York - Seneca Institute for Mathematics, Science and Technology Education

COLLEGE MATHEMATICS PROJECT 2009

FINAL REPORT

For the

Ontario Ministry of Education

and the

Ontario Ministry of Training, Colleges and Universities

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Preface

In publishing this report, the College Mathematics Project (CMP) project team wishes to acknowledge several individuals and groups; without whom the project could not have been undertaken. First, we have been grateful to the Ministry of Education and the Ministry of Training, Colleges and Universities, not only for funding the project but also for their ongoing support and constructive advice throughout the year.

Second, the CMP Steering Committee and the college Vice-Presidents, Academic and their appointed CMP College Leads have worked hard to ensure that CMP had the data with which to conduct its research and we appreciate this enormously.

The School/College/Work Initiative has been an important partner at each stage but particularly in the organisation of the forums where its Regional Planning Teams played a key role.

The CMP has been conducted by researchers from the York/Seneca Institute for Mathematics, Science and Technology Education (YSIMSTE), whose co-Director at York University is Professor Margaret Sinclair. She has been involved with CMP since the outset and her critical advice and careful reading of the report has been invaluable.

Finally, the support of Seneca College's Academic Computing Services (ACS) department; especially John Meskes, Mehrdad Ziaei and Mohsen Rezayatmand; have provided the unseen work without which the CMP research could not have been conducted nor its results displayed.

Le present document est également disponible en français au site http://collegemathproject.senecac.on.ca.

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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.

Funded by the Ministry of Education and the Ministry of Training, Colleges and Universities, and led by a team of researchers from the York-Seneca Institute for Mathematics, Science and Technology Education (YSIMSTE) based at Seneca College, CMP 2009 included all 24 colleges and 72 district school boards in all regions of the province.

The CMP employs the overall methodology of deliberative inquiry, in which research into the current situation is linked to deliberations among stakeholders over appropriate courses of future action. The CMP 2009 research analysed the secondary school and college records of almost 80,000 students who enrolled in all college program areas in fall 2008. Of these, over 30,000 took a first-semester mathematics course and the research focused on their achievement in these courses, relating this to a variety of factors, including the choice of mathematics courses taken at secondary school.

Highlights of the research include the following:

- 67% of students achieved "good grades" (A, B or C) in first-semester mathematics in college, while 33% received grades of D or F or withdrew from the course, placing them at risk of not completing their chosen program. This represents a small improvement over last year's results.
- Recent Ontario graduates (students under the age of 23 on December 31, 2008 *and* who graduated from an Ontario secondary school) formed 69% of first-semester mathematics students.
- 65% of recent Ontario graduates (ROGs) achieved good grades, compared with 72% of older students or those from outside Ontario.
- While males outnumber females in first-semester mathematics by almost 2:1, females out-perform males in all age groups.
- The proportion of students attaining good grades rises sharply with age, with 79% of males in their 30s and 87% of females in the 40s obtaining good grades.

- Choices of school mathematics courses and achievement in the chosen courses have a major impact on first-semester college achievement. For example:
    - The proportion of students taking MCT4C has increased significantly over last year, particularly among those students who had taken the revised mathematics curriculum.
    - Achievement levels of those who have taken both MAP4C and MCT4C have also improved, relative to last year.
    - Students with high marks in MAP4C also tend to be successful in college; 78% of those scoring over 80% in MAP4C obtained good grades in college.
    - Choice of course in Grade 11 is also very important; the most commonly taken sequence (MBF3C + MAP4C) led to 55% good grades in college, compared with the less commonly taken sequence (MCF3M+MCT4C) which led to 70% good grades.
    - The recently revised curriculum opened up a pathway from Grade 10 Applied Mathematics (MFM2P) to MCF3M; 289 students followed this path (compared with none last year) and 66% of them obtained good grades in college.
- The CMP research database is now accessible to approved users at colleges and school boards. This provides systematic feedback to all school boards and secondary schools about the success of their graduates in first-semester college mathematics.

Following completion of the research, the CMP held nine deliberative forums in all parts of the province, in which representatives of participating colleges and school boards, along with provincial organizations, received reports of the CMP research and listened to panels of students describing their own mathematics experiences at school and college. They also discussed ways of improving student achievement, and examined a range of initiatives that had been implemented by the institutions.

From these deliberations, the CMP team concludes that there is a consensus that both schools and colleges are actively seeking ways to increase student success and that there is a continuing interest in sharing both research and experiences in this area. The annual report of CMP 2009 concludes with a discussion of four themes that emerged from these deliberative forums:

- School Mathematics and Real World Mathematics
  Most students learn best when mathematics is embedded in the context of a practical field of interest to them. CMP is encouraging school and college teachers to work together to strengthen the range of available examples, faculties of education to support greater understanding of colleges and college programs through their I/S teacher education programs and the development of authentic Contextualised Learning Activities related to sector specific college programs.

- Focus on Foundations
  Many of the students who are identified by CMP as being "at risk" have inadequate understanding of concepts they were first taught in elementary school – key concepts such as fractions, ratio and proportion, and percentages, among others. CMP is encouraging students and parents, and elementary and secondary teachers to recognize the importance of these topics and to revisit them as necessary throughout a student's education to ensure that they are mastered before students reach the postsecondary level.

- Learning Skills Revisited
  The report of CMP 2008 raised awareness of the importance of "Learning Skills" – self-discipline, time management, study skills, independent learning, among others – to success at the college level. This report reiterates this importance and encourages teachers at all levels to integrate these skills into their courses; it also suggests that the Ministry of Education, colleges and schools act to ensure that students and parents are aware of their importance to student success and career development.

- Learning: K to Career
  Concerns raised at CMP forums in the past concerning the complexity of admissions to postsecondary institutions and the difficulties this causes for schools and students were repeated often at this year's forums. CMP has come to recognize that decisions by individual colleges concerning admissions policies, decisions by the Ministry of Education about which courses should make up the overall school curriculum, decisions by individual schools on which of these courses to offer, and decisions by individual students on which courses to take in preparation for college are all inter-related. Yet there is no forum where all these issues can be discussed with a view to making the transition from secondary school as seamless and successful as possible for all students. CMP is therefore recommending the creation of a Provincial Roundtable on Secondary/Postsecondary Transitions with broad representation and a mandate to deliberate and recommend policy changes aimed at ensuring that adequate numbers of appropriately prepared students transition successfully from secondary schools to postsecondary institutions.

Chapter 1: Why is the College Mathematics Project important?

The most recent annual report of Ontario's Task Force on Competitiveness, Productivity and Economic Progress underlines the critical place of postsecondary education in the future of Ontario. Its authors write: "The education of the workforce is … a fundamental driver of economic growth.[1]" As Ontario emerges from the most challenging economic times in recent history, therefore, it is critical that our education systems – elementary, secondary, and postsecondary – be at their most efficient and effective. Throughout the developed and developing world, increasing the proportion of young people receiving postsecondary education and training is recognized as the most important key to our economic future.

This is important not only for the overall future prosperity of the province but also for the personal wellbeing of its individual citizens. A recent federal government labour market outlook concluded that: "Over the next 10 years, more than two thirds of the 1.7 million new non-student jobs created (69.2%) are expected to be in occupations usually requiring postsecondary education (university or college) or in management. In 2005, approximately 60% of all non-student workers had jobs in these categories.[2]" Fully one-third of this growth, the largest share of any sector, is expected to be in occupations requiring college-level education and training. The smooth and successful movement of students from secondary school to college is therefore important for their ultimate transition into a workforce requiring increasingly high levels of knowledge and skill.

From an academic preparation perspective, Mathematics and Language (English and/or French) are usually recognized as the most critical foundations for many of these high-skill occupations and for the training programs that lead to them. Certainly, courses in these subjects form part of the first semester curriculum of the vast majority of programs at Ontario Colleges of Applied Arts and Technology. The College Mathematics Project (CMP) has found in the past that as many as one-third of all students taking mathematics in the first semester of a college program are failing or barely passing[3]. This places them at risk of not completing their chosen program; it reduces the overall effectiveness of the college (at least as measured by program completion rate); it reduces the impact of taxpayers' investment in education; and it reduces the potential

[1] Task Force on Competitiveness, Productivity, and Economic Progress. *Navigating through the recovery*. Eighth annual report (Toronto: Institute for Competitiveness and Prosperity, 2009), p. 40.
[2] Mario Lapointe et al. *Looking Ahead: A 10-year Outlook for the Canadian Labour Market (2006-2015)*. (Ottawa: Human Resources and Social Development Canada (HRSDC), 2006), p. 41.
[3] Laurel Schollen *et al*. *College Mathematics Project 2007: Final Report* (Toronto: Seneca College, 2008) and *College Mathematics Project 2008: Final Report* (Toronto: Seneca College, 2009). These reports can be downloaded from the CMP website: http://collegemathproject.senecac.on.ca

contribution of these students to economic growth. Poor levels of achievement in mathematics therefore have negative consequences not only for students, but also for colleges, taxpayers, and the Ontario economy.

The College Mathematics Project (CMP) was initiated at Seneca College in 2005 because of increasing awareness within the colleges of this problem. Following two pilot projects in which methods of data collection and analysis were developed and refined, the first full-scale CMP was mounted in 2007 involving 20,000 students at 6 colleges in the Greater Toronto Area.[4] In 2008, the project expanded, this time to include 50,000 students at 11 colleges in four regions of the province[5]. Now in 2009, CMP has achieved full coverage of the province with the participation of nearly 80,000 students at all 24 colleges and 72 district school boards.

CMP Goals and Methodology

The goals of the College Mathematics Project are unchanged from previous years:

- 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 for the CMP is called "Deliberative Inquiry". It is a cyclical methodology (see Figure 1) designed for integrating research with deliberations about future courses of action. The questions for inquiry (2) are derived from deliberations about the problems of practice (1) and deliberations are based on questions (5) emerging from the research. The cycle of inquiry and deliberation continues, drawing ideas from existing theory (3), generating recommendations for practice (6), and contributing further ideas to theory (4). In the case of the CMP, each year the project continues, new suggestions for research emerge from the previous year's deliberations and from new theoretical perspectives. At the same time, the recommendations from one year contribute to changes of practice in the next. Research enables practice to evaluate the efficacy of interventions so that progress can be measured year over year. And so the cycle continues.

[4] CMP 2007 and the second pilot study were supported by the Connecting GTA Teachers regional planning team of the School/College/Work Initiative.

[5] CMP 2008 included Algonquin, Centennial, Confederation, Durham, George Brown, Georgian, Humber, Mohawk, Niagara, Seneca and Sheridan colleges. Since 2008, CMP has been supported financially by the Ministry of Education and the Ministry of Training, Colleges and Universities.

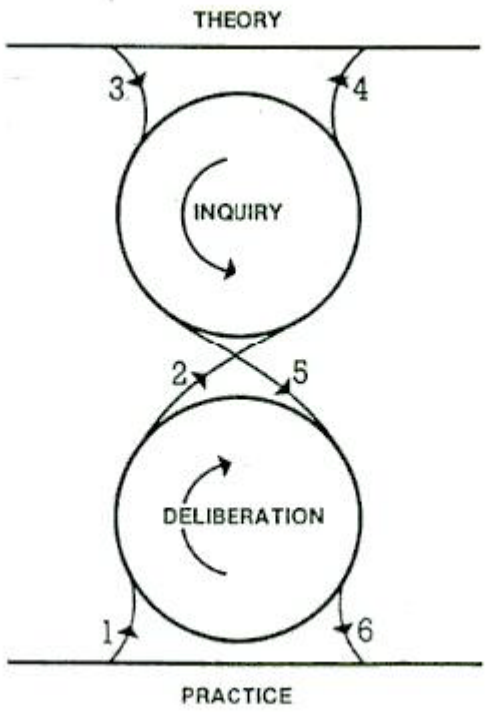


Figure 1. **Deliberative Inquiry - the CMP Methodology**

The CMP is directed by a steering committee comprised of representatives of the supporting Ministries, and provincial organizations related to colleges and secondary schools[6]. This committee met three times during 2009 and once in early 2010: its first meeting in March approved the research questions for the CMP to address during 2009; the second (in June) planned the deliberative forums to take place in the Fall; the third meeting (in September) reviewed the preliminary results of the CMP research prior to their being sent to Forum participants; and the final meeting (in January 2010) reviewed this report and set research plans for CMP 2010.

Researchers from the York/Seneca Institute for Mathematics, Science, and Technology Education (YSIMSTE) based at Seneca College conduct the CMP research, supported by technical staff of Seneca College's Academic Computing Services department. Following data collection and analysis in 2009, nine regional forums were held at which over 500 individuals from colleges and school boards participated. Forum participants discussed the implications of the CMP research, shared "promising practices", and listened to students' perspectives on the

[6] The members of the CMP Steering Committee along with the "CMP leads" from each College are listed on the project's web site (http://collegemathproject.senecac.on.ca). The CMP project team acknowledges with thanks the contributions of all members of this committee.

issues raised. They then spent time in deliberating how to improve student success in mathematics. This report is the culmination of that process.

Data Collection and Analysis

All data used in the CMP is obtained from participating colleges. The principal data sources include students' secondary school transcripts as provided to colleges from the Ontario College Application Service (OCAS) and students' first semester grades in mathematics courses. These files are combined and student identifiers are then removed in order to ensure student anonymity[7]. Finally, the data is validated by each college prior to its being mounted on a web-based database, from which more specific analyses can be made. Data reports are presented in a manner and sequence consistent with the CMP research questions.

CMP 2009 Research Questions

The research questions addressed by the CMP this year addressed and further developed the same four areas of interest used in CMP 2008 – information about the participants, distribution of grades in first semester college math, the relationship between college achievement and secondary school mathematics background, and the relationship between students' first semester math achievement and the school boards (and secondary schools) from which they came. The questions, which relate to students taking first semester college mathematics in Fall 2008, were:

A. *PARTICIPATION*

A1. What are the numbers of students in our sample, by college, gender, and program cluster?

A2. What are the numbers of students under the age of 23 (December 31, 2008) and who are graduates of Ontario secondary schools (Recent Ontario Graduates -ROGs) by college, gender, and program cluster? – also broken down by one-year age groups?

A3. What are the numbers of students with a Grade 12 mathematics course taken in fall semester 2007 or later, by college, gender and program cluster (Very Recent Ontario Graduates -VROGs)?

A4. What are the numbers of students (ROGs, non-ROGS and VROGs) enrolled in all math courses, in college-level math courses, and in preparatory math courses, by college, gender and program cluster?

[7] CMP has a policy on data confidentiality available on its web site (http://collegemathproject.senecac.on.ca) and the research methodology has been given ethics reviews by participating colleges.

B. COLLEGE MATH ACHIEVEMENT

Note 1: This applies to students taking mathematics courses only (as shown in A4)

B1. What is the mathematics grade distribution for ROGs, non-ROGs and VROGs, by college, gender, and program cluster? (ROGs also broken down by age as in A2).

B2. What are the % of students achieving a "good passing grade" (A, B, C, P) and "at risk" (D, F, W) for ROGs, non-ROGs and VROGs by college, gender, and program cluster?

B3. How do students' college English (or French) marks compare with their college mathematics marks?

C. SECONDARY SCHOOL MATHEMATICS BACKGROUNDS

Note 1: This applies to ROGs and VROGs only (as shown in A3)

C1. What are the numbers of both ROGs and VROGs taking each secondary school mathematics pathway and what % of those taking each pathway achieve good grades or are at risk in college?

C2. For both ROGs and VROGs following a pathway culminating in MCT4C, MAP4C, or a 12U course, how do students' Grade 12 math marks compare with their college math marks?

C3. What is the profile (gender, college, program cluster) of students following selected pathways?

D. COLLEGE ACHIEVEMENTS BY SCHOOL BOARD AND SCHOOL

Note 1: This applies to ROGs and VROGs only (as shown in A3)

D1. What are the % of students with a "good passing grade" (A, B, C, P) and "at risk" (D, F and W) from each district school board? – also broken down by secondary school?

D2. What are the % of students enrolled in college-level courses and preparatory courses from each district school board?

D3. Which secondary schools in Ontario offered MCT4C during 2007-08 and were college mathematics achievement levels of graduates of those schools significantly different from graduates of other schools?

College Programs and Policies

As in past years, the CMP has reviewed all college programs as part of its data collection process. The project includes all full time Ontario College Certificate, Ontario College Diploma and Ontario College Advanced Diploma programs. In 2006/07 these programs represented more than 90% of the system registrants[8]. College bachelor degree, apprenticeship, and graduate certificate programs are excluded from the study. Once the list of programs from each college is collected, they are classified according to the program cluster system used in previous iterations of the project.

Table 1.

