YSIMSTE

York - Seneca Institute for Mathematics, Science and Technology Education

COLLEGE MATHEMATICS PROJECT 2010

FINAL REPORT

For the

Ontario Ministry of Education

and the

Ontario Ministry of Training, Colleges and Universities

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Preface

Once again, we are pleased to present the annual report of the College Mathematics Project (CMP). In doing so, the CMP team acknowledges the critical work of many individuals and groups whose contributions have enabled the project to operate throughout the year. These include:

- the Ministry of Education and the Ministry of Training, Colleges and Universities for their ongoing support, both financial and professional;
- the CMP Steering Committee, the college Vice-Presidents, Academic and the CMP College Leads, who have ensured that CMP had the data with which to conduct its research;
- the School/College/Work Initiative (SCWI), whose Regional Planning Teams have organised forums at which CMP research has been shared with school and college educators;
- Seneca College's Information Technology Services (ITS) department, especially John Meskes, Mehrdad Ziaei and Mohsen Rezayatmand, who have enabled the CMP data to be assembled, analysed and displayed.

2010 is the second year in which the CMP has included all 24 colleges in Ontario. This report is therefore an interim report on the project's overall program of research and deliberations concerning student success in college mathematics. As in the past, we see the achievement of this goal as a shared responsibility, with schools, colleges, government, and students all having a part to play. We therefore commend our research for further deliberations over ways all these groups can contribute to improvements.

Le présent 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.

CMP 2010 included all 24 colleges and 72 district school boards in all regions of the province. It was 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.

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 2010 research analysed the secondary school and college records of almost 95,000 students who enrolled in all college program areas in fall 2009. Of these, over 35,000 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 CMP 2010 research include the following:

- 68.6% of students achieved good grades (A, B or C) in first-semester college mathematics, while 31.4% were considered to be “at risk” (having received a D or F or having withdrawn from the course). This percentage (of good grades) represents an improvement from 67.0% last year and 64.6% the year before.
- Of the Very Recent Ontario Graduates – those who have taken the most recently revised mathematics curriculum in secondary school – 64.1% of the males and 71.0% of the females achieved good grades.
- Second Career students achieved better than other students: 83.1% of males and 87.0% of females achieved good grades.
- Graduates of French-language school boards attend English- and French-language colleges in approximately equal numbers; their mathematics achievement in both types of college is very similar.
- Older students, particularly females, achieve significantly better than younger students: 66.2% of males and 89.3% of females aged 50 and over obtained good grades.

- Patterns of achievement analysed according to secondary school mathematics pathways follow similar patterns to those found in the past:
  - Many more students came to college with MAP4C than MCT4C in Grade 12 but their achievement was lower overall. The same applies to MBF3C and MCF3M in Grade 11.
  - However students with high marks in MAP4C do well in college mathematics; 78.6% of those with 80% and over in MAP4C obtained good grades in college.
  - Over 3,000 students in our sample took no mathematics after Grade 11; only 50.8% of those who took MBF3C as a terminal course achieved good grades in college mathematics.
  - The numbers of students transferring from Grade 10 Applied Mathematics to MCF3M is increasing each year from 0 in 2007 to 289 in 2008 to 665 in 2009. 62.9% of these students go on to obtain good grades in college mathematics.
- Research began this year into students taking one-year "foundation" programs at college and some important preliminary results were observed:
  - A sharp increase in both the numbers of foundation programs and enrolment in them took place in fall 2009 (enrolments up 33% overall and up 22.4% in mathematics compared with fall 2008).
  - 10% of all first-year college students were enrolled in foundation programs and a further 10% take preparatory mathematics courses as part of regular programs.
  - Mathematics achievement across different foundation programs varied significantly, with 73.7% of pre-health students, 61.7% of pre-business students, but only 45.9% of pre-technology students obtaining good grades.
  - CMP analysis of a small number of foundation program mathematics courses showed that they share a common emphasis on the mathematics skills required for college diploma programs and the occupations for which these programs prepare students. In this respect, they are similar to the diploma-level mathematics courses but contrast with secondary school mathematics courses which have a broader range of emphases. The skills featuring most prominently in college foundation mathematics courses include many of those originally taught in elementary school.

The CMP 2010 report concludes with some reflection on themes and recommendations from the past two years, comments on progress made, and suggestions for ways forward. This part of the report is organised into three aspects of the overall strategy for supporting student success in college mathematics: articulation, alignment, and integration.

Articulation refers to the ways in which the structures of secondary and postsecondary education provide for a smooth and successful transition of students from one sector to the other. The School/College/Work Initiative (SCWI) has for many years been an important means for promoting improved articulation between schools and colleges, particularly in its work of enabling dual credit courses. But CMP forums over the years have identified a number of articulation issues that call for a broader forum for discussion and for making concrete the vision of student success from Kindergarten through elementary, secondary and postsecondary education to career entry. To this end, last year the CMP proposed a Provincial Roundtable on Secondary/Postsecondary Transitions, an idea that has now been endorsed by Colleges Ontario. The CMP report also argues for the need for a permanent tracking system for students moving through the various levels of education based on the work initiated by CMP.

Alignment refers to the need for the curriculum and instructional systems of secondary and postsecondary education to be sufficiently coordinated that students can move smoothly and successfully from one to the other. The CMP's work in analysis of students' secondary school mathematics backgrounds has been aimed at helping to improve alignment, as is our current work in the analysis of foundational mathematics courses at college. This has revealed the much more intensive emphasis on mathematical skills in college courses than is the case at the secondary school level and the need for students to reach high standards in the required skills in order to be assured of success in college programs. This analysis is ongoing and the CMP will report further on this in its report next year. In the meantime, further dialogue between secondary school and college mathematics teachers continues to be of great value.

Integration is the third strategic component of the overall strategy for student success in college. For several years, CMP has highlighted the crucial importance of Learning Skills in the successful integration of students into postsecondary education. We believe that it is the good development of these skills that enables older students – and Second Career students in particular – to be more successful than younger students in first semester mathematics. We have noted a growing awareness amongst all stakeholders of this importance but we also note the need for more research and development in the areas of the acquisition and assessment of these skills at both secondary and postsecondary levels.

Overall, the CMP is encouraged by the progress being made by students entering college. However if the increased postsecondary targets contained in the Open Ontario Program are to be realised, we believe that more attention (in both policy and practice) to articulation, alignment and integration issues is required.

Recommendations

1. *The Government of Ontario should follow up on its announcement of the Open Ontario program by establishing the proposed Roundtable on Secondary/ Postsecondary Transitions, by monitoring student achievement in relation to these transitions, by supporting continuing stakeholders' deliberations concerning increased student success, and by undertaking a public awareness campaign aimed at encouraging all students to plan to obtain postsecondary education and training.*
2. *The CMP should undertake further research into the content and emphasis of initial mathematics courses at the college level; further research should also be extended to the secondary school level to enable clear conclusions to be drawn concerning the alignment of college mathematics with elementary and secondary mathematics in Ontario schools.*
3. *The CMP should seek information and commentary from all stakeholders in mathematics education on the subject of alignment in order to provide clear advice to the Ministry of Education when the mathematics curriculum is next revised.*
4. *Teachers of mathematics at secondary school and college increase their efforts to understand each other's curriculum and instructional methods, so as to support students' successful transition from school to college.*
5. *Ministries, Colleges and Schools should continue to give prominence to the importance of the acquisition of learning/employability skills by students through further consideration of policies concerning recording and reporting, together with professional development, and communications to students, parents and the public.*
6. *Given its importance to student success and retention at postsecondary level, the Higher Education Quality Council of Ontario should sponsor further research addressing promising practices in the acquisition and assessment of learning/employability skills at postsecondary institutions.*

Chapter 1: Introduction to the College Mathematics Project

Postsecondary education is increasingly recognized as an important driver of both the social and economic progress of a country or province. From the economic perspective, Canada needs highly trained citizens to fill positions in the developing knowledge economy. From the social perspective, Canadians need to be confident that they have the skills required for employment in the 21st century[1].

In response to this economic and social imperative, the Ontario Government has recently announced its "Open Ontario Plan[2]." An important component of this plan – entitled "Investing in Postsecondary Education" – calls for increasing of the proportion of Ontarians with a postsecondary education from the present level of 62% to 70%, a significant increase. While the details of the plan have yet to be spelled out, it is evident, first, that if Ontarians' skills and the jobs of the future are to be well matched, increased enrolments will be required at both universities (baccalaureate and graduate degree programs) and at colleges (diploma, certificate and baccalaureate degrees)[3]. It is also clear that students' mathematics and language skills are among the keys to their success in many of these postsecondary programs and that individual skill shortages in these areas will thus have negative consequences, first for students themselves, and second for Ontario's economic prosperity.

King and his colleagues found that, in 2007, 81.5% of new students at Ontario universities and 43.8% of those at Ontario colleges entered postsecondary education directly from Ontario secondary school[4]. Yet, until recently, there has been little systematic research on the success of Ontario secondary school graduates as they transition to the postsecondary system or on the reasons for their success (or lack of it). The College Mathematics Project – and more recently, the College English project – are the first and (to date) the only systematic monitoring studies of this transition, the success of which is critical to achieving the targets identified in the Open Ontario plan.

The College Mathematics Project (CMP) was initiated at Seneca College in 2005 because of increasing awareness within many colleges too many students were either failing or barely passing their first semester college mathematics courses and this in turn affected graduation rates, one of five Key Performance Indicators the government instituted in 1988 to enhance the

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[1] For a recent analysis of the economic and social importance of postsecondary education in Ontario, see Rick Miner, *People Without Jobs, Jobs Without People,* (Toronto: Miner Management Consultants, 2010).

[2] Government of Ontario. *Open Ontario Plan: 2010 Ontario Budget Papers* (Toronto: Queen's Printer for Ontario, 2010), pp. 6-8.

[3] Mario Lapointe et al. *Looking Ahead: A 10-year Outlook for the Canadian Labour Market (2006-2015)*. (Ottawa: Human Resources and Social Development Canada, 2006), p. 41.

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

accountability of colleges and to measure college performance. 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.[5] In 2008, the project expanded, this time to include 50,000 students at 11 colleges in four regions of the province[6]. Since 2009, CMP has achieved full coverage of the province, it now includes all 24 colleges and 72 district school boards, and analyses the records of over 90,000 students. CMP also collects data for the newly established College English Project[7]. CMP 2010 is the second year in a three-year sequence of studies, in which all 24 colleges in Ontario have participated. In that respect, this report is an interim report. At the same time, each year of the CMP has also been complete in itself and has built on those of earlier years.

CMP Goals and Methodology

The goals of the College Mathematics Project have remained unchanged from the outset:

- 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. For example, CMP 2010 has seen additional research questions being explored concerning "second career" students, graduates from French-language schools, and preparatory or foundational mathematics courses – all topics that have arisen in deliberations of previous years. At the

[5] The second pilot study in 2006 and CMP 2007 were supported by the Connecting GTA Teachers regional planning team of the School/College/Work Initiative.

[6] 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.

[7] Full information about the College Mathematics Project is available on the CMP web site: http://collegemathproject.senecac.on.ca. For information about the College English project, contact Laurel Schollen.

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.

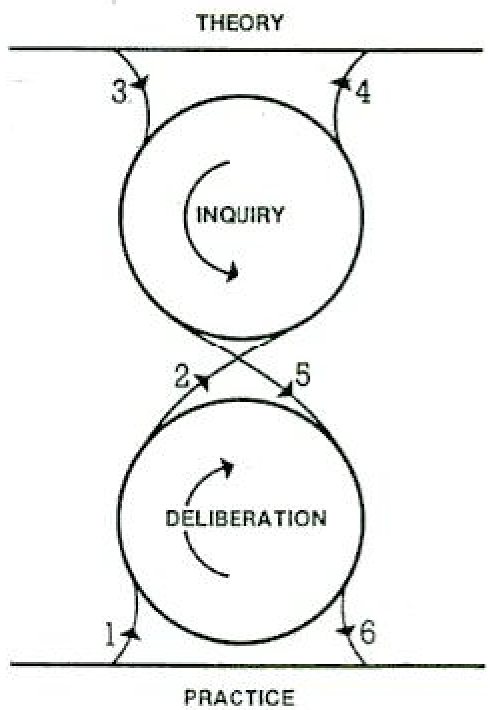

Figure 1. **Deliberative Inquiry - the CMP Methodology**

The CMP is directed by a steering committee comprised of representatives of the supporting Ministries, and provincial organizations related to colleges and secondary schools[8]. This committee met three times during 2010 and once in early 2011: its first meeting in January approved the research questions for the CMP to address during 2010; the second (in June) focused on the ways in which the recommendations of CMP 2009 were being (and could be) implemented; the October meeting discussed the preliminary results of the CMP 2010 research; and the final meeting (in January 2011) reviewed the first draft of this report and set preliminary research plans for CMP 2011.

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 Information Technology Services department. All data used

[8] 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.

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[9]. 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.

Following data collection and analysis this year, three regional forums were held in fall 2010 and four more are planned for the winter and spring of 2011[10]. Forum participants discussed the implications for their own areas of practice of the CMP research as presented in the CMP backgrounder. Because the forums are being organised in a different manner from that of the past, this year's CMP report is focused more on this year's data and emerging trends, and on progress being made in relation to the themes and recommendations from past forums, than on "conclusions" from the forums currently taking place.

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 2009 – 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 2009, were:

A. *PARTICIPATION*

A1. What are the numbers of students in our sample, by college, gender, and program cluster? (with course type and age filters)

A1f. As (A1) but for graduates of French language boards only (also by region).

A2. What are the numbers of students under the age of 23 (December 31, 2009) and who are graduates of Ontario secondary schools (ROGs) by college, gender, and program cluster? (with course type and age filters)

[9] 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.

[10] This year, the forums have been organised and funded entirely by the Regional Planning Teams (RPTs) of the School/College/Work Initiative (SCWI) with CMP providing professional support as required.

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 (VROGs)? (with course type and age filters)

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? (with course type, gender and age filters)

A4a: What are the features of first semester mathematics courses designated as “preparatory”, “remedial’, “foundational,” and “diploma-level” and how can CMP best describe the trends in participation and achievement in these courses?[11]

A5. What are the overall numbers of students (ROGs only) from each school board by college, gender and program cluster?

A6. What are the overall numbers of “second career” students in our sample, by college, gender, and program cluster (with course type and age filters).

B. COLLEGE MATH ACHIEVEMENT

B1. What is the mathematics grade distribution for ROGs, non-ROGs and VROGs, by college, gender, and program cluster? (With age, gender and course filters)

B2. What are the percentage of students achieving a “good passing grade” (A, B, C) and “at risk” (D, F, W) for ROGs, non-ROGs and VROGs by college, gender, and program cluster? (With age, gender and course filters)

B2f. As (B2) but for graduates of French language boards only (also by region)

B3. What are the percentage of students achieving a “good passing grade” (A, B, C) and “at risk” (D, F, W) for “second-career” students (with age, gender, and course filters).

C. SECONDARY SCHOOL MATHEMATICS BACKGROUNDS

C1. What are the numbers of students taking each secondary school mathematics pathway and what % of these achieve good grades or are at risk in college? (with filters for student types ROGs and VROGs and college course type).

