CSAP/PREC

COLLEGE STUDENT ACHIEVEMENT PROJECT

Discussion Paper

Assessing Mathematics Skills for College: A Way Forward?

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Introduction

The focus of the College Student Achievement Project (CSAP) – like that of its predecessor, the College Mathematics Project (CMP) is on the transition of students into the first year of Ontario college diploma and certificate programs. The main thrust of CSAP research is the analysis of student achievement in mathematics and language in their first and second semesters and relating this to demographic and academic factors, including the students' secondary school backgrounds. However, in its current research program, the CSAP team have been asked to undertake several new activities, including:

- An investigation of mathematics skills assessment tools presently used by colleges;
- Investigating the feasibility of developing one mathematics skills assessment tool for use by all colleges;
- Investigating the feasibility of having common learning outcomes and common curricula for first semester college mathematics courses;

Subject to the outcomes of this feasibility study, the CSAP has also been invited to coordinate the development of (one or all of) a common assessment tool, common learning outcomes and common curricula for various types of first semester mathematics courses in business and technology.

This discussion paper represents the conclusion of the investigation of the assessment tools presently in use across the college system and the first step in determining the feasibility of developing a common assessment tool, common learning outcomes, and common curricula for first semester mathematics. This paper is *not* the final outcome of this component of CSAP which is due in August 2013. Rather it is designed to inform deliberations both at individual colleges and within province-wide college organisations over the desirability and feasibility of developing new common ways forward in our joint commitment to supporting greater success among college students, particularly in mathematics and mathematics-based programs. To that end, the paper concludes with questions for discussion and invites feedback from all interested parties.

Following this introduction, the paper is divided into six main sections: the first describes the results of surveys of the colleges into their practices with respect to the assessment of the mathematics skills of incoming students; the second summarises the results of a brief survey of other provinces and the United States; the third proposes a set of principles to underpin a common approach to mathematics skills assessment; and the fourth section proposes a concrete model for consideration. The paper concludes with proposals concerning common learning outcomes and common curricula and some questions to stimulate discussion and promote feedback.

Ontario College Survey Results

Before further discussions can take place regarding the feasibility of a province-wide mathematics assessment tool, the current assessment situation for Ontario's twenty-four colleges must be investigated. The CSAP was asked to undertake such a review of current practices across the college system in regard to the assessment of mathematics skills of incoming students.

The first step in the review was an email survey of each college to determine which of the colleges conducted a mathematics assessment. Of the twenty-four colleges in Ontario, ten do not currently conduct any form of mathematics assessment, while fourteen do.

A teleconference was conducted with each of the fourteen colleges who conduct a mathematics assessment in order to better understand their assessment practices and to learn more about the level of satisfaction with what they are currently doing. The following questions formed the basis of these teleconference discussions:

1. What sorts of assessment instruments are used? - a proprietary one (such as Accuplacer or Canadian Achievement Test (CAT) or a locally developed instrument?
2. What purposes are served by the assessments? - Admission, Placement, Diagnostic, etc.? How are the results used?
3. For locally developed instruments,
    a. How are these validated?
    b. How do they link to the college curricula and/or high school curricula?
4. What strengths and/or weaknesses do you see in your present system? What would you like to see improved?

Further, each college was asked to consider and discuss their level of support for a province-wide assessment tool.

Through our conversations with college representatives about these discussion questions, CSAP was provided with a thorough, comprehensive picture of how current assessments are conducted, the successes and challenges that each college faces and the level of satisfaction around their current practices[1]. It was evident that, at all colleges, participants had the best interests of students and student success in mind, and there was general agreement that these types of open discussion provide a powerful vehicle for ongoing support and collaboration around changes to assessment practices. Each college was open to further contact after the telephone conference if elaboration on or clarification of any discussion point was needed and in several cases this took place.

From these surveys, we found that a variety of assessment tools were used:

- five colleges primarily use assessment tests that had been developed in house;
- four primarily use ACCUPLACER, a proprietary assessment tool developed in the United States[2];

[1] In what follows, the opinions stated represent those of the people we talked with in the teleconferences and not necessarily those of the CSAP team.
[2] https://www.accuplacer.org/cat/

- four primarily use an assessment tool based on a test developed some years ago by the Ontario College Mathematics Association (OCMA); and
- one college uses the COMPASS mathematics assessment test, a proprietary tool developed by the Australian Council for Educational Research[3].