CMP System of Program Clusters

Major Cluster	Sub-clusters	Sample Program
Applied Arts (AA)	Applied Arts	Broadcasting-Radio
	Human Services	Early Childhood Education
	Health Services	Practical Nursing
	Hospitality & Tourism	Hotel and Restaurant Management
Business (B)	Accounting & Finance	Business –Accounting
	Business Administration & Management	Business – Human Resources
	Office Administration	Office Administration - Legal
General (G)	General Arts & Science	General Arts & Science
	Pre-Health	Pre-Health Science
	Pre-Technology	Technology Foundations
Technology (T)	Applied Science	Chemical Laboratory Technology
	Computer	Computer Engineering Technician
	Construction	Civil Engineering Technology
	Electrical	Electronics Engineering Technician
	Mechanical	Mechanical Engineering Technology - Automation

In addition, the CMP analyses the grading policies of all colleges and aligns them using a simplified CMP grading system developed in the pilot studies several years ago. Finally, the CMP obtains detailed information about the first semester mathematics courses required in each college program, both regular college-level and preparatory (remedial) courses (where these are offered). These three aspects of the CMP research program are all essential pre-requisites to the analysis of student data on mathematics achievement that is the CMP main focus. We have described these aspects in detail in past CMP reports and therefore they are summarized briefly here.

[8] King, A.J.C. et al. *"Who Doesn't Go to Post-Secondary Education?"- Final Report of Findings*, Colleges Ontario, 2009.

Program Clusters

The CMP uses Ministry of Training, Colleges and Universities (MTCU) program codes to cluster all programs into four major clusters, each of which is subdivided into sub-clusters, as shown in Table 1. This clustering ensures comparability of the aggregate analysis across colleges and also affords researchers opportunities to "drill down" further into the data to investigate achievement at the sub-cluster and program level. The results of classifying all of the college programs according to these clusters and sub-clusters are shown on the CMP web site[9].

Table 2.

CMP Grading System

Good Grades		
	A (includes A+ and A-)	80% - 100%
	B (includes B+ and B-)	70% - 79%
	C (includes C+ and C-)	60% - 69%
	P (used for courses with Pass/Fail grades)	
At Risk		
	D (includes D+ and D-)	50% - 59%
	F	under 50%
	W	withdrawal

Grading Policies

We have noted in earlier reports that, since all colleges have their own grading systems, the College Mathematics Project has developed – for the purposes of aggregating achievement data across multiple colleges – its own simplified system of grades, to which grades from all college data sets are transformed. The final report of the CMP 2007 study contained a full discussion of this issue[10] and this is not repeated here. The CMP grading system is shown in Table 2 and the detailed comparison of this system with that of each participating college is also available on the CMP web site. In addition, CMP has found from earlier studies that a D grade in first semester mathematics is often followed by a student dropping out or changing programs. We therefore classify D grades along with F and W as evidence that students are "at risk" of not completing their chosen program.

[9] Program cluster and college grading policy information is available for review at the CMP website: http://collegemathproject.senecac.on.ca/cmp/links.php

[10] Laurel Schollen et al. *College Mathematics Project 2007: Final Report*. (Toronto: Seneca College of Applied Arts & Technology, 2008), pp 10-13.

College Mathematics Courses

The programs selected for detailed study in the CMP all have mathematics scheduled in the first semester of the college curriculum[11]. In the following discussion college-level refers to courses that are part of the regular curriculum, and preparatory or remedial refers to courses that may be offered by colleges to prepare students for college-level courses. College mathematics courses themselves vary both across colleges and across programs within a college. Some aspects of this variety were the subject of detailed CMP study in 2006 and 2007 but with the overall growth of the CMP this aspect of the research has had to be curtailed.

In some colleges, preparatory or remedial mathematics courses are available and some students – usually after undergoing a placement test or other form of assessment – are advised (or required) to take such a course prior to entering the mathematics course that is part of the regular curriculum for their program. In the past (in CMP 2007 and CMP 2008), we have reported on the enrolment and achievement in such preparatory courses in the final report of the project. This year we have data from all 24 colleges and are in a better position to assess this approach.

Our current database shows that a total of 3,234 students (just over 10% of the total first-semester mathematics enrolment) are enrolled in preparatory at 8 of the 24 colleges. Since 6 of these 8 colleges and over 98% of the enrolment are located in the Greater Toronto Area (GTA) this suggests that while these data were significant in CMP 2007 (in which 6 GTA colleges participated), they are not as significant on a province-wide basis.

Moreover, in the light of the nine forums held around the province (reported in more detail in chapter 3), the operation of preparatory mathematics courses can be seen as simply one strategy designed to promote student success and retention. As the promising practices presentations at the forums showed, colleges employ a wide variety of strategies including remedial modules, peer tutoring, additional tutorial classes, and many others. In particular, there appears to be an increased use of one-year (two semester) Ontario College Certificate foundation or fundamentals programs (such as pre-health, pre-technology etc.) for students whose academic background appears to be insufficient for entry to their desired college program or who wish to determine their suitability for a particular field. For example, of the six Business Foundations and Fundamentals programs offered, two were approved to start in 2007, two in fall 2008, and one in fall 2009. Nineteen of the colleges offer a pre-health type of program and 11 offer pre-technology programs. These programs are classified within the CMP

[11] In a few colleges, some programs have the first mathematics course scheduled in the second semester curriculum. However, since the CMP only collects data following first semester, we are unable to include these programs in our analyses.

"General" program cluster and their mathematics courses would be classified as "regular college-level courses" within those programs. The "General" cluster also contains "laddered" certificates and general arts and science and liberal arts diploma programs.

It would therefore seem to be misleading to continue to highlight enrolments and achievement in preparatory mathematics courses when the use of such courses is not as widespread as was first thought. We have therefore dropped this element of the CMP Final Report, although the data remains in the CMP database for the benefit of colleges using this strategy. A more comprehensive picture of the developmental or remedial strategies employed by colleges across the province would be an important topic for future research and deliberation, both for the colleges using them and for the school boards whose graduates appear to require them.

College Admission Policies

The CMP has reported on college admission policies in previous studies; readers are encouraged to refer to the CMP 2008 report which provides a thorough treatment of the subject. As noted in our 2008 report, all colleges' admissions policies must comply with the *Binding Policy Directive Concerning Admissions*[12] of the Ministry of Training, Colleges and Universities which provides a clear and consistent method that colleges must use when considering applicants to all college programs.

The basic requirement for consideration 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 a requirement for Grade 12. Colleges are not allowed to include university preparation courses or Ontario Academic Courses, with the exception of applied degree and integrated collaborative degree programs, as part of their admission requirements. The binding policy directive also speaks to the practice of weighting courses: "To ensure consistency and to adhere to the destination-based objective of the new secondary school curriculum, the practice of weighting between university (U) and university/college (U/C) and college (C) courses in the new curriculum is not appropriate when making admissions decisions."[13]

A secondary school university-preparation (or university/college-preparation) course may be accepted in lieu of a secondary school college preparation course. Previous CMP studies have found this practice takes place to a great extent and this year's data indicates that about 30% of first semester college students had taken university-preparation mathematics courses in

[12] Ontario Ministry of Training, Colleges and Universities. Colleges of Applied Arts and Technology Policy Framework 3.0. Programs Admissions Criteria - Minister's Binding Policy Directive.
[13] Ibid.

secondary school (see chapter 2, Table 10). Consistent with our findings, a recent report authored by Allan King and colleagues, found that 28.1% of students enrolling directly in a college program from secondary school had taken university-preparation courses in school[14].

In past CMP forums, and also again this year, secondary school guidance counselors and teachers have reported that, while they believe they understand university program admission requirements, they are often confused regarding the courses and grades colleges expect of applicants. However, universities and colleges may not differ as much as perceived. King examined the requirements for admission to both universities and colleges. He found that while (secondary school) marks play an important role in university admission decisions, the minimum requirements for admission for similar programs may differ greatly from university to university. He also studied admissions to similar programs offered at four different colleges and found considerable disparity between institutions, depending on whether the program was highly competitive (such as Dental Hygiene, where no students with marks below 60% received an offer) or not very competitive (such as Police Foundations, where significant numbers of offers were made to students with grades below 60%). So the sense that college admission criteria (courses and grades required) differ significantly from institution to institution is a valid one. This has become an important issue for CMP and we discuss it further along with other related issues in chapter 4.

Possibly adding to the confusion is that college programs in Ontario are defined in terms of outcomes. That is, graduates of a college program must demonstrate they have met the program learning outcomes, which are usually tied to a specific career occupation at the time of graduation from their program. These program learning outcomes are published as the Ontario College Program Standards[15] and they identify the essential employability skills and the professional, vocational and general education requirements for each program. Each college offering a given program is free to build its own curriculum as long as it can demonstrate that it meets the corresponding program standards. So while the *endpoint* of a program is consistent from one college to another, the journey to that endpoint, including where students "start" – the admission requirements – may vary. In this respect, colleges differ from the more familiar system at universities.

[14] King, A.J.C. et al. *Who Doesn't Go to Post Secondary Education? Final Report of Findings.* Colleges Ontario, October 2009.

[15] Available at: http://www.edu.gov.on.ca/eng/general/college/progstan/intro.html

The CMP 2009 Student Cohort

The student cohort that has been studied this year entered college in the fall of 2008. This section of the report contains a description of this cohort in terms of program cluster, gender, age, participation in first semester mathematics courses, and secondary school background.

Enrolment by Program Cluster and Gender

The 24 colleges participating in the CMP 2009 offer a total of 2,296 postsecondary programs[16] in which nearly 80,000 students are enrolled – approximately equal numbers of males and females – as shown in Table 3[17]. As noted earlier, not all college programs contain a mathematics course in first semester. Of the 2,296 programs reported by the participating colleges, 1,046 included a mathematics course in first semester, as shown in Table 4. Over 30,000 students are enrolled in these mathematics courses and it is their records of achievement that are the focus of study in the CMP.

Table 3.

Programs and Enrolments by Program Cluster

Cluster	Programs	Enrolment	Males	Females	% M	% F
Applied Arts	936	37,847	13,209	24,576	35.0%	65.0%
Business	387	13,645	6,833	6,777	50.2%	49.8%
General	191	9,699	3,966	5,705	41.0%	59.0%
Technology	782	18,342	15,093	3,212	82.5%	17.5%
TOTAL	**2,296**	**79,533**	**39,101**	**40,270**	**49.3%**	**50.7%**

Table 4.

Programs with 1st Semester Mathematics

Cluster	Programs	Enrolment	Males	Females	% M	% F
Applied Arts	65	2,625	897	1,723	34.2%	65.8%
Business	269	9,678	5,032	4,624	52.1%	47.9%
General	92	5,336	2,095	3,237	39.3%	60.7%
Technology	620	14,167	12,100	2,045	85.5%	14.5%
TOTAL	**1,046**	**31,806**	**20,124**	**11,629**	**63.4%**	**36.6%**

Comparison of Tables 3 and 4 also shows that while overall male and female enrollments in college are almost identical, male enrolment in programs containing mathematics is much higher than female enrolment, since the programs most favoured by females (such as those in

[16] CMP investigates all postsecondary diploma and certificate programs except applied degree, post diploma and apprenticeship programs.

[17] The combined numbers of males and females is less than the total because gender was not identified on some records. This also affects figures shown in Tables 4, 5, 6 & 7.

the Applied Arts major cluster which includes programs in hospitality and tourism, health and human services, and applied arts) are much less likely to contain mathematics than programs chosen more often by male students (such as those in the Technology major cluster).

Enrolment by Student Type

The CMP is interested in analyzing mathematics achievement in light of students' secondary school backgrounds. For this purpose, we distinguish between students aged 23 or under (as of December 31, 2008) *and* who have graduated with an Ontario Secondary School Diploma (OSSD) from those who are either older or who have graduated from secondary schools in other jurisdictions. The former are designated Recent Ontario Graduates (ROGs) and the latter non-ROGs in all CMP analyses.

In addition, this year, we have created a new category of students – those who have taken an Ontario Grade 12 math course in Fall 2007 or later – and who are therefore assumed to have taken the most recently revised mathematics curriculum from Grade 9 through Grade 12[18]. We call this group of students "Very Recent Ontario Graduates" (VROGs). As in past reports, we use the ROG category for analyzing students' secondary school mathematics backgrounds. This year, the VROG category enables us also to identify changes in participation or achievement corresponding to the introduction of the revised mathematics curriculum.

Table 5.
Programs and Enrolments by Student Type

Student Type	Overall Enrolment	Mathematics Enrolment	% Enrolment in Mathematics
Recent Ontario Graduates (ROG)	52,645	21,964	41.7%
Non-ROGs	26,888	9,842	36.6%
TOTAL	**79,533**	**31,806**	**40.0%**
Very Recent Ontario Graduates (VROG)	17,405	9,689	55.7%

Table 5 compares enrolments of ROGs, non-ROGs and VROGs, both overall and in first semester mathematics. ROGs represent slightly more than two-thirds of overall mathematics enrolment. It should be noted that the VROGs are a subset of the ROGs and that they show a significantly higher rate of enrolment in mathematics. In fact, if the VROGs are removed from the ROG category, the remaining ROGs show a mathematics enrolment of only 34.8% (instead of 41.7%) – a proportion very similar to that of the non-ROGs. It would appear therefore that VROGs are

[18] This assumption is not accurate for all students, of course. However since the revised mathematics curriculum retains many of the same course codes as the former curriculum, we have no other way of identifying VROGs.

choosing math-heavy college programs at a higher rate than in the past; this bears further investigation into the CMP 2008 data.

Table 7 shows that over half of all the VROGs enrolled in first semester mathematics are in Technology programs, while Table 6 shows that 44.2% of ROG's are enrolled in that cluster. By contrast, CMP 2008 reported the proportion of mathematics students (ROG) taking Technology programs (albeit in 11 colleges) as 41.8%. If the VROGs were to be removed from the ROG category, the proportion of mathematics students in Technology programs would drop from 44.2% to 38.8%, which serves to underline the interest in technology of the VROG group.

Table 6.

Mathematics Enrolment: Recent Ontario Graduates (ROGs)

Cluster	Overall	ROGs	% by cluster	Males	Females	% M	%F
Applied Arts	2,625	1,788	8.1%	641	1,146	35.9%	64.1%
Business	9,678	6,724	30.6%	3,642	3,074	54.2%	45.8%
General	5,336	3,741	17.0%	1,446	2,293	38.7%	61.3%
Technology	14,167	9,711	44.2%	8,386	1,319	86.4%	13.6%
TOTAL	**31,806**	**21,964**	**100%**	**14,115**	**7,832**	**64.3%**	**35.7%**

Table 7.

Mathematics Enrolment: Very Recent Ontario Graduates (VROGs)

Cluster	Overall	VROGs	% by cluster	Males	Females	% M	%F
Applied Arts	2,625	602	6.2%	223	379	37.0%	63.0%
Business	9,678	2,857	29.5%	1,645	1,212	57.6%	42.4%
General	5,336	1,281	13.2%	427	854	33.3%	66.7%
Technology	14,167	4,949	51.1%	4,318	627	87.3%	12.7%
TOTAL	**31,806**	**9,689**	**100%**	**6,613**	**3,072**	**68.3%**	**31.7%**

Tables 6 and 7 also address gender representation within both the ROG and VROG groups. Consistent with the increased enrolment by VROGs in technology programs and the higher proportion of males in technology programs, the percentage of males enrolled in first semester mathematics also shows an increase among VROGs (68.3%) relative to ROGs (64.3%). For comparison purposes, last year the percentages of students enrolled in first semester mathematics were 64.2% (all students) and 65.8% (ROGs).

Enrolment by College

A possible explanation for the increase in mathematics enrolments relative to CMP 2008 is that the addition of 13 colleges to CMP has changed the balance of programs and mathematics enrolment and so we decided to investigate this by comparing the proportions of students from the 11 colleges participating in CMP 2008 who were enrolled in mathematics over two years. Table 8 shows this comparison both for all students and also for VROGs. The 13 colleges which were new to CMP this year are also shown. The Table shows that clearly the VROGs are mostly responsible for the increase in mathematics enrolment. While the 13 new colleges do show a higher rate of participation overall than the 11 colleges that participated last year, it is a small difference compared with the much larger difference shown by the VROGs.

