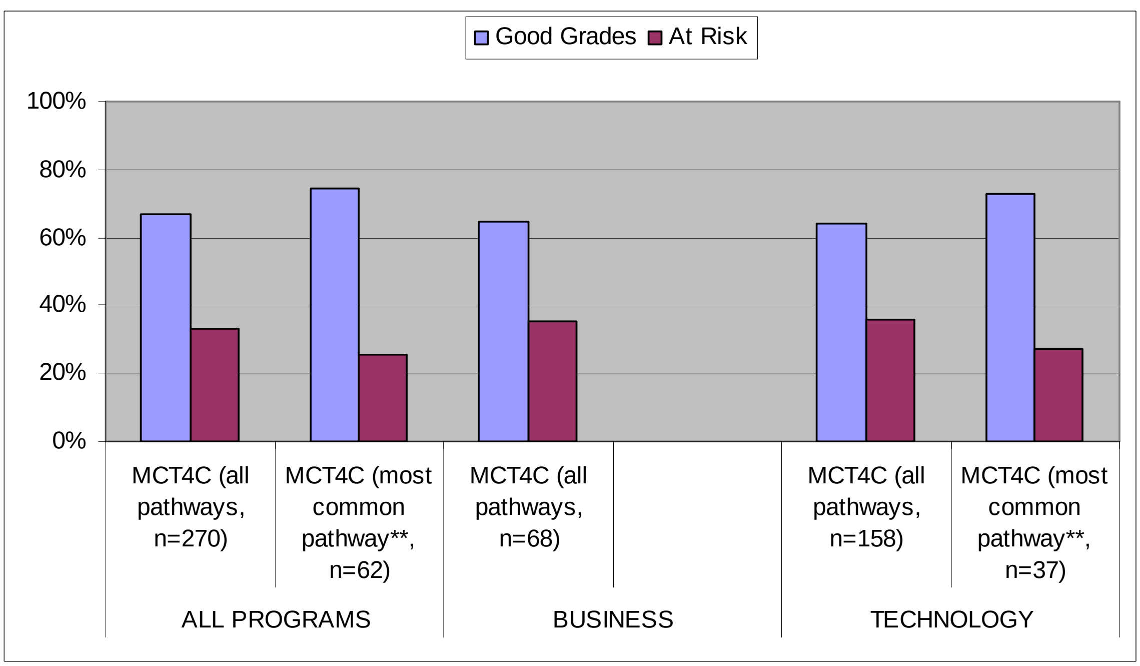


***Figure 19.* Achievement of students with MCT4C. (**Most common pathway for Technology students = MPM1D, MPM2D, MCF3M, MCT4C).**

Figure 19 shows the dramatic difference in success of students who took MCT4C in preparation for Technology programs (over 70% received good grades). But it also shows the very small numbers of students (270) who had taken this course. School Board colleagues confirmed that this low enrollment was related to the fact that only a small number of schools offered the course, a finding documented in the Phase 4 Double Cohort Report[17]. The pathway designed for technology-bound students is MPM1D, MPM2D, MCF3M and MCT4C and this pathway was not taken by a significant number of students aimed at other destinations, including Business programs.

Some students select one or more Grade 12 university-preparation course prior to enrolling in a college program. Table 21 shows the participation and achievement of students whose pathways included from one to three such 12U courses. It is interesting to note that close to 30% of all students entering college had participated in such a course and that achievement of these students was uniformly high.

Table 21
Participation and Achievement of Students Having Grade 12 U Mathematics Courses

	Participation	% (of 5,912)	Good Grades	At Risk
Any 12U course(s)	1,757	29.7%	77.9%	22.1%
One 12U course	1,016	17.2%	76.3%	23.7%
• **MDM4U**	472	8.0%	76.5%	23.5%
• **MCR4U**	521	8.8%	77.4%	22.6%
• **MGA4U**	23	0.4%	78.3%	21.7%
Two or more 12U courses	741	12.5%	80.2%	19.8%
• **MDM4U+MCB4U**	423	7.2%	77.5%	22.5%
Three 12U courses	120	2.0%	79.2%	20.8%

Impact of Grade 11 and 12 Course Selection

Given that the choice of Grade 12 college preparation courses in mathematics is often limited, the CMP team determined that the impact of the selection of Grade 11 course should also be examined. Figures 20 through 23 show participation and achievement in both college-level and preparatory mathematics courses of students with a variety of Grade 11 and 12 courses:

[17] In the *Double Cohort Study – Phase 4 Report for the Ministry of Education*, King and his colleagues found that MCT4C accounted for just 4.2% of the provincial enrolments in grade 12 mathematics courses and was offered by 57.6% (n=53) of schools studied.

Figure 20 compares participation and achievement of students in both college-level and preparatory mathematics in all program clusters from the following four secondary school mathematics backgrounds:

- MBF3C (Grade 11) + MAP4C (Grade 12)
- MCF3M or MCR3U (Grade 11) + MAP4C (Grade 12)
- MBF3C (Grade 11) + MCT4C (Grade 12)
- MCF3M or MCR3U (Grade 11) + MCT4C (Grade 12)

This shows that many more students who took MCF3M or MCR3U rather than MBF3C in Grade 11 achieved good grades: 68% compared to 51% for those with MAP4C, and 71% compared to 52% for those with MCT4C. In addition, the number of MCF3M/MCR3U students who took preparatory math courses (n=61) was far lower than the number of MAP4C students (n=760) who did so.

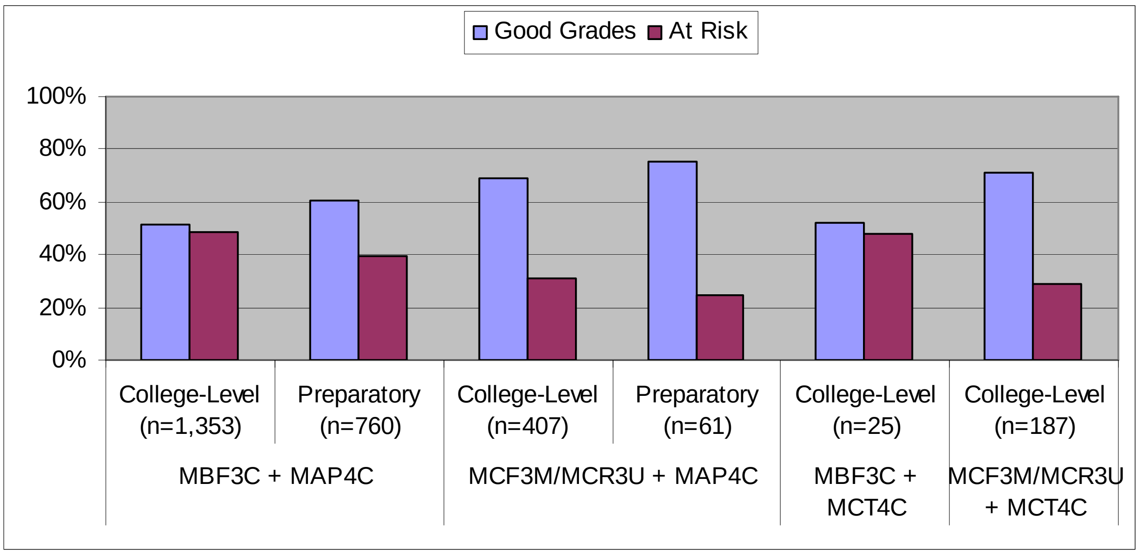


Figure 20.* Achievement of students with selected college-oriented grade 11 and 12 courses (all programs*).

Figure 21 shows similar results for Technology students. While MAP4C is clearly not as appropriate a preparation for college Technology as MCT4C, Figure 21 shows that 68% of those who took MCF3M or MCR3U in grade 11 and MAP4C in grade 12 received good grades in college-level mathematics; and for this group the number that took preparatory mathematics was 18, compared to 197 for those with MBF3C in grade 11 and MAP4C in grade 12.