For particular cases or programs, some colleges use more than one assessment.

The delivery method of the assessment test varies but most colleges are moving towards online delivery because of the adaptive nature or other features of some tests, and because of the ease of administration, grading and reporting. Nine of fourteen colleges use online delivery, four colleges use paper-and-pencil tests while one college uses both online and paper-and-pencil tests.

All of the 14 colleges administer the assessment post-admission, within a few weeks of first year students arriving on campus, either in a computer lab or assessment facility or in one of the first mathematics classes of the term. Admission of most students is not impacted by assessment test results at any of these colleges[4]. At some colleges, the assessment test is optional for students, at others mandatory. Some colleges have program-specific mathematics assessments, particularly for mathematics-intensive programs such as technology and business, with one college having a mathematics assessment for incoming communication students. A few colleges offer incentives for taking the optional assessment test such as additional marks on a first-year mathematics course.

Test results are used in a wide variety of ways including:

- Student profiling;
- Streaming students into levelled mathematics courses;
- Flagging at-risk students;
- Flagging potential peer tutors ;
- Mathematics course exemption;
- To inform course instruction and content;
- As a student retention strategy ;
- For college statistical analysis ;
- As a diagnostic mechanism;
- For advising students .

There is a great variation across the colleges in how (or if) assessment test results are shared with students. This seems to relate to how the assessment results are used by the college. When students are given feedback from the assessment, it is given in a variety of ways, from a simple score to the student's relative position amongst their peers to detailed reports indicating where the student's achievement was above, at, or below the college's expectations for success. At some colleges, only college staff, program administrators or faculty are provided with assessment results. In some cases, a student may become aware of their achievement on the assessment test only by the particular first year mathematics course they are placed in or whether remediation courses are recommended.

[3] http://www.acer.edu.au/tests/compass

[4] However, several colleges use mathematics admission testing for students who apply on the basis of mature status without meeting the documented admission requirements.

The mathematics assessment tests currently in use are intended to assess basic mathematics skills that are considered necessary for success in first year college mathematics courses. Secondary school grades have traditionally been used as the main indicator of mathematics understanding and predictor of success in college but some colleges believe that these mathematics assessment tests may provide a more reliable indication of success. We have not reviewed any direct evidence for this, however.

Strengths and challenges of current mathematics assessments were offered very frankly by representatives of the colleges during the teleconferences. A summary of those strengths and challenges, regardless of the particular assessments, provides an idea of those characteristics that colleges find important and their implications for a possible province-wide assessment.

Strengths are indicated when an assessment:

- Has a strong connection to both secondary and college mathematics curricula;
- Is familiar and trusted and in use for many years, particularly where results have been tracked;
- Can be used both post- and pre-admission;
- Is reputable, validated and normalized;
- Is convenient for large scale testing;
- Can be administered at various locations, beneficial for international students;
- Is multiple-choice;
- Is adaptive, tailored to range of student skills demonstrated;
- Gives immediate and detailed feedback;
- Is flexible (including modules necessary for specific programs);
- Is cost-effective.

Challenges or criticisms are indicated by the following statements:

- Single assessment test is more suitable for some programs than for others;
- Assessment has not stood up to statistical validation which is problematic if it were to be used for admission purposes;
- Security of test in question if the same test is used every year, especially with paper tests;
- Assessment test results can only be used at one college, or for one program;
- Linked to foreign curricula rather than Canadian mathematics curricula;
- Not diagnostic;
- No clear benchmarks indicating acceptable levels of mathematics achievement;
- Difficult to manage student accommodations (use of calculator, scribe) ;
- Level and timeliness of student feedback;
- More and different modules necessary for use in different programs;
- Assessment test focuses on grades 11 and 12 where more basic skills taught in earlier grades should also be assessed.

While these strengths and challenges refer specifically to the assessment test instrument itself, concerns were also expressed about the assessment processes in use. Because assessment tests are taken post-admission, are often optional and without evident consequence for the student,

some students are not motivated to take the tests, to prepare for them, or to participate in remediation, if their results indicate a need to do so. Some students, it was even claimed, purposely achieve poorly on the assessment in the hopes of being placed in a lower level (and therefore easier) mathematics course.