Table 8

Mathematics Enrolment by College

	11 Colleges*	13 Colleges*	TOTAL
CMP 2008			
Total Enrolment	50,586		
Math Enrolment	19,970		
% Mathematics	39.5%		
CMP 2009 - all Students			
Total Enrolment	54,160	25,373	79,533
Math Enrolment	20,484	11,322	31,806
% Mathematics	37.8%	44.6%	40.0%
CMP 2009 - VROGs			
Total Enrolment	11,753	5,652	17,405
Math Enrolment	6,151	3,538	9,689
% Mathematics	52.3%	62.6%	55.7%

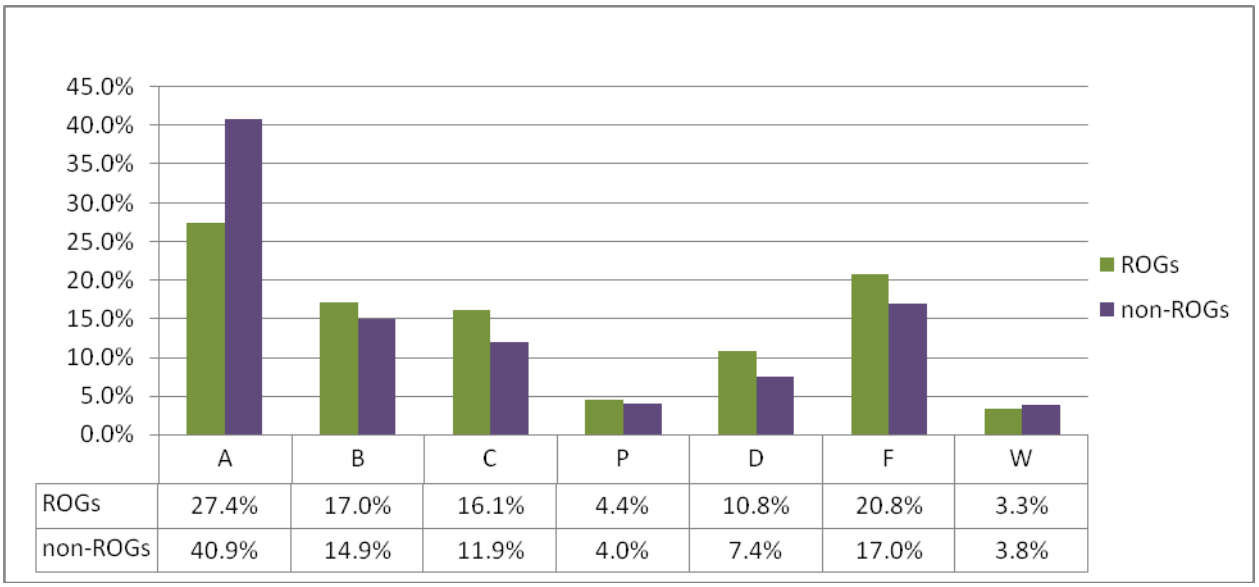
*The 11 colleges are those that participated in CMP 2008 and the 13 colleges are those that participated in CMP 2009 for the first time.

Chapter 2: What does the CMP research show?

The essence of the CMP research program has been maintained with each successive annual study, since our long term goal is to assemble a longitudinal database on student achievement that will provide evidence of change – hopefully improvement – as schools and colleges work towards the goal of increased student success. Many of the research questions (outlined in chapter 1) are therefore the same as in previous years and will continue in 2010. However each year also sees new aspects of the research – often as a result of suggestions made at our deliberative forums in past years. This year, the creation of the new group of students known as Very Recent Ontario Graduates (VROGs) enables us to examine achievement of those who have come directly from secondary school to college and who have taken the most recently revised mathematics curriculum in secondary school. Several of the tables and charts shown in this chapter therefore have three parts to them: Recent Ontario Graduates (ROGs), non-ROGs, and VROGs.

Factors Affecting College Mathematics Achievement

First of all, we look at the grade distribution, using the CMP grading policy in all first semester mathematics courses (Figure 2) taken in the fall of 2008.



	A	B	C	P	D	F	W
ROGs	27.4%	17.0%	16.1%	4.4%	10.8%	20.8%	3.3%
non-ROGs	40.9%	14.9%	11.9%	4.0%	7.4%	17.0%	3.8%

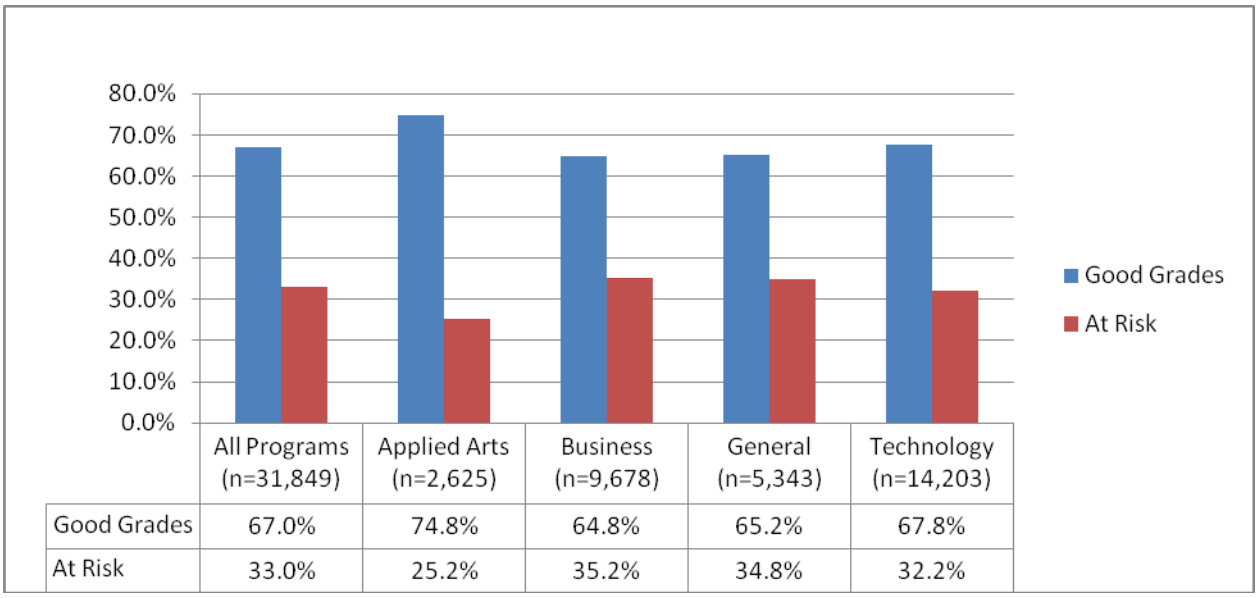
Figure 2. **Grade Distribution, ROGs and non-ROGs (n=31,945)**

The pattern of achievement is the same as in previous years, though the achievement of the ROGs is somewhat improved this year – we shall examine this further later in this chapter. While we make some comparisons with previous years, we do so only with great care as CMP

2009 is the first year with all 24 colleges involved. CMP 2008 saw 11 colleges participating and CMP 2007 only 6 (in the GTA). For this reason, 2009 will be the baseline year for many of the future research analyses.

Achievement by Program Cluster

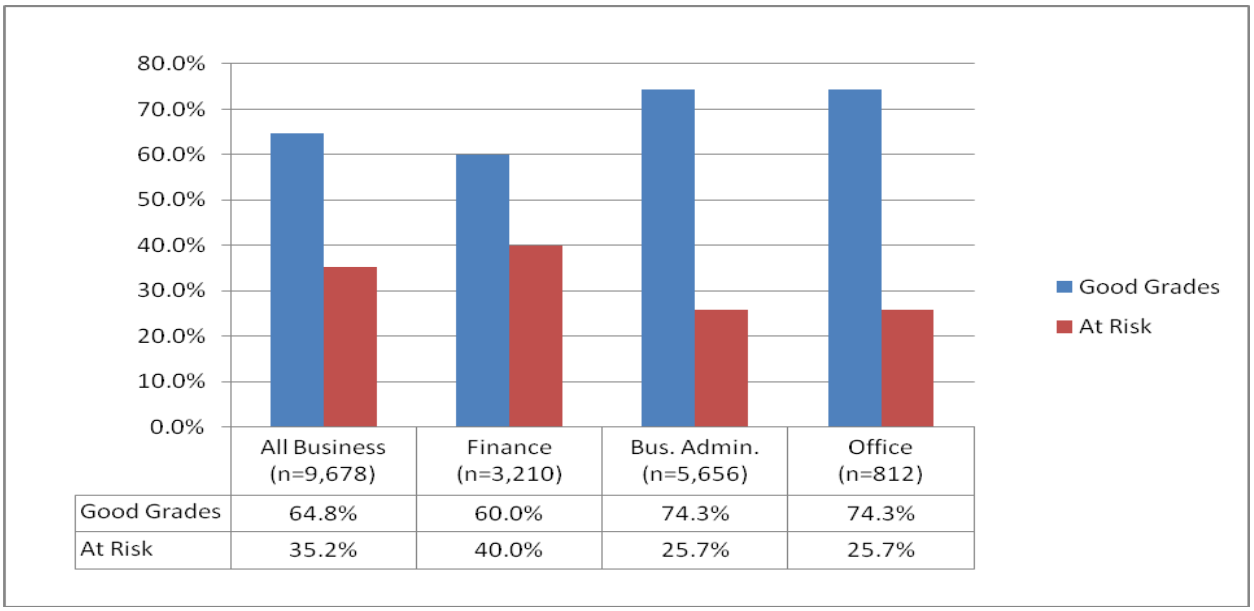
As indicated above, overall mathematics achievement has improved somewhat in CMP 2009, with the proportion of students receiving "good grades" rising from 64.7% in CMP 2008 to 67% this year. However, at the level of program cluster (Figure 3) there is very little difference from last year in the general pattern of achievement, except that achievement in Technology programs seems to be somewhat improved over last year.



	All Programs (n=31,849)	Applied Arts (n=2,625)	Business (n=9,678)	General (n=5,343)	Technology (n=14,203)
Good Grades	67.0%	74.8%	64.8%	65.2%	67.8%
At Risk	33.0%	25.2%	35.2%	34.8%	32.2%

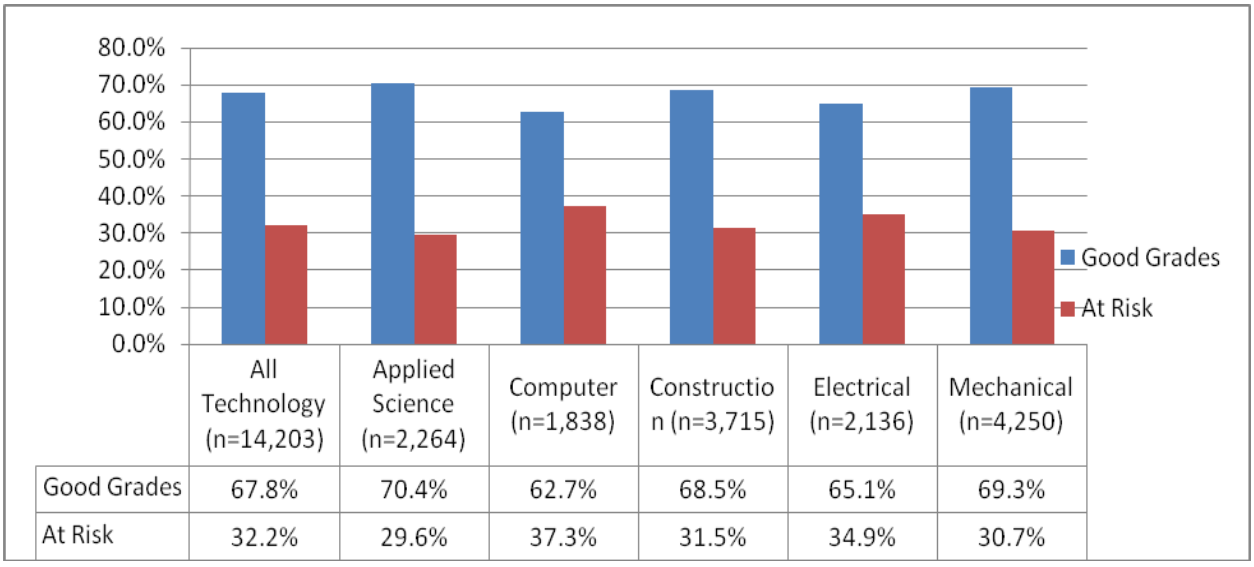
Figure 3: **Achievement by Program Cluster – CMP 2009 (Fall 2008)**

While the pattern of achievement varies little across clusters (except for Applied Arts where there are relatively few students), the differences become more pronounced at the sub-cluster level (as shown for Business and Technology programs in Figures 4 and 5). While most Technology sub-clusters are somewhat similar, it is perhaps surprising that the Finance sub-cluster is seeing rather lower levels of mathematics achievement.



	All Business (n=9,678)	Finance (n=3,210)	Bus. Admin. (n=5,656)	Office (n=812)
Good Grades	64.8%	60.0%	74.3%	74.3%
At Risk	35.2%	40.0%	25.7%	25.7%

Figure 4. **Achievement by Program Sub-Cluster – Business Programs**

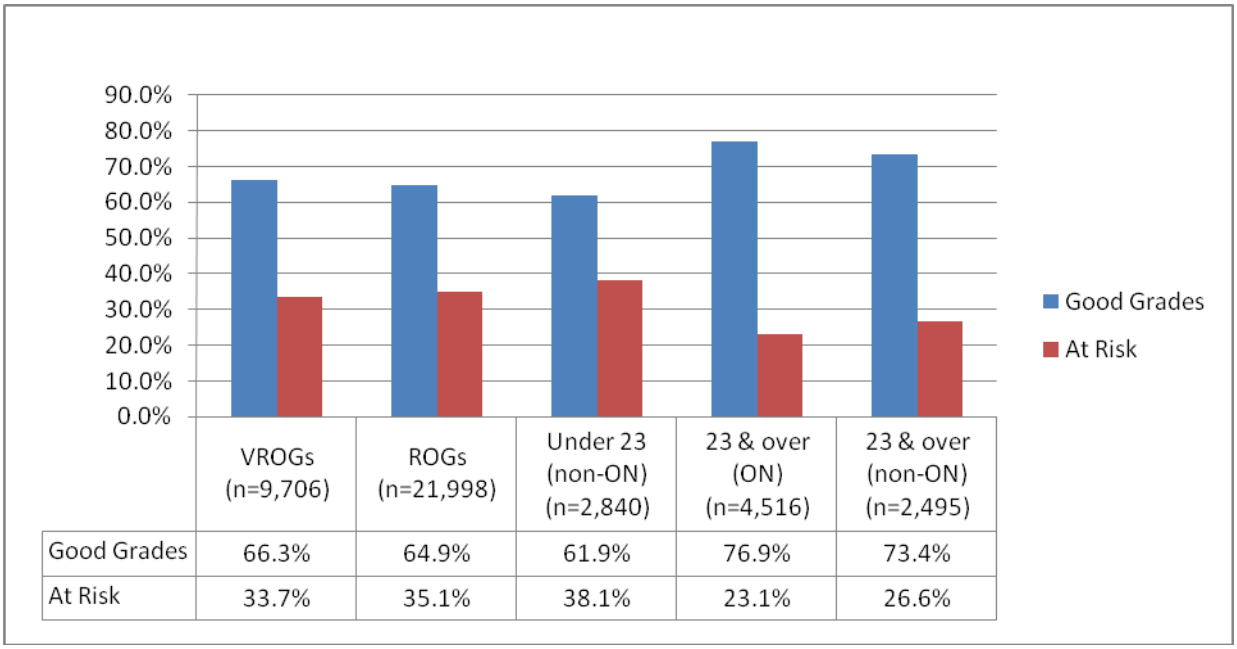


	All Technology (n=14,203)	Applied Science (n=2,264)	Computer (n=1,838)	Constructio n (n=3,715)	Electrical (n=2,136)	Mechanical (n=4,250)
Good Grades	67.8%	70.4%	62.7%	68.5%	65.1%	69.3%
At Risk	32.2%	29.6%	37.3%	31.5%	34.9%	30.7%

Figure 5. **Achievement by Program Sub-Cluster – Technology Programs**

Achievement by Age and School Location

We have observed in previous studies and again here (Figure 2) that Recent Ontario Graduates (ROGs) tend to be outperformed by non-ROGs – those from outside Ontario or 23 and over. Figure 6 provides a comparison of achievement between the different "populations" of students in our study, including the Very Recent Ontario Graduates (VROG), which are a subset of the ROGs. The achievement of VROG group is very similar to the ROGs.



	VROGs (n=9,706)	ROGs (n=21,998)	Under 23 (non-ON) (n=2,840)	23 & over (ON) (n=4,516)	23 & over (non-ON) (n=2,495)
Good Grades	66.3%	64.9%	61.9%	76.9%	73.4%
At Risk	33.7%	35.1%	38.1%	23.1%	26.6%

Figure 6. **Achievement by Student Age and School Location (n=31,849)**

Several participants at CMP Forums have raised questions about the rather heterogeneous non-ROG group, suggesting that it be disaggregated to discover whether the differences in achievement between ROGs and non-ROGs is principally a factor of age or of school location. So this year, with the first full set of province-wide data, we decided to explore this question further. The first step was to separate the two criteria for designation as an ROG and to calculate the achievement of each sub-group. Figure 6 shows quite clearly that the two "23 & over" groups (columns 4 & 5) outperform the corresponding groups of younger students (columns 2 & 3), regardless of school location.

This important finding led us to examine the age factor in more detail independently of school location. The CMP database has been modified this year to enable analysis of achievement by student age (as of December 31, 2008) and Table 9 provides such an analysis. It shows very clearly that, while the bulk of the student enrolment falls in the 18-20 age group, the highest levels of achievement are reached by students in the 30-50 age range.