[11] This research question was added late in the year

C1f. As C1 but for students from French language boards only.

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? (with filters for age, gender, school course and college course type).

C3. What is the profile (gender, college, program cluster) of students following selected pathways? (with filters for student type <ROGs and VROGs> and college course type)

D. COLLEGE ACHIEVEMENTS BY SCHOOL BOARD AND SCHOOL

D1. What are the percentage of students with a "good passing grade" (A, B, C) and "at risk" (D, F and W) from each district school board? – also broken down by secondary school? (with filters for student type <ROGs and VROGs> and college course type)

D2. What are the % of students enrolled in college-level courses and preparatory courses from each district school board? (with filters for student type <ROGs and VROGs> and college course type)

This report includes the highlights of research results relating to these questions from a provincial perspective. More detailed results, particularly as they relate to specific colleges and school boards, can be found on the CMP interactive database, which is accessible from the CMP web site[12].

College Programs and Grading 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[13]. 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. The CMP uses Ministry of Training, Colleges and Universities (MTCU) program codes to organise 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"

[12] http://collegemathproject.senecac.on.ca/cmp/en/research.php

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

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[14].

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

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[15] and 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.

[14] Program cluster and college grading policy information is available for review at the CMP website: http://collegemathproject.senecac.on.ca/cmp/links.php
[15] Laurel Schollen et al. *College Mathematics Project 2007: Final Report*. (Toronto: Seneca College of Applied Arts & Technology, 2008), pp 10-13.

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

Mathematics Courses and College Programs

The programs selected for detailed study in the CMP all have mathematics scheduled in the first semester of the college curriculum[16]. While most students entering college take the regular curriculum of their chosen program, an increasing number of students in all colleges are taking alternate programs in order to prepare them for their desired occupation-focused program. In some cases, students are required to take these foundational programs; in others they are advised to take them following assessments – usually in mathematics and language – taken after admission; in still other cases, students choose to take a foundational program (such as a pre-technology, pre-business, or pre-health science program) because they are not yet decided which career direction to take. In some colleges, particularly in the Greater Toronto Area, preparatory mathematics courses are used where skills assessment tests suggests that students would benefit from such courses.

There are therefore a growing number of students taking a mathematics course in first semester that would not normally be classified as a “college-level” mathematics course. While CMP continues to collect data on student achievement in all courses, both college-level and preparatory, it has become quite difficult to interpret these data without additional information about the substance of the mathematics courses involved. For this reason, we added to the list of research questions in CMP 2010 a question (#A4a) that explores the features of these various types of mathematics course and the basis for students being selected to take such courses.

[16] 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.

The results of this initial exploration may lead us to collect more data on a system-wide basis in CMP 2011 or at least to clarify the enrolment and achievement data already being collected. The results of this exploratory investigation are reported in chapter 3 of this report.

CMP 2010 Student Cohort

The student cohort that has been studied in CMP 2010 entered college in the fall of 2009. 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. The tables also include comparisons with the fall 2008 cohort as reported in last year's CMP report[17].

Enrolment by Program Cluster and Gender

The 24 colleges participating in the CMP 2010 offer a total of 2,559 postsecondary programs[18] in which over 94,000 students are enrolled (Table 3). This represents an 11.5% increase in the number of programs and a 12.1% increase in enrolment over fall 2008. The increased enrolment appears to be smaller in the Business cluster than in the other program clusters.

Table 3.
Programs & Enrolments, Fall 2008 and Fall 2009 by Program Cluster

	Fall 2008		Fall 2009		Change 08-09	
Cluster	**Programs**	**Enrolment[19]**	**Programs**	**Enrolment**	**Programs**	**Enrolment**
Applied Arts	936	40,828	1,041	46,405	11.2%	13.7%
Business	387	13,680	421	14,468	8.8%	5.8%
General	191	10,331	220	11,482	15.2%	11.1%
Technology	782	19,157	877	21,792	12.1%	13.8%
TOTAL	**2,296**	**83,996**	**2,559**	**94,147**	**11.5%**	**12.1%**

Table 4 shows the number of programs with first semester mathematics courses and the enrolments in those courses. There has been a similar increase in enrolment in mathematics courses in 2009 over 2008. Of note is the increase in the numbers of programs with mathematics courses in the General cluster – most of which are foundational programs – and in the numbers of students enrolled in them. This is explored further in chapter 3.

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[17] Graham Orpwood et al. *College Mathematics Project 2009: Final Report* (Toronto: Seneca College of Applied Arts & Technology, 2010), pp. 18-21.

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

[19] The fall 2008 data for total enrolment as reported in the CMP 2009 final report is now considered to be an under-estimate because of some data collection problems at two colleges. The figures reported here have been adjusted in order that the percentage year-over-year increase is not overestimated.

Table 4.

Programs with 1st Semester Mathematics and Enrolments, Fall 2008 & Fall 2009

	Fall 2008		Fall 2009		Change 08-09	
Cluster	**Programs**	**Enrolment**	**Programs**	**Enrolment**	**Programs**	**Enrolment**
Applied Arts	65	2,625	76	2,871	16.9%	9.4%
Business	269	9,678	293	10,100	8.9%	4.4%
General	92	5,336	118	6,204	28.3%	16.3%
Technology	620	14,167	691	16,115	11.5%	13.8%
TOTAL	**1,046**	**31,806**	**1,178**	**35,290**	**12.6%**	**11.0%**

The gender split in all programs (Table 5) and in mathematics courses (Table 6) follows a pattern that we have observed for the past three years. The percentage of males in all programs (50.1%) and in mathematics courses (64.3%) is very similar to those reported last year (49.3% and 63.4% respectively). As has been noted in other years, the percentages based on gender do not total 100% since some students do not declare a gender.

Table 5.

Overall Enrolments by Gender, Fall 2009

Cluster	M	F	Total	M	F	Total
Applied Arts	17,013	29,276	46,405	36.7%	63.1%	**99.8%**
Business	7,231	7,209	14,468	50.0%	49.8%	**99.8%**
General	4,815	6,610	11,482	41.9%	57.6%	**99.5%**
Technology	18,121	3,617	21,792	83.2%	16.6%	**99.8%**
TOTAL	**47,180**	**46,712**	**94,147**	**50.1%**	**49.6%**	**99.7%**

Table 6.

Mathematics Enrolments by Gender, Fall 2009

Cluster	M	F	Total	M	F	Total
Applied Arts	1,064	1,800	2,871	37.1%	62.7%	**99.8%**
Business	5,316	4,767	10,100	52.6%	47.2%	**99.8%**
General	2,485	3,692	6,204	40.1%	59.5%	**99.6%**
Technology	13,815	2,264	16,115	85.7%	14.0%	**99.8%**
TOTAL	**22,680**	**12,523**	**35,290**	**64.3%**	**35.5%**	**99.8%**

The higher proportions of males enrolled in mathematics reflect their higher enrolment in Technology programs. By contrast, females outnumber males in the Applied Arts cluster where relatively few programs include mathematics courses.

Enrolment by Student Type

In reporting data for students who undertook first-semester mathematics in fall 2009, CMP has defined a variety of sub-groups, which appear in the analyses contained in this report. Readers should therefore note the following definitions:

Recent Ontario Graduates (ROGs): Students under the age of 23 (as of December 31, 2009) and having an Ontario Secondary School Diploma (OSSD). These students are those whose secondary school mathematics backgrounds are analysed. Others – "non-ROGs" – include older students or those whose secondary education is from outside Ontario. While we still have data for ROGs and non-ROGs available in the CMP database, the analyses displayed in this year's backgrounder does not show them separately.

Very Recent Ontario Graduates (VROGs): ROGs whose most recent Grade 12 mathematics course is recorded since September 1 2007[20]. This group of students is assumed to have followed the most recently revised Ontario mathematics curriculum. It should be noted that this group is significantly larger this year than it was last year, which was the first year that graduates of the revised curriculum entered college.

Direct Entry Students: VROGs whose OSSD has been awarded since January 1 2009.

Second Career Students: Students designated as such on their college admission documentation.

Table 7.
Mathematics Enrolment by Student Type

Cluster	All Math	ROGs	VROGs	Direct Entry	2nd Career
Applied Arts	2,871	1,886	948	508	147
Business	10,100	6,341	3,953	2,311	659
General	6,204	4,046	2,056	1,010	196
Technology	16,115	9,881	6,942	3,783	1,634
TOTAL	**35,290**	**22,154**	**13,899**	**7,612**	**2,636**

Table 7 shows the mathematics enrolments analysed by each student sub-group. The VROG group is significantly larger this year than in CMP 2009 as more students had followed the revised mathematics curriculum in Fall 2009 than in Fall 2008. These sub-groups are identified

[20] By defining this group in terms of the date of their most recent Grade 12 mathematics course, we inadvertently omitted those students who have followed the revised mathematics curriculum through secondary school but who did not take a Grade 12 mathematics course. Nevertheless, we have chosen to retain the current definition for CMP 2010 in order to maintain comparisons with CMP 2009. This definition will be reconsidered in CMP 2011.

separately here as their mathematics achievement is also analysed separately, as reported in the following chapter.

Enrolment of French-Language Students

While the CMP database does not include records of students' mother tongue, it does include information relating to the (Ontario) school board from which they graduated. For the past two years, CMP research has examined the college enrolment and mathematics achievement of the graduates of Ontario's French-language school boards. While many of these enroll in programs at the province's two French-language colleges, many also participate in programs at the 22 English-language colleges. In this report therefore, we use the term "francophones" to refer to the graduates of Ontario French-language school boards. We recognize that the French-language colleges (particularly La Cité collégiale) enroll other French-language students (from Québec, for example) but these are not included in the following analyses.

Table 8.
Francophone Enrolment by Program Cluster and Language of College: Fall 2008 and Fall 2009

	Fall 2008			Fall 2009			Change 2008-2009		
	F	**E**	**Total**	**F**	**E**	**Total**	**F**	**E**	**Total**
Applied Arts	780	481	1,261	779	602	1,381	-0.1%	25.2%	9.5%
Business	158	147	305	174	152	326	10.1%	3.4%	6.9%
General	113	115	228	121	140	261	7.1%	21.7%	14.5%
Technology	362	321	683	407	351	758	12.4%	9.3%	11.0%
TOTAL	**1,413**	**1,064**	**2,477**	**1,481**	**1,245**	**2,726**	**4.8%**	**17.0%**	**10.1%**

Note: F and E refer to French- and English-language colleges respectively.

Table 8 shows the overall enrolment of francophones by program cluster and language of college. It shows, first, that in fall 2009, 54.3% of francophones are enrolled in programs at French-language colleges and 45.7% at English-language colleges. It also shows that this represents a 10.1% increase from Fall 2008 but that this increase favours the English-language colleges significantly. In addition, the total college enrolment of 2,726 francophones represents 2.9% of the first semester college enrolment, a smaller proportion than the 4.1% of francophones in the Ontario 2006 census population.

Table 9 shows the mathematics enrolments of francophone students in both French- and English-language colleges, by program cluster. The table shows a 19.6% increase in mathematics enrolment from 2008 to 2009, and this time, the French-language colleges show the larger increase. These increases are particularly marked in the General and Technology program clusters at the French-language colleges.

Table 9.
Mathematics Enrolment of Francophones by Program Cluster and Language of College: Fall 2008 and Fall 2009

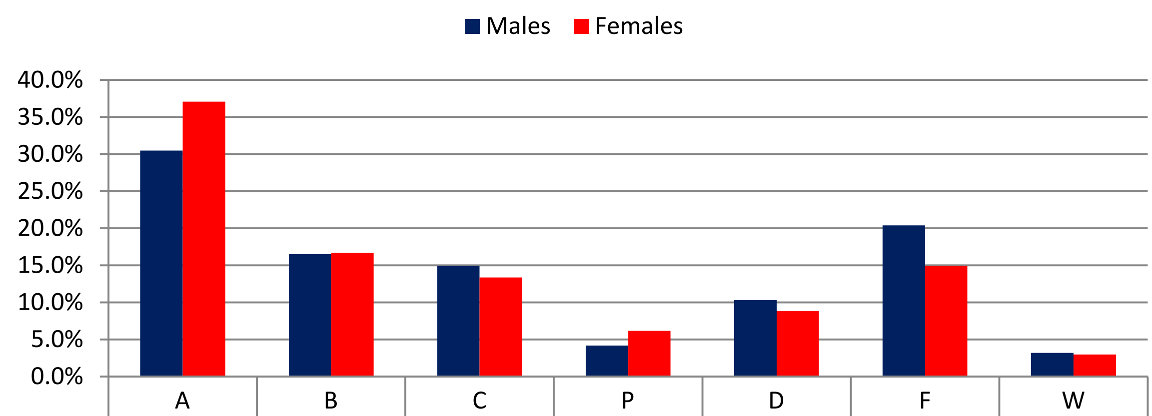
	Fall 2008			Fall 2009			Change 2008-2009		
	F	**E**	**Total**	**F**	**E**	**Total**	**F**	**E**	**Total**
Applied Arts	0	34	34	0	44	44	0.0%	29.4%	29.4%
Business	94	78	172	106	88	194	12.8%	12.8%	12.8%
General	64	65	129	86	85	171	34.4%	30.8%	32.6%
Technology	209	259	468	278	273	551	33.0%	5.4%	17.7%
TOTAL	367	436	803	470	490	960	28.1%	12.4%	19.6%

Note: F and E refer to French- and English-language colleges respectively.

The mathematics achievement of francophone students in both English- and French-language colleges is described in chapter 2.

Chapter 2: College Mathematics Achievement in Fall 2009

Since the main focus of the College Mathematics Project (CMP) has always been the mathematics achievement of first semester college students, it is inevitable that accounts of the CMP research results are very similar year after year. At the same time, we are constantly looking for new insights and new ways to analyse and display these data; we hope that our regular readers will note that this year's presentation has a number of notable differences from past years. In this report we have made a special focus on gender, on the variety of new subgroups of students that were defined in chapter 1, and most particularly on the changes in the achievement data between the Fall 2008 cohort (the first year for which the CMP included all 24 colleges) and the Fall 2009 cohort.