Concerns were also expressed that remedial courses offered to students *concurrently with* regular first year program mathematics courses or courses such as physics or chemistry having embedded mathematics, often overburden students who are already at-risk. Offering grade incentives to students who take the assessment test is also seen to inflate course marks or unfairly advantage those students.

All of the college representatives were supportive of investigating a province-wide mathematics assessment. A feasibility study into a common assessment test appears timely in view of the fact that several colleges who administer a mathematics assessment are undergoing internal studies into making changes to their current practice, looking at developing their own, utilizing proprietary tools such as ACCUPLACER, and making assessments mandatory.

The benefits of having a common assessment included:

- Having a 'made in Canada' assessment tool;
- Having greater consistency for assessment across the colleges;
- An opportunity for better comparisons to be made;
- The ability to administer the assessment earlier, prior to course registration or post-application/pre-admission;
- The ability to provide better and immediate feedback to students;
- The ability to provide remediation or advice to seek remediation to students earlier;
- Test results could be used to apply to more than one college or program;
- Having better benchmarks; ensure a standard level of mathematics ;
- Informing elementary and secondary school practice;
- Having a more proficient student enter the college programs;
- Beneficial for collecting data and offering students greater access to results;
- Less resource intensive for colleges examining their assessment protocol.

Concerns about having a common mathematics assessment were also noted:

- Colleges want to maintain autonomy with regards to how they use the test results;
- Finding agreement from all colleges or college programs on what assessment tool to use or develop might be difficult.

This first section of the discussion paper has described the results of two surveys of the colleges into their practice with respect to the assessment of the mathematics skills of incoming students. Participation by all twenty-four colleges in Ontario has allowed for a comprehensive summary of current mathematics assessment practices across the colleges as well as an indication of the level of support for a province-wide mathematics assessment tool. To broaden our sense of the current state of mathematics assessment in colleges, we decided next to contact a limited number of Canadian colleges outside Ontario and to learn something of their experience in this area.

Survey of Colleges Outside of Ontario

In order to gain a snapshot of assessment practices across the country, several colleges were contacted by telephone. Eight colleges in eight provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Manitoba, Saskatchewan, Alberta and British Columbia) were surveyed.

An overall theme emerging from the conversations with these eight colleges was that each college finds itself in a state of transition in regard to assessment. In recent years, colleges in other provinces have noted a significant gap between the mathematics skills and understanding that students bring with them from secondary school and those which are needed for success in college mathematics. Further, some colleges reported concerns with motivation and attitude of incoming students, which also negatively impact student success in college.

Some provinces have recently made changes to the mathematics curriculum in the school system to address these (and other) concerns, while others are currently undergoing changes. Colleges are reacting in several ways, including considering changes to admission requirements and assessment policies, noting that, in their view, secondary school marks are becoming less reliable predictors of college success. Colleges who have not conducted mathematics assessments in the past are now considering instituting mathematics assessments and some have already completed pilot assessments with incoming students, though none has yet adopted a particular assessment tool. Several colleges noted that they offer mathematics remediation to students who need it.

An open-access college in the Maritimes does not conduct any form of assessment, having programs open to any student who meets the necessary secondary school prerequisites, offering admission to the first students who apply with those minimum standards. Another college, whose programs are very competitive, noted that because they only accept students with the highest grades, they are less concerned about knowledge gaps and poor motivation amongst students as other colleges.

One college tests all incoming students using ACCUPLACER prior to course enrolment. Students are provided with a report outlining any concerns in achievement to inform the student, recommended remediation if necessary, and indicated academic readiness for college programs. The results are not used for admission purposes. This college has found ACCUPLACER to be an excellent predictor of student success.

Four of the eight colleges surveyed only administer a mathematics assessment for incoming students who are unable to provide records of prior academic achievement. These may be those applying as mature students, or international and refugee applicants. The assessment test is different for all four colleges. In one case, ACCUPLACER is used while at the second college, the CAT test is used, the third uses a test developed in house twenty years ago and the last administers the Grade 12 diploma tests for mathematics and English. This group represents a very small number of students. The colleges which used ACCUPLACER as an assessment tool did note that it was costly to administer and focused on an American curriculum, which they did not consider ideal.

All the colleges surveyed from outside Ontario expressed interest in the CSAP research as they review their assessment practices. While support for a province-wide common assessment tool was

indicated amongst the representatives of Ontario colleges, some colleges outside Ontario suggested that a 'Made in Canada' mathematics assessment tool for the nation's colleges would be beneficial.