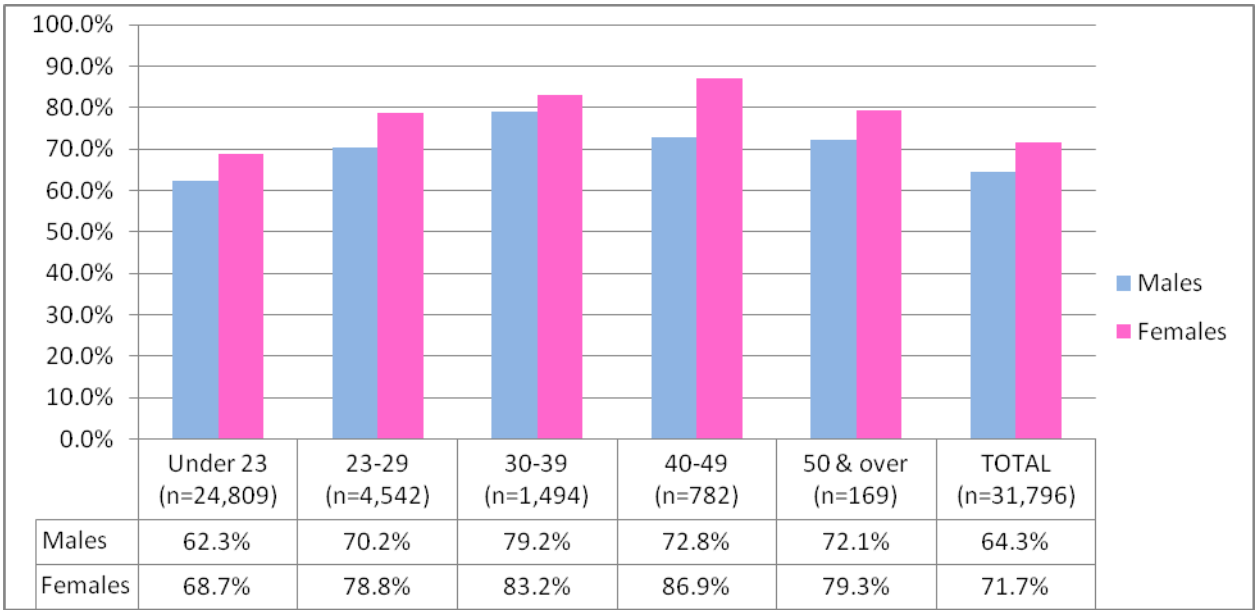
Table 9

Achievement by Student Age

	Total	Math	GG*	AR*	%GG*	%AR*
16 & under	32	9	4	5	44.4%	55.6%
17	326	98	68	30	69.4%	30.6%
18	17,933	7,401	4,926	2,475	66.6%	33.4%
19	19,593	8,094	5,089	3,005	62.9%	37.1%
20	11,045	4,425	2,730	1,695	61.7%	38.3%
21	7,236	2,956	1,932	1,024	65.4%	34.6%
22	4,846	1,855	1,285	570	69.3%	30.7%
23	3,397	1,304	918	386	70.4%	29.6%
24	2,537	966	685	281	70.9%	29.1%
25	1,829	724	546	178	75.4%	24.6%
26	1,359	536	405	131	75.6%	24.4%
27	1,118	437	341	96	78.0%	22.0%
28	866	344	261	83	75.9%	24.1%
29	667	245	189	56	77.1%	22.9%
30	615	234	188	46	80.3%	19.7%
31	501	213	174	39	81.7%	18.3%
32	475	185	145	40	78.4%	21.6%
33	414	139	118	21	84.9%	15.1%
34	373	138	114	24	82.6%	17.4%
35	349	122	95	27	77.9%	22.1%
36	350	114	101	13	88.6%	11.4%
37	304	116	92	24	79.3%	20.7%
38	329	125	95	30	76.0%	24.0%
39	298	114	93	21	81.6%	18.4%
40	241	85	69	16	81.2%	18.8%
41	273	111	92	19	82.9%	17.1%
42	260	88	69	19	78.4%	21.6%
43	247	103	82	21	79.6%	20.4%
44	245	96	76	20	79.2%	20.8%
45	249	99	68	31	68.7%	31.3%
46	187	67	60	7	89.6%	10.4%
47	176	60	44	16	73.3%	26.7%
48	156	37	26	11	70.3%	29.7%
49	122	40	33	7	82.5%	17.5%
50 & over	585	169	126	43	74.6%	25.4%
TOTAL	**79,533**	**31,849**	**21,339**	**10,510**	**67.0%**	**33.0%**

*GG = Good Grades; AR = At Risk

This led us in turn to investigate the combined effects of age and gender on achievement and the results of this analysis are shown in Figure 7. Consistent with last year's results, we found that overall, females outperform males. This was true for all age categories. Overall, the difference was 7.4% and there is a distinct peak in achievement for men in the 30-39 age group and for women in the 40-49 age group[19]. This leads us to contend that combinations of maturity-related factors are likely to be significant determinants of success in college mathematics and that the diversity of student ages, well known to college faculty, should be taken into account when making decisions about many aspects of course design and teaching methods.



	Under 23 (n=24,809)	23-29 (n=4,542)	30-39 (n=1,494)	40-49 (n=782)	50 & over (n=169)	TOTAL (n=31,796)
Males	62.3%	70.2%	79.2%	72.8%	72.1%	64.3%
Females	68.7%	78.8%	83.2%	86.9%	79.3%	71.7%

Figure 7. **Achievement (% Good Grades) by Student Age and Gender (n=31,796)**

While Figure 6 shows that the place of origin (i.e. Ontario or elsewhere) has little impact on achievement, we shall retain the ROG/non-ROG distinction in our research because much of our work relates students' college mathematics achievement to their Ontario secondary school mathematics background and, for this purpose, we use the ROG population exclusively.

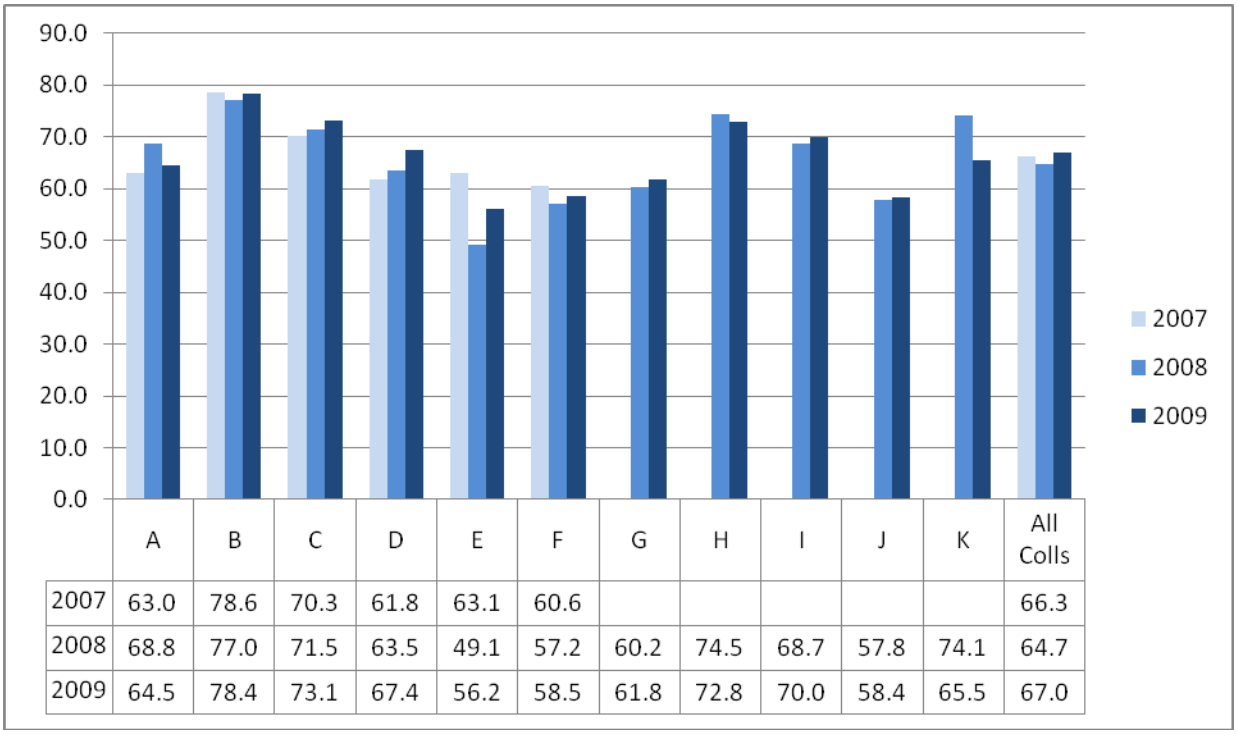
Achievement by College

Student achievement aggregated to the college level – as we have observed in past studies – shows variation across colleges. However this variation is impossible to interpret without additional information. The variations across colleges – among students, programs and

[19] It has also been pointed out that older students are more likely to have had prior postsecondary education. However, if this were in a mathematics-based field, it is likely that they would be exempted from first semester college mathematics and therefore absent from CMP data.

program mix, and approaches to assessment in mathematics, at the least – are all well established and any one of these would be sufficient grounds for not making much of inter-college comparisons. The CMP policy on data confidentiality prevents the identification of individual colleges or school boards in our reports and each college has access to its own data in the CMP database.

The one analysis that we can now publish is the review of changes in achievement over time on the part of the six colleges that have participated in CMP for three years and the 11 colleges that have participated for two years and this is shown in Figure 8[20]. As the figure shows, changes in achievement over the past three years either at the individual college level or in the aggregate have been very small. In 2010, with all 24 colleges participating we can begin to track changes at the college level more systematically and each college will also be looking to track changes in mathematics achievement at the levels of program clusters, sub-clusters and individual programs, as they implement new student success initiatives.

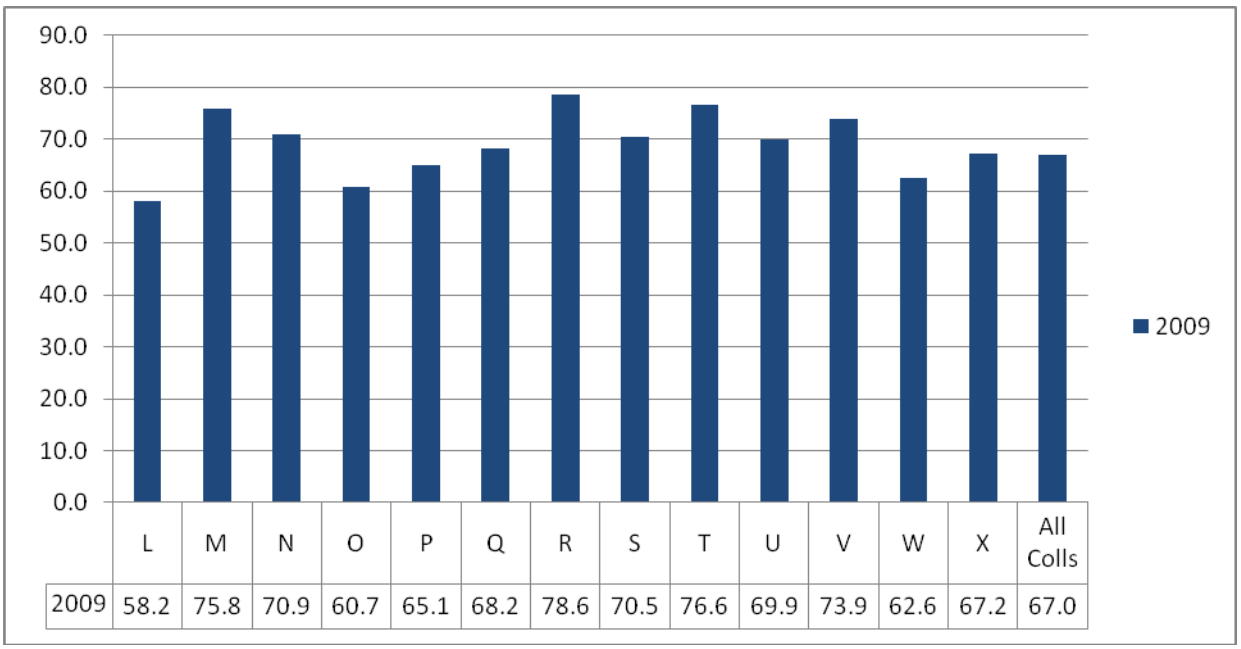


	A	B	C	D	E	F	G	H	I	J	K	All Colls
2007	63.0	78.6	70.3	61.8	63.1	60.6						66.3
2008	68.8	77.0	71.5	63.5	49.1	57.2	60.2	74.5	68.7	57.8	74.1	64.7
2009	64.5	78.4	73.1	67.4	56.2	58.5	61.8	72.8	70.0	58.4	65.5	67.0

Figure 8. **Change in Achievement (% Good Grades) Over Time by College (11 colleges that have participated in CMP for more than one year)**

[20] The year shown in Figures 8 and 9 is the year of the CMP project, not the year in which the student entered the college.

CMP only has data related to one year for the remaining 13 colleges and this is shown in Figure 9. In 2010, we shall be able to use this year as the baseline for identifying changes throughout the college system. Individual colleges can identify themselves in these charts by accessing the CMP database.



	L	M	N	O	P	Q	R	S	T	U	V	W	X	All Colls
2009	58.2	75.8	70.9	60.7	65.1	68.2	78.6	70.5	76.6	69.9	73.9	62.6	67.2	67.0

Figure 9. **Achievement (% Good Grades) Over Time by College (13 colleges new to CMP in 2009)**

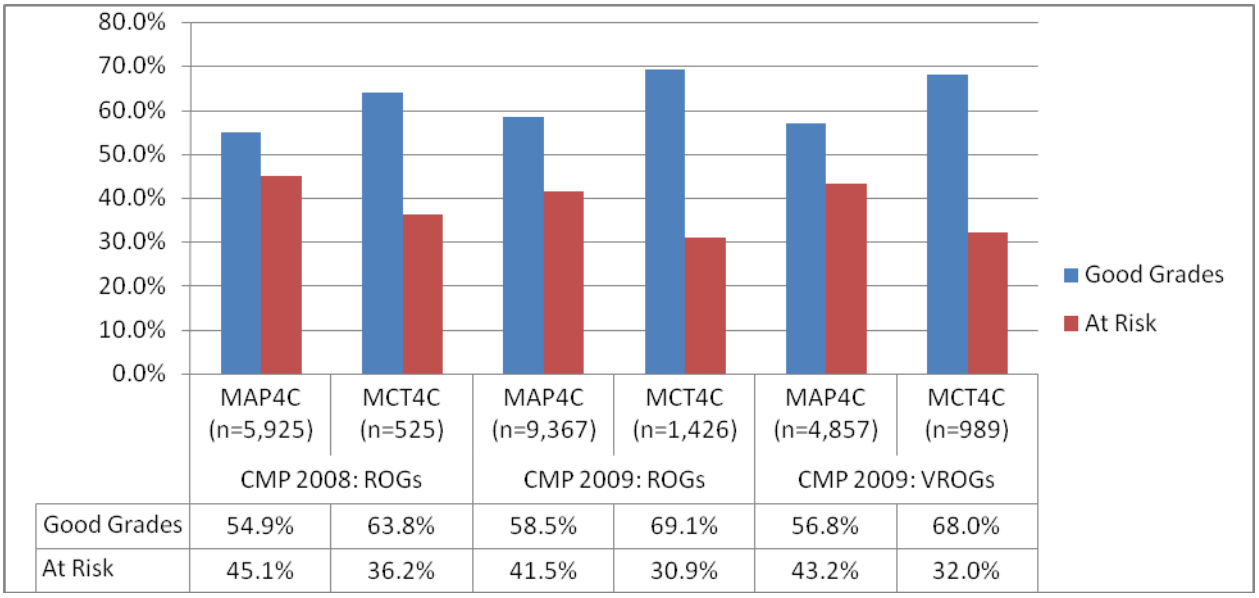
Mathematics Background at Secondary School

While student success in first year college mathematics is a complex matter, as our analyses by age (Table 9 and Figure 7, above) have shown, the majority of college students come either directly from school (the VROG group) or within a few years of graduating from secondary school (the remaining ROGs). It is useful therefore to examine their secondary school mathematics backgrounds to see what can be learned about more or less effective pathways to college programs.

Impact of Grade 12 Mathematics Courses

Figure 10 shows the college mathematics achievement of students, both ROGs and VROGs, who have taken either of the two Ontario secondary school college preparation mathematics courses in Grade 12, known as MAP4C (Foundations for College Mathematics) and MCT4C

(Mathematics for College Technology)[21]. It also includes a comparison of the CMP 2009 results with those of CMP 2008.



	MAP4C (n=5,925)	MCT4C (n=525)	MAP4C (n=9,367)	MCT4C (n=1,426)	MAP4C (n=4,857)	MCT4C (n=989)
	CMP 2008: ROGs		CMP 2009: ROGs		CMP 2009: VROGs	
Good Grades	54.9%	63.8%	58.5%	69.1%	56.8%	68.0%
At Risk	45.1%	36.2%	41.5%	30.9%	43.2%	32.0%

Figure 10. **Achievement of Students with Grade 12 courses MAP4C and MCT4C[22]**

While the absolute numbers of ROGs taking each course in CMP 2009 are not comparable with those in CMP 2008 (because of the increased number of colleges), it should be noted that the 525 ROGs taking MCT4C in CMP 2008 represents 4.4% of the overall sample, whereas the 1,428 ROGs taking MCT4C in CMP 2009 represents 7.3% of the corresponding sample. In other words, while the numbers of students taking MCT4C are still small, the overall proportion of them has increased by 40% (from 4.4% to 7.3%). Readers should also note that the proportion of the VROG group (who have taken the recently revised mathematics curriculum) enrolled in MCT4C has reached 11.3%. In addition, Figure 9 shows a significant increase in achievement on the part of those taking MAP4C (from 54.9% with good grades in CMP 2008 to 58.5% this year) and also those taking MCT4C (from 63.8% with good grades in CMP 2008 to 69.4% this year).