	A	B	C	P	D	F	W
Males	30.5%	16.5%	14.9%	4.2%	10.3%	20.4%	3.2%
Females	37.1%	16.7%	13.3%	6.2%	8.8%	14.9%	3.0%

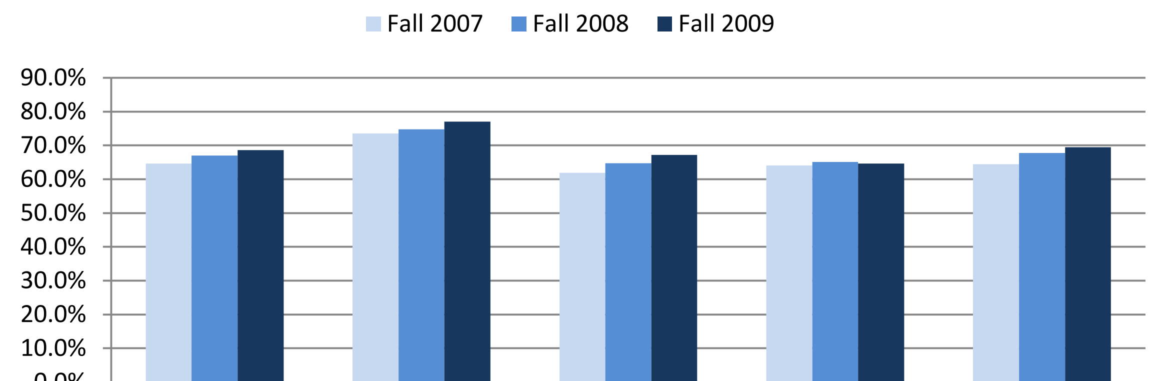
***Figure 2*. Mathematics Grade Distribution, Males and Females, Fall 2009 (n=35,384)**

Figure 2 presents the mathematics grade distribution for both males and females in the cohort of students entering college in Fall 2009[21] for all programs. The general shape of this display is similar to that presented in previous years. However this year we note that females outperform males, obtaining A grades more frequently and F grades less so. In other respects, the bimodal distribution (with peaks at A and F grades) shown in Figure 2 is a characteristic we have observed every year. As in the past, for all of the subsequent analyses, we cluster the grades as shown in Table 2 (in chapter 1) into Good Grades (A, B, C & P) and At Risk (D, F, or W).

[21] Readers should note that the total number of students shown in a particular figure (designated by "n") varies somewhat from table to table. This variation is largely because: (a) some students take more than one mathematics course and thus show up more than once, which appears to inflate the numbers; and (b) some students do not declare a gender, thus appearing to reduce the overall numbers.

Achievement by Program Cluster

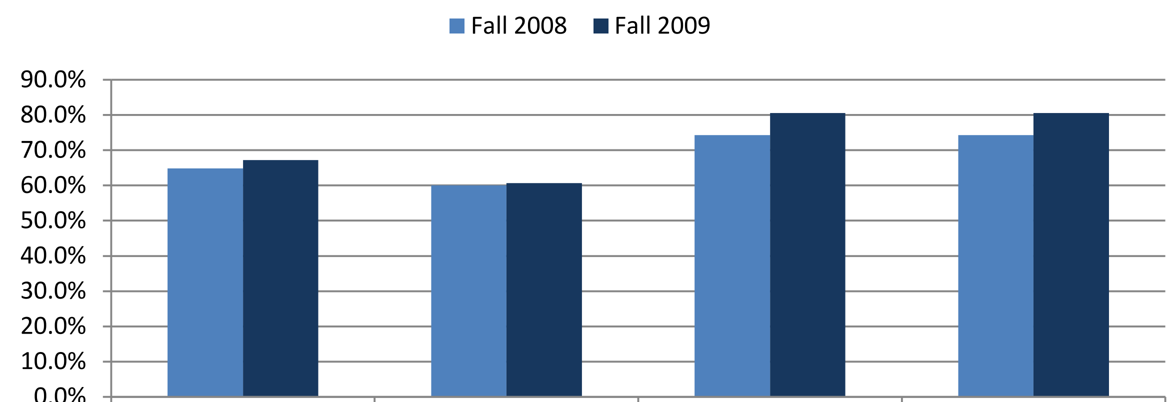
Figure 3 shows the mathematics achievement (in terms of the percentage of students achieving good grades) in the four major program clusters over the past three years. While the CMP 2008 (Fall 2007) study included only 11 of 24 colleges, the results are presented to emphasize the overall progress that has been made in student achievement over time. While only 64.6% of students in Fall 2007 obtained good grades, this proportion rose in Fall 2008 to 67.0% and again this year to 68.6%, a steady year-over-year improvement.



	All Programs	Applied Arts	Business	General	Technology
Fall 2007	64.6%	73.5%	61.9%	64.0%	64.5%
Fall 2008	67.0%	74.8%	64.8%	65.2%	67.8%
Fall 2009	68.6%	77.1%	67.2%	64.7%	69.5%

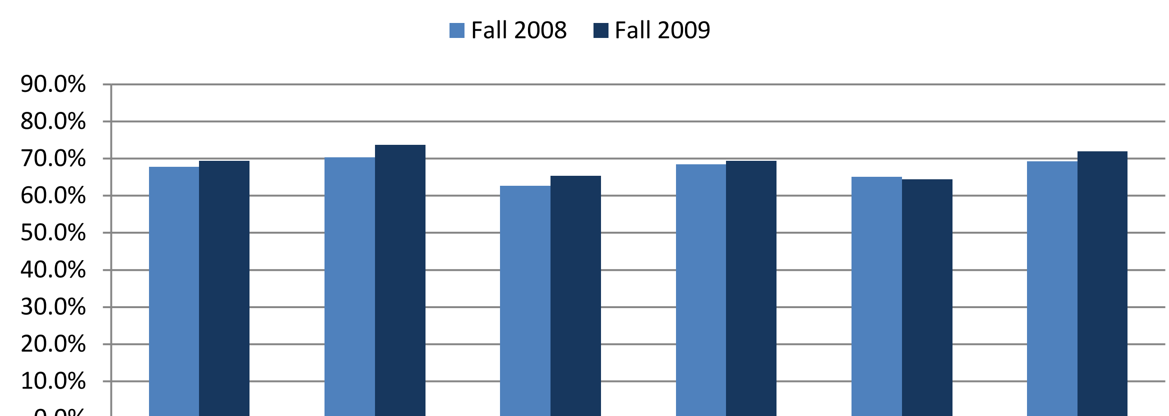
***Figure 3*. Achievement (% Good Grades) by Program Cluster, Fall 2007, Fall 2008, & Fall 2009**

As before, there is very little difference in achievement levels between the major clusters. However, the sub-clusters tell a somewhat different story, with greater variation among them, as is shown for the Business sub-clusters (Figure 4) and the Technology sub-clusters (Figure 5). Compared with Fall 2008, all the Business sub-clusters showed significant improvement and as did all the Technology sub-clusters with the exception of the Electrical sub-cluster.



	All Business	Finance	Bus. Admin.	Office
Fall 2008	64.8%	60.0%	74.3%	74.3%
Fall 2009	67.2%	60.7%	80.6%	80.6%

Figure 4. **Achievement by Business sub-clusters, Fall 2008 and Fall 2009**

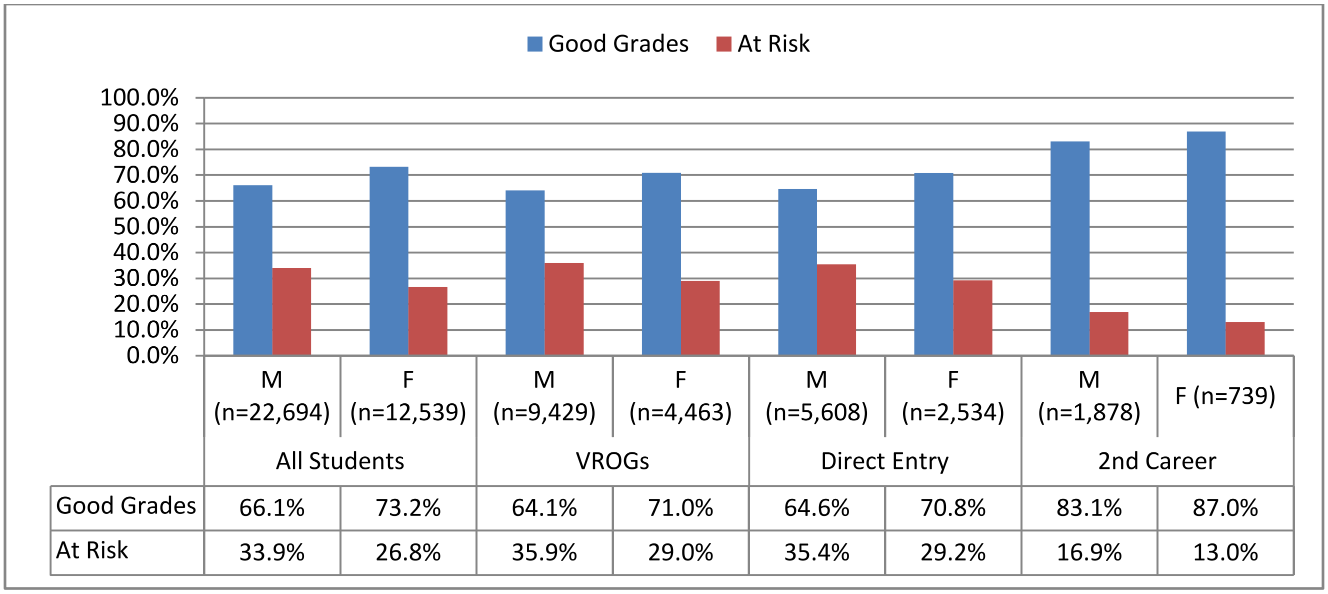


	All Technology	Applied Science	Computer	Construction	Electrical	Mechanical
Fall 2008	67.8%	70.4%	62.7%	68.5%	65.1%	69.3%
Fall 2009	69.5%	73.6%	65.3%	69.4%	64.4%	71.9%

Figure 5. **Achievement by Technology sub-clusters, Fall 2008 and Fall 2009**

Achievement by Student Type and Gender

In Chapter 1, a series of sub-groups of students was defined and the numbers of each were shown in our overall Fall 2009 cohort. Figure 6 compares the mathematics achievement of each group and shows, once again, that females out-perform males in each group but that there is little overall difference among the total student group, the very recent Ontario graduates (those who had taken the new curriculum through secondary school), and the direct entry students.



	All Students		VROGs		Direct Entry		2nd Career	
	M (n=22,694)	F (n=12,539)	M (n=9,429)	F (n=4,463)	M (n=5,608)	F (n=2,534)	M (n=1,878)	F (n=739)
Good Grades	66.1%	73.2%	64.1%	71.0%	64.6%	70.8%	83.1%	87.0%
At Risk	33.9%	26.8%	35.9%	29.0%	35.4%	29.2%	16.9%	13.0%

Figure 6. **Achievement by Student Type and Gender**

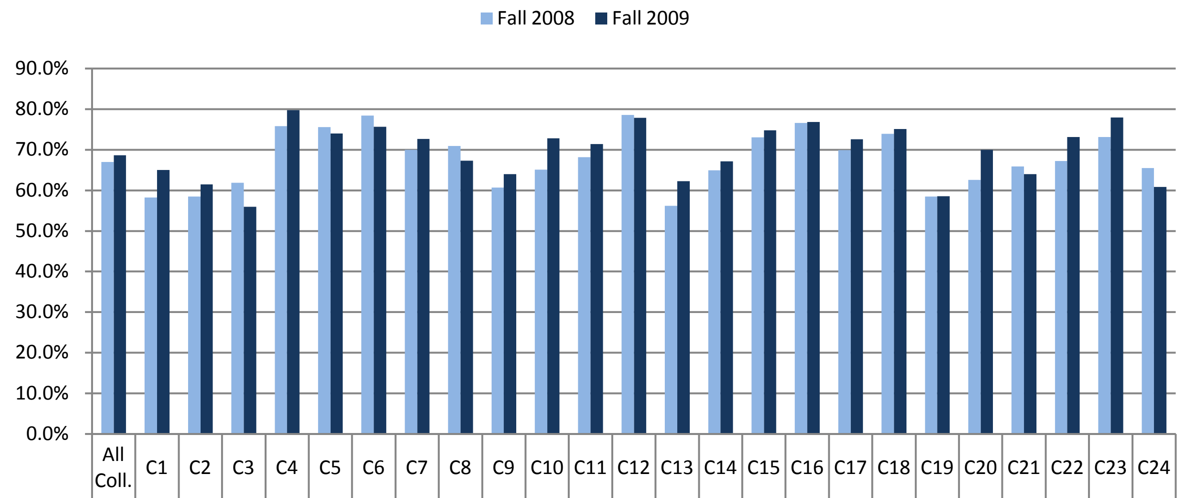
However, the Second Career students achieved significantly higher grades than any of the others[22]. The Second Career program was designed by the Ministry of Training, Colleges and Universities to provide laid off workers with skills training to assist them in finding employment in high demand occupations. Individual received government grants to support them in their studies. Since most members of this group have probably been out of school for some time, this is a result of particular interest. It should certainly stimulate further deliberation over the factors that affect achievement in college mathematics most significantly.

Achievement by College

Figure 7 shows mathematics achievement for the past two years aggregated to the college level[23]. It reflects the general increase in achievement noted earlier, in that 18 of the 24 colleges also show an improvement. However, two years of system-wide data are not sufficient to establish clear trends and, since each college has a unique mix of programs and serves a unique community, we cannot make too much of differences among colleges. Over time these data will become more meaningful, particularly at the individual college level.

[22] Note that the numbers of second career students presented in this report do not include those enrolled in Academic Upgrading programs.

[23] As is our practice, and in accordance with the CMP data protection policy, individual colleges are not identified by name. Rather, representatives of each college can examine their own data in much more detail through accessing the CMP database.

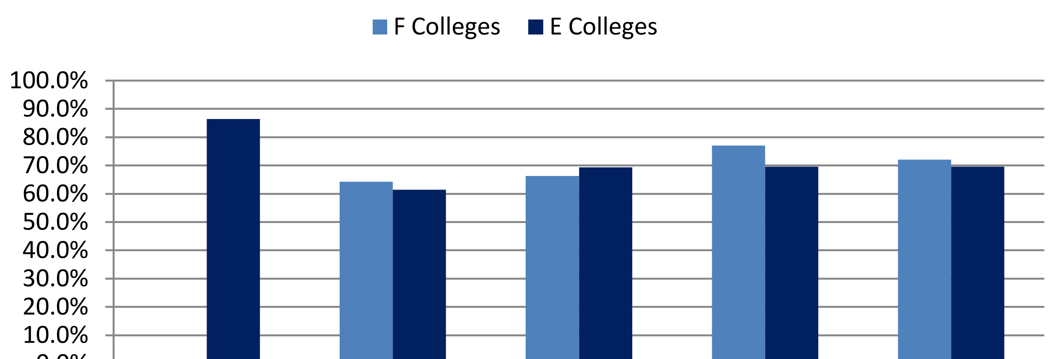


	All Coll.	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24
Fall 2008	67.	58.	58.	61.	75.	75.	78.	70.	70.	60.	65.	68.	78.	56.	64.	73.	76.	69.	73.	58.	62.	65.	67.	73.	65.
Fall 2009	68.	65.	61.	55.	79.	74.	75.	72.	67.	64.	72.	71.	77.	62.	67.	74.	76.	72.	75.	58.	70.	64.	73.	77.	60.

***Figure 7*. Achievement by College, Fall 2008 and Fall 2009**

Achievement of Francophone Students at English- and French-language Colleges

As noted in chapter 1, graduates of French-language school boards in Ontario go to both English and French-language colleges in approximately equal numbers. As Figure 8 shows, the mathematics achievement (shown as the percentage of those achieving Good Grades) of the two groups of students is also approximately the same. Note that there are no students enrolled in mathematics in Applied Arts programs in the French-language colleges.



