York - Seneca Institute for Mathematics, Science and Technology Education

COLLEGE MATHEMATICS PROJECT 2009

PATHWAYS ANALYSIS REPORT

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Preface

This is an additional report based on the research of the College Mathematics Project in 2009. The main report was released in March 2010 and contained reports of both the research and deliberations of the CMP 2009, together with the recommendations that flowed from them. This report is an expansion of the research into the college mathematics achievement of students in the light of the sequences of mathematics courses (pathways) taken in secondary school. It is designed to support the work of teachers and parents who advise students on the choice of mathematics courses and that of school board and school administrators who must decide which mathematics courses should be offered in their schools. Of course, there are many other factors that influence student success in college but secondary school mathematics preparation is one that is of particular interest to educators at both school and college levels.

The authors' thanks are due to the Guidance teachers whose forum participation suggested the idea of such a supplementary report, to John Gatti, Guidance & Career Counsellor at Woodbridge College, York Region District School Board, for his valuable editorial advice, and especially to our colleagues in the Seneca College Academic Computing Services (ACS) department (Hassan Assiri and John Meskes), without whom the data would not be so relatively straightforward to access and interpret.

Finally we are grateful to the Ontario School Counsellors Association (OSCA), which has sent representatives to participate in the CMP Steering Committee (Muriel Rampersad and Jennifer Boston), which has welcomed CMP participation at the annual conference for the past two years, and which is assisting us in the distribution of this report.

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

Introduction

During their secondary school education, Ontario students make many choices among mathematics courses and Ontario teachers are often called upon to advise students on these choices. Since the development of the "destination-related" curriculum, where courses have been designated as preparation for university, college, and workplace, these labels have been the primary basis on which to base these choices. However, the College Mathematics Project now has data that links the mathematics achievement of first semester college students with the mathematics pathways they chose in secondary school and the CMP 2009 final report[1] has documented some of these data.

The CMP team believes that those who advise students, especially guidance teachers and mathematics teachers, would appreciate a more systematic and detailed set of pathways analyses than was available in the final report and this supplementary report provides this. Obviously, we cannot advise teachers exactly what advice they should provide to individual students because every situation is unique and we do not do so here. Rather, we present a full set of data on the college mathematics achievement of students who have taken a selection of 16 mathematics courses or course combinations in secondary school, organised according to the program areas that those students pursue in college.

This report is organised as follows. This introduction is followed by a section that describes the research methods used in the College Mathematics Project to obtain pathways analyses. This is important for readers to understand the limitations of the data and what can and cannot be reasonably inferred from them. The 16 data analyses are then presented, each with explanatory notes specific to each table or group of tables. The report concludes with some questions for teachers and school administrators to consider as decisions are made in regard to course offerings at the school level.

Finally, we draw readers' attention to the fact that all of this information has been developed from the CMP research database, which is accessible to approved users. Interested users should consult policies on acceptable use and database access on the CMP web site.

CMP Research Methods

The pathways analysis in this report is undertaken as part of the overall CMP research program, the data for which is obtained from each of the 24 Colleges of Applied Arts and Technology in

[1] Graham Orpwood et al. *College Mathematics Project 2009: Final Report*. Toronto: Seneca College, 2010. This report is available for download free of charge on the CMP web site: http://collegemathproject.senecac.on.ca.

Ontario[2]. Students' secondary school transcripts (which colleges download from OCAS as part of their admissions process) are combined with information concerning college programs and data concerning students' first semester college marks. After all personal identifiers have been removed, the resulting data are posted on the web-based CMP database, initially for validation by each college, and subsequently for analysis according to the research questions being studied each year. CMP 2009 studied the mathematics achievement of students entering colleges in the Fall 2008. This report is therefore based on data from this one student cohort only and no year-over-year trends can be inferred from the analyses shown here.

These students have been admitted to a wide range of programs in college. CMP collects data on students in the full range of postsecondary college programs[3]. However, many of these programs do not contain a first semester mathematics course and most of the subsequent CMP analyses only concern the approximately 31,000 students taking mathematics in first semester. For CMP purposes, these students are divided into groups. Some (about 16.8% of this group) have come from other jurisdictions (e.g. other Canadian provinces or from other countries) and we have no detailed knowledge of their secondary school mathematics backgrounds. Others (14.2%) have had their secondary education in Ontario, but from 5-40 years ago, which makes linking their secondary school records with college marks somewhat problematic! The remaining 69% are called Recent Ontario Graduates (ROGs), and the pathways analysis in the CMP Final Report addresses the records of these students. However, the Ontario mathematics curriculum has been revised relatively recently and the first group of graduates of this revised curriculum began to enter college in Fall 2008. This group – a sub-group of the ROGs – numbers 9,689 students and CMP labels them Very Recent Ontario Graduates (VROGs). The present report is based on VROG records only, since we want analyses to reflect the most recent curriculum revision that students will be following for the next few years.

When the mathematics pathways followed by all VROGs are analysed, we find 604 distinct pathways. However, many of these are followed by very few students and the CMP analysis only documents the 97 pathways followed by 10 or more students. This reduces the number of students in the current analysis to 8,547 (or 88.2% of the total) but this reduction has very little impact on the levels of achievement shown in the tables.