Principles of Assessment

The first test of the feasibility of a province-wide college initiative is a consensus on the principles underpinning it and this section proposes a number of principles on which a joint initiative on mathematics assessment could be undertaken. These cover such essential elements as the purposes of the assessment, the basis for selecting its content, the ways its results will be used, and its overall operation and management.

1. Assessment for Learning

The most significant development in the theory and practice of assessment in the past few decades has not been in the area of psychometrics, though the latest techniques for evaluating the quality of tests and the items that make them up have been impressive. It has not even been in the area of technology, though the growth of computer adaptive testing has been amazing. Rather it has been the focusing of educators' attention on what should be the most important purpose of assessment: the support of students' learning. With the increasing demand on the use of assessment for accountability, selection and certification, these 'managerial' functions tend to distract attention away from the needs of students and toward the needs of institutions.[5] In recent years, however, a growing body of literature throughout the world has reminded educators of what should be the primary purpose of assessment in education.[6] This priority has recently been reinforced through Ontario policy documents of the Ministry of Education and the Ministry of Training, Colleges and Universities[7].

In practice, this means that any assessment should be designed and used with the needs of students' learning first and foremost. We should ask ourselves: "How can this assessment *directly* improve learning?" The emphasis on the *direct* impact on learning is important. It can be argued that all assessment, whether for placement of students into remedial courses, collection of information for curriculum development, or even annual collecting of data on incoming students, can have an *indirect* benefit to students. But to have a *direct* impact, the assessment must be linked directly to where students are and where they need to go next. With this perspective, assessment becomes

[5] Stobart, G. (2008). *Testing times: The uses and abuses of assessment*. London: Routledge.
[6] Black, P. and Wiliam, D. (1998). 'Assessment and classroom learning,' *Assessment in Education*, 5: 7-71. Stiggins, R. (2005). *Student-involved classroom assessment*. Upper Saddle River, NJ: Merrill Prentice Hall. Assessment Reform Group (2002). *Assessment for learning: 10 principles*, University of Cambridge: Assessment Reform Group. Earl, L. (2003). *Assessment as learning: Using classroom assessment to maximise student learning*. Thousand Oaks, CA: Corwin Press.
[7] Ontario Ministry of Education. (2010). *Growing success: Assessment, evaluation and reporting in Ontario schools*. Toronto: Ministry of Education. Ontario Ministry of Training, Colleges and Universities. (2012) *Ontario adult literacy curriculum framework: Foundations of assessment*. Toronto: Ministry of Training, Colleges and Universities.

embedded in the learning process. Stobart (2008, p. 145), citing the work of the UK-based Assessment Reform Group, identifies five features of such 'assessment *for* learning':

- The active involvement of pupils in their own learning;
- The provision of effective feedback to pupils;
- Adjusting teaching to take into account of the results of the assessment;
- The need for pupils to be able to assess themselves;
- Recognition of the profound influence that assessment has on the motivation and self-esteem of pupils, both of which are crucial influences on learning[8].

Placing the primary purpose of assessment on students' learning does not reduce its potential value as a tool for colleges. Designed effectively, a mathematics skills assessment can assist colleges in placing students into appropriate courses in their first semester, it can enable institutions to use the results as baseline data for program or course evaluation, and it can enable the early identification of students likely to require additional support in college. As we have seen, the 24 colleges have very varied approaches to supporting student success and retention and a valid and reliable assessment can be a useful tool in relation to these.

In addition, a mathematics skills assessment for students entering college programs can be of value to the K-12 school system also. The CSAP team has frequently encountered questions from members of the secondary school community about 'what (mathematics skills) the colleges want or expect' of their incoming students. Given the diversity of college programs, this has always been a hard question to answer. But a mathematics skills assessment endorsed by all colleges would provide the clearest statement yet of the range and depth of those mathematics skills which college faculty regard as essential for entering diploma programs, particularly in business and technology. The assessment would facilitate a more constructive conversation between the mathematics communities in secondary schools and colleges, as both seek ways to enhance the success of their students.