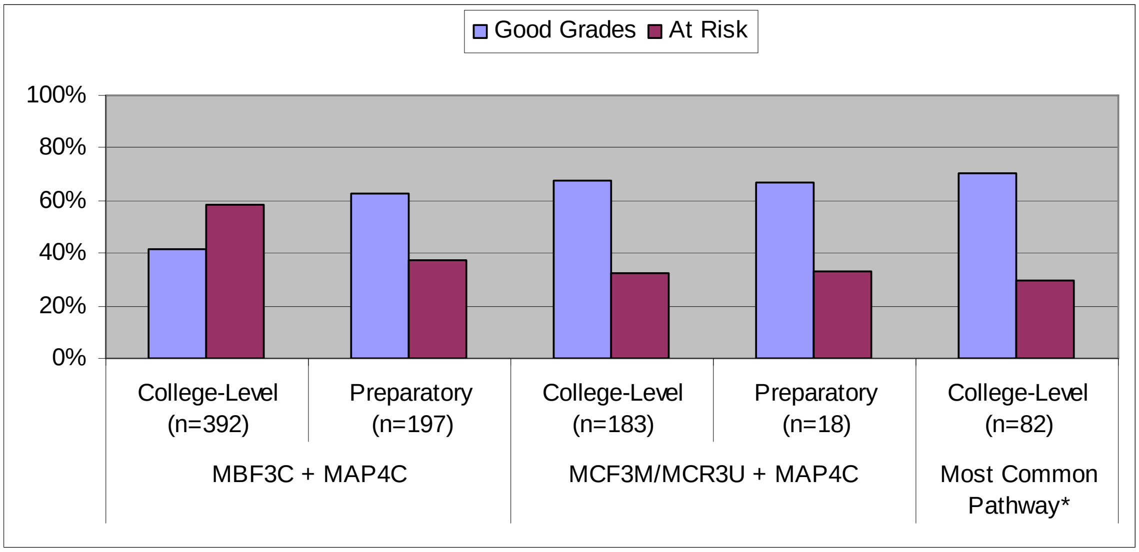


***Figure 21*. Achievement of students with selected college-oriented grade 11 and 12 courses (Technology programs). (*Most common pathway = MPM1D, MPM2D, MCF3M, MCT4C).**

Figure 22 shows similar results for Business students with the selection of the more demanding Grade 11 courses (MCF3M and MCR3U).

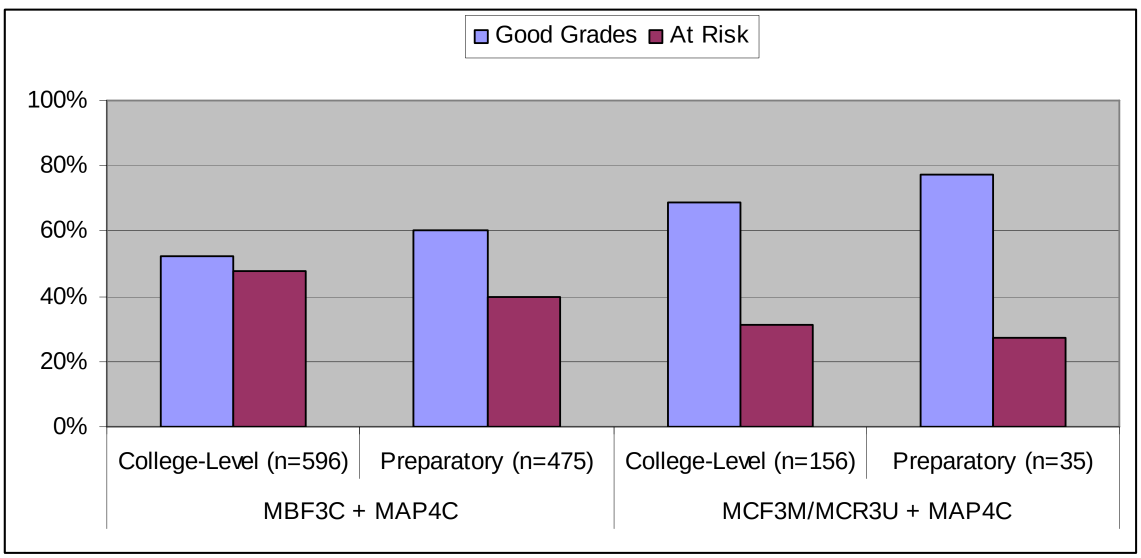


***Figure 22.* Achievement of students with selected college-oriented grade 11 and 12 courses (Business programs).**

Not all students take mathematics courses at Grade 12 level and Figure 23 shows the impact of choosing to take no further mathematics after grade 11. Again, the specific choice of Grade 11 course makes a substantial difference. With MBF3C in their background, a large number of students needed to take preparatory mathematics in first-semester college and, of those who did take the regular college-level course, more than half fell into the at risk category. The results of students whose final secondary school course was MCF3M or MCRU were much better, though not as good as those who continued to Grade 12.

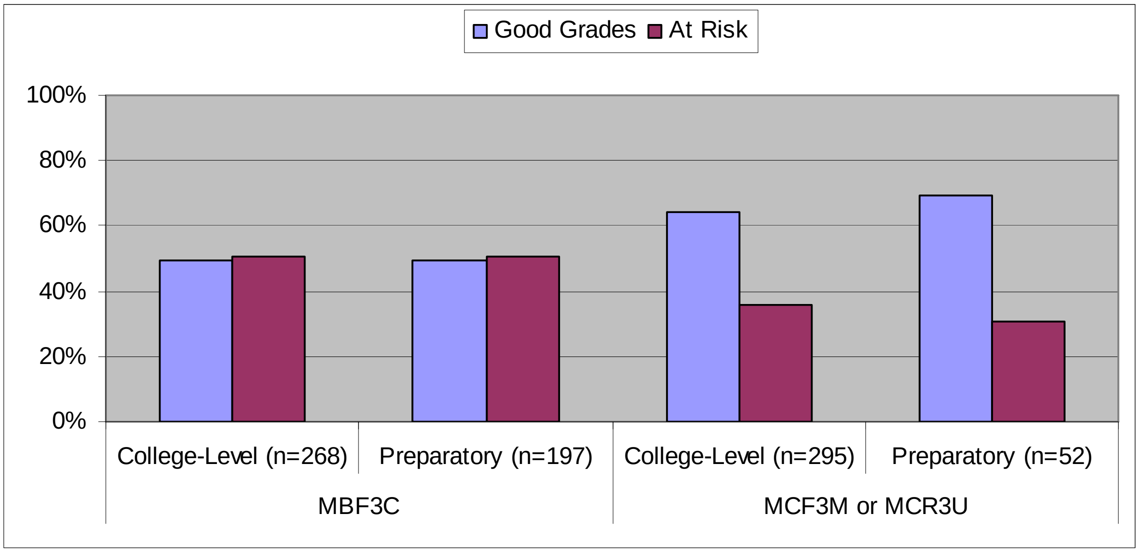


Figure 23. **Achievement of students whose highest mathematics course was a grade 11 course.**

Participation and Achievement in Preparatory Versus College-Level Mathematics Courses

At the time of the study, four of the six colleges participating in CMP offered preparatory mathematics courses for students in need of them and it is interesting to compare the participation and achievement of students in preparatory courses and college-level courses according to their secondary mathematics backgrounds.

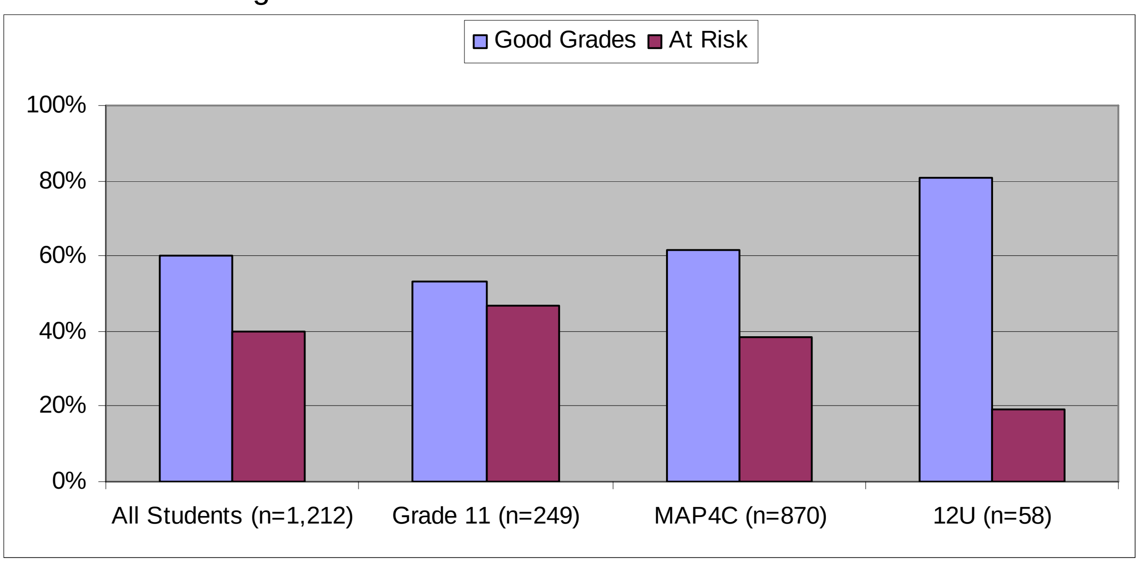


Figure 24. **Participation and achievement in preparatory courses by culminating secondary school mathematics course.**