Of course, many students enter college with Grade 12 mathematics courses other than these two College-preparation courses. These data are shown in Table 10 along with a breakdown for Business and Technology program clusters[23].

[21] Ministry of Education. *The Ontario Curriculum, Grades 11 & 12 – Mathematics*. (Toronto: Queens Printer, 2007).
[22] Data relates to students' highest level Grade 12 mathematics course. For example: a student who has taken MAP4C and no other Grade 12 course would be included in the MAP4C group; a student who has taken MCT4C or both MAP4C and MCT4C would be included in the MCT4C group; and a student who has taken either of these courses *and also* a Grade 12 U course would not be included in this table at all. This convention applies to all data tables in this section.

Table 10
Enrolment and Achievement by Highest Grade 12 Mathematics Course

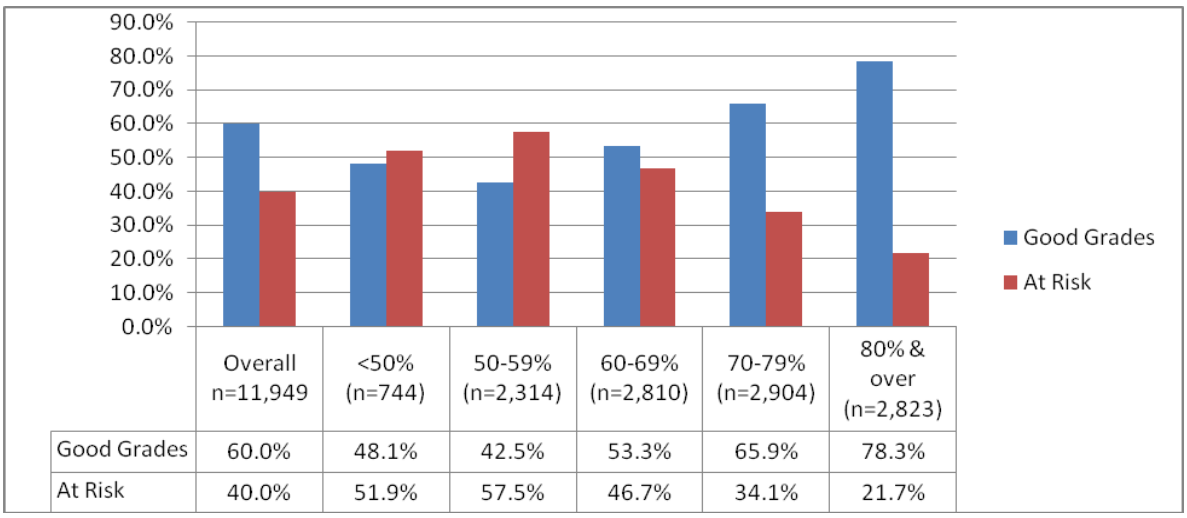
	ROGs	Highest Mathematics Course			VROGs	Highest Mathematics Course		
	Sample*	MAP4C	MCT4C	any 12U	Sample*	MAP4C	MCT4C	any 12U
ALL PROGRAMS								
# of students	19,693	9,367	1,426	5,603	8,547	4,857	989	2,701
% of sample*	100%	47.6%	7.2%	28.5%	100%	56.8%	11.6%	31.6%
% Good Grades	64.6%	58.5%	69.1%	80.0%	65.4%	56.8%	68.0%	79.9%
BUSINESS								
Number of Ss	5,959	2,771	247	1,929	2,462	1,401	148	913
% of sample*	100%	46.5%	4.1%	32.4%	100%	56.9%	6.0%	37.1%
% Good Grades	62.3%	58.5%	64.8%	74.0%	62.7%	56.7%	58.8%	72.6%
TECHNOLOGY								
Number of Ss	8,779	4,378	1,013	2,611	4,376	2,343	740	1,293
% of sample*	100%	49.9%	11.5%	29.7%	100%	53.5%	16.9%	29.5%
% Good Grades	65.3%	58.5%	68.4%	82.5%	65.1%	54.4%	68.0%	82.8%

*The pathways analyses are conducted on pathways followed by 10 or more students. The absolute numbers in this table are therefore smaller than the overall ROGs and VROGs groups.

Table 10 shows that MAP4C was the highest Grade 12 mathematics course taken by 47.6% (of the sample of 19,693 ROGs whose secondary school mathematics pathways were analysed), MCT4C the highest taken by 7.2%, and 28.5% had taken one or more 12U mathematics courses. An even higher proportion of VROGs (31.6%) had taken a 12U course.

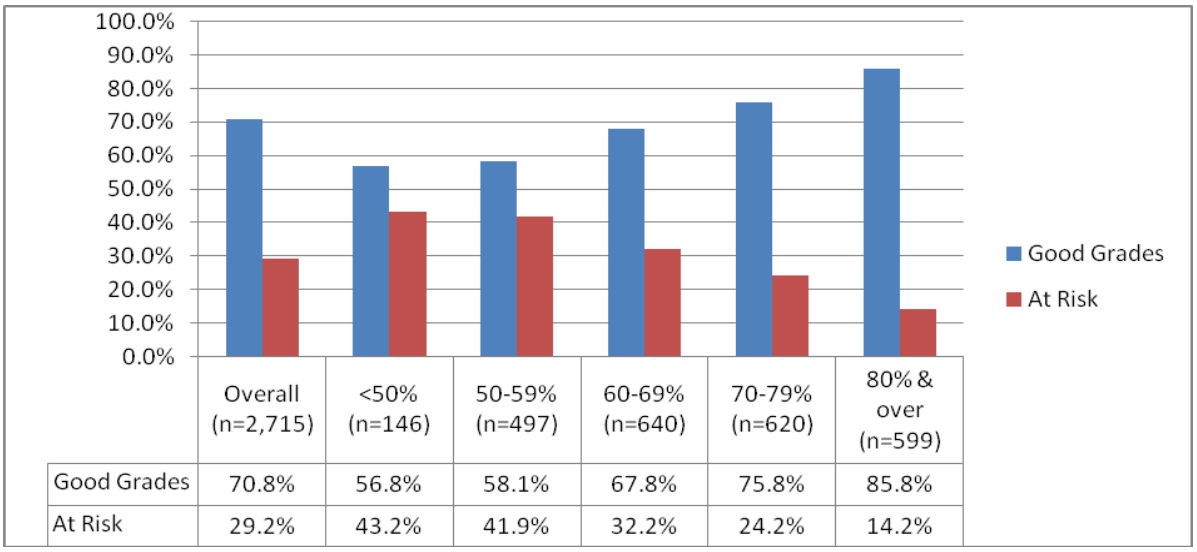
Having completed a mathematics course in secondary school is one thing; the level of success achieved is quite another. CMP 2009 has data on students' marks in key courses such as MAP4C and MCT4C and Figures 11 and 12 show how the level of success in each of these courses is related to students' subsequent achievement in first semester college mathematics. Both figures include all attempts made. It should be noted that, while, in general, CMP data suggests that MAP4C may not be a very good preparation for college mathematics, a high mark in MAP4C significantly increases a student's prospects of doing well in college.

[23] Data in this table is based on an analysis that only included pathways followed by 10 or more students. While the absolute numbers are therefore reduced by an average of about 10% from the overall numbers of ROGs and VROGs shown in Tables 6 and 7, they are still considered to be representative samples.



	Overall n=11,949	<50% (n=744)	50-59% (n=2,314)	60-69% (n=2,810)	70-79% (n=2,904)	80% & over (n=2,823)
Good Grades	60.0%	48.1%	42.5%	53.3%	65.9%	78.3%
At Risk	40.0%	51.9%	57.5%	46.7%	34.1%	21.7%

***Figure 11*. College Mathematics Achievement (ROGs) by MAP4C marks**



	Overall (n=2,715)	<50% (n=146)	50-59% (n=497)	60-69% (n=640)	70-79% (n=620)	80% & over (n=599)
Good Grades	70.8%	56.8%	58.1%	67.8%	75.8%	85.8%
At Risk	29.2%	43.2%	41.9%	32.2%	24.2%	14.2%

***Figure 12*. College Mathematics Achievement (ROGs) by MCT4C marks**

Impact of Grade 11 and 12 Mathematics Courses

Table 11 shows that the college mathematics achievement of students – both ROGs and VROGs – is related to their choice of mathematics courses in both Grades 11 and 12.

Table 11

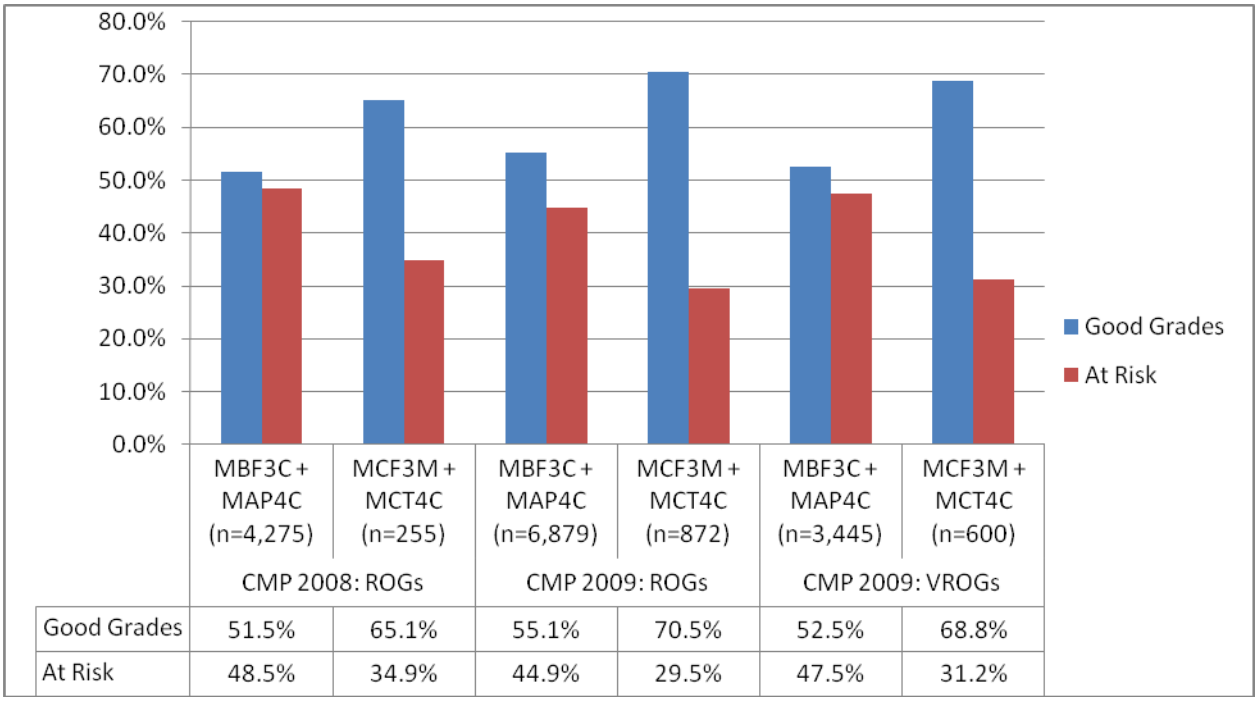
Enrolment and Achievement by Highest Grade 11 and 12 Mathematics Courses

ROGs		MBF3C MAP4C	MCF3M MAP4C	MCR3U MAP4C	MBF3C MCT4C	MCF3M MCT4C	MCR3U MCT4C	any 11 & 12U
ALL PROGRAMS	**Sample**							
Number of Ss	19,693	6,879	1,749	544	280	872	256	5,388
% of sample	100%	34.9%	8.9%	2.8%	1.4%	4.4%	1.3%	27.4%
% Good Grades	64.6%	55.1%	68.0%	73.2%	56.4%	70.5%	77.3%	80.2%
BUSINESS								
Number of Ss	5,959	2,072	508	121	55	161	27	1,817
% of sample	100%	34.8%	8.5%	2.0%	0.9%	2.7%	0.5%	30.5%
% Good Grades	62.3%	55.6%	64.2%	73.6%	58.2%	66.5%	66.7%	74.3%
TECHNOLOGY								
Number of Ss	8,779	3,162	819	312	190	615	196	2,545
% of sample	100%	36.0%	9.3%	3.6%	2.2%	7.0%	2.2%	29.0%
% Good Grades	65.3%	55.1%	66.9%	71.5%	54.2%	69.6%	77.6%	82.5%

VROGs	Sample	MBF3C MAP4C	MCF3M MAP4C	MCR3U MAP4C	MBF3C MCT4C	MCF3M MCT4C	MCR3U MCT4C	any 11 & 12U
ALL PROGRAMS								
Number of Ss	8,547	3,445	990	252	194	600	184	2,641
% of sample	100%	40.3%	11.6%	2.9%	2.3%	7.0%	2.2%	30.9%
% Good Grades	65.4%	52.5%	65.6%	80.2%	55.2%	68.8%	77.7%	80.2%
BUSINESS								
Number of Ss	2,462	1,031	277	43	35	95	16	874
% of sample	100%	41.9%	11.3%	1.7%	1.4%	3.9%	0.6%	35.5%
% Good Grades	62.7%	53.5%	62.8%	86.0%	42.9%	63.2%	62.5%	73.1%
TECHNOLOGY								
Number of Ss	4,376	1,638	469	155	137	444	150	1,278
% of sample	100%	37.4%	10.7%	3.5%	3.1%	10.1%	3.4%	29.2%
% Good Grades	65.1%	49.9%	63.3%	76.8%	56.2%	68.0%	78.0%	83.0%

Of these Grade 11/12 combinations, some are of particular importance. The pathway most favoured by students going to college is MBF3C and MAP4C. However it is also the pathway that, as we have observed in the past, yields the lowest levels of achievement in college

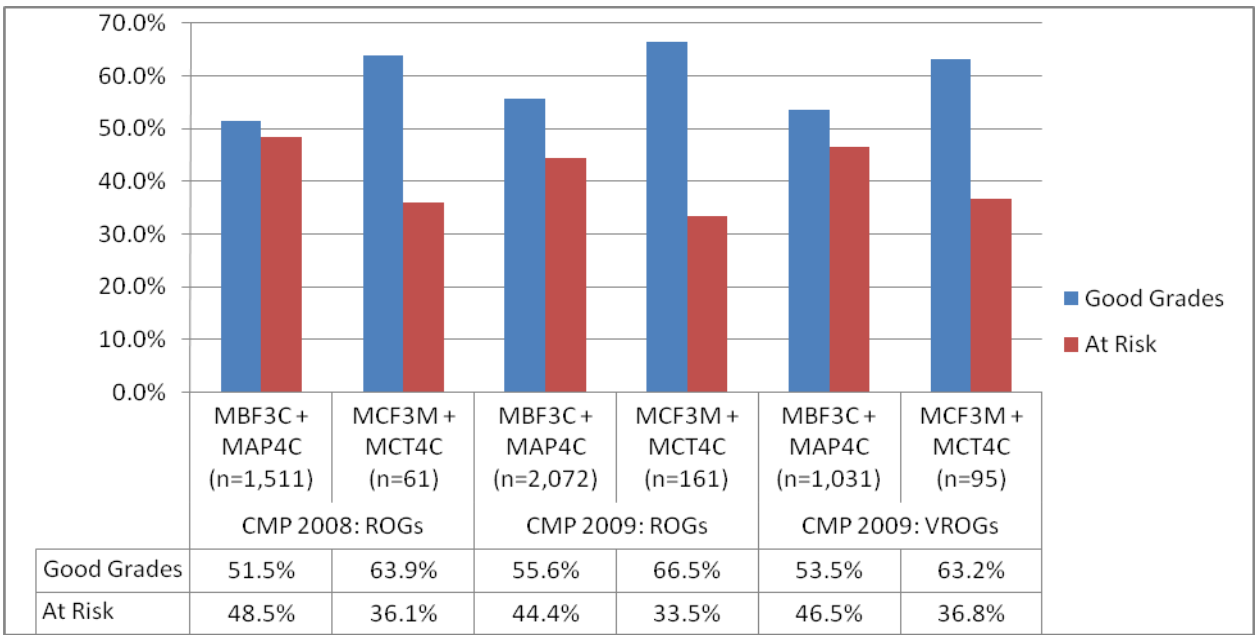
mathematics. This is true, moreover, in Business and Technology programs as well as overall. The second most popular set of pathways, by contrast, also yield the highest levels of achievement in college mathematics. These are the pathways that combine a choice of any Grade 11 and any Grade 12U mathematics course. Figure 13 illustrates two combinations for both ROGs and VROGs and also shows a comparison with data from CMP 2008. From this, we can see that all combinations have shown higher achievement levels and that 7% of VROGs selected the MCF3M/MCT4C pathway – higher than ROGs in CMP 2009 (4.4%) and much higher than the ROGs in CMP 2008 (2.1%). This increase was one of the goals of the recent revisions to the mathematics curriculum.