2. Assessment of Mathematics Fundamentals

In 2011, the College Mathematics Project undertook a detailed topical analysis of first semester diploma-level and foundational mathematics courses in business and technology programs across the college system.[9] This analysis showed that there was a substantial degree of agreement across the college system over the content of foundational mathematics courses and a somewhat broader diversity of diploma-level mathematics courses. The report of this research identifies those numeracy skills "considered to be most critical in relation to preparing for diploma level college mathematics in both business and technology programs." (p. 50). In both pre-technology and pre-business mathematics, the list is headed by order of operations, fractions, decimals, percentages, ratio and proportion, and basic algebra.

When colleges use mathematics skills assessments for incoming students, it is not surprising, therefore that we see the same skills appearing on many of the test instruments currently in use.

[8] Stobart, G. (2008). *op. cit.*
[9] Orpwood, G. et al. (2012). *College Mathematics Project 2011: Final Report*. Toronto: Seneca College.

These skills reflect a strong consensus across the college community concerning the basic mathematics competencies required for successful participation in a diploma programs. More precisely, while a basic list applies to participation in both business and technology programs, there are some additional skills required specifically for technology programs. This has led some colleges to use one test for business students and another for technology students.

Nevertheless, two points emerge clearly from our analysis both of the mathematics courses and the assessments in current use, and these provide us with two principles concerning the content of any province-wide assessment being planned for the future. The first is that an assessment should focus on mathematics fundamentals rather than on the content of mathematics courses at the Grades 11/12 level. Faculty participating in forums where CMP research findings have been discussed have told us that, while they can re-teach topics from Grades 11/12 mathematics that students have forgotten or not mastered, it is much more difficult for them to help college students whose fundamental skills in mathematics are not well developed.

The second is that consistently high levels of competence or mastery of these fundamental skills must be demonstrated for students to be confident in their ability to achieve success in a diploma-level college mathematics course. A 50% pass mark (in these fundamental skills) is not sufficient in the occupations for which colleges prepare students for employment in technology, business, healthcare or other occupations, and it is not sufficient for students entering those college programs either. A province-wide mathematics skills assessment may focus on skills at a very fundamental level but it should also call for students to demonstrate a high level of competence in those skills.

3. High Quality Assessment

Textbooks of educational assessment have always identified validity and reliability as hallmarks of quality for assessments but, in recent years, these have been superseded by a richer array of standards of quality for educational assessment.[10] While a detailed discussion of these is beyond the scope of this discussion paper, certain features are of particular importance. The following is based on the draft standards for classroom assessment developed by a joint US-Canada committee and expected to be published in 2013.

First, the standards emphasise that an assessment should be recognised as a process rather than as a document. The process includes all aspects of deciding what and how to assess, the methods and conduct of assessment, the collection, evaluation and communication of the results and, most significantly, the decisions made on the basis of the assessment.

Second, the standards emphasise, as we have already done, the importance of assessments being aligned with expectations for student learning, supportive of students' ongoing learning, and linked with instructional opportunities. Timely feedback to students (and, where appropriate, to others also) should be an essential design element as should the provision of instructional follow-up.

[10] For example: *Principles for fair student assessment practices for education in Canada* (1993) (Edmonton: Joint Advisory Committee, Faculty of Education, University of Alberta); Joint Committee on Standards for Educational Evaluation (JCSEE). *Classroom assessment standards* (5th draft) (2013). In publication.

Thirdly, quality assessments should respect the students' linguistic and cultural diversity, they should take into account the specific educational needs of all students, and be free of bias. They should also provide sufficient and appropriate information that supports sound decisions about students' knowledge and skills (validity). And they should provide such information consistently and dependably (reliability).

These requirements for quality assessments set a high standard and, if a decision is made to proceed with a provincial college mathematics assessment, then such an assessment must aim to be of the highest quality possible.

4. Cost-Effectiveness of Assessment

In addition to these basic conceptual and ethical principles underlying a province-wide college mathematics assessment, there are many practical considerations that must be taken into account for the enterprise to be successful. Issues requiring consideration include:

- Ownership and day-to-day management of the assessment system;
- Effective bilingual operation of the assessment;
- Maintenance and renewal of the assessment items;
- Choice of an appropriate interactive technology platform;
- Ease of access by students;
- Secure transmission of data between users and colleges;
- Business plan for development and ongoing operation ;
- Public awareness of the assessment system, especially to specific client groups;
- Framework for evaluation of the assessment system.

The feasibility of developing a mathematics assessment requires at least the prospect that these issues can all be resolved in an acceptable manner within the next several months. These issues will continue to be investigated and the final report of the project will provide updated information.