	Applied Arts	Business	General	Technology	TOTAL
F Colleges	0.0%	64.2%	66.3%	77.0%	72.1%
E Colleges	86.4%	61.4%	69.4%	69.6%	69.6%

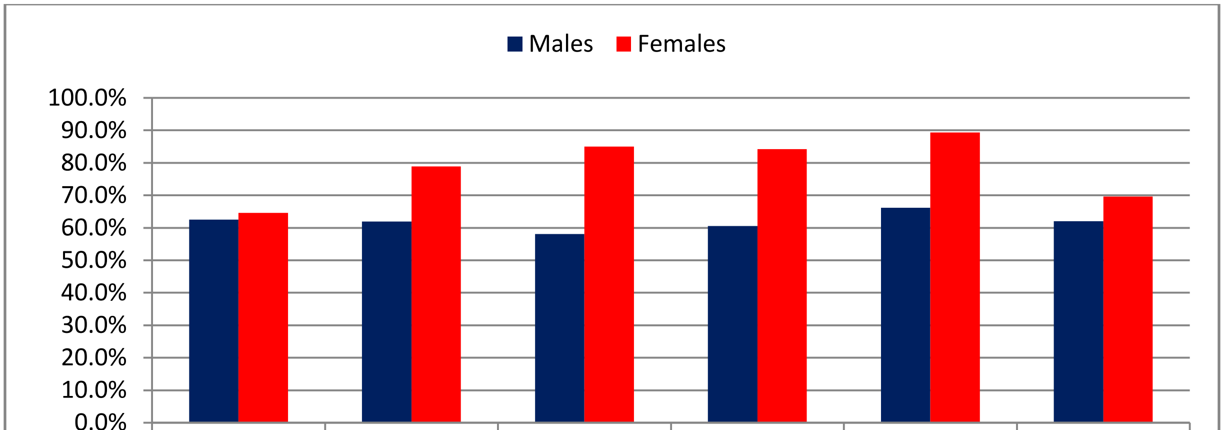
***Figure 8*. Achievement of Francophone Students in English- and French-language Colleges, Fall 2009**

Achievement by Age and Gender

The analyses shown in Figures 2 and 6 as well as those shown in last year's report suggest that there is a systematic variation in achievement by both age and gender. Table 8 and Figure 9 illustrate this variation. Table 10 also demonstrates the capacity of the CMP database to "filter" achievement data by age, so that the achievement of all students of a particular age can be determined. Achievement is shown here as the actual numbers and percentages of students obtaining "Good Grades" (GG) and those who are considered to be "At Risk" (AR).

Table 10
Achievement by Age and Gender

	Total	Math	GG	AR	%GG	%AR	M	F
Under 17	45	15	10	5	66.7%	33.3%	66.7%	60.0%
17	277	68	50	18	73.5%	26.5%	76.2%	69.2%
18	17,532	6,817	4,642	2,178	68.1%	31.9%	78.8%	56.3%
19	21,846	8,317	5,258	3,064	63.2%	36.8%	64.9%	67.0%
20	13,004	4,680	2,901	1,787	61.9%	38.1%	63.2%	69.0%
21	8,147	3,038	1,934	1,108	63.6%	36.4%	61.5%	70.6%
22	5,773	2,144	1,449	697	67.5%	32.5%	59.9%	74.1%
Under 23	**66,624**	**25,079**	**16,244**	**8,857**	**64.7%**	**35.3%**	**62.5%**	**64.6%**
23	4,125	1,536	1,105	432	71.9%	28.1%	62.6%	74.2%
24	3,151	1,147	861	286	75.1%	24.9%	62.4%	80.1%
25	2,385	889	674	217	75.6%	24.4%	60.4%	80.6%
26	1,805	638	480	159	75.1%	24.9%	65.2%	80.7%
27	1,535	589	464	126	78.6%	21.4%	59.5%	83.9%
28	1,206	438	326	113	74.3%	25.7%	60.3%	78.2%
29	964	336	262	74	78.0%	22.0%	60.5%	80.5%
23-29	**15,171**	**5,573**	**4,172**	**1,407**	**74.8%**	**25.2%**	**61.9%**	**78.9%**
30	853	295	236	59	80.0%	20.0%	61.0%	86.0%
31	805	283	228	55	80.6%	19.4%	57.3%	85.1%
32	692	252	208	44	82.5%	17.5%	53.4%	85.1%
33	654	259	214	46	82.3%	17.7%	55.4%	83.3%
34	641	243	204	39	84.0%	16.0%	56.7%	88.9%
35	631	253	212	41	83.8%	16.2%	67.1%	85.2%
36	609	208	174	34	83.7%	16.3%	57.8%	83.0%
37	584	215	179	36	83.3%	16.7%	55.1%	84.2%
38	593	227	186	41	81.9%	18.1%	56.0%	85.3%
39	545	206	168	38	81.6%	18.4%	60.8%	83.3%
30-39	**6,607**	**2,441**	**2,009**	**433**	**82.3%**	**17.7%**	**58.1%**	**85.0%**
40	483	184	154	30	83.7%	16.3%	62.1%	82.9%
41	497	186	156	30	83.9%	16.1%	55.5%	87.3%
42	440	179	146	33	81.6%	18.4%	60.3%	80.6%
43	406	159	133	27	83.1%	16.9%	61.7%	87.9%
44	477	188	152	36	80.9%	19.1%	56.6%	82.5%
45	450	188	147	41	78.2%	21.8%	61.0%	82.6%
46	392	153	127	26	83.0%	17.0%	64.3%	86.5%
47	382	160	134	26	83.8%	16.3%	62.7%	87.7%
48	347	126	99	27	78.6%	21.4%	59.6%	85.1%
49	327	111	88	23	79.3%	20.7%	65.5%	78.9%
40-49	**4,201**	**1,634**	**1,336**	**299**	**81.7%**	**18.3%**	**60.6%**	**84.2%**
50 & over	**1,544**	**563**	**470**	**93**	**83.5%**	**16.5%**	**66.2%**	**89.3%**
TOTAL	**94,147**	**35,290**	**24,231**	**11,089**	**68.6%**	**31.4%**	**62.0%**	**69.6%**



	Under 23 (n=25,079)	23-29 (n=5,573)	30-39 (n=2,441)	40-49 (n=1,634)	50 & over (n=563)	TOTAL (n=35,290)
Males	62.5%	61.9%	58.1%	60.6%	66.2%	62.0%
Females	64.6%	78.9%	85.0%	84.2%	89.3%	69.6%

***Figure 9*. Achievement (% Good Grades) by Student Age and Gender (n=35,290)**

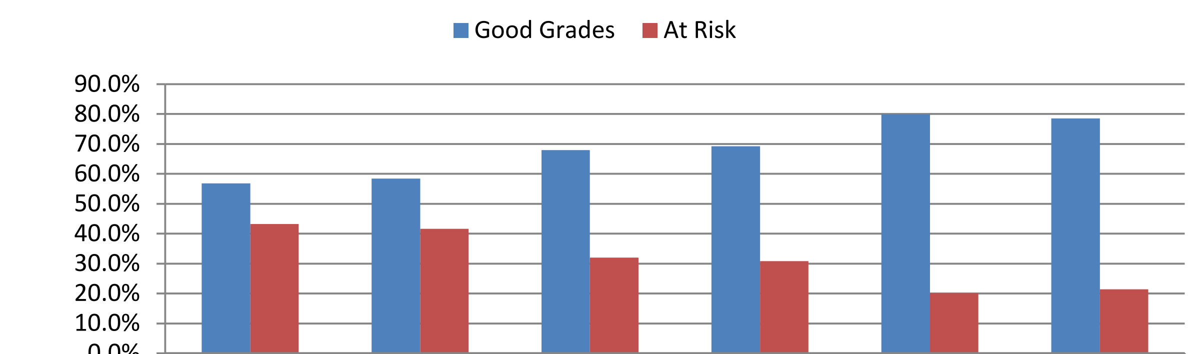
Figure 9 summarizes the same data in five age groups and also shows the percentages of males and females in each age group achieving Good Grades. As was found last year, females outperform males at each age level. Readers should note that the representation of males and females is not equal in all clusters. For example, 85.7% of the students enrolled in mathematics in the technology cluster were male, while 62.7% of the applied arts mathematics enrolments were by females. Refer to table 6 for mathematics enrolments by gender. However last year's analysis showed male achievement increasing with age in a similar manner to that of the females, while this year male achievement appears to be relatively flat compared with the steady increase in female achievement with age.

We would welcome comments on this surprising finding. In general, CMP forum participants have attributed increased achievement with age to the well developed life skills (or learning skills) that older students bring to their postsecondary education, but this does not account for the gender disparity seen in this year's data. It would be interesting to know if researchers in other jurisdictions and those who have studied student achievement at universities have found similar results. In the meantime, we shall await next year's data to see if this year or last year was unusual. We would also be interested to know if readers have experience of gender differences in the use of academic support systems at the college level, which might also help to explain these results.

Secondary School Mathematics Background

One of the features of the CMP research that has attracted much attention each year has been the analysis of achievement based on students' different pathways though the secondary school mathematics curriculum. In fact, since the final reports have only offered a small sampling of the pathways data, and there was so much interest on the part of readers, CMP published a second report last year focusing exclusively on the achievement of students who had taken various pathways through secondary school mathematics and who went on to a variety of college programs. The *Pathways Analysis Report* is based on the data from Fall 2008 and is freely available for download from the CMP web site.[24] The data displayed here is from the Fall 2009 cohort and is based entirely on the VROG group – those students who have followed the most recently revised mathematics curriculum in secondary school.

Grade 12 Mathematics Courses



	MAP4C		MCT4C		any 12U	
	Fall 2008 (n=4,857) 56.8%	Fall 2009 (n=6,935) 54.8%	Fall 2008 (n=989) 11.6%	Fall 2009 (n=1,380) 10.9%	Fall 2008 (n=2,701) 31.6%	Fall 2009 (n=4,255) 33.6%
Good Grades	56.8%	58.4%	68.0%	69.2%	79.9%	78.6%
At Risk	43.2%	41.6%	32.0%	30.8%	20.1%	21.4%

Figure 10. **Achievement of VROGs with various Grade 12 mathematics courses[25]**

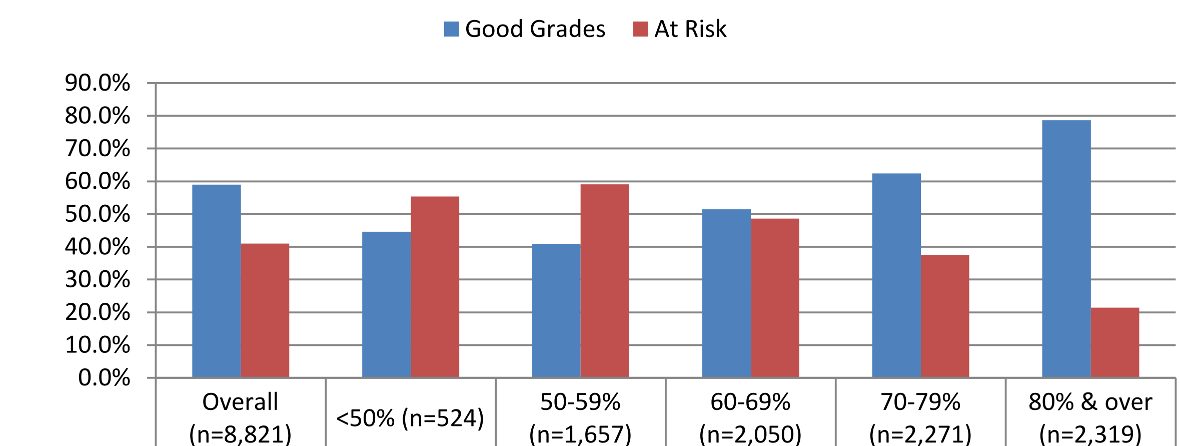
[24] http://collegemathproject.senecac.on.ca

[25] 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.

Figure 10 shows the college mathematics achievement of students whose highest Grade 12 mathematics course was MAP4C, MCT4C, or any 12U course. MAP4C and MCT4C are both designated as college preparation courses. The largest number of students in our sample (6,935 – 54.8% of the total) came to college mathematics with MAP4C and a much smaller number (1,380 – 10.9%) came with MCT4C as their highest Grade 12 mathematics course. A sizeable number (4,255 – 33.6%) came to college with a Grade 12 U mathematics course (of which MDM4U was the most common).

The pattern of achievement among students with these three backgrounds is the same as in previous years. Good grades in college mathematics were obtained most often by those with the 12U course(s), followed by MCT4C. The course most frequently chosen in Grade 12, MAP4C, led to much lower levels of achievement in college mathematics (only 58.4% obtained good grades). It is ironic that the English name of the MAP4C course is "Foundations for College Mathematics", although at the time of the last curriculum revision, there was no CMP data to inform that course revision process[26].

Students' levels of achievement in these courses also makes a difference in how they perform in first semester college mathematics, as the data shown in Figures 11 and 12 demonstrate.



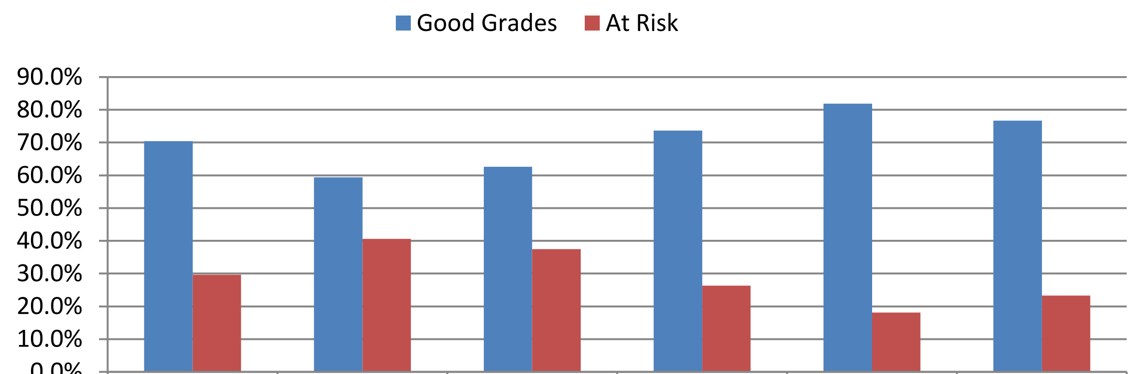
	Overall (n=8,821)	<50% (n=524)	50-59% (n=1,657)	60-69% (n=2,050)	70-79% (n=2,271)	80% & over (n=2,319)
Good Grades	59.0%	44.7%	40.9%	51.4%	62.4%	78.6%
At Risk	41.0%	55.3%	59.1%	48.6%	37.6%	21.4%

***Figure 11*. College Mathematics Achievement by MAP4C Marks**

In Figure 11, college mathematics achievement (% Good Grades and % At Risk) is shown as vertical bars for groups of students whose achievement in MAP4C fell into various ranges of marks (shown on the horizontal scale). This shows that students who obtain high marks (such

[26] Interestingly, the French language version of the curriculum gives the same course a different title, "Méthodes de Mathématiques," which does not imply its suitability as preparation for college mathematics.

as 80% or better) in MAP4C perform well in college mathematics. This is an important point as many students do not have easy access to MCT4C as schools report that it is often not offered because of shortages in enrolment. The much lower college achievement of those with lower school mathematics marks (50-69%) suggests that simply having an MAP4C credit is no guarantee that those students are adequately prepared for college mathematics.