The pathways analysis reported here also investigates the achievement of students by program area. CMP employs four broad program clusters each of which is also divided into sub-clusters as described in the Final Report. For the purpose of this report, the analyses show achievement for all students regardless of program, for students in each of the four major clusters – Applied

[2] The data is collected under a protocol that ensures the privacy of individuals and the maintenance of strict security of the data, in accordance with the *Freedom of Information and Protection of Privacy Act* (FIPPA).
[3] With the exception of applied degree programs, graduate certificate programs and apprenticeship programs.

Arts, Business, General and Technology – and in the sub-clusters of Business (Administration, Finance and Office) and Technology (Applied Science, Computer, Construction, Electrical, and Mechanical). Readers wanting to know more about the composition of these clusters can find more information in the CMP 2009 Final Report (p. 13) and on the CMP web site (where a detailed clustering of all 2000 college programs is posted) and on the Ministry of Training, Colleges and Universities website[4] where college program standards are posted. Because CMP only analyses data relating to pathways followed by 10 or more students, there are small and unavoidable discrepancies between the sub-cluster analyses (which studied pathways involving 10 or more students from the cluster) and the cluster analyses (which studied pathways involving 10 or more students overall).

College mathematics achievement is reported in all CMP reports in terms of "Good Grades" (meaning an A, B, or C) and "At Risk" (D, F or W). These grades are in turn derived from the original college marks by a "translation" process developed several years ago and used consistently CMP. It is also described in general in the CMP 2009 Final report (p. 14) and on the web site (where a detailed college-by-college analysis of grades is shown).

Explanation of the Data Tables

In each of the sections of the report that follow, there are tables which are divided into two parts. The left hand section (columns 1-4) is common to all 16 tables and shows the numbers (column 2) and achievement (columns 3 and 4) for all VROGs within each program cluster and sub-cluster (as shown below). The right hand section (columns 5-8) provides the equivalent information for each course selection or course combination as indicated at the top of the table.

1	2	3	4	5	6	7	8
Program Clusters	All VROGs			Course Selection: Mxxxx			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk

The VROG overall data is presented each time so that the relative significance of the specific pathway data for each program area can be assessed. For example, Table 1 concerns the Grade 11 course MBF3C. The enrolments in this course, as shown in columns 5 and 6, are mostly over 40% of all VROGs, which indicates that the achievement data in columns 7 and 8 are of major significance. By contrast, Table 8 shows data for the much less common combination of MBF3C

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

and MCT4C. Enrolments in this course combination amount to a small number of Technology students and a negligible number of others as column 6 shows[5]. Readers should also note that some program clusters or sub-clusters have very few students enrolled in some courses or course combinations. In general, achievement data for groups smaller than about 50 should not be regarded as very representative or reliable.

The 16 sets of pathways analyses are organised in four groups:

- Analyses of students having various Grade 11 courses (3)
- Analyses of students having various Grade 12 courses (3)
- Analyses of students having various Grade 11 and 12 course combinations (6)
- Analyses of students having various Grade 10 & 11 course combinations (4)

Some comments about each of these sets now follow. However, readers are invited to study the analyses and draw their own conclusions, particularly in relation to the best advice to provide students. It is important when reviewing these data to remember that the source of the data constrains the inferences that can be drawn in important ways. In particular, since the data only relates to students taking college mathematics courses, no valid conclusions can be drawn about the overall value of the courses but only about their relative value *as preparation for college mathematics.* Similarly, some courses or course combinations may be effective preparation for mathematics in the context of some college programs but less so in the context of others.

Another caution is that these analyses record the college mathematics achievement of all students who have achieved specific mathematics credit in secondary school. They do not differentiate among students according to the level of their achievement in secondary school mathematics. CMP has found that there is often a significant relationship between college mathematics achievement and secondary school mathematics marks, even in a course that does not generally lead to high achievement in college mathematics (see CMP 2009 Final Report, page 32). This factor should also be taken into consideration when considering advice for a student.

Grade 11 Course Pathways

[5] Readers should note that the percentages shown in column 6 are based not on the overall VROG population shown as N in column 2, but on a somewhat smaller total number since the Pathways Analysis reviews pathways followed by 10 or more students only.

There are three mathematics courses taken by most students who later go on to college mathematics: MBF3C, MCF3M and MCR3U. Tables 1, 2 and 3 show the proportions of students in the CMP database taking each of these three courses and their subsequent college mathematics achievement. MBF3C is taken by over 40% of all the students but only 52.6% go on to get good grades in college mathematics (Table 1). MCF3M is taken by fewer than 30% of students overall but more than 68% of those achieve good grades in college mathematics (Table 2). MCR3U is designed for university bound students but nearly 27% of college math students have taken that course in secondary school and over 80% of these get good grades in college mathematics (Table 3).