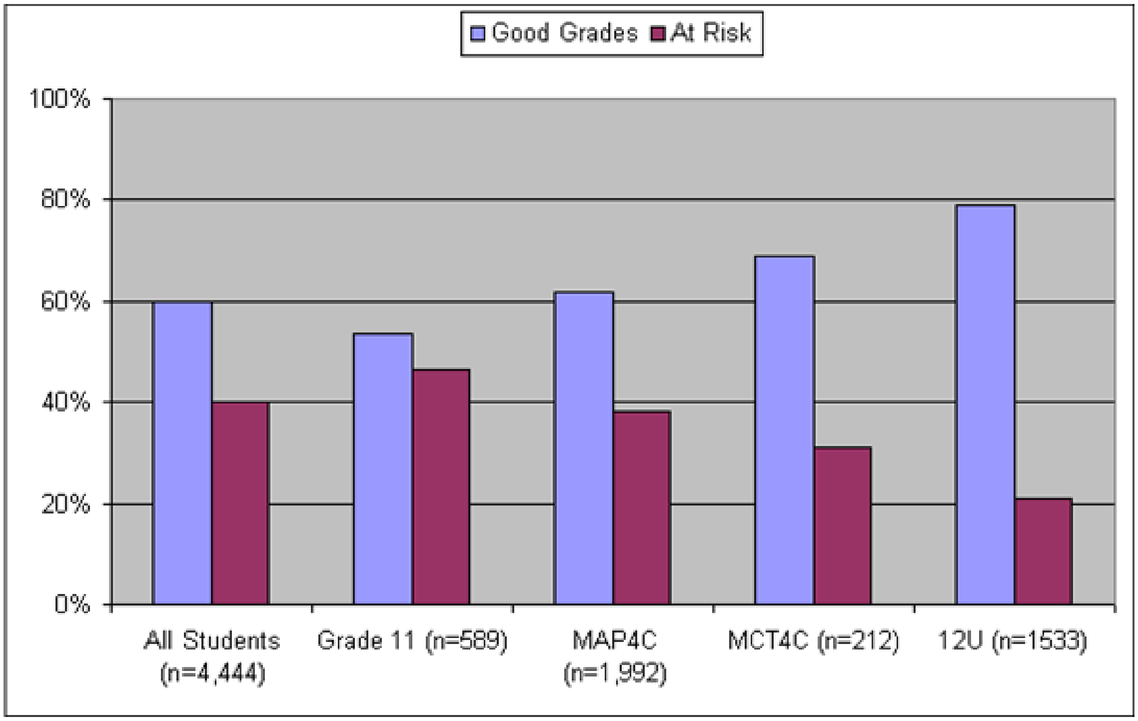


Figure 25. **Participation and achievement in college-level courses, by culminating secondary school mathematics course.**

Figures 24 and 25 show these comparisons[18]. The pattern is very clear and it summarizes well the conclusions of these analyses of achievement based on students' secondary school mathematics backgrounds.

- Overall, about 60% of all students achieved good grades in college (in both preparatory and college-level mathematics courses) and 40% were at risk.
- For students whose school mathematics ended with Grade 11, the ratio of students with good grades to those at risk, was close to 50:50.
- Students with MAP4C as their final mathematics course achieved slightly better than the 60:40 average in college (but this was very dependent on the program area).
- Students whose school mathematics was MCT4C did better again (70:30) but the number of such students was very small.
- Students with one or more 12U courses tended to achieve at a high level (80% received good grades).

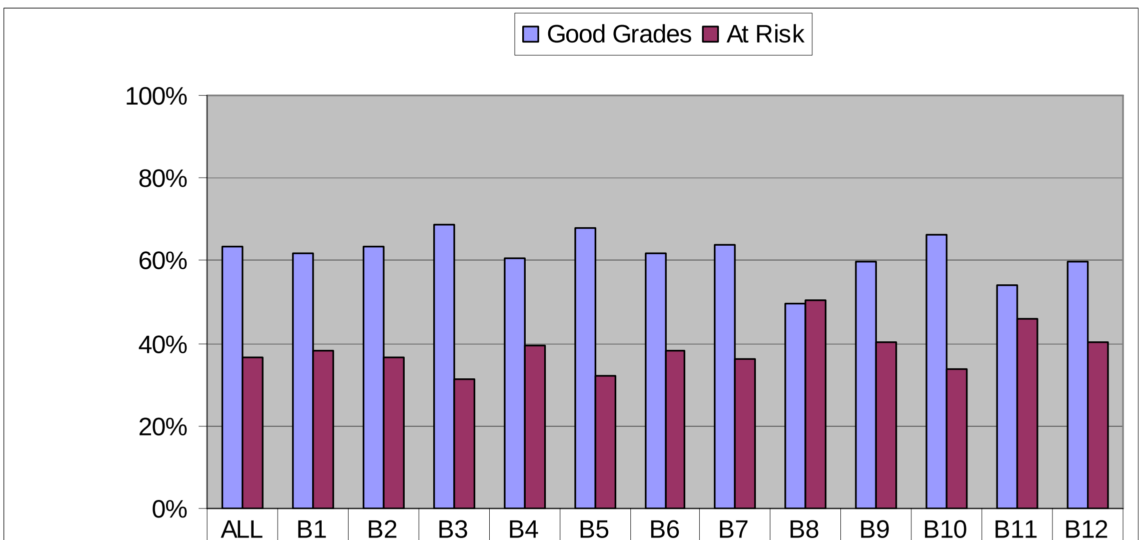
[18] In both these Figures, the numbers of students in each category do not add up to that shown for "all students" since only selected pathways are represented.

School Boards and Schools

The CMP 2007 has a sufficiently large and geographically focused sample of students that analysis of student achievement by school board and even school can be undertaken with reasonable confidence. Of course, these analyses like those of the mathematics pathways described earlier only apply to Recent Ontario Graduates (ROGs).

Twelve school districts correspond to the area served by the six colleges and all of these were participants in CMP 2007. Indeed, of the 7,538 ROGs in the overall study, 6,789 (90%) were graduates of these boards. The converse is not the case, however; not all the college-bound graduates of the 12 boards are represented in the study, since some will have attended other colleges. This is particularly the case for school boards on the geographical edges of this year's project. Care must therefore be taken in interpreting the results of this analysis.

Figure 26 shows the overall achievement results of the graduates of the 12 boards. As before, the identities of the boards have been obscured and only percentage achievements are shown, to maintain confidentiality[19]. It can be seen that achievement varied across the 12 boards, though most were within 5% of the overall ratio of 2:1 for good-grades and at-risk achievement.



	ALL	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Good Grades	64%	62%	63%	69%	60%	68%	62%	64%	49%	60%	66%	54%	60%
At Risk	37%	38%	37%	32%	40%	32%	38%	36%	51%	40%	34%	46%	40%

***Figure 26.* Achievement by graduates of CMP school boards (All programs, n=6,789).**

[19] Individual boards have been provided with their own data directly.

Figures 27 and 28 display the same data for the two major program clusters of Business and Technology, respectively. Once again, the spread among school boards was more pronounced when individual program clusters were examined.

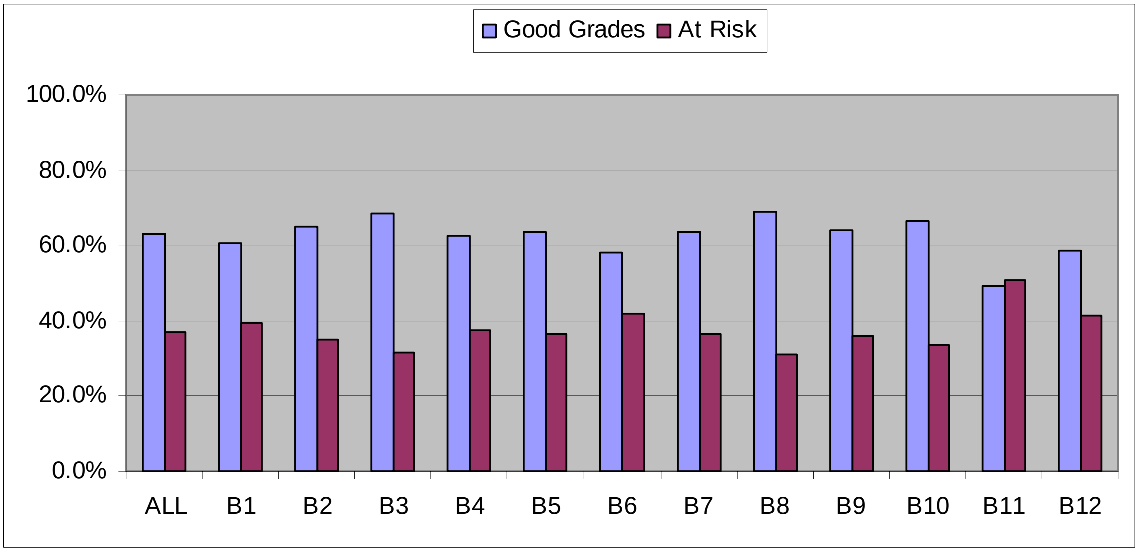


Figure 27. **Achievement by graduates of CMP school boards (Business programs, n=2,923).**