A Proposed Assessment Model

In our survey of present practices across the Ontario college system, we learned about many aspects of assessment and the model proposed here draws on these experiences. In what follows, we present for discussion a potential model for mathematics skills assessment for the Ontario college system. This is not a 'take it or leave it' proposition. There may be aspects that readers decide are desirable and feasible and others they do not feel to be so. We invite feedback both on the underlying principles and also on the following model.

1. Modular design for diagnostic purposes

In order to maximise the assessment system's benefits for student learning, a modular design that enables diagnosis and feedback leading to remediation is desirable. We envision a system made up

of a basic set of numeracy modules (each focussed on one topic, such as fractions, decimals, percentages etc.) together with supplementary sets focused on technology-specific and business-specific topics. Students could choose to take the basic set and (optionally) either or both of the other sets, depending on the program areas they were interested in pursuing at college. Each module would be made up of a number of pre-tested items sufficient to establish a reliable topic score, from which to infer whether or not a student had demonstrated competence on that topic.

2. Computer-based assessment

In order to provide multiple consistent and reliable assessments, the test system would be computer-based. Each individual test would be constructed from a pool of items whose psychometric characteristics have been established. In addition, each test module would be linked to a remedial self-instructional unit so that students failing any given topic could immediately seek support.

3. Internet platform for universal access

In order to provide students with access to the assessment system throughout the province, we anticipate that both the assessment and instructional systems would be mounted on a web based technological platform accessible initially from any college in Ontario. It should also be possible for the remedial instructional modules to be accessible separately so that students could use them at school or at home as well as at college (see section 4 for more details of alternative modes of use).

4. Informal and formal modes of use

In order to maximise the value of this assessment system, we propose two modes for its use, informal and formal. The informal use would be widely accessible to students while still at school and who are thinking about applying to college. It would use one part of the item pool and provide tests for general use, with feedback being provided to users (only) along with access to the remedial units. No permanent record would be kept of students' achievement for this mode of use. The advantage to students of taking the assessment would be to build self-confidence in their readiness for a college program and/or to alert them of areas in need of further preparatory work prior to enrolling at college. The advantage to the colleges would be a reduction in the numbers of students requiring remediation or in danger of being 'at risk.'

By contrast, the formal use of the assessment would be under the supervision of a college and be accessible to students who had received an offer of a place in (any) college program. The items would be a parallel but separate set from those being used in the informal mode and the results could be recorded on the student's OCAS student profile where it could be accessed by any college to which the student had made application. As with the informal mode, the results would also be provided to the student along with access to remedial units where needed. Students would be invited to take the assessment as soon as they received an offer of a place and, if remediation was

required, to retake the assessment again with the results being recorded on the student's OCAS file each time. At the discretion of a college, as is the case at present, all or some students entering business or technology programs could be required to take the assessment.

5. Test Development

To develop and field test a sufficiently large number of items for such a modular assessment to function in both informal and formal modes requires the cooperation of the entire college system and the mathematics teaching community in particular. We anticipate that, if the assessment were approved in principle, test items and instructional modules would be sought from all colleges, edited into standard format and returned for field testing. In addition, the Ontario College Mathematics Council would be asked to set up a special advisory committee to review the items being developed, to approve their final selection following field testing, and assist in the development of self-study units. Input from the mathematics teaching community at the K-12 level is also important to ensure the overall quality and appropriateness of the test items. In addition, specialist psychometric support will be required to establish the item characteristics and design the modular test system.

Common learning outcomes? Common curricula?

The mandate of this component of CSAP includes the consideration of the feasibility not only of a common mathematics assessment instrument but also of common learning outcomes for various types of first semester mathematics courses and even of common curricula. We are not ready to develop a firm proposal for these at this point but we have some suggestions for discussions at colleges and at provincial organisations over the next few weeks and months.

The feasibility of developing common learning outcomes and/or common curricula in mathematics depends on two separate factors: the degree of system-wide diversity that currently exists; and, where there is significant diversity, whether that is simply an artefact of the separate curriculum development across the college system over many years or, on the other hand, if it reflects important and principled differences in the needs of students or programs.