Program Clusters	All VROGs			Course Selection: MBF3C			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**3,639**	**42.6%**	**52.6%**	**47.4%**
Applied Arts	**602**	**75.7%**	**24.3%**	**260**	**46.8%**	**65.8%**	**34.2%**
Business	**2,857**	**63.8%**	**36.2%**	**1,066**	**43.3%**	**53.2%**	**46.8%**
B-Administration	1,832	59.7%	40.3%	707	47.7%	51.2%	48.8%
B-Finance	945	70.2%	29.8%	272	39.7%	55.1%	44.9%
B-Office	80	83.8%	16.3%	40	58.8%	77.5%	22.5%
General	**1,281**	**68.0%**	**32.0%**	**538**	**46.7%**	**52.6%**	**47.4%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,775**	**40.6%**	**50.4%**	**49.6%**
T-Applied Science	663	64.3%	35.7%	272	48.7%	44.9%	55.1%
T-Computer	597	59.8%	40.2%	152	32.6%	41.4%	58.6%
T-Construction	1,260	68.9%	31.1%	432	40.6%	52.5%	47.5%
T-Electrical	885	63.3%	36.7%	319	42.1%	46.7%	53.3%
T-Mechanical	1,544	68.5%	31.5%	582	43.8%	55.5%	44.5%

Table 1. College mathematics achievement of students who took MBF3C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: MCF3M			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**2,445**	**28.6%**	**68.3%**	**31.7%**
Applied Arts	**602**	**75.7%**	**24.3%**	**150**	**27.0%**	**78.0%**	**22.0%**
Business	**2,857**	**63.8%**	**36.2%**	**734**	**29.8%**	**65.1%**	**34.9%**
B-Administration	1,832	59.7%	40.3%	449	30.3%	61.5%	38.5%
B-Finance	945	70.2%	29.8%	186	27.2%	73.1%	26.9%
B-Office	80	83.8%	16.3%	21	30.9%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**348**	**30.2%**	**76.4%**	**23.6%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,213**	**27.7%**	**66.6%**	**33.4%**
T-Applied Science	663	64.3%	35.7%	130	23.3%	64.6%	35.4%
T-Computer	597	59.8%	40.2%	140	30.0%	54.3%	45.7%
T-Construction	1,260	68.9%	31.1%	301	28.3%	70.4%	29.6%
T-Electrical	885	63.3%	36.7%	216	28.5%	64.4%	35.6%
T-Mechanical	1,544	68.5%	31.5%	354	26.7%	70.6%	29.4%

Table 2. College mathematics achievement of students who took MCF3M in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: MCR3U			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**2,298**	**26.9%**	**82.6%**	**17.4%**
Applied Arts	**602**	**75.7%**	**24.3%**	**137**	**24.6%**	**91.2%**	**8.8%**
Business	**2,857**	**63.8%**	**36.2%**	**587**	**23.8%**	**77.0%**	**23.0%**
B-Administration	1,832	59.7%	40.3%	289	19.5%	75.4%	24.6%
B-Finance	945	70.2%	29.8%	210	30.7%	82.4%	17.6%
B-Office	80	83.8%	16.3%	7	10.3%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**251**	**21.8%**	**85.7%**	**14.3%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,323**	**30.2%**	**83.6%**	**16.4%**
T-Applied Science	663	64.3%	35.7%	149	26.7%	89.9%	10.1%
T-Computer	597	59.8%	40.2%	170	36.5%	78.2%	21.8%
T-Construction	1,260	68.9%	31.1%	324	30.5%	87.7%	12.3%
T-Electrical	885	63.3%	36.7%	219	28.9%	79.5%	20.5%
T-Mechanical	1,544	68.5%	31.5%	385	29.0%	82.6%	17.4%

Table 3. College mathematics achievement of students who took MCR3U in secondary school

The other finding from this analysis is that there is remarkably little variation in this general conclusion across program areas. The proportions of students taking each of the three courses and their levels of college mathematics achievement vary little. For example, while in its original form (prior to the most recent revision), MBF3C used to be called “Mathematics for Personal Finance”, as preparation for mathematics in college Business programs it seems to be

no better than as preparation for mathematics in Technology programs, with the exception of the Office Administration subcluster.

In earlier CMP studies, we found that some students graduated from secondary school with the minimum three mathematics courses permitted – in other words, they had no mathematics credits beyond Grade 11. In CMP 2009, at least among the VROG group, there were no such students; all VROGs had completed at least one Grade 12 mathematics course. This means that the students whose records are reported in Tables 1, 2 and 3 all followed these grade 11 courses with at least one grade 12 course, and the third set of pathways analyses (below) outline the range of participation and achievement in several Grade 11 and 12 course combinations.

Grade 12 Course Pathways

Tables 4, 5, and 6 describe student participation and achievement in college mathematics in relation to the particular mathematics courses they have taken at the Grade 12 level. The courses of particular interest to colleges are the two designed for college preparation, MAP4C and MCT4C and also the courses designed for university preparation – MDM4U, MCV4U and MHF4U – which are also taken by many students who go to college[6].