	MBF3C + MAP4C (n=4,275)	MCF3M + MCT4C (n=255)	MBF3C + MAP4C (n=6,879)	MCF3M + MCT4C (n=872)	MBF3C + MAP4C (n=3,445)	MCF3M + MCT4C (n=600)
	CMP 2008: ROGs		CMP 2009: ROGs		CMP 2009: VROGs	
Good Grades	51.5%	65.1%	55.1%	70.5%	52.5%	68.8%
At Risk	48.5%	34.9%	44.9%	29.5%	47.5%	31.2%

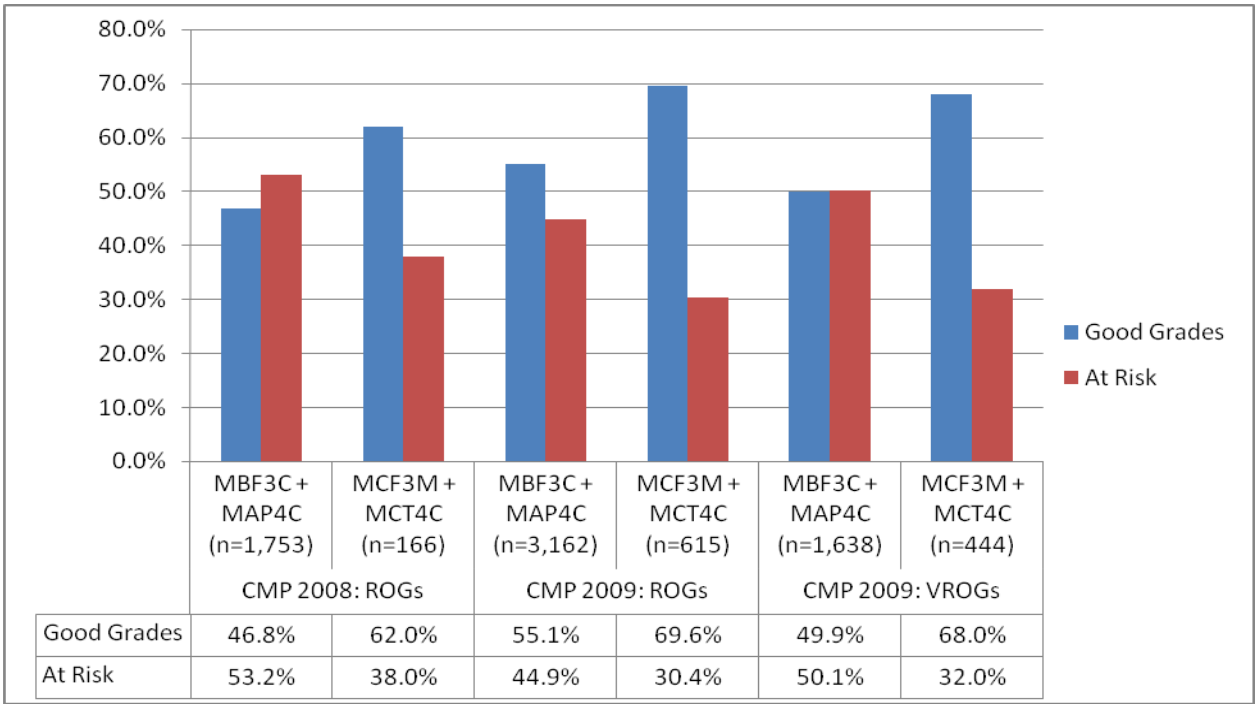
Figure 13. **Achievement of Students with different Grade 11 and 12C course combinations (All Programs)**

Figures 14 and 15 show similar analyses for Business and Technology programs.



	MBF3C + MAP4C (n=1,511)	MCF3M + MCT4C (n=61)	MBF3C + MAP4C (n=2,072)	MCF3M + MCT4C (n=161)	MBF3C + MAP4C (n=1,031)	MCF3M + MCT4C (n=95)
	CMP 2008: ROGs		CMP 2009: ROGs		CMP 2009: VROGs	
Good Grades	51.5%	63.9%	55.6%	66.5%	53.5%	63.2%
At Risk	48.5%	36.1%	44.4%	33.5%	46.5%	36.8%

Figure 14. **Achievement of Students with different Grade 11 and 12C course combinations (Business Programs)**

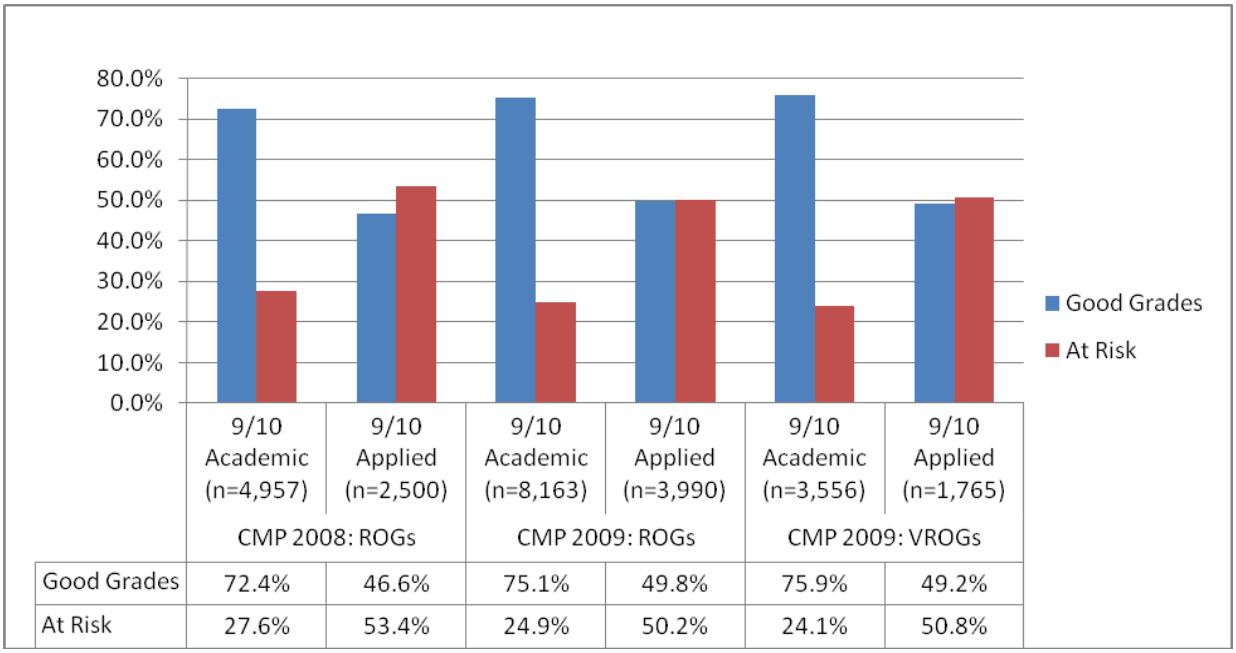


	MBF3C + MAP4C (n=1,753)	MCF3M + MCT4C (n=166)	MBF3C + MAP4C (n=3,162)	MCF3M + MCT4C (n=615)	MBF3C + MAP4C (n=1,638)	MCF3M + MCT4C (n=444)
	CMP 2008: ROGs		CMP 2009: ROGs		CMP 2009: VROGs	
Good Grades	46.8%	62.0%	55.1%	69.6%	49.9%	68.0%
At Risk	53.2%	38.0%	44.9%	30.4%	50.1%	32.0%

Figure 15. **Achievement of Students with different Grade 11 and 12C course combinations (Technology Programs)**

Impact of Grades 9 and 10 Mathematics Courses

The pattern of achievement of students who have taken Grades 9 and 10 Academic or Applied courses has not changed much from earlier years (Figure 16).



	9/10 Academic (n=4,957)	9/10 Applied (n=2,500)	9/10 Academic (n=8,163)	9/10 Applied (n=3,990)	9/10 Academic (n=3,556)	9/10 Applied (n=1,765)
	CMP 2008: ROGs		CMP 2009: ROGs		CMP 2009: VROGs	
Good Grades	72.4%	46.6%	75.1%	49.8%	75.9%	49.2%
At Risk	27.6%	53.4%	24.9%	50.2%	24.1%	50.8%

Figure 16. **Achievement of Students with Grades 9/10 Academic and Applied Mathematics**

However of more interest this year is the transition from the Grade 10 Applied Mathematics course to the Grade 11 MCF3M course, a pathway opened up as a result of the recent revisions to the mathematics curriculum. Last year, no students made this transition. This year, of 8,547 VROGs whose pathways were analysed, 289 students made the transition and 65.7% went on to obtain good grades at college (Table 12). This is clearly a critical pathway for students and we will undertake further investigation of it in CMP 2010.

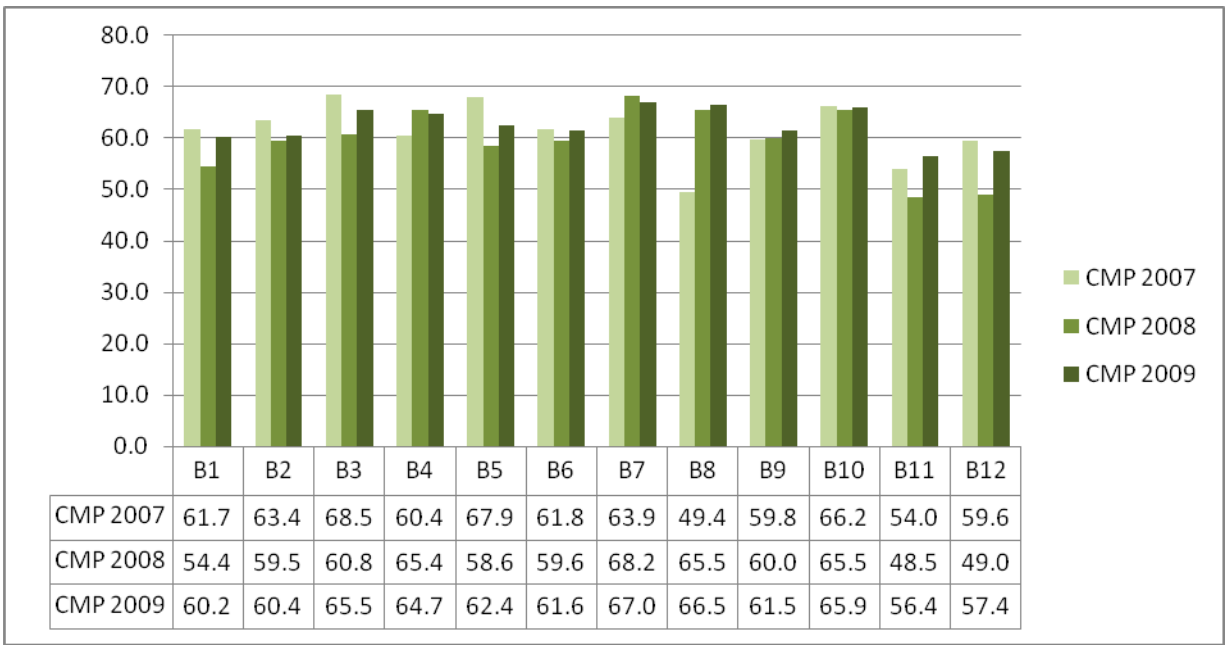
Table 12

Transition from Applied Mathematics to MCF3M (VROGs)

Pathway	TOTAL	# Good Grades	% Good Grades
MFM2P – MCF3M – MAP4C	168	102	60.7%
MFM2P – MCF3M – MCT4C	75	50	66.7%
MFM2P – MCF3M – MDM4U	46	38	82.6%
TOTAL	**289**	**190**	**65.7%**

Mathematics Achievement by School Board and School

While CMP collects information about the graduates of all school boards and their secondary schools, we do not consider inter-board or inter-school comparisons to be of great value, as we lack sufficient contextual information to enable valid interpretation. In this respect, school board data is comparable to college data, in that the most useful analyses will be those undertaken by each board as they drill into the CMP database for information about the numbers and success of their graduates who go to college. In addition, year over year comparisons of each board's results can be of interest (as in Figure 16) though it should be remembered that this is the first year where all 24 colleges have participated. School board data from earlier years may therefore be incomplete and not fully representative. CMP 2007 only involved colleges from the Greater Toronto Area (GTA) and so Figure 17 only includes 12 school boards from this area.



	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
CMP 2007	61.7	63.4	68.5	60.4	67.9	61.8	63.9	49.4	59.8	66.2	54.0	59.6
CMP 2008	54.4	59.5	60.8	65.4	58.6	59.6	68.2	65.5	60.0	65.5	48.5	49.0
CMP 2009	60.2	60.4	65.5	64.7	62.4	61.6	67.0	66.5	61.5	65.9	56.4	57.4

Figure 17. **Change in Achievement (% Good Grades) Over Time by School Board (GTA)**

CMP Database

All of the analyses presented in this chapter have been developed from data views downloaded from the CMP Database, which is available for access by approved representatives of all colleges and school boards[24]. The CMP policy on data confidentiality restricts such access to the user's home college or board and the aggregate data on all colleges and boards. This report has focused principally on province-wide analysis but readers from participating colleges and school boards are encouraged to explore the data in ways that are of specific interest to themselves.

[24] Information on the CMP Database including access policy and procedures are available on the CMP web site (http://collegemathproject.senecac.on.ca).

Chapter 3: What did forum participants have to say?

The CMP methodology ("Deliberative Inquiry") integrates research with deliberation, resulting in recommendations for practice and suggestions for further research. As the CMP matures, the recommendations from one year contribute to changes of practice in the next and the research enables practice to evaluate the efficacy of interventions so that progress can be measured year over year. The CMP forums are the primary venues for the deliberative aspect of the project, though they are not the only ones[25].

This year, the College Mathematics Project, along with Regional Planning Teams of the School/College/Work Initiative, sponsored nine forums across Ontario, as follows.

• Northern Francophone	Collège Boréal, Sudbury	October 20
• Greater Toronto Area	Seneca College, Markham	October 28
• Near North	Cambrian College, Sudbury	October 29
• East Central Ontario	Durham College, Oshawa	November 3
• Northeast Ontario	Northern College, Timmins	November 5
• South East Ontario	Algonquin College, Ottawa	November 12
• South West Ontario	Fanshawe College, London	November 13
• West Central Ontario	Royal Botanical Gardens, Hamilton	November 17
• Northwest Ontario	Confederation College, Thunder Bay	November 20

More than 575 participants from colleges, school boards, the Ministry of Education, the Ministry of Training, Colleges and Universities and several other provincial organisations spent a day at one of these forums to receive the results of the CMP research on mathematics achievement, to share information about initiatives already being undertaken at colleges and school boards to promote student success in mathematics, to hear from students about their personal experiences related to mathematics at school and college and to reflect and deliberate over courses of action to improve student success.

[25] Deliberations also take place at the CMP Steering Committee, at meetings with CMP Ministry partners, in CMP project team meetings, at professional meetings and conferences where CMP team members are invited to present, and in many other contexts.

Each forum was adapted to meet the needs of its stakeholder groups. However, the structure of the day was modeled on a common agenda:

1. Welcome to the CMP Forum – setting the tone and context for the day
2. Presentation of the CMP Research
3. Message from the Ministries
4. Presentation of Promising Practices by Colleges and Boards
5. Student Panel
6. Breakout Sessions for Deliberations – discussions related to guidance, student success, curriculum and teaching, and policy.
7. Reports and Recommendations from Breakout Groups

It is impossible to capture in a summary report all the interesting and significant comments made in over 60 hours of vigorous discussion. The forum reports, including the preliminary CMP research report, copies of "promising practices" presentations, videotapes of student panels and reports of the deliberative sessions are all posted on the CMP website. The conclusions and the recommendations that emerged from them are outlined in chapter 4.

Message from the Ministries

At each forum, officials from one or both Ministries addressed the forum participants, describing the impact of CMP on Ministry activity and policy and outlining some of the initiatives being undertaken by the Ministries to promote student success.

Colleges and School Boards: Promising Practices

Since the College Mathematics Project has been holding forums for four years, some participants from colleges and school boards have been reflecting on the research and deliberations and implementing local action plans in response to the recommendations emanating from the CMP. Others, while not participating in CMP directly or personally, have been aware of the CMP findings from reading the CMP reports or media accounts and have similarly been seeking ways to increase student success. Still others have been working independently, often with the support of the School/College/Work Initiative (SCWI), to address similar problems in their own contexts. We felt that it was useful to share some of these "Promising Practice" experiences at the forums in order to stimulate discussion about ways to implement CMP recommendations.

Since the time available for the sharing of Promising Practices at each forum was limited, some reports were submitted as posters that were displayed during breaks in the forum program

while others were presented "live" during the program. All presentations, posters and reports are summarised here and can be accessed in full on the CMP web site[26].