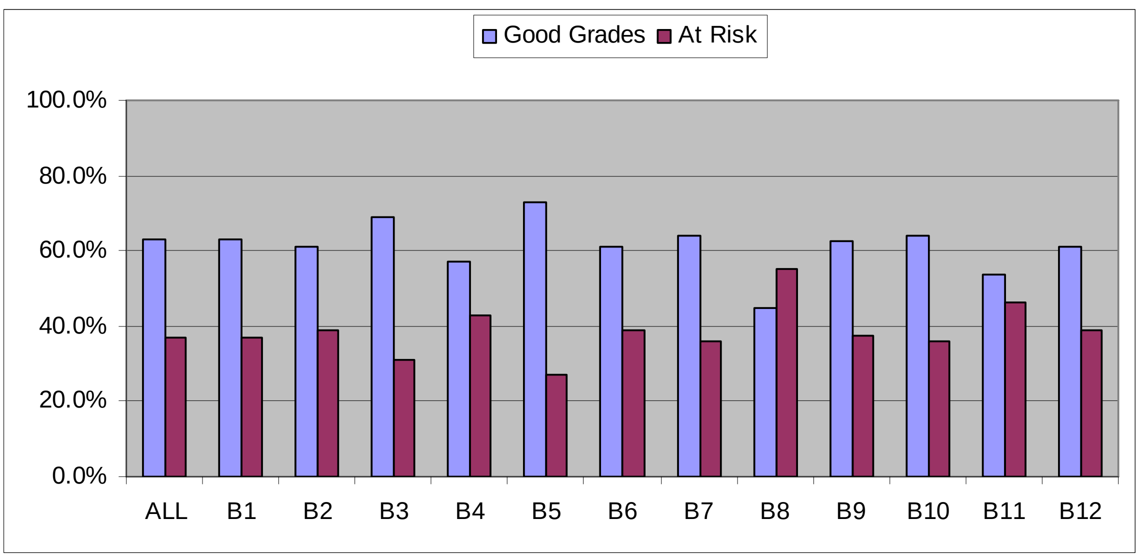


Figure 28. **Achievement by graduates of CMP school boards (Technology programs, n=2,255).**

Achievement at the school-board level can also be analysed from the perspective of the type of mathematics course taken by graduates. Figure 29 shows the proportions of graduates from each board who took preparatory or college-level mathematics. Since only 4 colleges offered preparatory mathematics, graduates of some boards were less likely to have had the opportunity to take such a course.

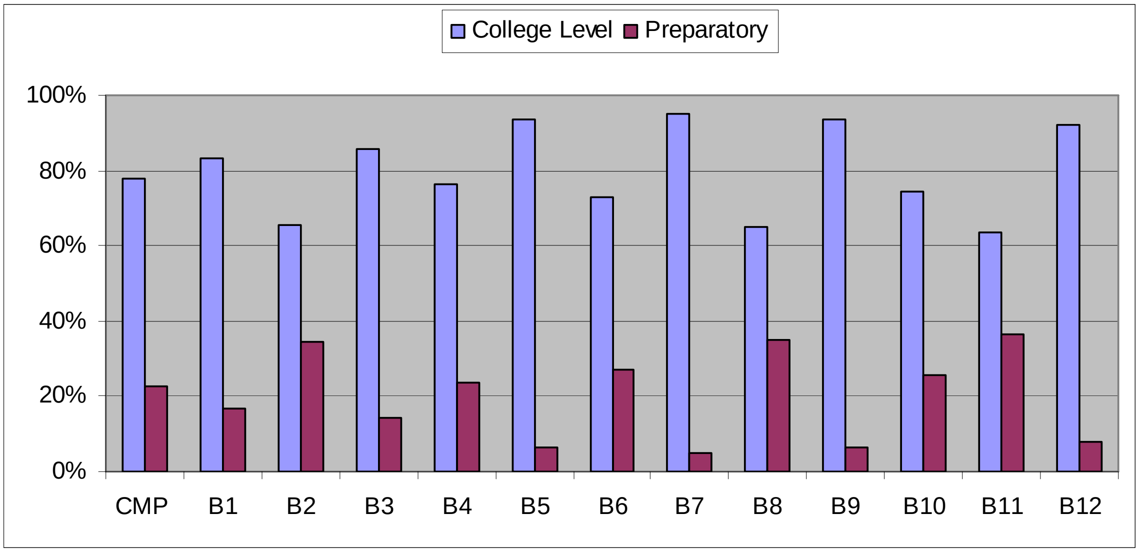


***Figure 29*. Enrolment in college-level and preparatory mathematics by graduates of CMP school boards.**

Figures 30 and 31 show the achievement for preparatory mathematics and college-level mathematics analysed by school board. Once again, readers are cautioned that the absence of preparatory courses at some colleges may have affected participation rates significantly for reasons having nothing to do with the students themselves.