	Overall (n=2,395)	<50% (n=451)	50-59% (n=601)	60-69% (n=623)	70-79% (n=591)	80% & over (n=129)
Good Grades	70.4%	59.4%	62.6%	73.7%	81.9%	76.7%
At Risk	29.6%	40.6%	37.4%	26.3%	18.1%	23.3%

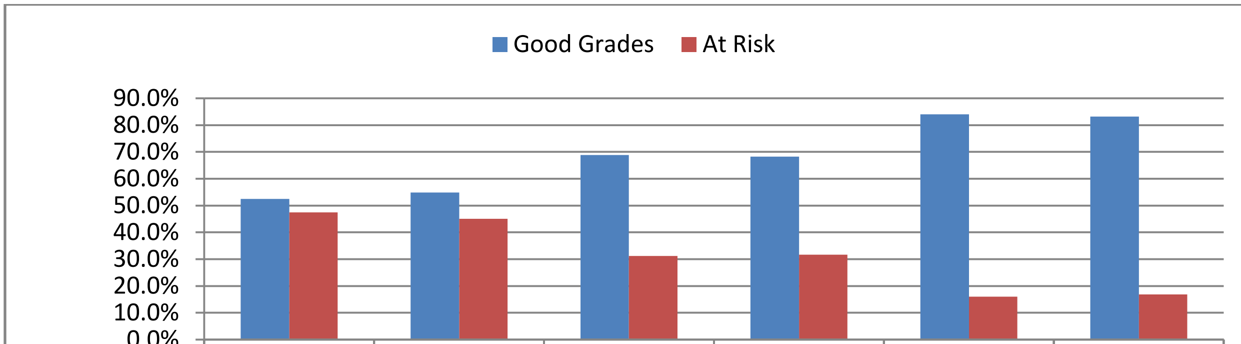
***Figure 12*. College Mathematics Achievement by MCT4C Marks**

Figure 12 shows a similar analysis for students who took MCT4C. This analysis confirms our conclusion from other years that MCT4C is a generally good preparation for college mathematics. Gender analysis of these data shows the same pattern of achievement as in earlier displays. Females outperform males at each level of each course. It should be noted that, while Figures 11 and 12 present similar analyses, they are not directly comparable as the courses MAP4C and MCT4C are quite different courses and also because the data in Figure 11 represents students from broad range of college programs whereas in Figure 12 over 70% are from technology programs.

Grade 11 and 12 Mathematics Courses

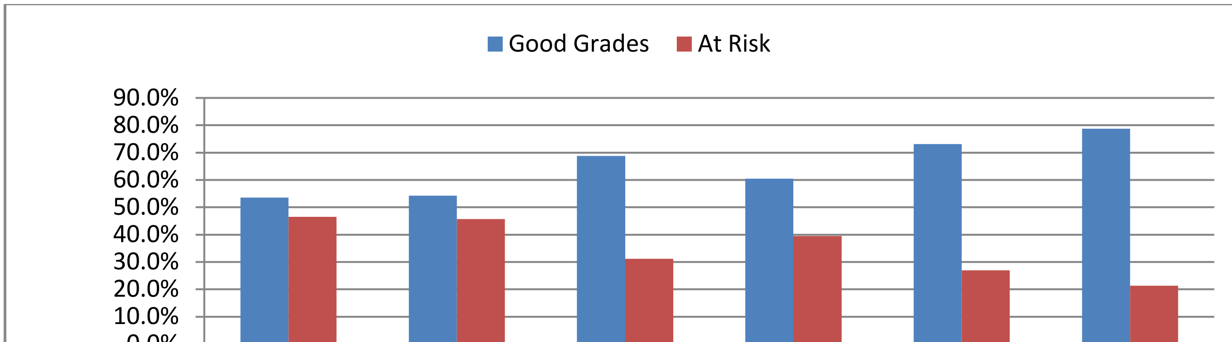
At one of the earliest CMP forums, it was suggested that while the Grade 12 data was interesting, the combined Grade 11 and 12 data might be equally so. We have therefore identified the most commonly followed mathematics pathways in Grades 11 and 12 and presented the achievement data in Figures 13, 14 and 15. Three pathways are shown corresponding to the most common college preparation sequences. These are: MBF3C & MAP4C; MCF3M & MCT4C; and MCR3U & any 12U course.

Figure 13 shows the college mathematics achievement for students in all programs who have followed one of these pathways in secondary school; Figure 14 shows the same for students in Business programs; and Figure 15 shows the same for students in Technology programs. Data for both Fall 2008 and Fall 2009 cohorts are shown.



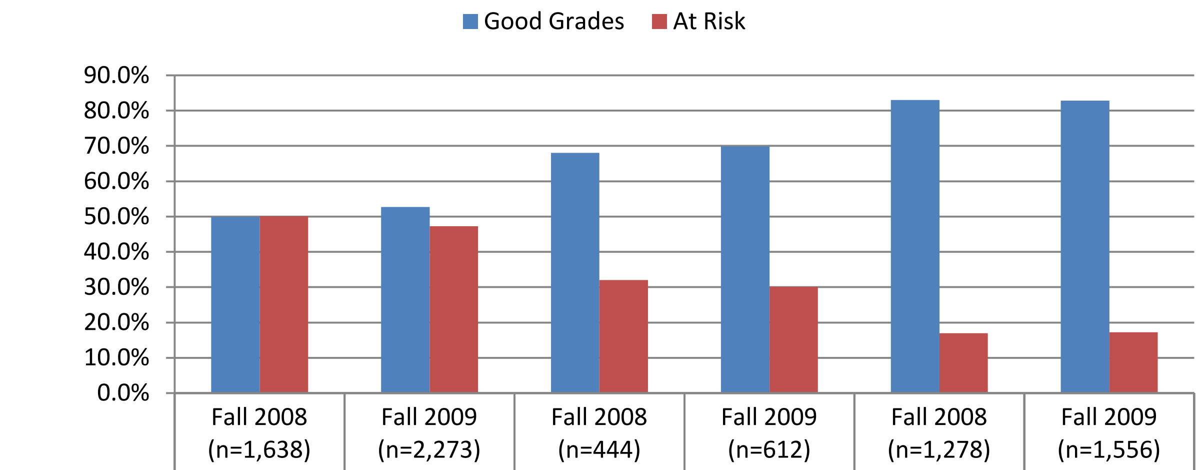
	MBF3C + MAP4C		MCF3M + MCT4C		MCR3U + any 12U	
	Fall 2008 (n=3,445) 40.3%	Fall 2009 (n=4,859) 38.4%	Fall 2008 (n=600) 7.0%	Fall 2009 (n=884) 7.0%	Fall 2008 (n=1,846) 21.6%	Fall 2009 (n=2,897) 22.9 %
Good Grades	52.5%	54.9%	68.8%	68.3%	84.0%	83.2%
At Risk	47.5%	45.1%	31.2%	31.7%	16.0%	16.8%

***Figure 13*. College Mathematics Achievement of Students (All Programs) by Grades 11 & 12 Courses**



	MBF3C + MAP4C		MCF3M + MCT4C		MCR3U + any 12U	
	Fall 2008 (n=1,031)	Fall 2009 (n=1,382)	Fall 2008 (n=95)	Fall 2009 (n=162)	Fall 2008 (n=874)	Fall 2009 (n=784)
Good Grades	53.5%	54.3%	68.8%	60.5%	73.1%	78.7%
At Risk	46.5%	45.7%	31.2%	39.5%	26.9%	21.3%

***Figure 14*. College Mathematics Achievement of Students (Business Programs) by Grades 11 & 12 Courses**



	MBF3C + MAP4C		MCF3M + MCT4C		MCR3U + any 12U	
	Fall 2008 (n=1,638)	Fall 2009 (n=2,273)	Fall 2008 (n=444)	Fall 2009 (n=612)	Fall 2008 (n=1,278)	Fall 2009 (n=1,556)
Good Grades	49.9%	52.7%	68.0%	69.9%	83.0%	82.8%
At Risk	50.1%	47.3%	32.0%	30.1%	17.0%	17.2%

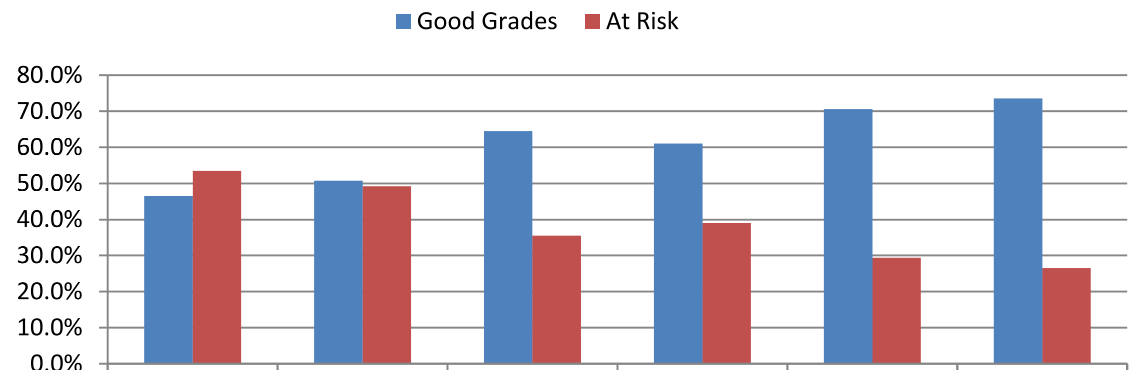
***Figure 15*. College Mathematics Achievement of Students (Technology Programs) by Grades 11 & 12 Courses**

These figures show that the most commonly followed (MBF3C-MAP4C) pathway is no better a preparation for college mathematics in Business programs than it is in Technology programs. While the MCR3U-12U pathway clearly shows the highest achievement results, this is not a pathway that can be required for college admission[27] nor is it a pathway to be recommended for all students. We discuss this dilemma for both policy and practical decisions in chapter 4. Readers interested in other combinations of Grade 11 and 12 courses and the subsequent college mathematics achievement of students in various program areas at the college level can find this information in the CMP Pathways Analysis Report.

Grade 11 Mathematics as a Terminal Mathematics Course

Some students choose to pursue mathematics only as far as Grade 11, since this is the minimum level required for the Ontario Secondary School Diploma (OSSD). In our records of recent Ontario graduates, some 3,000 such students (nearly 10% of those in first semester college mathematics) entered college in Fall 2009. However, as Figure 16 shows, only those who took MCR3U could be reasonably confident of success in college mathematics. Only 61.0% of those taking MCF3M and 50.8% of those taking MBF3C as terminal mathematics courses in secondary school achieved good grades in college mathematics. We intend to follow this in CMP 2011 to determine if there is any trend.

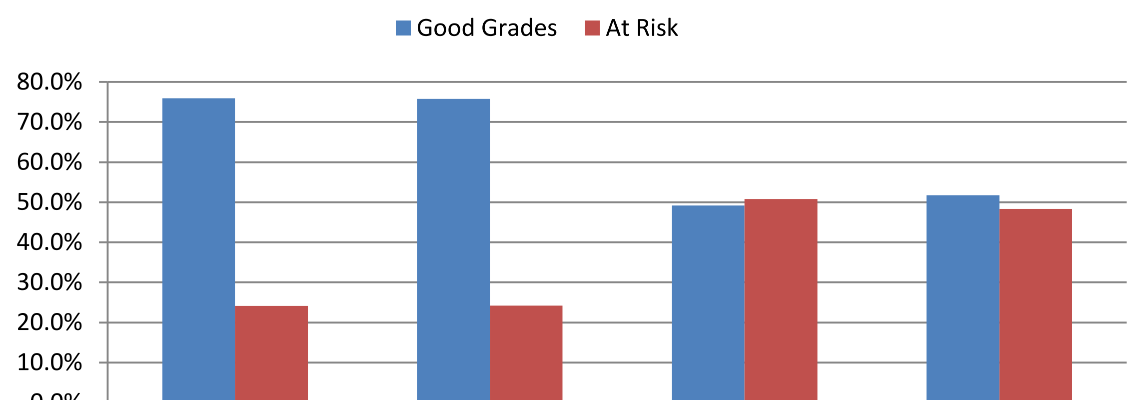
[27] Admission policies for college programs were discussed in detail in last year's final report.



	MBF3C		MCF3M		MCR3U	
	Fall 2008 (n=1,768) 9.0%	Fall 2009 (n=1,617) 8.2%	Fall 2008 (n=954) 4.8%	Fall 2009 (n=1,013) 5.1%	Fall 2008 (n=337) 1.7%	Fall 2009 (n=419) 2.1%
Good Grades	46.5%	50.8%	64.5%	61.0%	70.6%	73.5%
At Risk	53.5%	49.2%	35.5%	39.0%	29.4%	26.5%

***Figure 16*. Achievement of students with a terminal mathematics course in Grade 11**

Grades 9 and 10 Mathematics Courses



	Grades 9 & 10 Academic		Grades 9 & 10 Applied	
	Fall 2008 (n=3,556) 41.6%	Fall 2009 (n=5,228) 41.3%	Fall 2008 (n=1,765) 20.7%	Fall 2009 (n=2,663) 21.0%
Good Grades	75.9%	75.8%	49.2%	51.7%
At Risk	24.1%	24.2%	50.8%	48.3%

***Figure 17*. Achievement of Students with Grades 9/10 Academic and Applied Mathematics**

Figure 17 shows the college mathematics achievement of students who took Academic or Applied mathematics in Grades 9 and 10.[28] Once again, we should point out that while a much higher proportion of college bound students took the Academic sequence of courses in Grades 9 and 10, and their achievement in college was significantly higher, this should not be taken to imply that Grades 9 and 10 Applied mathematics courses are completely unsuitable for college bound students. Nor does it imply that students who have taken applied mathematics should be discouraged from pursuing college programs.

In particular, since the curriculum was revised to enable students who have taken Grade 10 Applied Mathematics (MFM2P) to enroll in the Grade 11 University/College Functions course (MCF3M), thus opening up the opportunity to pursue MCT4C or MDM4U at the Grade 12 level, this pathway has been pursued by increasing numbers of students, as shown in Table 11. Since Fall 2008 – the first year that students who made this transition could enter college – the proportion of these students has increased from 10.5% to 16.4%. This shows that the transition is meeting a need.