Throughout the history of the college system, each college has developed its own academic policies and programs with little need for these to be coordinated with those of the other colleges. Thus, for example, as we discovered at the start of the CMP research program, each college developed its own system of grading for student achievement and these has been little need – until CMP began its research – for these 24 grading systems to be brought into alignment. However, there appears to be little by way of fundamental principle behind this diversity and there has even been some discussion about whether the college system should have a single grading system. To this point, however, the benefits of such a reform have not been so evident so as to outweigh the upheaval at each college of changing its system.

By contrast to diversity of practice being just the natural outcome of the academic autonomy of the colleges, it can also be the result of principled decisions about the mathematics skill requirements of different types of program. The systematic differences between mathematics courses for business

programs and mathematics courses for technology programs is an obvious instance of this type of diversity. Thus, where colleges differ in matters of academic policy and practice, one must pause to determine the reasons for the difference and the costs and/or benefits of removing such a difference.

We would argue that the variety of learning outcomes and curriculum in first semester mathematics illustrates both of these. The following conclusions are based on the research conducted as part of the CMP in 2011[11]. We present them here as the basis for discussion among our college partners.

Foundational Mathematics Courses

There appears to be a high degree of similarity across colleges within pre-Business mathematics courses and within pre-Technology courses, and we would propose that it is feasible to develop common learning outcomes and common curricula for each of these.

Diploma- Level Mathematics Courses

There is a moderate degree of similarity across colleges within Business mathematics courses and it should be feasible to develop common learning outcomes and curricula in this area. There is also a moderate degree of similarity across colleges within Technology mathematics courses but in several colleges there are several mathematics courses for technology programs, which vary across technology sub-clusters. For example the mathematics for electrical and electronics may vary significantly from the mathematics for applied science or mechanical technology programs. The CMP research conducted last year was based on one technology mathematics course from each college and so that research cannot assist us here. We therefore propose that the feasibility of developing common learning outcomes and curricula for technology mathematics be reviewed further by the Ontario College Mathematics Council prior to a decision being reached.

The process for developing common learning outcomes and common curricula for pre-business foundation mathematics and pre-technology foundation mathematics can take place as the development of the assessment instruments take place. In fact, the three parts are intimately related to each other as the assessment will address the same learning outcomes as are contained in foundational mathematics courses and the remedial units will correspond in part to those already being taught in foundation mathematics courses.

Feedback on Discussion Paper Issues

Before the final report on this project can be prepared we need to have feedback from our college partners and from those provincial organisations and individuals with a stake in the issues raised here. To assist us in analysing this feedback, we invite respondents to use the link below and to identify whether they are responding as individuals or on behalf of a college or organisation. We are requesting colleges for an initial response by April 15, 2013 and for all other responses to be submitted by June 15. In preparing the final report of this feasibility study (which is due on August 31), we will take all of this feedback into account.

[11] Orpwood, G. et al. (2012). *College Mathematics Project 2011: Final Report*. Toronto: Seneca College.

Questions to which we invite responses are as follows. Each question provides for respondents to express their agreement or disagreement with a given statement and an opportunity for comments.

Principles Underpinning College Mathematics Assessment

1. *The primary purpose of the assessment should be to support students' learning.*
2. *The focus of the assessment should be on high levels of competence on basic numeracy skills.*
3. *The assessment should be developed and operated according to high standards of quality.*
4. *The assessment should be as cost-effective as possible.*

Proposed Assessment Model

Since the aspects of the proposed model discussed in the paper are inter-dependent, we do not invite a response to each one separately. Rather we would welcome your overall judgment about the appropriateness of the model, together with a sense of what you consider to be its strengths and weaknesses.

5. *The proposed assessment model is an appropriate one for the colleges to adopt.*

Common Learning Outcomes/Common Curricula

The paper proposes that the colleges work towards developing common learning outcomes and common curricula for some mathematics courses but not yet for others, as indicated below. We invite you to indicate your agreement or disagreement and add your comments.

	Common Learning Outcomes	***Common Curriculum***
6. *Pre-Business Mathematics;*	Yes	Yes
7. *Pre-Technology Mathematics;*	Yes	Yes
8. *Business Diploma Level Mathematics;*	Yes	Yes
9. *Technology Diploma Level Mathematics ;*	Not yet	Not yet

Please use the following link to the Feedback Response form:

https://docs.google.com/spreadsheet/viewform?fromEmail=true&formkey=dHZ6bzUyaEtwMnJBemY1YU5QUTBOWnc6MQ