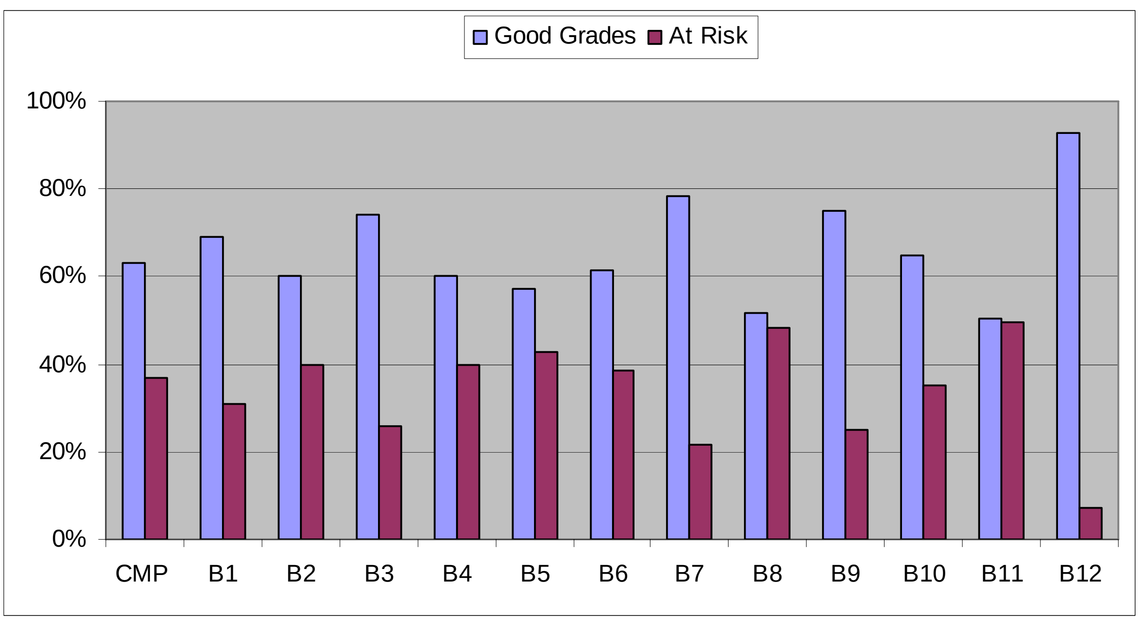


***Figure 30.* Achievement in preparatory mathematics by graduates of CMP school boards (n=1,523).**

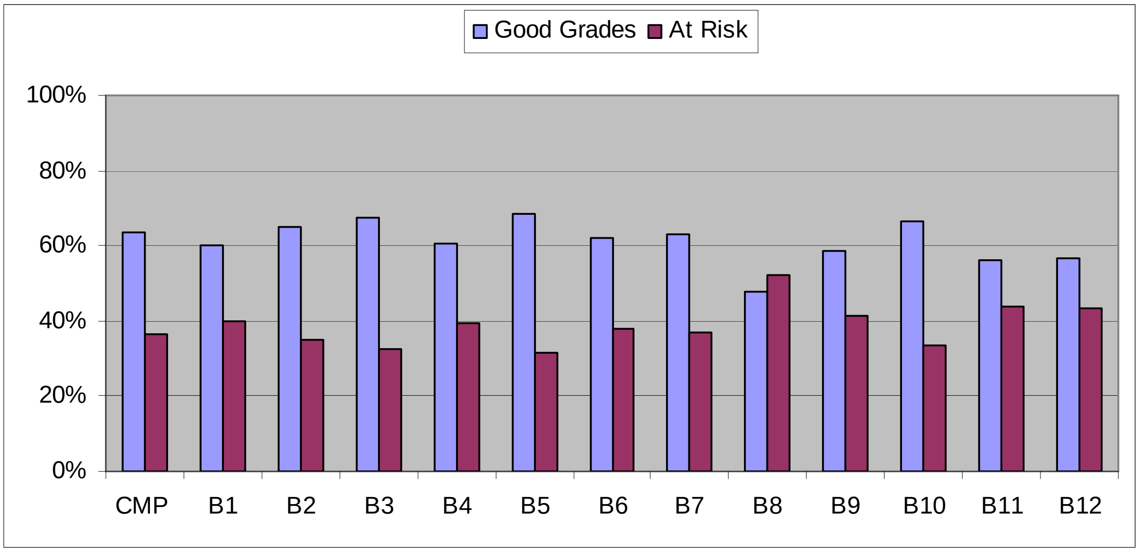


Figure 31. **Achievement in college-level mathematics by graduates of CMP school boards (n=5,266).**

Finally, Figure 32 shows a typical analysis of achievement at the school level within one of the CMP participating school boards. Readers will note that, here, rather than show percentages of students achieving good grades or being at risk, we have presented actual numbers. The reason for this is that some schools (see for example S37, S38, and S40) have very few graduates taking college mathematics and in such cases, the use of percentages is misleading. Schools with successful results as shown in Figure 32 (such as S5, S25, S30 and S36) are those where the blue columns (good grades) are *relatively* much longer than the purple columns (at risk), regardless of their absolute length.

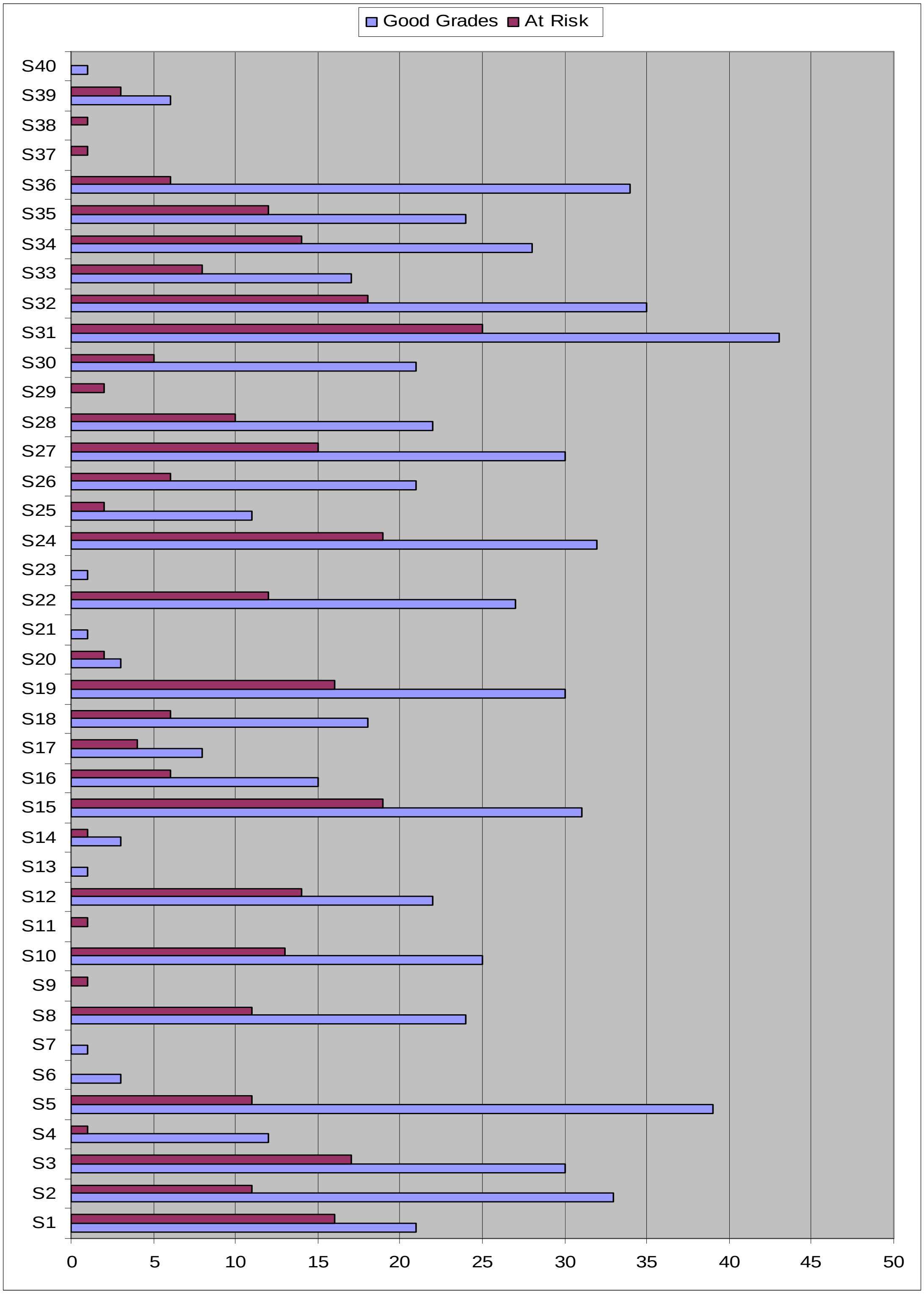


Figure 32. **Achievement by graduates of schools within one CMP school board.**

Chapter 4: Deliberative Forum

Central to the "deliberative inquiry" model used in the College Mathematics Project is that research results should form the basis of deliberations among the key stakeholders. Accordingly, once the first round of data analysis was completed, a CMP Forum was held to which representatives of all the participating colleges and school boards were invited, together with representatives of the Ministry of Education, the Ministry of Training, Colleges and Universities, Colleges Ontario, and the Higher Education Quality Council of Ontario. Altogether, about 120 attended at this event, which took place on October 26, 2007 at the King Campus of Seneca College, sponsored by the School/College Work Initiative (SCWI) through the *Connecting GTA Teachers* regional planning team.

The goals of the Forum were to:

1) update the results of research conducted last year (CMP 2006);
2) incorporate new data and analyses arising from research focusing on preparatory courses and their consequences for students;
3) learn about initiatives colleges and school boards had implemented since last year's Forum;
4) discuss possible changes and improvements at the school and college levels.

Agenda

In anticipation for the Forum, a "CMP Forum Backgrounder" was prepared, which included highlights of the qualitative and quantitative research results completed to that point, together with supplementary material about the project.[20] A summary of the Forum agenda is as follows:

- Welcome to the Forum (Cindy Hazell, Senior VP Seneca College)
- CMP Research Reports (CMP Project Team)
- Implementation of Local Action Plans and Best Practices[21] Reports (CMP colleges and school boards)
- "Implementing the Revised Math Curriculum" (Anthony Azzopardi, Ministry of Education)
- Breakout Group Deliberations
    - Implications for guidance teachers

[20] The Forum Backgrounder, the Proceedings and all other information relating to the CMP Forum is available on line at: http://cgtat.org/forum_071026_CMP_SenecaKing.html
[21] Best Practices refers to initiatives aimed at improving success for students.

  - o Implications for mathematics teachers
  - o Implications for Student Success Leaders
  - o Implications for the Province, boards, and colleges
- Group Reports and Recommendations

Since the Forum, analyses of the research results, both qualitative and quantitative, have been developed further (in part, as a result of suggestions made by Forum participants) and chapters 2 and 3 of this report are the latest and most detailed account. A full account of all items of the Forum agenda is provided in the Proceedings[22] and summaries only are presented here.

Best Practices Reports

CMP 2006 provided the first multi-college systematic research into the problems of student success in first-semester college mathematics. However, individual colleges had been aware of the problem for several years earlier than this and several had begun to develop strategies aimed at increasing student retention and success. As part of the CMP 2007 Forum, therefore, it was decided to share experiences and best practices in this area, and all six participating colleges and three school boards reviewed aspects of their own experience.

Centennial College

Phil Cox described a system of assessment of new students in the School of Business and the subsequent assignment of students to one or more of three mathematics courses, depending on the student's need for remedial algebra. He cited college statistics suggesting that "about 60% of those who would normally fail their first-semester math course" are saved by this system.