Table 11
Transition from MFM2P to MCF3M, Fall 2008 & Fall 2009

		Fall 2008			**Fall 2009**	
Pathway	**TOTAL**	**Good Grades**	**% GG**	**TOTAL**	**Good Grades**	**% GG**
MFM2P - MCF3M - MAP4C	168	102	60.7%	314	193	61.5%
MFM2P - MCF3M - MCT4C	75	50	66.7%	187	120	64.2%
MFM2P - MCF3M - MDM4U	46	38	82.6%	164	105	64.0%
TOTAL	**289**	**190**	**65.7%**	**665**	**418**	**62.9%**
% of all MFM2P in sample	10.5%			16.4%		

While the college mathematics achievement of those who pursued MCF3M after MFM2P was slightly lower in Fall 2009, we shall continue to follow the data on this transition. Unfortunately the overall numbers here are too small to enable further analysis such as the degree of success in subsequent mathematics courses of these students.

The CMP Database and Additional Analyses

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

[28] For simplicity, the display omits those students who took one type of mathematics course in Grade 9 and the other in Grade 10. The overall numbers of students in this analysis is also somewhat smaller as student data for Grades 9 and 10 was not available from a few colleges.

colleges and school boards[29]. The CMP policy on protection of privacy and 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.

In particular data is available on the college and program destination of graduates of each school board and secondary school in Ontario and on their college mathematics achievement. It is now possible for school boards and secondary schools to know[30] which colleges their graduates have gone to, which programs they have enrolled in, and their mathematics success in the first semester of college. While the average college mathematics achievement of graduates of Ontario school boards has increased, the trend over time of graduates of each board is not published in this provincial report.

Conclusions from the CMP 2010 Data Analyses

We draw two principle conclusions from the data presented in this chapter:

- There is evidence of improvement in college mathematics achievement on a system-wide basis over the past 3 years; and
- There is still room for much greater improvement if the aspirations of students, educators and the government of Ontario are to be met.

The improvements over the past three years should be a source of encouragement to all stakeholders. Ministries, colleges, school boards, schools, educators at all levels, students and their parents (and, we believe, the CMP itself) have all made contributions to this improvement and should take encouragement from these results. Yet the continuing recognition that *over 10,000 students in Ontario are at risk of not completing their college programs because of their first semester mathematics achievement* gives us no room for complacency. Chapter 4 of this report summarises some of the areas in which CMP has recommended changes in policy and practice, reflects on progress that has been made, and points to ways forward.

[29] Information on the CMP Database including access policy and procedures are available on the CMP web site (http://collegemathproject.senecac.on.ca).
[30] Subject to the CMP data protection policy, which limits displays to groups of greater than 5 students.

Chapter 3: Foundation Programs

Colleges have a wide variety of strategies designed to maximize student success and retention, several of which the CMP has noted in its past reports. One, which featured prominently in the early years of the Project, is the use of preparatory mathematics courses for those students who appear to need them. This early focus resulted from the origins of the CMP in the Greater Toronto Area where most colleges have such preparatory mathematics courses. As the CMP developed to a province-wide project however, it was evident that such courses are not extensively offered beyond the GTA. Last year's CMP report noted that of the 8 colleges that offered them, 6 were in the GTA, and that these accounted for 98% of the provincial enrolment.

Another – and it appears more widespread – strategy involves the use of (typically) one-year foundational programs – programs that enable students to bridge their way from secondary school graduation to a regular college-level vocational program. CMP has always included these "foundation programs" in the General program cluster (Pre-Health Science and Pre-Technology sub-clusters, for example) but until recently our research has not explored them in any detail. However, discussions with college faculty, particularly during the CMP 2009 forums, have led us to believe that there has recently been a significant growth in such programs.

This has led the CMP team to add an additional research question[31] late in 2010 to explore some of the features of foundation programs, the ways in which students are selected to take them, and new research approaches that CMP might consider in the future. While this research is by no means complete – in 2010, we did not collect qualitative data system wide but only from four colleges on an exploratory basis – the early results are very interesting. Accordingly, this chapter outlines four aspects of the work to date:

- identifying and clustering foundation programs;
- exploring student participation and achievement in foundation-program mathematics in 2008 and 2009;
- identifying the features of foundation-program mathematics through analysis of course outlines and interviewing college faculty and administrators at four colleges;
- identifying methods of student selection for foundational programs

What are Foundation Programs?

As the variety of programs offered by colleges has evolved, the CMP clustering system is sometimes not able to identify particular groups of programs and it too must evolve. Such is

[31] See research question A4a on page 5.

the case with the sub-clusters of the General program cluster. Currently (as outlined in chapter 1) there are three sub-clusters within the General cluster: Pre-Health, Pre-Technology, and General Arts & Science (GAS). The Pre-Health sub-cluster includes just one set of programs, all based on the MTCU program code 41601 (Preparatory Health Sciences). The Pre-Technology sub-cluster is equally straightforward and includes programs based on the MTCU codes 44702 (Pre-Technology) and 44704 (Technology Foundations).

However the GAS sub-cluster – the largest both in terms of numbers of programs and enrolments – now turns out to be too heterogeneous. It includes a set of programs that could be called “Pre-Business”: 40205 (Pre-Business); 40208 (Business Fundamentals); and 40214 (Business Foundations). We shall call this group the Pre-Business sub-cluster for the purpose of the present analysis. The GAS cluster also contains one-year General Arts & Science certificate programs (MTCU code 44700) which are used in many colleges with a variety of specializations, including Pre-Business and Pre-Technology. Finally there are other programs in the GAS sub-cluster that are *not* regarded as foundational programs, such as the two year GAS diploma program.

Accordingly, for the purpose of determining the scope of the foundation programs and for analyzing foundational mathematics courses, we shall use revised sub-clusters as shown in Table 12.

Table 12
Revised Sub-Clusters for Foundation Programs

Foundation Program Sub-Cluster	MTCU Program Codes
Pre-Health	41601
Pre-Technology	44702, 44704
Pre-Business	40205, 40208, 40214
General Arts & Science	44700

How many students take foundation programs and what is the level of their mathematics achievement?

Analysis of the numbers of programs offered and numbers of students enrolled in 2008 and 2009 bears out our sense that the use of foundation programs is increasing significantly[32]. Table 13 shows that the number of programs has increased by 17.5% in the last year and the student enrolment has increased by an overall 33% in the same time. The proportion of

[32] Data presented in this chapter refer to all students in foundation programs and are not analysed into subgroups such as ROGs, VROGs, direct-entry, etc.

students enrolled in foundation programs now numbers one-tenth of all first year college students.

The numbers in each of the sub-clusters is more difficult to gauge as the General Arts & Science certificate program enrolments also include pre-business and pre-technology students. We plan to gather more information from colleges in CMP 2011 concerning these specializations within the GAS certificate program so as to be able to get a better measure of enrolments in each of the foundation program sub-clusters.

Table 13.
Foundation Programs and Enrolments, Fall 2008 and Fall 2009

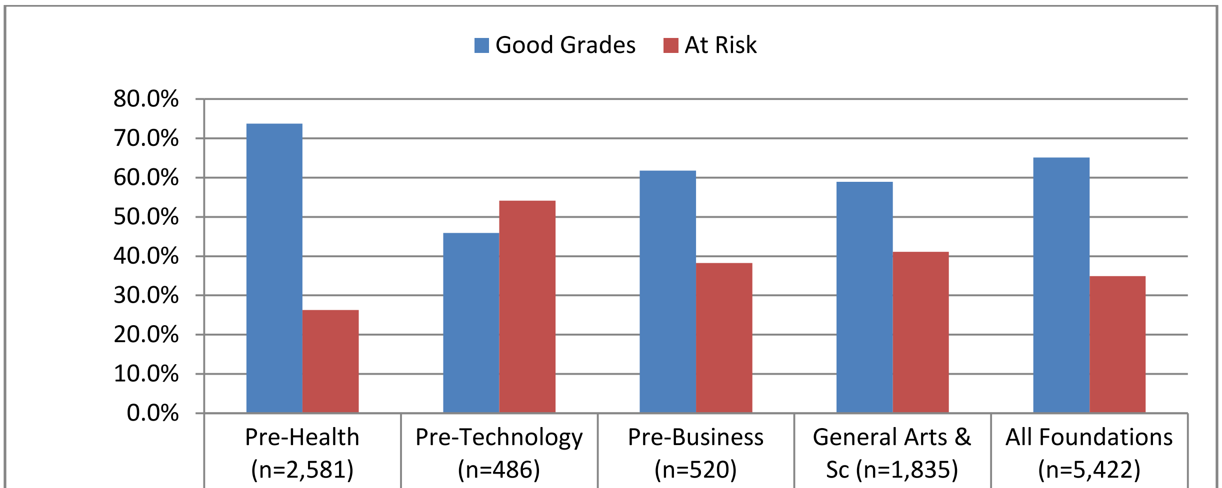
Sub-cluster	Fall 2008		Fall 2009		Increase 08-09	
	Programs	**Enrolment**	**Programs**	**Enrolment**	**Programs**	**Enrolment**
Pre-Health	30	2,411	31	3,410	3.3%	41.4%
Pre-Technology	15	513	18	652	20.0%	27.1%
Pre-Business	10	537	14	668	40.0%	24.4%
General Arts & Science	71	3,648	85	4,722	19.7%	29.4%
TOTAL	**126**	**7,109**	**148**	**9,452**	**17.5%**	**33.0%**

Table 14 shows the numbers of students enrolled in mathematics courses in foundation programs. Once again, we see a significant increase in both the number of programs and the student enrolments from 2008 to 2009. The percentage of all first semester mathematics students taking foundation programs is over 15%. If one were to add in the 10% of first year students taking preparatory mathematics courses as part of a 2 or 3-year vocational program then fully one-quarter of all the mathematics being taught in first semester would appear to be foundational or preparatory in nature.

Table 14.
Foundation Programs and Mathematics Enrolments, fall 2008 and Fall 2009

Sub-cluster	Fall 2008		Fall 2009		Increase 08-09	
	Programs	**Enrolment**	**Programs**	**Enrolment**	**Programs**	**Enrolment**
Pre-Health	21	2,143	23	2,568	9.5%	19.8%
Pre-Technology	13	415	16	483	23.1%	16.4%
Pre-Business	8	434	12	514	50.0%	18.4%
General Arts & Science	25	1,419	37	1,835	48.0%	29.3%
TOTAL	**67**	**4,411**	**88**	**5,400**	**31.3%**	**22.4%**

Finally, in this outline of the foundation programs cohort, we turn to mathematics achievement. Figure 18 shows a wide variety of levels of achievement with pre-health students achieving quite highly (73.7% with Good Grades) and pre-technology students much less well (45.9% with Good Grades). The Fall 2009 cohort is the first for which mathematics achievement has been calculated and further research will be required to assess if this pattern of achievement is sustained over several years. More important, if it is, then deliberations over ways to increase the achievement of pre-technology students will be urgently required.



	Pre-Health (n=2,581)	Pre-Technology (n=486)	Pre-Business (n=520)	General Arts & Sc (n=1,835)	All Foundations (n=5,422)
Good Grades	73.7%	45.9%	61.7%	58.9%	65.1%
At Risk	26.3%	54.1%	38.3%	41.1%	34.9%

Figure 18. Mathematics Achievement in Foundation Programs, Fall 2009

What are the features of mathematics courses in foundation programs?

For this part of the research, a member of the CMP research team visited four colleges, interviewed faculty and administrators, and analysed pre-technology and pre-business foundation program mathematics courses. The four colleges were selected to include French- and English-language colleges, colleges from the GTA, as well as from eastern and northern Ontario, and small, medium and large colleges. While no selection of four colleges could be taken as representative of all 24, we believe that these are varied enough as to sample a range of different approaches to foundation program mathematics. For this exploratory research, pre-technology and pre-business mathematics only were reviewed.

Pre-Technology Mathematics

The four colleges reviewed (identified here as A, B, C, and D) reflect both the growth of pre-technology programs and the variety of faculties where they are housed. Colleges A and B offer their pre-Technology programs as General Arts and Science (44700) while College D bases its program on the Pre-Technology (44702) program standard. Two of these programs (colleges A and D) were offered in 2009 and both had specific mathematics courses for the pre-technology students. The third program (at college B) is still being developed and will use a common first semester mathematics course with other GAS programs. College C offers its pre-technology foundation program in its Academic Upgrading department.[33] Prior to Fall 2009, the college had a second mathematics course that was required in first semester[34] and this course is included in this analysis. Table 15 shows the topics that appear in the 4 courses.

Table 15.
Topic Analysis of Pre-Technology Mathematics Courses

	College A	College B	College C	College D
	Pre-technology mathematics in GAS program	*Common mathematics in GAS program*	*Pre-technology mathematics*	*Pre-technology mathematics*
Order of operations	Yes	Yes	Yes	Yes
Fractions	Yes	Yes	Yes	Yes
Percents	Yes	Yes	Yes	Yes
Ratio and proportion	Yes	Yes	Yes	Yes
Scientific Notation accuracy/precision	Yes	Yes	Yes	Yes
Linear Equations	Yes	Yes	Yes	Yes
Exponents	Yes	Yes	Yes	
Logarithms	Yes			
Trigonometry	Yes	Yes	Yes	
Quadratic Equation	Yes			
Vectors			Yes	
Calculator	Yes	Yes	Yes	Yes

While these four courses cannot be taken as representative of all pre-technology mathematics, they are remarkable in their similarity and several results of this analysis can be taken as indicators or hypotheses for further research.

[33] CMP does not collect data from Academic Upgrading programs and so data relating to this program would not be included in the CMP database.
[34] College C has replaced this course with a summer program covering the same topics. Their goal is to have students arrive in the fall with these essential math skills already in place.

The common thread through all four courses at the four different colleges is an emphasis on *mathematics as an employability skill* where accuracy and precision are important. Mathematical skills are required in all college technology programs. The mathematics courses in the foundational technology programs all focus on the essential skills required in the student's chosen technology program.

The second observation from this analysis is that, as noted in the final report of CMP 2009, many of the topics appearing in these pre-technology foundational mathematics are topics that students were originally taught in elementary school: fractions, percentages, ratio and proportion, and so on[35]. The presence of these basic skills in college foundational mathematics courses underlines the importance of high levels of proficiency required of students entering technology programs.

Pre-Business Mathematics

Only two of the four colleges offer a program specifically designated as a foundational business program. One (College C) is housed in the Academic Upgrading department; the other (College A) is a pre-Business specialization within the GAS certificate program. The other two colleges (B and D) state that the GAS (44700) program will help prepare students for diploma programs in the Business area.

The topics covered in the pre-Business foundational mathematics courses in three of the colleges are shown in Table 16.

Table 16.
Topic Analysis of Pre-Business Mathematics Courses

	College A	College B	College D
	Mathematics in GAS (Pre-Business specialization)	*Mathematics in GAS program*	*Mathematics in GAS program*
Order of operations	Yes	Yes	Yes
Fractions	Yes	Yes	Yes
Percents	Yes	Yes	Yes
Ratio and proportion	Yes	Yes	Yes
Scientific Notation accuracy/precision	Yes	Yes	Yes
Linear Equations	Yes	Yes	Yes

[35]Graham Orpwood et al. *College Mathematics Project 2009: Final Report* (Toronto: Seneca College, 2010), p. 51.