Northern Francophone Forum

- Collège Boréal: "Round Table Discussion"

Participants from francophone boards and Collège Boréal engaged in a round table discussion to exchange information on a number of subjects including assessment practices, curriculum, teaching methodology, and the use of technology in teaching.

Greater Toronto Area Forum Report

- Dufferin-Peel Catholic District School Board: "Contextualized Learning Activities"

Michelle Oullette presented an overview of how Contextualized Learning Activities (CLAs), which are a requirement of a Specialist High Skills Major (SHSM) program, can contribute to student success. The CLA provides 6 to 8 hours of instruction, where in the examples presented, mathematics is taught in the context of the SHSM. CLAs provide connections to real world applications, which enhance the learning experience. CLAs have been created "in house" and by the Ministry. A potential role for college faculty in the review of existing CLAs and collaboration on the development of new CLAs was identified.

- Humber College: "Predicting a Student's Success at a Post-Secondary Institution"

Rebecca Milburn and Patricia Morgan presented the results of a study investigating the correlation between college math entry placement scores, the final grades in the required college math courses and the final overall grade point average (GPA) of the students that have completed an advanced diploma at Humber College ITAL. The research team is also looking at how to improve placement tests to better identify specific areas of weakness in order to improve student success.

Near North Forum

- Cambrian College: "Business Mathematics with Lyryx"

Cambrian College is using the Lyryx online learning and assessment system for its business mathematics courses. For students, the system provides a personalized on line study guide and algorithmically generated which are instantly graded, providing immediate feedback. For faculty, the system enables the posting of specific course information, assignments, class grades and statistical reports on individual and class performance. Both students and faculty are responding positively to the technology.

- Sault College: "Supporting a Wide Variety of Student Needs"

Sault College examined the secondary school mathematics backgrounds of students in the "Applied Resource" cluster of programs. These results indicated there is a wide range of

[26] http://collegemathproject.senecac.on.ca

backgrounds with a resultant challenge of trying to meet the variety of needs. Building on a problem solving approach to teach mathematical concepts and processes, metacognition, skills and attitudes are strengthened. The college is using MyMath Test software to identify a student's strengths and areas that need improvement. This application aids students by providing step-by step practice tests and on the spot evaluation by identifying areas of difficulty. Students have responded very favourably to the system, citing the value of targeted, self paced learning.

- Near North District School Board: "Using Podcasts for Homework"

Rod Sinclair demonstrated the 'Homework Help' chat room designed for grade 7 to 10 students to ask questions to an online tutor. The tutor will ask leading questions in order to establish the level of understanding, and then assist the student in obtain the answer using an interactive whiteboard controlled by both tutor and student. Homework Help has additional resources such as including 24/7 resources: Best Sessions; examples of commonly asked questions and best solutions given to students over the years, a Locker which archives the individual student's sessions for future reference, Listen & Learn, a series of power point presentations on concepts that students commonly have difficulty with, Interactive Tutorials that provide feedback to students, as well as a Calculator and Glossary.

East Central Ontario Forum

- Kawartha Pine Ridge District School Board:"E-Learning module for delivering the MCT4C1 math course"

Kawartha Pine Ridge DSB has been using the e-learning model for delivering the MCT 4C1 math course to meet the needs of our students since 2007-2008. The board reports a growth in participation rates in MCT4C in both face to face and e-learning delivery models. Improvements have been made to the e-learning course to make it more interactive and student success is improving.

- Loyalist College: "Individualized Learning"

Harvey Hayashi of Loyalist College presented an overview of a teaching method he is using which moves away from the traditional 'Chalk-and-talk' approach to a more individualized learning model using the concepts of Learner-centered education and the work of Maryellen Weimer.

- Trillium Lakelands District School Board: "Metathink"

Shelley Yearley shared how TLDSB is using research and data such as EQAO scores from Grades 6 and 9, marks and participation in Grade 9, 10 and 11 mathematics courses and other board data to construct a "map" that presents the various pieces of data in a novel manner. Guiding questions for teachers and administrators, and short "bites" of research findings are embedded

in the "map" to stimulate discussion and the development of strategies to enhance student success.

- Durham District School Board: "Top five strategies to encourage MCT4C"

The board has developed a "Promising Practices – a top 5 list for MCT math" to assist teachers. The list recommends encouraging students to take the Grade 12 Mathematics for College Technology (MCT4C) course, promoting the e-learning MCT4C course as an option for students, sharing course teaching resources to build capacity, engaging in formal discussions about MCT4C to track progress and to include the colleges in their MCT4C promotion strategy.

Northeast Ontario Forum

- Northern College: "Promising Practices"

Northern College has adopted the Accuplacer computer adaptive testing system in Mathematics and English for all students in order to identify individual strengths and weakness. This enables the college to introduce supportive strategies such as peer tutoring, and provision of online resources to promote success.

- James Bay Lowlands Secondary School Board:"'Promising Practices in Mathematics"

This presentation highlighted the fostering of connections between elementary and secondary schools with the goal of building relationships, improving mathematics instruction and to create excitement for senior mathematics. A secondary school to college transition project focussed on health and wellness was described.

- District School Board Ontario North East: "Promising Practices"

The presentation outlined how the District School Board Ontario Northeast is supporting teachers and students through a variety of strategies, such as "job embedded" professional development, math coaches, hands on learning using manipulatives, using open questions, and parallel tasks. The board seeks to further develop and support Professional Learning Communities between secondary and feeder elementary school teachers to create a support network, to align language and procedural fluency and to promote student success.

South East Ontario Forum

- St. Lawrence College and Queen's University: "SLC - Queen's Math LinQ"

The presentation described a pilot project in which third and fourth year students enrolled in Queen's University concurrent education program with a mathematics teachable were hired as math tutors for first semester St. Lawrence College. The reported outcomes of the pilot included increased student success for the college students and for the education students a greater appreciation and understanding of community college programs and college students.

- St. Lawrence College: "SLC Math Project"

An initiative created by St. Lawrence College which can help to identify areas of difficulty in mathematics. The algorithmic assessment test is administered through the utilization of modules and other resources to prepare first semester students for success in college mathematics. Twenty-two topics for math preparation were identified and to date St. Lawrence faculty have developed modules (available for download) including lessons and questions to address 11 of the topics.

- Algonquin College and Ottawa-Carleton District School Board: "Team Teaching"

This joint presentation was made by the secondary school teacher and college faculty involved in the teaching of a dual credit in Grade 12 Mathematics for College Technology (MCT4C) and Algonquin College's Technical Mathematics (MAT8100). Students experienced both the secondary school and college teaching approach and the teachers noted key differences that might contribute to the "disconnect" between secondary school and college.

- La Cité collégiale : La Cité collégiale : « Promising Practices in Mathematics at La Cité collégiale »

Even before joining CMP, La Cite has been active in working to promote student success in mathematics through appointing a mathematics coordinator for technology programs, implementing a diagnostic math test for new students and supporting students through a summer remedial course and a tutoring program. Since joining CMP, the college has maintained these initiatives and also set up a math help centre.

South West Ontario Forum

- Thames Valley Board of Education: "Montcalm/Hillcrest Transition Program"

A program designed for elementary students transitioning to secondary school which aims to inform students and parents on the various pathway options available for success.

- Fanshawe College: "Best Practices at Fanshawe College: Engaging the Student"

Fanshawe College's Learning Centre provides support for students in a flexible and engaging environment. The "Jumpstart" program, a series of workshops offered in the summer months, is available to all students who are enrolled in a first semester mathematics course. The workshops are designed to provide students who may lack confidence or who have been away from mathematics for some time the opportunity to practices and refresh their skills.

- Fanshawe College: "Communicating with the Regional School Boards"

Mark Henning described a collaboration initiated by Fanshawe College inviting Regional School Boards to share thoughts and ideas on the difficulties / success issues encountered by first year college math students.

West Central Ontario Forum

- Conestoga College: "Requiring MCT4C for Engineering Technology Programs"

This presentation described Conestoga College's experience in requiring Grade 12 Mathematics for College Technology (MCT4C) as the minimum requirement for admission into the Engineering Technology Program, including challenges, secondary school backgrounds of applicants and how Conestoga's Technology Foundations program is preparing students to enter engineering technology programs.

- Mohawk College: "Promising Practices, Mohawk College"

Mohawk College has been working on implementing recommendations from the CMP 2008 Final report, specifically the recommendation pertaining to learning skills and the identification of weaknesses in learning skills and the provision for feedback and support of same. As well, Mohawk faculty have paid careful attention to the research cited on academic and social integration and its importance to student retention. Mohawk has designed "Math Assessment for Success" to identify weaknesses. On line tutorials provide students with an opportunity to practice their skills, receive feedback and to review material at a later date. In addition, Mohawk has launched two new projects using peer tutors: 'Academic & Social Integration' where peer tutors provide assistance in mathematics, as well as an introduction to the college, to first semester students prior to September. The second project, "Keep Free Hour" ensures that students who wished to take advantage of peer tutoring could do so without scheduling conflicts.

- Niagara College: "Math Assessment Project, The Niagara College Experience"

The math assessment diagnostic tool is administered to new students in the first week of class, concentrating on five key mathematical areas. The findings revealed that fractions, percentages and ratio and proportions were the areas in which students had the most difficulty across all areas of studies. The college hopes to use the data to develop targeted strategies aim at increasing student success.

- Sheridan College: "Promising Practices for First Year Mathematics"

The presentation addressed that challenge that remedial math students have gaps in the foundational skills and students were not engaged. The college addressed this challenge by implementing scheduled tutorial sessions for all students. Strategies specific to information technology, engineering technology and skill trades programs were described.

Northwest Ontario Forum

- Confederation College: "Pre-Technology Program"

All first year technology students take a mathematics assessment test which helps identify areas of difficulty and provides various options to help students succeed in their chosen career path. The pre-technology program provides students with a solid foundation in mathematics which will enable them to be successful in a diploma program.

- Thunder Bay Catholic DSB and Lakehead DSB: "Secondary School Perspective"

Three initiatives being undertaken by local school boards were described. "Coaching for Math Teens", funded by the Ministry of Education, provides tutoring aimed at improving student success. A SCWI supported program, "Days of Our Lives" enables math instructors from Confederation College and schools to spend a day in each other's reality. Finally, the "Math Attack Program-Dual Credit" provides access to students taking MCT4C to an online skills assessment test developed by the college. Students can use the results of the assessment to upgrade their skills during the summer prior to entering college in the fall.

Students' Perspectives

This marked the second year the student perspective has been part of the forum program. At each forum, a student panel was held at which students currently enrolled in or recently graduated from college were invited to reflect on their mathematics experiences at secondary school and college, their transition to college, and to offer advice to teachers at both secondary school and college. Students spoke candidly about their experiences and what they thought could be done to address the challenges and barriers they or their peers had encountered. It was clear that the student's comments resonated with forum participants; as with last year, we found the student panel to be a powerful influence on the deliberations which followed.

Each panel was chaired by a student moderator and the moderator was provided with a series of suggested questions for the panel. Members of the forum were invited to ask panellists questions and/or seek clarification on their comments.

Suggested Questions for Student Panels

1. Program motivation, math background and belief:

- What was your secondary school math preparation (courses taken and achievement)?
- What decision(s) led you to your choice of program?
- Before you entered college, how did you view mathematics and what was your belief in your abilities in mathematics?

2. Math assessment practices:

- Did you have to write a mathematics skill assessment in order to be placed in a math course? If so, how did you feel about the experience?
- Were you provided with the results and if so, were they expected or a surprise?
- Were you placed in a preparatory math course as a result of the test?

3. Please tell us a little about the mathematics course you took (or are taking) in first semester:

- Would you describe the content as mostly new and at a higher level of difficulty than that presented in secondary school, or is some/all of the material a repeat of what you studied previously?
- Is/was the course presented in the context of your studies?

- In comparison to your secondary school experience, what are the key differences you noticed with respect to:
    i. Teaching style and methodology
    ii. Assessment practices – type and frequency
    iii. Concrete versus abstract treatment of the material – did you find a more "applied focus" and was this more interesting for you.
    iv. Student rights and responsibilities – e.g. due dates, accommodations, etc.

4. What advice would you give to high school teachers (and guidance counselors) with respect to helping students make the transition to college mathematics?

5. What advice would you give to your college mathematics teachers to help you succeed in math?

The student panel discussions were videotaped in all nine of the Forums and a link to the resulting videos is on the CMP web site[27].

Group Deliberations

The most important component of each Forum is the breakout group deliberations. Once again there were four groups, into which participants were pre-registered to ensure a balance of college and school board participation. The focus of the four groups was as follows:

- Mathematics Content and Teaching Methods
- Guidance & Career Counselling
- At Risk/Student Success Strategies
- Provincial, Boards and Colleges- Policy Discussion

Discussion questions were prepared to stimulate each group's deliberations, however groups were not restricted to the questions provided and were invited to discuss any issues arising from the CMP research or other aspects of the forum. Summary reports of issues raised and recommendations proposed were presented at the concluding plenary session of each forum and are appended to the CMP website. As with previous forums, these reports are the basis for the overall themes and recommendations which are presented in Chapter 4.

[27] http://collegemathproject.senecac.on.ca

Chapter 4: What does CMP 2009 conclude and recommend?

Participants at the CMP forums discussed many issues related to student success in secondary school and college mathematics and came up with hundreds of suggested recommendations (reports of these are all available for review on the CMP website). It would not be useful to repeat all of these here. Rather we shall follow our custom of identifying a small number of broad themes from the forum deliberations, based on the frequency with which the issues were raised and the amount of discussion that they commanded. We have researched each of these themes further, discussed them among the members of the CMP project team, and developed some draft recommendations which have then been reviewed by the CMP Steering Committee.

The themes that have emerged from this year's nine forums overlap (not entirely surprisingly) with those of last year. We have entitled them as follows:

- School Mathematics and Real-World Mathematics
- Focus on Foundations
- Learning Skills Revisited
- Learning: K to Career

School Mathematics and Real-World Mathematics

"I really learned how to multiply and divide fractions when I started working for a carpenter after I left school." (A student at the Northern Ontario francophone CMP forum at Collège Boréal)

"I was motivated to learn calculus when a teacher told me he studied it so that he could track the stock market and make money. So I said: 'teach me all you've got'." (A student at the Greater Toronto Area CMP forum at Seneca College)

"Having the college faculty member team-teach this dual credit course with me showed my students the applications and relevance of the material." (A secondary school teacher at the Eastern Ontario CMP forum at Algonquin College)

Students learn best when they see how the knowledge being presented to them is used in real-life situations. Comments such as those cited above were frequent refrains in student panels

and promising practice presentations at the CMP forums this year. As the CMP seeks to promote ways to increase student success in college mathematics, it has become evident that one of the features of college mathematics teaching is that it usually takes place in the context of a program designed to lead to a specific occupation. Faculty can therefore illustrate the mathematics they teach through examples drawn from occupational situations where the mathematics is being used: in construction technology, accounting, nursing, and so on. One forum was reduced to silence when a nursing student, asked about the possible consequences of her making an error in calculating a dosage of medication, responded simply: "the patient could die."

Mary Brenner and Judit Moschkovich have written about the tensions between two proposals both emanating from the (US) National Council of Teachers of Mathematics (NCTM), one encouraging school mathematics to reflect the practices of academic mathematicians and the other exhorting teachers in school to focus on the mathematical practices encountered in real-world activities[28]. This is not the place to rehearse the complexity of the arguments they explore but it would appear from the comments made at CMP forums that secondary school mathematics is influenced more by academic mathematics and college mathematics more by real-world mathematics – such mathematics includes mathematics used in highly specialized applications. Students have often commented to us that it was only when they became aware of how they might use a mathematical concept that they fully understood it or were motivated to learn it. Teachers of mathematics in secondary school, usually the products of an academic mathematics education themselves, have often never experienced the sorts of occupations for which colleges prepare their students and therefore lack the sort of first-hand experiences from which to draw examples that will engage and challenge their students. Many would likely appreciate the supports that college teachers can provide, as the third quotation (above) illustrates.

Teaching mathematics in the context of real world problems is also one of the principles underlying the senior secondary mathematics curriculum. The Ministry mathematics curriculum policy document for Grades 11 and 12 states: "Mathematical knowledge becomes meaningful and powerful in application. This curriculum embeds the learning of mathematics in the solving of problems based on real-life situations.[29]" Students who are not given sufficient opportunities to apply mathematical concepts to such situations or who have difficulty making

[28] Mary Brenner and Judit Moschkovich (eds.), *Everyday and Academic Mathematics in the Classroom* (Reston, VA: National Council of Teachers of Mathematics, 2002).
[29] Ministry of Education. *The Ontario Curriculum, Grades 11 & 12 – Mathematics* (Toronto: Queen's Printer, 2007), p. 4.

connections between concept and its' application, are ill prepared for college work; as a consequence, achievement and motivation suffer.