George Brown College

Paul Balog outlined how George Brown College's "Student Success Strategy" focused on three areas: ongoing orientation; academic competence; and early alert. Ongoing orientation includes the use of a collaborating team of coordinators, specialists, professors and peers to provide opportunities for student interaction and assistance. He illustrated this by describing "Rx for Success" the orientation program designed for Nursing students.

Georgian College

Lorri McLeod described her role as "Learning Strategist" at Georgian College. She pointed out that research shows that cognitive entry skills and IQ contribute 50% to student achievement and quality of instruction another 25%, affective characteristics (anxiety, study skills, and test taking skills) contributes the remaining 25%. Focusing on improving students' learning strategies is her role

[22] See note 20.

and, when students apply the skills they are taught here, they often see a 10-15% improvement in their marks! There are 2 Learning Strategists at the college, and in 2006-07, they assisted 800 students.

Humber College

Crystal Bradley outlined the need at Humber College for a preparatory math course for Technology students parallel to that operating in the School of Business. All students going into Technical Math courses are tested with the College Board's CPT tests in arithmetic and algebra. Students with scores of 160 and above have the skills to succeed. Those with less than 160 are at risk of failing the first level of technical math and are encouraged to attend the Math centre for extra help. Unfortunately many students do not heed this advice and fail first-level math. A new pilot project is planned for Fall 2008 for preparatory technical math for students with low CPT scores.

Seneca College

Jennifer Singh and Laurel Schollen split their account of the Seneca College experience, with Jennifer describing the online assessment system LYRYX®, which is used in both regular and preparatory math courses in the Faculty of Business. LYRYX® online math labs comprise 20% of a student's overall grade. Students can also use the online assessment to practice math questions and to reinforce concepts. Students and faculty have found the labs very beneficial.

Laurel mentioned the impact of CMP 2006 in the development of a new preparatory math course for use in the Faculty of Applied Science and Engineering Technology. Each school/program area is represented and resources for the development have included Grade 12 and college math texts as well as K-12 and college course outlines. In a pilot in fall 2007, 30-42% of students tested with CAT-3 Level 19 test initially fell below a cut score equivalent to grade 10.6 (i.e., lower than grade 11!) Results of all students are being tracked.

Sheridan College

Neil Robb described the approach used to handle "math deficiencies" through reorganizing students' first-year courses if required so that those subjects requiring good math skills are moved to semester 2 and semester 1 focuses on upgrading necessary math skills,.

York Region District School Board

York Region learned from CMP last year that students went on to college from a wide diversity of backgrounds and that not all those with what was thought to be the appropriate background were successful. Kathryn Stewart reported that the Board has set about "reculturing" teachers, guidance heads, parents and students with respect to colleges. There is a general focus on collaboration to improve student achievement.

Peel District School Board

Alan Jones reported that the Peel District School Board is engaged on a school success planning process using data driven dialogue. In mathematics there is a special focus on the use of "thinking tools", the use of the three-part lesson design in mathematics, purposeful talk about mathematics, and explicit teaching and the use of mathematical vocabulary. The MCT4C course has been promoted with mathematics department heads, guidance counselors, administrators, parents and students, and there has been some improvement in numbers this year.

Halton District School Board

Amy Lin reported that the results of the CMP Forum in 2006 were shared with mathematics leaders, secondary principals and guidance counselors. A "Choosing the Math Pathways to Success" slide presentation was created and used in presentations to parents of grade 8 and 9 students at course information nights. As a result of these initiatives, the number of secondary school sections of MCT4C has risen from 1 in 2005-06 to 19 this year. Pathway initiatives are also taking place in certain schools to encourage students to consider and be successful in a wider range of careers including apprenticeships.

Ministry of Education Report

New curriculum policy documents for Grades 11 and 12 Mathematics were released in 2006-2007. Accordingly, the CMP team decided that it would be useful for Forum participants to hear from Anthony Azzopardi, Education Officer at the Ministry of Education, who has special responsibility for secondary school mathematics and has strongly supported the work of the CMP since its inception.

In his talk, Anthony focused on the goals and processes through which the new policy documents were developed, the structure of the revised mathematics courses, particularly those aimed at preparing students for college, and the newly defined pathways. He noted the participation of colleges in assisting with the course revision and expressed the hope that the newly defined courses would contribute to overall increases in student success at college beginning in 2008, when students who have taken the new courses will begin to graduate from secondary school. His talk included a detailed comparison of the changes in course expectations between the 2000 curriculum and the 2007 curriculum.

For full details of this presentation, the reader is invited to review the original PowerPoint presentation, which is included in the Forum Proceedings.[23]

---

[23] See note 20.

Forum Deliberation Sessions

The CMP Forum deliberations occupied the afternoon session and took place in four groups, each of which focused on one of the following themes:

- Implications for guidance teachers
- Implications for mathematics teachers (both secondary school and college)
- Implications for Student Success Leaders (both secondary school and college)
- Implications for the Province, for colleges, and for school boards

The questions given to the groups are set out below.

Questions for Guidance Teacher Group

1. How do we ensure that students are made aware of the best choices for them?
2. How do we ensure that the courses most critical for student success are offered?
3. To what extent do students choose courses based on their expected postsecondary destination? What other factors are involved?
4. To what extent is any of the guidance for course selection supported by empirical data of any kind?
5. How well do you feel you are informed about careers that colleges prepare their grads for?
6. What additional information do guidance teachers need in order to be able to assist students headed for college programs
7. What recommendations would we like to make based on the results of this study?

Questions for Mathematics Teacher Group

1. Which outcomes from the study have the greatest impact for you? Why?
2. What are the implications of the CMP results for the college mathematics curriculum content in:
    a. applied arts programs
    b. business programs
    c. general programs
    d. technology programs?
3. What are the implications of the CMP results for the design of an assessment tool? Assessment for placement? (i.e., What is the key content? What are the key processes?)
4. What is the evidence that placement testing and preparatory courses in mathematics are beneficial?
5. What strategies/initiatives can help students be better prepared for college mathematics?

6. What modifications to content and pedagogy could help smooth transitions between secondary school and college?
7. Are there strategies that could be put into place between secondary schools and colleges that could provide a seamless transition for students as proposed by the study? What would these look like? How can these strategies be implemented? Measured?
8. What recommendations would we like to make based on the results of this study?

Questions for Student Success Leaders Group

1. What do we mean by “at-risk” in the context of this study?
    a. for secondary students:
    b. for college students:
2. What is the profile of a college bound student? What should it be?
3. What do the CMP results (to date) mean for students who are entering college programs?
4. Which college strategies have been shown to be most successful at increasing student success in mathematics? How should these be measured?
5. Specifically, what are the costs and benefits of placement tests and mandatory preparatory math courses?
6. What recommendations would we like to make based on the results of this study?

Questions for Province, Boards, and Colleges Group

1. What are the advantages/disadvantages of having a wide diversity across the colleges in the following areas:
    a. Admissions policies
    b. Placement testing (in mathematics)
    c. Preparatory courses (in mathematics)
    d. Grading policies
    e. Content and structure of first-semester mathematics courses
    f. Support systems for at-risk students
2. This is the first time that CMP has been able to provide systematic feedback to secondary schools concerning the success of their graduates in postsecondary education. How helpful will this be to schools and to what extent should it be expanded?
3. What responsibilities, if any, do the Ministries of Education, and Training Colleges and Universities have to increase student success at college?
4. In what areas are inter-college or inter-school board comparisons (a) helpful and (b) counter-productive? How do these answers differ if the comparisons are also made public?
5. What information arising from this study do students and their parents most need to have access to?
6. What are the lessons you take back from this Forum to your own institution?

7. What recommendations would we like to make based on the results of this study?

Deliberation Group Recommendations

Following the group discussions, each group gave a report of their discussion and recommendations at a plenary session. The recommendations have been combined, edited, and regrouped into three categories:

- Recommendations oriented towards colleges
- Recommendations oriented towards schools
- Recommendations oriented towards both colleges and schools

Readers should understand that the recommendations set out here are those emerging from the group discussions and do not necessarily reflect the views of the CMP team or the Steering Committee

Recommendations Oriented Towards Colleges

1. More use should be made of the following proven strategies for increasing student success in mathematics:
   a. Make use of Learning Strategists;
   b. Employee learning skills assistants (upper year students);
   c. Ensure support placement early in semester;
   d. Have shorter more frequent classes (3 one-hour blocks);
   e. Integrate math into real-life situations;
   f. Give students tools to self-identify risk, take responsibility (i.e., attend to the affective domain);
   g. Give students regular feedback;
   h. Credit recovery.
2. The process of evaluating mathematics curricula should be continued.
3. Technology should be integrated more into college mathematics courses.
4. College faculty should examine their pedagogical practices, particularly in relation to the amount of time students need to learn, and integrate co-operative learning strategies. .
5. Colleges should investigate the feasibility of adopting a common grading policy.
6. Colleges should investigate the issues surrounding the use of admission/placements tests including the potential of using a common mathematics placement test

Recommendations Oriented towards Secondary Schools

1. Secondary schools should place equal value on college oriented and university oriented courses, should eliminate roadblocks to offering classes with lower enrolment, and should offer the MCT4C (Mathematics for College Technology) course.