Exponents	Yes	Yes	
Logarithms	Yes		
Trigonometry	Yes		
Calculator	Yes	Yes	Yes

As was observed in the pre-technology mathematics courses, the emphasis in the pre-Business programs is on essential mathematics skills that will be required by the students in the core courses in a Business program and in the career of their choice. Accuracy in answers is critical in the business world, whether in accounting and break-even analysis or in finance and prediction. Once again, we can see that most of these skills form part of the mathematics curriculum in grades 1-8.

This heavy focus on mathematical skills in both pre-Technology and pre-Business programs mirrors the focus of many of the mathematics courses in diploma-level programs in Technology and Business program areas. It also stands in marked contrast to the more balanced emphasis of mathematics courses in elementary and secondary school, where a conceptual emphasis – aimed at encouraging students' understanding of mathematical concepts – a skills emphasis, a communications emphasis, and an applications emphasis, are all equally stressed[36].

One might even think of these college foundation courses less as courses in "mathematics" (the discipline) and more as "mathematical skills" or "numeracy skills" courses. In that respect, there is a clear parallel between secondary school courses in English and courses in some colleges called Communications – where that label is often used. A similar distinction at the secondary school level might be between the focus of the Ontario Secondary School Literacy Test (OSSLT)[37] and that of Ontario secondary school English courses[38].

More detailed comparisons of college foundation mathematics courses with elementary and secondary school mathematics courses, on the one hand, and college diploma-level mathematics courses, on the other, must wait for further research, but this exploratory research offers new insights into some of the possible mathematics-related challenges facing students entering college programs.

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[36] *The Ontario Curriculum, Grades 1-8, Mathematics*, (Toronto: Ministry of Education, 2005), pp. 18-23.
The Ontario Curriculum, Grades 9 and 10, Mathematics, (Toronto: Ministry of Education, 2007), pp. 23-29.
The Ontario Curriculum, Grades 11 and 12, Mathematics, (Toronto: Ministry of Education, 2007), pp. 23-29.

[37] The OSSLT is designed to assess "the reading and writing skills required to understand reading selections and communicate through a variety of written forms as expected in *The Ontario Curriculum* across all subjects up to the end of Grade 9" (EQAO, *Framework: Ontario Secondary School Literacy Test*, 2007, p.10).

[38] For example, *The Ontario Curriculum, Grades 9 and 10, English*, (Toronto: Ministry of Education, 2007), pp. 20-25.

Delivery of Foundation Mathematics Courses

In discussions at the four colleges, the following common delivery strategies emerged:

- the use of small classes (fewer than 40 and preferably closer to 20 students per class);
- frequent student feedback from quizzes, assignments and or computer exercises;
- the availability of help through tutorials or learning centres.

While specific strategies varied, faculty and administrators at all colleges spoke of trying to ease students' transition from secondary school to college mathematics.

Selection into Foundational Programs

All four colleges allowed students to self-select into the foundational programs in their first application to the college. However, students who failed their first-semester diploma program courses in the Fall might also be counseled into the corresponding foundational program for the Winter semester, if it was felt that eventual success in their chosen diploma program required such additional support. While these four colleges had similar selection processes for foundation programs, we know from informal discussions that a wider variety exists province-wide. An account of the full range of selection procedures must await further research.

Chapter 4: Increasing Student Success: Moving Forward

Over the past several years, the College Mathematics Project (CMP) has focused a spotlight on all aspects of student transition to college, using first semester mathematics achievement as its primary indicator of success. As its research has identified an unacceptably low level of success, CMP has brought members of both college and school communities together to share their experiences in a search for ways to improve student achievement. Every year, an important aspect of the CMP deliberative inquiry has been the series of forums from which a range of ideas and proposals have emerged. Now after five years of activity, we use this report to reflect on the full range of these ideas and proposals, to note areas of progress and improvement, and to suggest areas for further work. As was mentioned at the outset, CMP 2010 is the second of a three-year sequence of studies and the research and deliberation this year points towards new research questions for CMP 2011.

Of course, Ontario is not the only jurisdiction where concerns over the success of student transition to postsecondary education are being debated. There is a whole library of research literature emerging from the United States[39] and informal discussions with colleagues in postsecondary institutions in the UK, South Africa, and Australia have shown that these issues are of concern in all these countries. Closer to home, Quebec's Conseil Supérieur de L'Éducation recently published a brief to the Minister of Education, Recreation and Sports, entitled *New Perspectives on the Transition from Secondary School to College*[40]. While most of its recommendations refer specifically to the Quebec CÉGEP system, the brief contains a conceptual framework that is of more general application and we use it here as a way to help Ontarians think about their own solutions to the same range of problems.

The authors of the Quebec brief suggest that there are "three aspects of secondary-to-college transition," which they identify as articulation, alignment and integration, defined as follows.

- ***Articulation***
  Articulation refers to the process in educational structures that allows students to transition from one level of instruction to the next, from one program of study to another, or from the education system to the workplace. Articulation thus pertains to the education system, its structures, the rules governing certification of studies at one level and the admission requirements at the next.
- ***Alignment***
  Alignment refers to the linkages established for a seamless transition from one level of instruction to the next in one or more courses. Alignment focuses on knowledge and pedagogical and evaluation processes, and as such is the domain of teachers.

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[39] See, for example, the regular reports from the Community College Research Center at Columbia University (http://ccrc.tc.columbia.edu/).

[40] Conseil Supérieur de l'Éducation, *Regards renouvelés sur la transition entre le secondaire et le collegial* (Québec: Gouvernement du Québec, 2010)

- ***Integration***
  … Integration is the process of incorporating the individual (i.e. the student) into a new environment (i.e. the college community). Examining transition from this perspective would place students and colleges front and centre, where both share responsibility in undertaking a four-tiered process of institutional, intellectual, social and vocational integration.[41]

This analysis of the issues involved in the successful transition of students from secondary to postsecondary education is a helpful way to organize the themes and recommendations developed by the CMP over the past few years. All of them need to be optimized if student success is to be maximized but each requires the attention of a specific cluster of stakeholders.

Articulation Issues

This refers to the structures and mechanisms in the secondary and postsecondary education systems that allow students to move from one level to the next. Examples include Ministry of Education policies relating to the academic requirements for obtaining a Ontario Secondary School Diploma, Ministry of Training, Colleges and University policies governing college admissions, the admission policies of each of the 24 Ontario colleges. The concept of articulation also includes the general vision or guiding philosophy for the continuum of elementary, secondary and postsecondary education and the relations between these sectors.

Over the past few years, CMP reports have explored articulation issues in a variety of ways. The final report of CMP 2007 introduced the idea of a K-16 perspective on student success[42] to remind readers that while graduation from secondary school is an important achievement, it is not (or should not be) the ultimate goal for most Ontario students. Most students continue their education beyond secondary school and the concept of educational "success" should refer to achievement at both secondary and postsecondary levels. The need for this perspective has been a continuing theme of CMP reports. The CMP 2008 report encouraged the government to take concrete steps to implement this vision and the CMP 2009 report went one stage further, urging a "K-Career perspective" where all levels of education are seen as essential transitions to life and work, rather than as ends in themselves.

For many years, the School/College/Work Initiative (SCWI) has been an important element in the government's commitment to students' success as they move from school to college. In particular it has helped schools and colleges establish dual credits, themselves an excellent

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[41] Conseil Supérieur de l'Éducation, *New Perspectives on the Transition from Secondary School to College*. p. 5.

[42] This drew on the work of Michael Kirst & Andrea Vezina, *From High School to College: Improving Opportunities for Success in Postsecondary Education* (San Francisco: Jossey-Bass, 2004) and Nancy Hoffman et al. *Minding the Gap: Why Integrating High School with College Makes Sense and How to Do It* (Cambridge, MA: Harvard University Press, 2007).

example of an articulation mechanism designed to ease transition from school to college. SCWI forums have also brought teachers from both schools and colleges together to support greater mutual understanding and enhanced *alignment* of programs of study. We shall address this further in the next section of this chapter.

While SCWI has been an important and valuable program, its main impact has been at the local level, working as it does through Regional Planning Teams. There is also need for greater articulation at the provincial level and to this end the CMP 2009 report proposed the creation of a Provincial Roundtable on Secondary/Postsecondary Transitions.

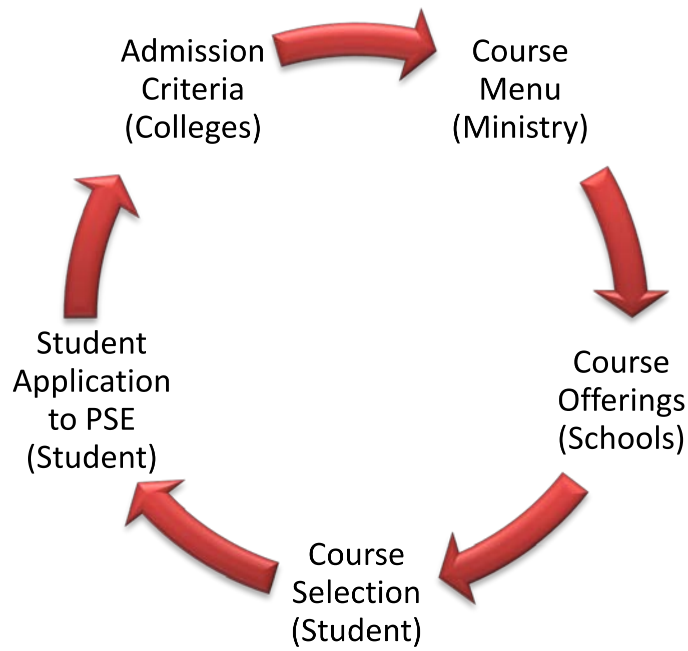

***Figure 19*. Inter-Relationships of Policies and Decisions Affecting College Admissions**

The report explained how many of the decisions made in relation to students' transitions from secondary to postsecondary education are inter-related (see Figure 19). Schools must offer courses from the Ministry of Education provincial curriculum but can only actually deliver those which enough students enroll in. Students are then constrained by these decisions when it comes to preparing for college and colleges' admission requirements are constrained by what students actually offer. And so it goes on.

Yet there is no forum where Ministries, Colleges & Universities, and School Boards can discuss the impacts of policies in one area on decisions made by others and the proposed Roundtable is designed to fill this need. Since it was first proposed in the CMP report, the idea has been further developed by the CMP team, endorsed by Colleges Ontario (on behalf of the 24 colleges) to the two Ministers. Now, progress is being made towards obtaining support for it from the other stakeholders[43]. The Roundtable would enable all participants to make the decisions for which they are responsible in a more informed and coordinated way and thus increase the degree of articulation between secondary and postsecondary education.

Other articulation-related tasks that the proposed Roundtable could address might include:

- Reviewing the impacts and effects of the “destination-related” curriculum structure introduced in the 1990s for Grades 11 and 12 in relation to school boards, colleges and universities;
- Discussing ways to enhance the impacts of MOE and MTCU programs and initiatives to increase student success and ease transitions among institutions, including dual credit, specialist high skills majors and credit transfer;
- Reviewing the MTCU binding policy on college admissions and its impacts and effects;
- Discussing ways of enabling students (and parents) to become more aware of courses that are most likely to lead to success in college and university programs;
- Suggesting ways in which college and university admission policies can be made more straightforward for students and teachers to understand;
- Discussing ways in which secondary school courses of most importance for postsecondary preparation can be made accessible to all students;
- Reviewing MTCU policies in regard to funding “remedial” or preparatory courses for students who need them;
- Discussing ways of increasing “postsecondary readiness” for all students;
- Discussing ideas from other jurisdictions to improve student success through the secondary-postsecondary interface.

An important aspect of articulation on which progress has been made is the need to monitor student transitions from secondary to postsecondary education and to provide feedback to both secondary and postsecondary institutions (as well as to government). CMP has been developing such a role for the past five years but its work has been limited to the college system and to achievement in mathematics. In this, it has been supported financially and professionally by the Ministry of Education and the Ministry of Training, Colleges and Universities. A College English Project has also now been mounted, the data for which is being collected by the CMP data collection process. The next step would be to expand the process to include universities and to integrate the monitoring into a permanent program housed in a provincial agency. Currently, the Higher Education Quality Council of Ontario is funding research that involves linking various datasets in an attempt to follow students through secondary school and postsecondary education. In addition to the research element however,

[43] The detailed Roundtable proposal is available on the CMP web site: http://collegemathproject.senecac.on.ca.

the deliberative aspect of the deliberative inquiry model, used by the CMP, has enabled a wide range of stakeholders to participate and, in the process, to become committed to implementing the resulting recommendations. We regard this commitment to using research for improvement and increased student success as the most valuable aspect of the CMP's work

In summary, we believe that improved articulation will make a significant difference to the overall success of Ontario students as they move from school to college. But it is essential that the government leads Ontarians in understanding that postsecondary education should be an integral part of every student's aspirations and that their transition to postsecondary education should be as smooth as possible.

There are lessons from history in relation to this. A century ago in Ontario, most students aspired to complete elementary school and only a few expected to attend secondary school. There was a wide gulf between elementary schools and secondary schools, between elementary and secondary teachers, and between elementary and secondary school boards. Over the past century, this gulf has almost completely closed as most students now expect to complete secondary school, most teachers in both panels are university graduates, and almost all elementary and secondary schools are operated by county boards of education. The challenge for the next decade is to move to the point where *most students aspire to obtain a postsecondary education* and where the gulf between secondary and postsecondary education also disappears (but does not take another century to do so). The CMP therefore recommends as follows:

1. *The Government of Ontario should follow up on its announcement of the Open Ontario program by establishing the proposed Roundtable on Secondary/ Postsecondary Transitions, by monitoring student achievement in relation to these transitions, by supporting continuing stakeholders' deliberations concerning increased student success, and by undertaking a public awareness campaign aimed at encouraging all students to plan to obtain postsecondary education and training.*

Alignment Issues

This category of transitional issues refers to the knowledge and skills taught and learned at secondary and postsecondary levels. The aim of all involved is, of course, to make students' transitions from one to the other as successful as possible. At the secondary school level, this is achieved by designing and delivering academic courses that prepare students for the college programs in which they intend to enroll. At the college level, it involves designing and delivering first-year courses that are well aligned with students' academic backgrounds and that integrate well into the diploma or certificate programs of which they are a part.

The CMP team and CMP forum participants have struggled with alignment issues since the inception of the project. From the outset, we all felt that a student's secondary school mathematics background was relevant to his or her college mathematics achievement. But the nature of that relationship has never been completely clear. Each time we uncover new data our view of it has changed and deepened. The following examples show the dilemmas we have tried to address.

Initially, and for several years, the CMP pathways analysis data (e.g., chapter 2, Figure 9) suggested that there was a poor alignment between college mathematics courses and MAP4C, a better alignment with MCT4C, and good alignment with the 12U courses. However, further analysis involving the levels of achievement in MAP4C (Figure 10) shows that students with high marks in MAP4C do very well in college mathematics. If the essential problem was the poor alignment (in the conventional sense) of MAP4C with college mathematics this would not be so. Some secondary school forum participants have suggested that the problem is less to do with the courses themselves and more to do with the ability levels of students who take the particular courses. We have problems with this analysis; it seems to imply a deterministic perspective, where students are seen as having a fixed level of ability and where schools can make little difference, a perspective we do not accept.