Program Clusters	All VROGs			Course Selection: MAP4C			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**4,857**	**56.8%**	**56.8%**	**43.2%**
Applied Arts	**602**	**75.7%**	**24.3%**	**377**	**67.8%**	**70.8%**	**29.2%**
Business	**2,857**	**63.8%**	**36.2%**	**1,401**	**56.9%**	**56.7%**	**43.3%**
B-Administration	1,832	59.7%	40.3%	925	62.5%	53.8%	46.2%
B-Finance	945	70.2%	29.8%	380	55.5%	60.3%	39.7%
B-Office	80	83.8%	16.3%	56	82.4%	83.9%	16.1%
General	**1,281**	**68.0%**	**32.0%**	**736**	**63.8%**	**57.2%**	**42.8%**
Technology	**4,949**	**66.1%**	**33.9%**	**2,343**	**53.5%**	**54.4%**	**45.6%**
T-Applied Science	663	64.3%	35.7%	353	63.1%	48.2%	51.8%
T-Computer	597	59.8%	40.2%	210	45.1%	42.4%	57.6%
T-Construction	1,260	68.9%	31.1%	587	55.2%	57.9%	42.1%
T-Electrical	885	63.3%	36.7%	420	55.5%	52.1%	47.9%
T-Mechanical	1,544	68.5%	31.5%	731	55.0%	59.6%	40.4%

Table 4. College mathematics achievement of students who took MAP4C in secondary school

[6] Some students in the CMP 2009 cohort had also taken one or more of the 12U courses since discontinued (MCB4U & MGA4U).

Program Clusters & Sub-clusters	All VROGs			Course Selection: MCT4C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**989**	**11.6%**	**68.0%**	**32.0%**
Applied Arts	**602**	**75.7%**	**24.3%**	**23**	**4.1%**	**82.6%**	**17.4%**
Business	**2,857**	**63.8%**	**36.2%**	**148**	**6.0%**	**58.8%**	**41.2%**
B-Administration	1,832	59.7%	40.3%	62	4.2%	59.7%	40.3%
B-Finance	945	70.2%	29.8%	19	2.8%	73.7%	26.3%
B-Office	80	83.8%	16.3%	2	2.9%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**78**	**6.8%**	**80.8%**	**19.2%**
Technology	**4,949**	**66.1%**	**33.9%**	**740**	**16.9%**	**68.1%**	**31.9%**
T-Applied Science	663	64.3%	35.7%	68	12.2%	73.5%	26.5%
T-Computer	597	59.8%	40.2%	85	18.2%	62.4%	37.6%
T-Construction	1,260	68.9%	31.1%	180	16.9%	71.7%	28.3%
T-Electrical	885	63.3%	36.7%	138	18.2%	63.0%	37.0%
T-Mechanical	1,544	68.5%	31.5%	260	19.6%	68.1%	31.9%

Table 5. College mathematics achievement of students who took MCT4C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: any 12U			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**2,701**	**31.6%**	**79.9%**	**20.1%**
Applied Arts	**602**	**75.7%**	**24.3%**	**156**	**28.1%**	**86.5%**	**13.5%**
Business	**2,857**	**63.8%**	**36.2%**	**913**	**37.1%**	**72.6%**	**27.4%**
B-Administration	1,832	59.7%	40.3%	494	33.4%	68.6%	31.4%
B-Finance	945	70.2%	29.8%	286	41.8%	79.7%	20.3%
B-Office	80	83.8%	16.3%	10	14.7%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**339**	**29.4%**	**85.0%**	**15.0%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,293**	**29.5%**	**82.8%**	**17.2%**
T-Applied Science	663	64.3%	35.7%	138	24.7%	89.1%	10.9%
T-Computer	597	59.8%	40.2%	171	36.7%	76.6%	23.4%
T-Construction	1,260	68.9%	31.1%	296	27.8%	86.8%	13.2%
T-Electrical	885	63.3%	36.7%	199	26.3%	79.4%	20.6%
T-Mechanical	1,544	68.5%	31.5%	337	25.4%	84.0%	16.0%

Table 6. College mathematics achievement of students who took any 12U mathematics course(s) in secondary school

Clearly, MAP4C is the Grade 12 course taken by most college-bound students – 56.8% of our sample took this course, compared with 11.6% who took MCT4C, and 31.6% who took one or

more Grade 12 U courses[7]. However, in general, college achievement levels of students with MAP4C are not high: only 56.8% of all VROGs who had taken MAP4C in secondary school received good grades in college mathematics. These achievement levels are somewhat higher in the Applied Arts programs, about the same in Business and General programs, but distinctly lower in Technology programs.

MCT4C is the Grade 12 mathematics course specifically designed for students intending to enrol in college technology programs (such as applied science and engineering technologies). However, it is only taken by 11.6% of all students (16.9% of Technology students) – reflecting the fact that the course is often not offered in secondary schools. However, achievement levels in college mathematics of those who do take it are significantly higher than for those who take MAP4C – 68.0% of all students (68.1% of Technology students) achieve good grades.