From the reports presented at CMP forums, dual credit courses are already helping to improve this situation. Where these are team taught, as in the Ottawa example cited earlier, teachers from schools and colleges can actively learn from each other. The Ministry of Education's Specialist High Skills Major (SHSM) program is also making a difference as the program encourages the development of Contextualised Learning Activities (CLAs) and places an emphasis on the use of essential skills in the context of specific occupational sectors[30].

Based on the comments and recommendations received at the forums, CMP has formulated several recommendations to promote a greater emphasis on real life problem solving in the teaching and learning of mathematics.

1. Secondary school mathematics teachers, and especially teachers of the secondary school college preparation courses, should continue to ensure that a range of examples from real-world mathematics, including examples from specialised workplaces, are included in their teaching and assessment practices. This may require specialised resources and professional learning for teachers.

2. College mathematics faculty should work with secondary school mathematics teachers to ensure the availability in schools of appropriate examples of workplace mathematics. The Coordinating Committee of Vice Presidents Academic (CCVPA) could assign responsibility for this to the colleges' Heads of Mathematics group, who - working with other Heads groups (Business, Technology, Health Sciences etc) – could establish a web site to collect and disseminate these examples.

The next recommendation is repeated from last year's CMP Final Report for three reasons: there has been limited policy discussion of it so far; the need – and successful examples – has been repeated at CMP forums this year; and because it represents another excellent way to increase the presence of everyday mathematics including workplace mathematics in school classrooms[31].

3. The Ontario College of Teachers should require that Faculties of Education provide appropriate experiences in college settings (such as extended visits, internships, teacher

[30] Ministry of Education, Specialist High Skills Majors (www.edu.gov.on.ca/eng/studentsuccess/pathways/shsm/)
[31] Laurel Schollen et al. *College Mathematics Project 2008: Final Report*. (Toronto: Seneca College of Applied Arts & Technology, 2008), pp 42-43.

shadowing, tutoring opportunities, and teaching practice) for all Intermediate/Senior teacher candidates.

The Ministry of Education has already introduced appropriate programs to link students' school learning with workplace skills[32]. Now the opportunities need to be increased and bridges built to the college system.

4. Regional Planning Teams of the School/College/Work Initiative (SCWI) should explore the use of team teaching of dual credit courses in mathematics by college faculty and secondary school teachers as a strategy to increase student success.

The potential of students' incorporation of Specialist High Skills Majors (SHSMs) into their secondary school programs appears to be a good way to increase their subsequent success in college programs. Since SHSMs include Contextualised Learning Activities (CLAs), this affords further opportunity for collaborative work between college-based and school-based mathematics teachers. This would also enhance their mutual understanding and support greater student motivation.

5. College mathematics faculty and secondary school mathematics teachers should jointly develop authentic Contextualised Learning Activities related to sector-specific college programs.

6. Colleges should indicate to prospective students how they recognize the completion of a college program related Specialist High Skills Major.

Focus on Foundations

While most of the suggestions for improving student success focus on actions by secondary schools, colleges and provincial agencies, one area of increasing concern to forum participants affects elementary schools as well. If college faculty members are asked about specific concepts that most often are a problem for students at risk in first semester mathematics courses, the same concepts tend to get repeated time after time, in particular, fractions (especially multiplication and division of fractions), ratio and proportion, percent, among others. The interesting thing about the list of concepts is that they are not concepts taught in Grade 11 or 12 or even in secondary school, but in Grades 5, 6, 7 or 8.[33] It appears that many students – too many – have been taught these concepts at one time and failed to understand them properly. They have then proceeded through mathematics courses in secondary school,

[32] These programs have also been endorsed by an independent research group – Charles Ungerleider, "Evaluation of the Ontario Ministry of Education's Student Success/Learning to 18 Strategy" (Vancouver: Canadian Council on Learning, 2008).

[33] Ministry of Education. *The Ontario Curriculum, Grades 1-8 Mathematics, 2005*. (Toronto: Queens Printer, 2005).

where the teachers tell us there is no time to re-teach concepts taught earlier, until they reach college where either they have to take remedial work at their own expense or risk failure to progress to their chosen occupation.

This observation should not be taken as a criticism of elementary school teachers who undoubtedly do their best to teach these concepts in the grades where they are featured. Rather it is a criticism of the system as a whole – elementary, secondary and postsecondary – that critical concepts that underlie much of school mathematics and the mathematics of specialised work places are not given adequate attention. In particular, teachers at all levels need to help students recognise and build connections between and among mathematics concepts-even if those concepts were introduced in earlier grades. We know that significant numbers of students arrive at college with fundamental concepts either unlearned or only partially learned and these students tend to be those who are most “at risk”.

The need to focus on developing these fundamental mathematical concepts and skills has come up at every forum CMP has ever held and we feel that it is time to address them in this report. And as is often the case, CMP finds that there is much that can be done by a variety of groups to alleviate the situation.

The Ministry of Education, working with math specialists has identified many “big ideas” in the school mathematics curriculum. Prominent among these big ideas is ratio and proportion. Students who have a deep understanding of ratio and proportion are able to work with fractions, decimals and percent, and are able to make critical connections to similarity in geometry; all of these are critical to success in many college programs and the careers for which they prepare students.

7. The Ministry of Education should communicate the results of its work with math specialists to the wider educational community and ensure that research on the most appropriate methods for teaching these particular concepts is made available to teachers in elementary schools.

8. Elementary and secondary school teachers need to ensure that they place special emphasis on the concepts of ratio and proportion wherever these occur in the school curriculum and provide appropriate remediation for students who have not yet mastered them.

9. Student Success Leaders in school boards and secondary schools should ensure that appropriate strategies are in place to support students who are at risk in the area of numeracy.

10. The Ministry of Education should give consideration to ways in which provincial assessment policy (including both EQAO and school-based assessment) can be more effectively used to draw students' and parents' attention to basic numeracy.

We recognise that not all of these recommendations can or should be implemented immediately. Even if consensus about their appropriateness is achieved quickly, it will take at least 2-3 years for their implementation. However we believe that general debate over ways to address fundamental concepts in mathematics should begin now. College students (and likely university students too) will continue to fail or be at risk until they are mastered.

Learning Skills Revisited

The final report of CMP 2008 contained a discussion and several recommendations concerning what are known as "Learning Skills."[34] At the forums held in 2008, we noted a growing awareness that factors beyond students' mathematics backgrounds were also important in relation to student success in college – self-discipline, study and time management skills, ability to work independently, and a personal sense of responsibility for learning, among others.

The comments on the CMP 2008 report appear to have struck a nerve and we have sensed significant movement on the part of many towards greater recognition of the importance of learning skills. Additional research has strengthened our conviction that this is an area for further work. A colleague from Sault College found, in his analysis of student data at that college, that 95% of the students who failed first semester mathematics *also* failed at least one other course. This suggested that there were factors affecting student success generally quite apart from mathematics-related factors. In addition, the research reported in chapter 2 on the relationship between achievement and student age suggests that the acquisition of life skills (which include many of the so-called learning skills) and mature attitudes have a positive impact on college achievement.

These conclusions were strongly endorsed by forum participants. Student panels often contained older students who recounted specific examples of how they had "grown up" after leaving secondary school and how this affected their motivation and approach to learning at college. Active discussion among forum participants over the most important learning skills and how they can best be taught and learned led to consensus over a variety of points that provide us with several recommendations to build on those we proposed last year. Reference was also made to the similarity of the learning skills to employability skills – one college administrator, reviewing the Ministry of Education's list of Learning Skills, commented that these were precisely those skills and attitudes demanded by employers at a recent program advisory

[34] A complete list of Learning Skills is available on the CMP web site (http://collegemathproject.senecac.on.ca/cmp/links.php)

committee he had attended. Unfortunately, the deliberations also reflected widespread misunderstanding of Ministry of Education policy with regard to learning skills.

11. Students at all levels of education (and their parents) should recognize that while their academic coursework may gain them admission to postsecondary institutions, their learning skills will ensure their subsequent success. They should therefore aim to develop these skills to as high a level as possible while in secondary school.

12. Teachers at both schools and colleges should make renewed efforts to integrate the acquisition of learning skills into their courses. Faculties of Education should ensure that methods for this integration form part of pre-service and in-service teacher education for all teacher candidates.

13. Colleges and schools should continue to emphasise the importance of these skills to student success and career development and to communicate this to parents and students.

14. The Ministry of Education should continue to emphasise the importance of learning skills in its policy documents and take more active steps to counter public and professional misperceptions about existing policy in relation to learning skills.

Learning: K to Career

Even when everyday mathematics is part of all secondary school mathematics classrooms, when key foundational topics have been well taught and learned, and when students have acquired all the learning skills they need, there will still be problems for students aiming at a smooth and successful transition from school to college.

CMP forum participants point out:

- that college program admission policies are confusing for schools and students, that they differ from college to college and from program to program, and that neither students, parents, nor guidance teachers know the best way to prepare;

- that each college has its own system of assessments to determine students' readiness for specific programs, systems that are not transparent to students and schools, thus making appropriate preparation of students for college even more difficult;

- that colleges cannot risk the unilateral raising of admission standards to reflect the real requirements of programs in business and technology for fear that this would deter students from applying. This is particularly true of colleges in a highly competitive

situation (such as in the GTA) and of small colleges where many programs are highly dependent on adequate enrolment;

- that those secondary school mathematics courses best suited for successful transition to college mathematics are either university-preparation courses (which MTCU policy does not permit colleges to require of students with the exception of college degree programs) or MCT4C (which is not currently available in sufficient numbers of schools for the majority of students to be able to enroll);[35]

- that, as a result of these factors, many students end up arriving at college academically unprepared for the program they want to take and must either take additional courses in college or remain at risk of not completing their chosen program;

Overall, it has become apparent to us that all of these problems are inter-related, that changes cannot be made in one area without changes being required in another, that individual colleges cannot easily make changes to their own admission policies without similar changes being made by other colleges, that admissions policies at colleges and those at universities are inter-related, that all postsecondary admissions criteria are closely tied to Ministry of Education policies for secondary school curriculum and assessment, that secondary school curriculum policy is largely determined centrally by the Ministry of Education while college and university admission policies are largely determined locally by each college and university, and that – above all – there are no structures or mechanisms in place for joint (K-12 and postsecondary) deliberation over any of these policies or conflicts that may arise among them.

If these internal challenges are not enough, recall the predictions of the labour market outlook, with which we began this report, that call for a very significant increase in the numbers of graduates of postsecondary institutions over the coming decade. We can be fairly sure that many of these will require mathematics as a foundational subject and that both colleges and universities will need to respond to this increased demand.

Until now, we have tended to think about policymaking in the educational system in terms of its separate component parts: the elementary and secondary school system; universities; and colleges with relatively few links between these parts. Indeed, at the postsecondary level, relationships have often been characterized by competition (rather than interdependence and cooperation). We are coming to think, however, that the future effectiveness of the overall system depends on the development of a new vision, new relations, and new ways of strategic planning.

[35] However, as Figure 10 shows, students with high marks in MAP4C can also be successful in college mathematics.

This new vision is not required only to serve Ontario's economic needs; meeting students' aspirations for a seamless and successful passage through the education system into a satisfying career and life demands changes to our traditional views also. Last year's CMP report contained a call for a K-16 perspective on student success. While many at this year's CMP forums endorsed this suggestion, it was also pointed out that a K-16 perspective does not go far enough. We need to measure student success not just by graduation from secondary school (Learning to 18), nor even by successful transition to postsecondary education (K-16), but by the completion of postsecondary education and training programs and successful transition to a career. Postsecondary education is not an end in itself but (for those who take it) yet another step along the way. *Learning: K-Career* should be the new goal for all students and our elementary, secondary and postsecondary systems need to ensure that the avenues for students to reach that goal are as clear and straightforward as possible.

Endorsing such a goal is easy; figuring out the concrete steps needed to be taken by each component part of the educational system is much more complex. While we are tempted to outline our own vision for a renewed system for enabling students to transition from secondary school to postsecondary education – including a new structure for preparatory mathematics courses, a new assessment and modular developmental support systems for those without the recommended background, and a funding model that is aimed at maximizing student success through the transition from secondary to postsecondary education – we realize that to do so would go beyond the CMP mandate. Furthermore, and consistent with the principles of deliberative inquiry, we recognize that having good ideas for improving education is only one goal, the other being the development of a stakeholder consensus that translates into a strong commitment to action. We therefore recommend as follows:

15. The Ministries of Education and Training, Colleges and Universities should create a Provincial Roundtable on Secondary/Postsecondary Transitions to include representation from colleges, universities, school boards and both ministries with a mandate to deliberate and recommend policy changes aimed at ensuring that adequate numbers of appropriately prepared students transition successfully from secondary school to postsecondary institutions.

Ideally, such a Roundtable would not just be a place for exchanging traditional views or defending the status quo. Rather it should be adequately funded to enable it to study successful systems of transition elsewhere in Canada and internationally, publish discussion papers (to engage the broader community in the process), hold consultations, and be required to develop timely recommendations for action at both provincial and institutional levels. If the Roundtable follows a method that is highly consultative and participatory (such as CMP's

deliberative inquiry) it will not only come up with good conclusions, it will build the commitment to act on them as well.

Conclusion

This report has described the processes and conclusions of CMP 2009, including its research on student success in the light of their secondary school mathematics background and the deliberations undertaken in nine forums by over 500 educators from both colleges and school boards.

The commitment and passion showed by forum participants is a reflection of the commitment and passion they (and we) have for students and their success. It is our hope that this report and its recommendations will, in turn, motivate others to work with us as we continue to advocate for the recommendations and to research the mathematics achievement of the next cohort of college students.

Appendix: Technical Notes on Data Analyses

The data analyses shown in this report have all been developed from the CMP Database which is accessible to interested readers from colleges and school boards. However, in order to replicate the analyses, researchers also need to be aware of some of the characteristics of the data-views available there, which affect the analyses contained in this report. The notes in this Appendix are organised by the chapter and table or figure to which they refer.

Chapter 1

Table 3: Based on data view A1. Note that 162 students did not declare a gender.

Table 4: Based on data views A1 and A4. Note that 53 students who took math did not declare a gender.

Table 5: Based on data view A4.

Table 6: Based on data views A2 and A4. Note that 17 ROGs who took math did not declare a gender.

Table 7: Based on data views A3 and A4. Note that 4 VROGs who took math did not declare a gender.

Table 8: Based on data view A1 (CMP 2008) and data views A1 & A3 (CMP 2009).

Chapter 2

Readers should note that, while data views A report numbers of students, data views B report numbers of mathematics grades. Some students take more than one mathematics course, with the result that they show up as 1 in data views A but more than 1 in data views B. Accordingly, data views A1 and A4 show 31,806 students enrolled in a math course, data view B1 shows a total of 31,945 mathematics grades, and data view B2 shows 31,849 students who either have “good grades” or are “at risk.” The notes on the following Figures and Tables make clear the basis for each analysis.

Figure 2: Based on data view B1 (n=31,945)

Figure 3: Based on data view B2 (n=31,849)

Figure 4: Based on data view B2 – Business program cluster (n=9,678)

Figure 5: Based on data view B2 – Technology program cluster (n=14,203)

Figure 6: Based on data view B2 (n=31,849). Data concerning students with good grades and at risk (from Ontario, all ages) was obtained from a special data view provided for CMP staff which is not publicly available. Data in the other sections of this figure were calculated using the "age filter" in data view B2. Note that the VROGs are a subset of the ROGs.

Table 9: Based on data view B2 using the age filter (n=31,849).

Figure 7: Based on data view B2 using the age filter (n=31,796 – 53 did not declare a gender).

Figure 8: Based on data view B2 from CMP 2007, CMP 2008 and CMP 2009 (expanded view showing all colleges, not publicly available).

Figure 9: Based on data view B2 from CMP 2009 only (expanded view showing all colleges, not publicly available).

Figure 10 & 13 – 16 and Tables 10 – 12: The pathways analyses are based on data view C1 filtered for either ROGs (n=21,194, 822 pathways) or VROGs (n=9,698, 604 pathways). The complete data views were first downloaded to an Excel spreadsheet and then reduced to a manageable size by eliminating all pathways followed by fewer than 10 students. All subsequent analyses were based on the data of 19,693 ROGs (169 pathways) and 8,547 VROGs (97 pathways). We are confident that the (approximately) 10% reduction in each of these populations does not impact the resulting analyses significantly. In addition, four colleges were unable to provide data concerning student records from Grades 9 and 10. This is reflected in the smaller overall numbers shown in Figure 16. Both of these factors are likely to impact the data shown in Table 12, which may be an underestimate of the number of students making a transition from MFM2P to MCF3M.

Figures 11 & 12: Based on data view C2

Figure 17: Based on data view D1 from CMP 2007, CMP 2008, and CMP 2009 (expanded view showing all school boards, not publicly available). Note that since data was collected from colleges, data in CMP 2007 and 2008 may not reflect all of the graduates of each school board who went on to college. For example, a graduate of a school board east of Toronto who attended Centennial College would be included in all three years, whereas if that graduate attended Durham College the data would only be included in CMP 2008 and CMP 2009 and if the graduate attended Fleming College, the data would only be included in CMP 2009. This problem will diminish In 2010 since all colleges are now included in CMP.