Another dilemma is highlighted by the age-related analysis (Table 8 and Figure 8). If a student's secondary school mathematics background is so important in relation to his or her college mathematics achievement, then students whose secondary school mathematics was long ago, should have more problems with college mathematics relative to those with a recent mathematics experience. But as the data shows, the reverse is in fact the case, with greater proportions of older students achieving good grades.

Another factor that is relevant to this discussion of alignment was raised in last year's forums and reported as a theme under the heading "Focus on Foundations." This theme drew readers' attention to the fact that when college faculty are asked about the mathematics topics that students most often have difficulty with, the ones most frequently cited are fundamental mathematical topics taught in grades 5 through 8, such as fractions, ratio and proportion, and percentages, rather than topics from the Grade 11 or 12 mathematics curriculum. This suggests that the concept of "alignment" must attend to more than just the fit between mathematics courses at the end of secondary school and the beginning of college programs.

Finally, the exploratory investigation into preparatory or foundational mathematics courses (chapter 3) shows little difference in terms of content topics between the preparatory courses analysed and the diploma-level mathematics courses. The major differences appeared to be structure, class sizes and pedagogy, rather than content. All of these considerations have obliged us to rethink our initial conclusions concerning the alignment – or lack of it – between school and college mathematics. The next section of this chapter advances a new way of thinking about these alignment related issues and a hypothesis for further exploration, hopefully in CMP 2011.

Emphases in Mathematics Courses

Douglas Roberts[44] has developed the concept of curriculum emphasis (primarily in the context of science education, but its application is general), to capture the fact that curriculum and instruction communicate to students at more than one level. At one level, there is the subject matter *content* being taught and learned – the topics of the course. But simultaneously, there are messages being communicated to the student about the intent or *purpose* of their learning – about what the students are expected to be able to do in relation to the particular content and why. For example, one teacher might be teaching about percentages with the primary intention that students *understand the concept of percentage* and focus the instruction (and the subsequent assessment) on this goal, while another teacher might be teaching the same concept with the primary goal of having students being able to *apply it in the context of laboratory calculations*. Comparing the lessons of these two teachers, the topic is the same but the purpose is quite different, and the teaching method and assessment would be correspondingly different.

Our preliminary investigation of the introductory mathematics courses at the four colleges reported in chapter 3 suggests that this concept of "emphasis" might be helpful in understanding why college mathematics courses might appear to be not well aligned with secondary school mathematics courses. As we reported in chapter 3, all the college courses reviewed were focused on having the students conduct calculations (of various kinds) and obtain accurate results. This made sense because of the context of the mathematics courses involved: they required students to use *mathematics as a tool* in the service of health care, technology or business, rather than learn *mathematics as a discipline* for its own sake. This goal and the related "skills" emphasis stands in contrast to the more "conceptual" emphasis that may be characteristic of many secondary school mathematics courses.

An interesting and helpful parallel is the way in which "English" at secondary school level is followed, in many colleges, by courses called "Communications" (rather than English), which underline the emphasis of the course and its relationship to the students' program. The name "English" may suggest an emphasis on creative writing or the study of literature, which may not be as relevant to a vocational college program as are preparing of reports and correspondence,

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[44] Roberts, D.A. (1982). Developing the concept of "curriculum emphases" in science education. *Science Education 66(2)*, 243-260.

reading and understanding of instruction manuals, or making oral presentations. Similarly, the word “Mathematics” seems to focus on the discipline itself and on being initiated into the processes of mathematical thinking, and there is no obvious word (corresponding to “Communications”) to characterize the equivalent emphasis in college mathematics. “Mathematical” (or “Computational”) skills may not be quite adequate.

This interpretation of the differences between school mathematics and college mathematics is offered here as a hypothesis to account for some of the difficulties students have as they transition from secondary school to college programs. Certainly, school mathematics (at all grades and in all courses) has in recent years focused more on mathematical understanding, at least compared with the narrow skills emphasis of fifty years ago. Skills are present too of course. But, at the secondary school level these are most often the more advanced skills or “thinking processes” rather than the reinforcement of basic computational skills taught initially at much earlier grades. This shift in emphasis in the Ontario mathematics curriculum was consistent with similar shifts going on throughout (at least) the English-speaking world at this time.

Added to this, the radical reform of the Ontario curriculum introduced by the Harris government in the late 1990s made the removal of what was called “the spiral curriculum” as one of its foundation stones. This meant, for example, that topics such as the multiplication and division of fractions which are taught in Grade 8 could not appear in any subsequent grade. The same principle applies to every content topic and key skill.

An important consequence of this, as we discovered at CMP forums from listening to secondary school teachers, was that many of them did not feel it was their responsibility to re-teach those topics even when students clearly had not grasped them. Indeed, they had a full curriculum of their own they were responsible for and they felt they had no time to “go back” and teach such topics again. As a result many students progressed through school with serious skill shortages in mathematics and when, at college, they were confronted with a course that placed its major emphasis on computational skills, they ran into difficulties. This reality of this situation was confirmed to us by several of the students who contributed to the CMP forum student panels.

The preliminary investigation of preparatory or foundational mathematics courses begun this year as part of CMP 2010 was striking in the fact that not only did the first semester diploma level courses have an emphasis on such computational skills, the preparatory or foundational mathematics courses did also. In fact, in one college there appeared to be little difference between the two types of course, other than by taking the preparatory course (as well as the diploma level course) students received more opportunities to “gain ownership” of these essential mathematical skills. This analysis of the mathematics courses from the four colleges investigated this year is clearly not sufficient to be able to make claims about the system as a whole. We therefore propose this as a hypothesis at this stage and will try to obtain more conclusive evidence during CMP 2011. However we would welcome discussion and feedback from mathematics teachers at both levels about the hypothesis and its implications.

If this hypothesis is confirmed, then the issues of alignment can be revisited with a new perspective. It could be that the factor that contributes most to success in first semester college mathematics is the ability to handle mathematical skills easily and accurately, that this specific ability has been acquired through work and life experience by the older students, and by *some* of those students coming directly from secondary school. With this perspective, one might suggest that the key alignment issue for college mathematics should not be with the content topics in MAP4C or MCT4C (or any other secondary school course) but rather with the skills that have been taught in the senior grades of elementary school. Those students who have thoroughly learned and retained those skills are those that find subsequent success at college and those who have not are those who find college mathematics to be challenging. Such a conclusion, if supported by further evidence, would clearly carry implications for all levels of education, elementary, secondary and college.

For now, we clearly need to have further research into the mathematics curriculum (and assessments) at all three levels as well as discussions with practitioners at all levels as well. Accordingly, the CMP recommends that:

2. *The CMP should undertake further research into the content and emphasis of initial mathematics courses at the college level; further research should also be extended to the secondary school level to enable clear conclusions to be drawn concerning the alignment of college mathematics with elementary and secondary mathematics in Ontario schools.*
3. *The CMP should seek information and commentary from all stakeholders in mathematics education on the subject of alignment in order to provide clear advice to the Ministry of Education when the mathematics curriculum is next revised.*
4. *Teachers of mathematics at secondary school and college increase their efforts to understand each other's curriculum and instructional methods, so as to support students' successful transition from school to college.*

Integration Issues

For several years, a series of CMP data analyses and forum contributions have suggested that the academic challenges faced by some students in the first semester of their college program are not the results of failures of institutional articulation or curriculum alignment. Rather they were more personal to the students themselves having to do with students' skills and attitudes in relation to learning at the postsecondary level.

The final report of CMP 2008 discussed this first under the theme of "accountability for learning." The notion that certain skills, attitudes or habits of mind were critical elements in a student's academic success was first suggested explicitly by students themselves. Several students who participated in CMP forum panels commented on their need, at the postsecondary level, to take much greater responsibility for their own learning than had been required at the secondary school level. This translated into such practical matters as attendance and punctuality at class, organizing their time so as to get work completed on time, taking care over accuracy, working well with others in group projects, and being prepared to show initiative.

In CMP 2009, we analysed college mathematics achievement data by age and observed a strong relationship, a relationship that has been noted once again this year (see Table 8 and Figure 8 in Chapter 2). Clearly there is something that older students are bringing to their college education – other than their secondary school mathematics background (which for many is long in the past) – that is enabling them to achieve at a high level. And as we also noted last year, this effect goes beyond mathematics: often students who fail mathematics in first semester also fail other courses as well.

Accordingly, the final reports from both CMP 2008 and CMP 2009 featured recommendations relating to the importance of learning skills and we are now in a position to report progress. At the provincial level, in April 2010, the Ministry of Education published a new policy on assessment, evaluation and reporting, entitled *Growing Success*.[45] This new policy places Learning Skills and Work Habits in the forefront, emphasizing that, while assessment of these skills should not form part of a student's grades, they are considered important enough to warrant special attention and reporting progress to parents. Consistent with this, the Provincial Report Card has also been revised to give greater prominence to the development of these skills. This policy is now being implemented throughout the province and we have heard from forum participants this fall that special training for teachers is being provided to support this process.

At the same time, the Coordinating Committee of Vice-Presidents Academic (CCVPA) for the college's, endorsed the CMP recommendation that colleges should "reference the importance of learning skills in their advertised program admission requirements[46]" and recommended that all colleges should undertake this. Seneca College, for example, now has the following statement placed in its printed and electronic documents under "admission requirements" for all programs:

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[45] Ministry of Education. *Growing Success: Assessment Evaluation and Reporting in Ontario Schools*. (Toronto: Ministry of Education, 2010) - also available at http://www.edu.gov.on.ca.
[46] Laurel Schollen et al. College Mathematics Project 2008: Final Report (Toronto: Seneca College, 2009) p. 41.

The Importance of Learning Skills:

> Student success in college requires well developed learning skills (such as being able to work independently, participate in a team, be well-organized, develop good work habits, and show initiative). These skills are as important as prior academic achievement. While it is expected that applicants would have developed these skills through previous education and life experiences, Seneca offers support to assist students with further development of these important skills.[47]

In identifying learning skills as important for success in college, Ontario is not alone. The further we review the research literature the more we find similar initiatives taking place in the United States, Europe, Australia, to name a few. One of the most interesting findings from our review of this literature is that the skills called "Learning Skills and Work Habits" by the Ministry of Education are almost identical to those described by the Ministry of Training, Colleges and Universities as "Essential Employability Skills[48]", to the "Enabling Skills[49]" of the Lisbon Council (an EU think tank), and to the "21st Century Skills[50]" of a major new international project for educational transformation supported by Cisco, Intel and Microsoft.

It is clear that – in this at least – government, business, and education are "on the same page" in recognizing that, in addition to the academic skills related to specific subjects (in schools) or occupational programs (in college), there are a set of generic skills required of all students for success in advancing their own learning, in being a productive employee, and in living a successful life. While there are small differences in the definitions of these skills as one moves from statement to statement, there is no difference in the common belief that, in a world where knowledge is changing constantly, these are the skills that sustain an individual's ability to learn and adapt.

Given this perspective, it is clear that the students who come to their college programs after several years of life experience, whether as an employee or having raised a family, have had opportunities to grow these learning skills and that they are accordingly "ready" for college. Of those students who come to college directly from secondary school, some have developed the same skills to a high degree and are successful in college, while others' skills are less well developed and they find the college experience more challenging.

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[47] A sample may be found at: http://www.senecac.on.ca/fulltime/ACC.html

[48] http://www.tcu.gov.on.ca/eng/general/college/progstan/essential.html. Readers should note that MTCU policy requires that Ontario colleges demonstrate how these are integrated into all college programs.

[49] The Lisbon Council, *Skills for the Future* (Brussels: The Lisbon Council, 2007) p. 8.

[50] Assessment and Teaching of 21st Century Skills, International project based at the University of Melbourne (Australia), (http://atc21s.org/default.aspx).

However while the literature (including the Ontario Ministry policies) is strong on defining these skills and on arguing for their importance, it is rather weak on the means by which individuals acquire such skills, what can best be done to support students (or employees) in the acquisition of them, and how the skills are best assessed, recorded and reported. There has been much effort expended on exploring what skills are important for postsecondary readiness but much less on how they can be taught and assessed. An exception in this regard is the work of Gabrielle Matters and David Curtis in Australia where the Commonwealth Department of Education, Science and Training commissioned an investigation of the most effective ways of assessing and reporting the employability skills of senior secondary students[51]. This work could provide an excellent foundation for further work here in Ontario.

While good progress has been made in this area, the CMP team believes that much more is also needed. For a start, it seems that the majority of students (and maybe their parents also) assume that their achievements that result in marks and grades are those of most value and that those that are not recognized that way must be correspondingly of lesser value. At secondary school, therefore, while we applaud the increased prominence being afforded to learning skills on the report card, we would encourage the Ministry of Education to consider ways of communicating their importance in more permanent ways, such as through adaptations to the Ontario Student Transcript or the Skills Passport.

Teachers at all levels need support in learning more about how to integrate the learning skills into the teaching of their subjects. Faculties of education and teacher candidates tend focus on "teachable subjects" at the Intermediate/Senior level – science, English, mathematics, and so on – and often the teaching of these generic skills takes second place.

The CMP therefore makes the following recommendations:

5. *Ministries, Colleges and Schools should continue to give prominence to the importance of the acquisition of learning/employability skills by students through further consideration of policies concerning recording and reporting, together with professional development, and communications to students, parents and the public.*
6. *Given its importance to student success and retention at postsecondary level, the Higher Education Quality Council of Ontario should sponsor further research addressing promising practices in the acquisition and assessment of learning/employability skills at postsecondary institutions.*

[51] Gabrielle Matters and David Curtis, *A Study into the Assessment and Reporting of Employability Skills of Senior Secondary Students*. (Canberra: Department of Education, Employment and Workplace Relations, 2008). The report is available at http://www.deewr.gov.au/employabilityskills.

This discussion of learning and employability skills has been set in the broader context of a consideration of ways in which students can be better integrated into college programs. Research cited in the report of CMP 2008 stressed that lack of integration, both social and academic was the most common cause of student dropout.[52] If the province is to meet the targets set out in the Open Ontario program, then postsecondary institutions need to understand more about ways of ensuring the integration of their students.

Concluding Thoughts

There have been several points in this report at which the need for further research has been noted before definitive conclusions can be drawn. This is particularly true of the alignment issues that relate to foundational mathematics courses. For CMP 2011, therefore, we plan to undertake a detailed analysis not only of foundational and preparatory mathematics courses, but also of the overall mathematics curriculum in selected college programs, and of the links between the elementary and secondary school mathematics curriculum and college mathematics courses. This will enhance the ongoing “conversation” among mathematics colleagues at secondary school and college levels.

This report of the College Mathematics Report has both reported on the research conducted this year and reviewed the issues of greatest importance that have been raised through our research and deliberations in the past three years. We feel very encouraged that not only are we appearing to make progress in relation to student achievement, there is a general sense that the College Mathematics Project has been a useful initiative and that it should be continued in some form. While CMP is funded until the end of 2011, we are also exploring ways in which this type of initiative can continue.

[52] Xin Ma and George Frempong, *Reasons for Non-Completion of Postsecondary Education and Profile of Postsecondary Dropouts* (Ottawa: HRSDC, 2008).