A significant proportion of all students (31.6%) take one or more 12U mathematics courses and, as one might expect, their achievement levels are higher again, with 79.9% achieving good grades. According to teachers who have contributed to the forums, this reflects the tendency on the part of many students to "keep their options open" by taking university-oriented courses through secondary school and then choosing their preferred program at the end, rather than taking college-oriented courses and limiting their postsecondary options.

Grade 11 and 12 Course Combinations

Tables 7 though 12 describe the participation and college mathematics achievement of students taking various combinations of Grade 11 and 12 courses. With 3 Grade 11 courses and 5 Grade 12 courses available to students there are many possible combinations that could be analysed and only those selected by significant numbers who also continue to college mathematics are shown here. These are as follows:

- Table 7: MBF3C + MAP4C
- Table 8: MBF3C + MCT4C
- Table 9: MCF3M + MAP4C
- Table 10: MCF3M + MCT4C
- Table 11: MCR3U + MCT4C
- Table 12: any Grade 11 + any Grade 12U

[7] Readers should note that the analysis methodology uses a "hierarchy" of Grade 12 courses which results in the data shown in these tables including students who took the designated course and any lower level courses in that grade but not including students who took a higher level course. Thus the MAP4C data (Table 4) shows students with MAP4C only, but the MCT4C data (Table 5) includes students who took MCT4C and MAP4C but not MCT4C and a 12U course, and the 12U course data (Table 6) includes students who took one or more 12U courses and may have taken MAP4C and/or MCT4C as well.

Program Clusters & Sub-clusters	All VROGs			Course Selection: MBF3C + MAP4C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**3,445**	**40.3%**	**52.5%**	**47.5%**
Applied Arts	**602**	**75.7%**	**24.3%**	**254**	**45.7%**	**66.5%**	**33.5%**
Business	**2,857**	**63.8%**	**36.2%**	**1,031**	**41.9%**	**53.5%**	**46.5%**
B-Administration	1,832	59.7%	40.3%	701	47.3%	50.8%	49.2%
B-Finance	945	70.2%	29.8%	265	38.7%	54.7%	45.3%
B-Office	80	83.8%	16.3%	40	58.8%	77.5%	22.5%
General	**1,281**	**68.0%**	**32.0%**	**522**	**45.3%**	**51.7%**	**48.3%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,638**	**37.4%**	**49.9%**	**50.1%**
T-Applied Science	663	64.3%	35.7%	260	46.5%	43.1%	56.9%
T-Computer	597	59.8%	40.2%	135	29.0%	39.3%	60.7%
T-Construction	1,260	68.9%	31.1%	404	38.0%	52.2%	47.8%
T-Electrical	885	63.3%	36.7%	295	39.0%	47.1%	52.9%
T-Mechanical	1,544	68.5%	31.5%	526	39.6%	55.5%	44.5%

Table 7. College mathematics achievement of students who took MBF3C & MAP4C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: MBF3C + MCT4C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**194**	**2.3%**	**55.2%**	**44.8%**
Applied Arts	**602**	**75.7%**	**24.3%**	**6**	**1.1%**	**33.3%**	**66.7%**
Business	**2,857**	**63.8%**	**36.2%**	**35**	**1.4%**	**42.9%**	**57.1%**
B-Administration	1,832	59.7%	40.3%	*			
B-Finance	945	70.2%	29.8%	*			
B-Office	80	83.8%	16.3%	*			
General	**1,281**	**68.0%**	**32.0%**	**16**	**1.4%**	**81.3%**	**18.7%**
Technology	**4,949**	**66.1%**	**33.9%**	**137**	**3.1%**	**56.2%**	**43.8%**
T-Applied Science	663	64.3%	35.7%	12	2.1%	83.3%	16.7%
T-Computer	597	59.8%	40.2%	17	3.6%	58.8%	41.2%
T-Construction	1,260	68.9%	31.1%	28	2.6%	57.1%	42.9%
T-Electrical	885	63.3%	36.7%	24	3.2%	41.7%	58.3%
T-Mechanical	1,544	68.5%	31.5%	56	4.2%	55.4%	44.6%

* - Fewer than 10 students in any pathway; pathways not analysed

Table 8. College mathematics achievement of students who took MBF3C & MCT4C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: MCF3M + MAP4C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**990**	**11.6%**	**65.6%**	**34.4%**
Applied Arts	**602**	**75.7%**	**24.3%**	**88**	**15.8%**	**77.3%**	**22.7%**
Business	**2,857**	**63.8%**	**36.2%**	**277**	**11.3%**	**62.8%**	**37.2%**
B-Administration	1,832	59.7%	40.3%	166	11.2%	57.2%	42.8%
B-Finance	945	70.2%	29.8%	79	11.5%	73.4%	26.6%
B-Office	80	83.8%	16.3%	13	19.1%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**156**	**13.5%**	**70.5%**	**29.5%**
Technology	**4,949**	**66.1%**	**33.9%**	**469**	**10.7%**	**63.3%**	**36.7%**
T-Applied Science	663	64.3%	35.7%	58	10.4%	53.4%	46.6%
T-Computer	597	59.8%	40.2%	49	10.5%	44.9%	55.1%
T-Construction	1,260	68.9%	31.1%	126	11.9%	70.6%	29.4%
T-Electrical	885	63.3%	36.7%	83	11.0%	62.7%	37.3%
T-Mechanical	1,544	68.5%	31.5%	136	10.2%	70.6%	29.4%