2. Secondary schools should be aware of data relating course pathways to student success and should recommend appropriate pathways to students.
3. Secondary schools should promote colleges (to both students and parents) as great destinations, encourage prospective students and their parents to visit college campuses, use co-op programs to assist students in selecting college programs, and dispel myths about how colleges treat their students.
4. Secondary schools should investigate the origins of the lack of student success in grade 11 math.
5. Secondary schools should use a program-specific instrument to indicate the level of student preparation for college.
6. Pre-service teacher education programs should include exposure to the college system through a practicum placement for secondary teachers.
7. School mathematics courses should be made more relevant to college programs.

Recommendations Oriented towards both Colleges and Secondary Schools

1. College and secondary school mathematics teachers should take part in regular dialogue, in job shadowing of each other, and through developing effective links between professional associations.
2. Colleges and schools need to increase communication, both formal and informal, among teachers, students, parents, and administrators.
3. Information about colleges needs to be made available at the Grade 6-8 level.
4. Feedback to secondary schools about the success of their graduates at college (as in CMP) is helpful and should be continued.
5. The “continuum of learning” should be extended to postsecondary programs including apprenticeships.
6. Collaboration between secondary schools and colleges through dual credits, “take our kids to college” days, and other joint ventures should be expanded.
7. College mathematics teachers should assist secondary school mathematics teachers with the creation of questions, problems or activities that relate to particular careers.

Chapter 5: Conclusions

CMP examined the interface between the secondary and college panels in Ontario. It investigated the achievement results of over 10,000 students in six Ontario colleges, collected information on college policies, and brought stakeholders together to discuss results and make recommendations.

We summarize here the major results of the study and our suggestions for addressing the issues raised.

Results of CMP 2007

Our main finding is that achievement of students in college mathematics courses is unacceptably low. We found that in fall term 2006 in the six participating colleges:

- On average, we would classify one-third of all students as at risk of not completing their programs as a result of their achievement in first-semester mathematics.
- In colleges where they were available, preparatory mathematics courses were taken by over 30% of all incoming students.
- Recent graduates from Ontario schools formed 70% of all first-semester students but occupied 80% of the places in preparatory (remedial) mathematics courses.
- In college-level courses, only 63% of recent Ontario graduates achieved good grades compared with 75% of older students or those from outside Ontario.

If these results are extrapolated to the rest of Ontario, as many as 3,000 of 9,000 students enrolled in Technology programs and 4,000 students out of 12,000 in Business programs could fail to graduate from college. This represents a loss not only to the students themselves but also to the economy, the college system and the taxpayer.

We identified a number of possible causes for the poor results. A key factor is that many students fail to select appropriate courses in secondary school to prepare them for college programs. This is particularly true in the area of Technology, where only 6.5% of recent Ontario graduates had taken the course designed by the Ministry of Education as preparation for college technology (MCT4C).

We also noted that there is a clear relationship between achievement in secondary school mathematics and college-level mathematics, but an inverse relationship between participation and achievement in secondary school courses (for college-oriented students). In other words, many students take lower level courses in school but do less well in college, while fewer students take more challenging courses in school but these students achieve greater success in college.

CMP can now track the achievement of individual colleges as well as graduates of participating school boards *and* schools through a new database created for the study. While simplistic comparisons based on one year's data are not helpful, these analyses will provide useful indicators over time for the institutions.

Looking Forward

One fundamental operating principle of CMP is to seek solutions to the problems that it documents rather than apportion blame for them. Another is that both the problems and solutions are shared by all members of the community -- colleges, schools, government, students, their parents and the public. With these principles in mind, the CMP, with its participating colleges and schools, are united in drawing the following conclusions:

- That students' achievement in first-semester mathematics in Ontario colleges needs to be significantly improved;

- That the achievement of this goal requires concrete action by all stakeholders, including students and parents, schools and teachers, colleges and faculty, and the Government of Ontario.

To this end, the CMP offers the following recommendations for action, based on those resulting from the CMP Forum.

Students and Parents

***Recommendation 1**. Students should select secondary school courses that are most appropriate to their desired postsecondary goals rather than those in which they expect to obtain high marks.*

Participants at the CMP forum commented that many students would often take a less challenging course in mathematics, in the hope of obtaining high marks, rather than a more challenging one, which would be a better preparation for their intended postsecondary destination. While this strategy might serve the short term goal of graduation from secondary school, CMP data shows that it can have serious consequences at the next stage.

***Recommendation 2**. Students and parents should seek information about colleges, their programs, the occupations they prepare students for, and the mathematics courses recommended, early in a student's secondary school career.*

Even 40 years after Ontario's system of Colleges of Applied Arts & Technology was established, Forum participants commented on the large amount of misinformation and prejudice about colleges that still exists. Grade 8 is not too early to begin to acquaint students with colleges and the opportunities that exist for them there. Colleges Ontario should consider how it can best assist in this regard.

Colleges and College Faculty

Recommendation 3. *Colleges and college faculty should strengthen their commitment to student retention and success by becoming better informed about policies and practices aimed at student success that have been found effective by other colleges and by secondary schools.*

The CMP Forum heard from all of its participant colleges and from several district school boards about actions being taken to improve student success but also learned that there are few channels for this information to be shared on a regular basis. Students who fail in first semester are less likely to persist to graduation, while assuring their success benefits the student, the college, and society.

Recommendation 4. *Colleges should collaborate to design a common and appropriate mathematics assessment tool, based on systematic analysis of the new secondary school courses and first-semester college courses, to enable early diagnosis and appropriate remediation of students' mathematics skills.*

The experience of colleges with systematic testing and support systems shows clearly that such systems are needed. But it is not necessary for every college to "reinvent the wheel" in this area. A high quality mathematics assessment tool would not only serve the entire college system well; it would also provide a clearer message to schools concerning college expectations in mathematics.

Schools and Teachers (both Mathematics and Guidance teachers)

Recommendation 5. *Secondary schools (and all teachers and administrators) should place equal value on colleges as postsecondary destinations for their students as they do on universities, and should demonstrate this attitude by ensuring:*

- *that all college-preparation courses are available to students,*
- *that students are advised appropriately with respect to course selection,*
- *that students receive opportunities to visit colleges and to receive information from school graduates now at college, and*
- *that teachers are encouraged to make personal contact with college faculty for professional dialogue and the development of cooperation between levels.*

Most secondary school teachers have not attended college courses. It is necessary, therefore, that they take special care not to treat colleges as "second-class institutions", or students who go to college as "second-class students."

Recommendation 6*. Schools and school boards should be aware of the data relating course pathways and school and school board identity with student success at college (such as provided by CMP) and use it as the basis for monitoring the success of their graduates.*

School boards and schools have many sources of data through which to measure the quality of the educational experiences they provide. CMP is pleased to be able to add one more and hopes that it will prove useful in helping schools improve their records over time.

Government of Ontario

Recommendation 7. *The Government of Ontario should broaden its concept of student success to encompass a "K-16" perspective and, as a first step, establish a working group including Ministry of Education and Ministry of Training, Colleges and Universities officials, in cooperation with representatives of colleges, universities and school boards, to consider possible actions to promote student success through primary, secondary and postsecondary education (including apprenticeship programs).*

In recognition of the importance to both social and economic development, many states in the USA have now established K-16 projects and it is time that Ontario considered doing the same.[24] Such an initiative could reassure Ontarians that continued success of its students is indeed a Provincial priority. The practical focus of the working group would complement the research focus of the newly established Higher Education Quality Council of Ontario.

Recommendation 8. *The Government of Ontario should continue to encourage research on the secondary-postsecondary interface, such as the College Mathematics Project, in order to monitor student success and also to build up long-term data on the impacts of new policies and programs.*

Research projects that focus on the secondary-postsecondary education interface are difficult to conduct as no regular funding sources exist with such projects in mind. The CMP is the first in Ontario to provide systematic feedback to individual secondary schools about the success of their graduates and such feedback is valued. Such research can assist government also; if funded in future years, CMP looks forward to being able to measure the impacts of the new mathematics courses and pathways in the 2007 curriculum.