Table 9. College mathematics achievement of students who took MCF3M & MAP4C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: MCF3M + MCT4C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**600**	**7.0%**	**68.8%**	**31.2%**
Applied Arts	**602**	**75.7%**	**24.3%**	**13**	**2.3%**	**100.0%**	**0.0%**
Business	**2,857**	**63.8%**	**36.2%**	**95**	**3.9%**	**63.2%**	**36.8%**
B-Administration	1,832	59.7%	40.3%	53	3.6%	58.5%	41.5%
B-Finance	945	70.2%	29.8%	15	2.2%	80.0%	20.0%
B-Office	80	83.8%	16.3%	2	2.9%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**48**	**4.2%**	**79.2%**	**20.8%**
Technology	**4,949**	**66.1%**	**33.9%**	**444**	**10.1%**	**68.0%**	**32.0%**
T-Applied Science	663	64.3%	35.7%	44	7.9%	70.5%	29.5%
T-Computer	597	59.8%	40.2%	51	10.9%	54.9%	45.1%
T-Construction	1,260	68.9%	31.1%	110	10.3%	70.0%	30.0%
T-Electrical	885	63.3%	36.7%	88	11.6%	65.9%	34.1%
T-Mechanical	1,544	68.5%	31.5%	151	11.4%	71.5%	28.5%

Table 10. College mathematics achievement of students who took MCF3M & MCT4C in secondary school

Program Clusters	All VROGs			Course Selection: MCR3U + MCT4C			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**184**	**2.2%**	**77.7%**	**22.3%**
Applied Arts	**602**	**75.7%**	**24.3%**	**4**	**0.7%**	**100.0%**	**0.0%**
Business	**2,857**	**63.8%**	**36.2%**	**16**	**0.6%**	**62.5%**	**37.5%**
B-Administration	1,832	59.7%	40.3%	9	0.6%	66.7%	33.3%
B-Finance	945	70.2%	29.8%	4	0.6%	50.0%	50.0%
B-Office	80	83.8%	16.3%	0	0.0%		
General	**1,281**	**68.0%**	**32.0%**	**14**	**1.2%**	**85.7%**	**14.3%**
Technology	**4,949**	**66.1%**	**33.9%**	**150**	**3.4%**	**78.0%**	**22.0%**
T-Applied Science	663	64.3%	35.7%	12	2.1%	75.0%	25.0%
T-Computer	597	59.8%	40.2%	17	3.6%	88.2%	11.8%
T-Construction	1,260	68.9%	31.1%	42	4.0%	85.7%	14.3%
T-Electrical	885	63.3%	36.7%	26	3.4%	73.1%	26.9%
T-Mechanical	1,544	68.5%	31.5%	53	4.0%	71.7%	28.3%

Table 11. College mathematics achievement of students who took MCR3U & MCT4C in secondary school

Program Clusters	All VROGs			Course Selection: any 11 + any 12U			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**2,641**	**30.9%**	**80.2%**	**19.8%**
Applied Arts	**602**	**75.7%**	**24.3%**	**155**	**27.9%**	**86.5%**	**13.5%**
Business	**2,857**	**63.8%**	**36.2%**	**874**	**35.5%**	**73.1%**	**26.9%**
B-Administration	1,832	59.7%	40.3%	482	32.5%	69.1%	30.9%
B-Finance	945	70.2%	29.8%	281	41.0%	79.4%	20.6%
B-Office	80	83.8%	16.3%	10	14.7%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**334**	**29.0%**	**85.3%**	**14.7%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,278**	**29.2%**	**83.0%**	**17.0%**
T-Applied Science	663	64.3%	35.7%	138	24.7%	89.1%	10.9%
T-Computer	597	59.8%	40.2%	171	36.7%	76.6%	23.4%
T-Construction	1,260	68.9%	31.1%	296	27.8%	86.8%	13.2%
T-Electrical	885	63.3%	36.7%	199	26.3%	79.4%	20.6%
T-Mechanical	1,544	68.5%	31.5%	337	25.4%	84.0%	16.0%

Table 12. College mathematics achievement of students who took any Grade 11 mathematics course and any Grade 12 U mathematics course in secondary school

The most popular combination of Grade 11 and Grad 12 mathematics courses for students going on to take college mathematics is, unfortunately, a sequence that does not lead to high levels of success. The MBF3C + MAP4C combination (Table 7) is followed by over 40% of all students who achieve, on average, 52.5% good grades – somewhat better in Applied Arts programs (66.5%) and worse in Technology programs (49.9%). The next most popular combination is the any Grade 11 + any 12U mathematics course combination (Table 12); 30.9% take this sequence and 80.2% of them subsequently achieve good grades in college mathematics. Third in popularity (11.6% of all students, Table 9) comes the MCF3M + MAP4C combination and 65.6% of students following this combination obtain good grades – not significantly different from the overall average achievement of 66.3%. A small proportion (7% of all students, but 10.1% of Technology students) take MCF3M and MCT4C (Table 10) and 68.8% of these achieve good grades. Fewer than 200 out of 9,000 students take the other two combinations, MBF3C + MCT4C (Table 8) and MCR3U + MCT4C (Table 11).

Grade 10 and 11 course combinations

Tables 13 through 16 show data for students who have taken various combinations of Grade 10 (Applied or Academic) Mathematics with Grade 11 MBF3C and MCF3M. Prior to this cohort, the mathematics curriculum prerequisite for MCF3M was Grade 10 academic mathematics but with the recent curriculum revisions, it is now possible for students who take Applied Mathematics in Grade 10 to take MCF3M in Grade 11 (and thus have the prospect of greater success in college mathematics).

Program Clusters	All VROGs			Course Selection: 10 Applied + MBF3C			
& Sub-clusters	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**2,372**	**27.8%**	**50.6%**	**49.4%**
Applied Arts	**602**	**75.7%**	**24.3%**	**165**	**29.7%**	**63.0%**	**37.0%**
Business	**2,857**	**63.8%**	**36.2%**	**645**	**26.2%**	**52.9%**	**47.1%**
B-Administration	1,832	59.7%	40.3%	436	29.4%	52.1%	47.9%
B-Finance	945	70.2%	29.8%	156	22.8%	53.2%	46.8%
B-Office	80	83.8%	16.3%	25	36.8%	72.0%	28.0%
General	**1,281**	**68.0%**	**32.0%**	**367**	**31.8%**	**46.6%**	**53.4%**
Technology	**4,949**	**66.1%**	**33.9%**	**1,195**	**27.3%**	**48.9%**	**51.1%**
T-Applied Science	663	64.3%	35.7%	125	22.4%	48.0%	52.0%
T-Computer	597	59.8%	40.2%	86	18.5%	43.0%	57.0%
T-Construction	1,260	68.9%	31.1%	332	31.2%	50.6%	49.4%
T-Electrical	885	63.3%	36.7%	211	27.9%	43.1%	56.9%
T-Mechanical	1,544	68.5%	31.5%	429	32.3%	51.7%	48.3%

Table 13. College mathematics achievement of students who took Grade 10 Applied Mathematics and MBF3C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: 10 Applied + MCF3M			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**289**	**3.4%**	**62.3%**	**37.7%**
Applied Arts	**602**	**75.7%**	**24.3%**	**21**	**3.8%**	**76.2%**	**23.8%**
Business	**2,857**	**63.8%**	**36.2%**	**72**	**2.9%**	**58.3%**	**41.7%**
B-Administration	1,832	59.7%	40.3%	46	3.1%	50.0%	50.0%
B-Finance	945	70.2%	29.8%	16	2.3%	62.5%	37.5%
B-Office	80	83.8%	16.3%	5	7.4%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**53**	**4.6%**	**69.8%**	**30.2%**
Technology	**4,949**	**66.1%**	**33.9%**	**143**	**3.3%**	**62.3%**	**37.7%**
T-Applied Science	663	64.3%	35.7%	19	3.4%	47.4%	52.6%
T-Computer	597	59.8%	40.2%	13	2.8%	46.2%	53.8%
T-Construction	1,260	68.9%	31.1%	46	4.3%	63.0%	37.0%
T-Electrical	885	63.3%	36.7%	31	4.1%	54.8%	45.2%
T-Mechanical	1,544	68.5%	31.5%	53	4.0%	67.9%	32.1%

Table 14. College mathematics achievement of students who took Grade 10 Applied Mathematics and MCF3M in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: 10 Academic + MBF3C			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**557**	**6.5%**	**65.7%**	**34.3%**
Applied Arts	**602**	**75.7%**	**24.3%**	**45**	**8.1%**	**80.0%**	**20.0%**
Business	**2,857**	**63.8%**	**36.2%**	**172**	**7.0%**	**60.5%**	**39.5%**
B-Administration	1,832	59.7%	40.3%	106	7.2%	58.5%	41.5%
B-Finance	945	70.2%	29.8%	42	6.1%	59.5%	40.5%
B-Office	80	83.8%	16.3%	9	13.2%	88.9%	11.1%
General	**1,281**	**68.0%**	**32.0%**	**76**	**6.6%**	**78.9%**	**21.1%**
Technology	**4,949**	**66.1%**	**33.9%**	**264**	**6.0%**	**62.9%**	**37.1%**
T-Applied Science	663	64.3%	35.7%	25	4.5%	48.0%	52.0%
T-Computer	597	59.8%	40.2%	24	5.2%	45.8%	54.2%
T-Construction	1,260	68.9%	31.1%	57	5.4%	64.9%	35.1%
T-Electrical	885	63.3%	36.7%	74	9.8%	63.5%	36.5%
T-Mechanical	1,544	68.5%	31.5%	72	5.4%	73.6%	26.4%

Table 15. College mathematics achievement of students who took Grade 10 Academic Mathematics and MBF3C in secondary school