---

[24] See: Michael Kirst and Andrea Venezia (2001) Bridging the Great Divide Between Secondary Schools and Postsecondary Education, *Phi Delta Kappan,* 83, 92–97.

A Final Word

These are not complex suggestions. They are not difficult to understand. They propose no expensive new government programs, structures or bureaucracies. Their total cost, even if fully implemented, is very small indeed, especially in comparison with the cost of student failure. However, most of them call for significant change in public and professional attitudes; that is not easy but the CMP believes we must face the task. The suggestions should be implemented now if Ontario is to increase its competitiveness and prosperity and if many of its citizens are to reach their full potential.

Appendices

Appendix A - College Mathematics Project Partners

Project Lead
Seneca College (http://www.senecac.on.ca) through the York/Seneca Institute for Mathematics, Science and Technology Education (http://www.ysimste.ca)

Funding
School/College/Work Initiative - http://www.gotocollege.ca
Connecting GTA Teachers Regional Planning Team - http://cgtat.org

Project Partners - Colleges
Centennial College – http://www.centennialcollege.ca
George Brown College – http://www.georgebrown.ca
Georgian College – http://www.georgianc.on.ca
Humber Institute of Technology & Advanced Learning – http://www.humber.ca
Seneca College – http://www.senecac.on.ca
Sheridan Institute of Technology & Advanced Learning – http://sheridaninstitute.ca

Project Partners – Boards
Toronto District School Board – http://www.tdsb.on.ca
Toronto Catholic District School Board – http://www.tcdsb.org
York Region District School Board – http://www.yrdsb.edu.on.ca
York Catholic District School Board – http://www.ycdsb.ca
Peel District School Board – http://www.peel.edu.on.ca
Dufferin-Peel Catholic District School Board – http://www.dpcdsb.org
Halton District School Board – http://www.haltondsb.on.ca
Halton Catholic District School Board – http://www.haltonrc.edu.on.ca
Simcoe County District School Board – http://www.scdsb.on.ca
Simcoe-Muskoka Catholic District School Board – http://www.smcdsb.on.ca

Project Partners – Government and other
Ministry of Education – http://www.edu.gov.on.ca
Ministry of Training, Colleges and Universities – http://www.edu.gov.on.ca
Colleges Ontario – http://www.collegesontario.org
Ontario Colleges Heads of Mathematics Coordinating Group
Ontario College Mathematics Association (OCMA) - http://math.mohawkcollege.ca/ocma/ocma.html

Appendix B - CMP Policy on Reporting of Confidential Data

A. Student Data

It is a fundamental principle of the College Mathematics Project that confidentiality of students' data must be strictly maintained.

Accordingly, student data sent from any College to the CMP Data Analysis Centre at Seneca College is stripped of all student identifiers and a new student ID code number substituted, according to the protocol to be prepared by the CMP Technical Committee. Thus it should be impossible to identify any student personally.

B. College Data

Some of the data being supplied by each College to the College Mathematics project is normally considered to be confidential to each College (e.g. pass rates in specific programs). There is therefore a need to respect such College confidentiality in the ways in which CMP data and analyses are presented, both publicly and to the CMP participating Colleges.

Data will be aggregated and analysed by College and Program and reported as follows. Public documents and documents reporting to the Steering Committee will contain data aggregated across all six colleges. No College will be identified specifically. In addition, analyses reported to each College will include that College's data together with the aggregated data. In other words, Colleges will get to see their own data and the aggregate data but not that of other Colleges.

Some comparative analyses that specifically require individual College data to be displayed will have College identifiers removed.

This policy may be suspended for specific purposes by consent of College representatives on the Steering Committee.

C. School Data

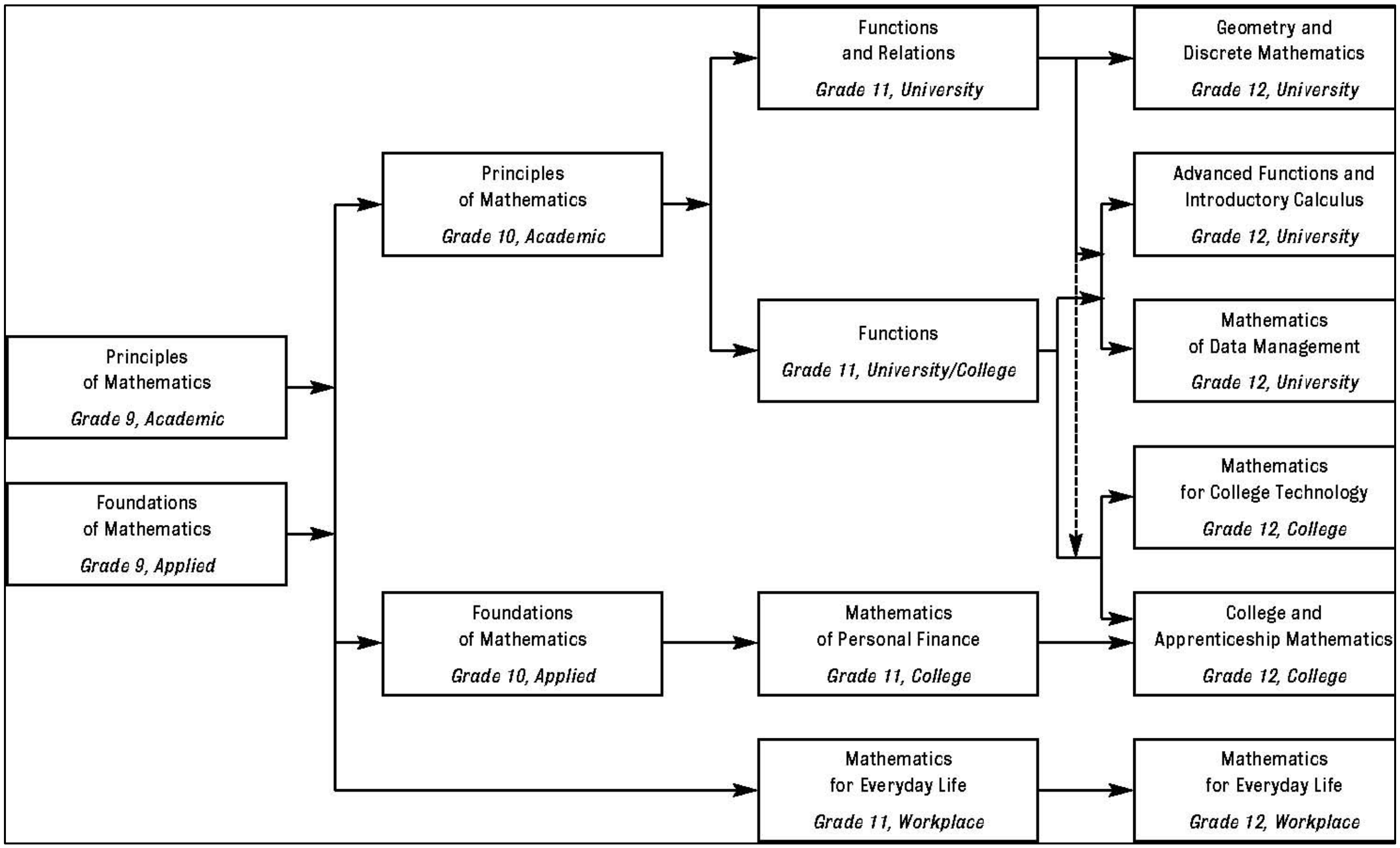
While school and board identifiers are present on extracts from student admission files, these will not be published in the analysis of board and school data. In addition, data such as total numbers of students will be removed as to ensure that a board cannot be identified specifically. Analyses reported to each school board will include that board's (including specific school data) together with the aggregated data. In other words, boards will get to see their own data (including school identification) and the aggregate data but not that of other boards.

D. Reporting to Government, Agencies, Media

Dissemination of information is essential to the attainment of the long term goals of CMP and to meet funding requirements. To this end, the CMP project team will prepare reports, research briefs and presentations. The identities of individual colleges, boards and schools will be protected; names/existing identifiers and be replaced with a code and total numbers removed in order to ensure that no college, board or school can be specifically identified.

Appendix C - Prerequisite Chart for Mathematics, Grades 9–12, Ontario Mathematics Curriculum, 2000

This chart maps out all the courses in the discipline and shows the links between courses and the possible prerequisites for them. It does not attempt to depict all possible movements from course to course.



Note: The dotted line indicates that the Grade 11 university preparation course Functions and Relations may also serve as a prerequisite for the Grade 12 college preparation courses.