Program Clusters & Sub-clusters	All VROGs			Course Selection: 10 Academic + MCF3M			
	N	College Math Grades		n	% of Total	College Math Grades	
		Good Grades	At Risk			Good Grades	At Risk
All Clusters	**9,689**	**66.3%**	**33.7%**	**1,504**	**17.6%**	**70.7%**	**29.3%**
Applied Arts	**602**	**75.7%**	**24.3%**	**100**	**18.0%**	**80.0%**	**20.0%**
Business	**2,857**	**63.8%**	**36.2%**	**419**	**17.0%**	**67.8%**	**32.2%**
B-Administration	1,832	59.7%	40.3%	268	18.1%	64.2%	35.8%
B-Finance	945	70.2%	29.8%	103	15.0%	75.7%	24.3%
B-Office	80	83.8%	16.3%	10	14.7%	100.0%	0.0%
General	**1,281**	**68.0%**	**32.0%**	**221**	**19.2%**	**77.8%**	**22.2%**
Technology	**4,949**	**66.1%**	**33.9%**	**764**	**17.5%**	**69.0%**	**31.0%**
T-Applied Science	663	64.3%	35.7%	58	10.4%	70.7%	29.3%
T-Computer	597	59.8%	40.2%	69	14.8%	52.2%	47.8%
T-Construction	1,260	68.9%	31.1%	211	19.8%	72.5%	27.5%
T-Electrical	885	63.3%	36.7%	141	18.6%	63.8%	36.2%
T-Mechanical	1,544	68.5%	31.5%	239	18.0%	72.8%	27.2%

Table 16. College mathematics achievement of students who took Grade 10 Academic mathematics and MCF3M in secondary school

While these data are somewhat limited[8], they do show that the most common combinations are not surprisingly Grade 10 Applied + MBF3C (27.8%, Table 13) and Grade 10 Academic + MCF3M (17.6%, Table 16). These two combinations lead respectively to 50.6% and 70.7% of students obtaining good grades. However, 289 students (3.4%) followed the newly opened route of Grade 10 Applied + MCF3M (Table 14) and achieved 62.3% good grades subsequently in college mathematics. This is the combination that we will follow with interest in future years.

Conclusions

All educators, including teachers, school and college administrators, Ministry officials and CMP staff, share the desire to increase student success and CMP is designed to generate the research and provoke the deliberations that will lead to the achievement of this goal. Following its research in each of the past years, CMP has hosted forums in which teachers and others to discuss the research findings and to generate suggestions concerning ways forward. Readers are encouraged to review the reports from CMP 2008 and CMP 2009 which are available on the

[8] Some colleges were unable to supply student data for Grades 9 and 10, with the result that the overall numbers shown are lower than for Grade 11 and 12 course combinations.

CMP web site to see the conclusions and recommendations from each of the past two years, particularly those relating to the issue of course selection.

The CMP 2008 report had a major section of conclusions entitled "Pathways to Success in College Programs" in which the following four recommendations were included:

- Colleges should clarify for secondary schools those Grades 11 and 12 mathematics courses and levels of achievement that are most likely to lead to success in each program, using such communications vehicles as web sites, program brochures, and special communications for parents.
- Secondary schools should make further efforts to ensure that students have access to important college preparation courses such as MCT4C, using summer school, e-learning and other means where enrolment is insufficient for regularly scheduled classes.
- Secondary school guidance teachers should use data on the likely consequences of course selection (such as are provided by CMP) to advise students.
- The Ministry of Education should give serious consideration to the revision and simplification of the course structure at Grades 11 and 12 (as recommended in the Double Cohort Study) with a view to the implementation of a new system as each subject area's next cyclical revision takes place.

While progress towards these has been made, more can still be done by colleges (in relation to clarifying their expectations for students), school boards and schools (in ensuring that all students have access to key courses such as MCT4C), and the Ministry (in reviewing the structure of mathematics courses at the senior level, particularly in the light of the recent simplification and coordination of the mathematics curriculum in the western provinces and northern territories[9]).

The CMP 2009 report built on the initiatives proposed in 2008 by calling for a vision of student success that extends from Kindergarten through to entry to careers and placing emphasis on the need for discussion among all stakeholders on issues of course offerings, postsecondary admissions policies, and student choices. Its major recommendation is as follows:

- The Ministries of Education and Training, Colleges and Universities should create a Provincial Roundtable on Secondary/Postsecondary Transitions to include representation from colleges, universities, school boards and both ministries with a mandate to deliberate and recommend policy changes aimed at ensuring that adequate

[9] For more information on this, see: http://www.wncp.ca/media/38771/math10to12.pdf.

numbers of appropriately prepared students transition successfully from secondary school to postsecondary institutions.

Course selection is not the only factor contributing to student success of course. The CMP reports of both 2008 and 2009 contain discussions of the importance of students' learning skills in relation to success in college, and of the methods of teaching mathematics at both school and college levels. Readers are encouraged to review the reports for those and other relevant topics.

Finally, this is the first detailed report based on the pathways analysis aspect of the CMP research. Readers are invited to send comments to us and to make suggestions for ways in which this type of research could be made more useful.