# REPORT OF THE

# MATHEMATICS TASK FORCE

*June 1999*

**BRITISH COLUMBIA**

Ministry of Education

## TABLE OF CONTENTS

## INTRODUCTION

In June 1997, a Provincial Working Group on Addressing Student Differences made recommendations on a number of broad and complex issues intended to address the range of student differences in schools.

The Working Group noted that between 25% - 30% of students are placed in ''modified'' or lower-level mathematics courses.  The Working Group concluded that this practice would, in effect, restrict students' future access to post-secondary education and training and subsequently reduce their future career options.

The Working Group recognized that there were a number of distinct and complex issues related to Mathematics education for which they did not have the necessary expertise to make recommendations on.  Due to this complexity, the Working Group suggested that a task force be struck which would make recommendations with respect to:

⇒ Working definitions of numeracy, mathematical literacy and problem solving;

⇒ Strategies to improve the teaching and learning of mathematics at each grade;

⇒ Strategies to increase the number of students engaged in high level secondary school mathematics; and,

⇒ The role of Mathematics 9A, 10A, and 11A and Introductory Mathematics 11 as provincial curricula.

This paper is the result of the work of the Math Task Force, created as a result of that suggestion.  Some of our recommendations suggest changes in provincial policy while others are focused at teachers, schools, school districts, the public, and post-secondary institutions. Much of what is proposed is based on the belief that improving student participation and success rates in Kindergarten to Grade 12 Mathematics can only be achieved through strong leadership from teachers, administrators and the local community.

We have not made recommendations concerning the content or course structure of the B.C. K to 12 Mathematics Integrated Resource Packages (IRPs) which are based on the Western Canadian Protocol (WCP) Framework for Mathematics K to 12.  The WCP aligned curriculum is grounded in the *Curriculum and Evaluation Standards for School Mathematics* developed by the National Council of Teachers of Mathematics (1989). The NCTM's standards describe the content standards (mathematics that students should know), and process standards (ways that students should acquire and use their mathematical knowledge) that its members have identified as being essential for the development of numerate citizens.

As the K - 12 Mathematics curriculum is in the process of being implemented, it would be counterproductive for us to suggest any change before appropriate feedback (based upon verifiable research) has been received.  It is also important to note that many schools and districts have made significant purchases of new learning resources, which were designed specifically for these courses.

## THE MATHEMATICS TASK FORCE

The Mathematics Task Force members and the Chair were appointed by the Minister of Education.

Dr. Robin Brayne (Chair) Superintendent, S.D. # 44, North Vancouver

Ron Coleborn, Secondary Mathematics Teacher, Burnaby South Secondary, S.D. # 41, Burnaby and President of BC Association of Mathematics Teachers

Dr. Leslee Francis-Pelton, Mathematics Education, Faculty of Education, University of Victoria

Helen Middleditch, Elementary Special Education Teacher, South Nelson Elementary, S.D. # 8, Kootenay Lake

Rosita Tam, District Resource Teacher, S.D. # 39, Vancouver

Carmel Walsh, Mathematics Department Head, Cariboo Hill Secondary, S.D. # 41, Burnaby

Bruce M$^c$Askill (Secretariat) Mathematics Coordinator, Curriculum Branch

## FRAMEWORK FOR ACTION

When we were asked to serve on the Math Task Force, it was with the understanding that our recommendations would be consistent with the following targets and beliefs first articulated in *The Kindergarten to Grade 12 Education Plan* (Province of British Columbia, 1994) and summarized in the discussion paper, *Addressing Student Differences: Next Steps* (Province of British Columbia, 1997):

## Targets

⇒ *Common curriculum K-10:* An important target for the K-12 school system is that all students, with the exception of some students with special needs, will attain the learning outcomes prescribed in the provincial curriculum K-10.

⇒ *Graduation:* A second target is that all students will attain a high school graduation diploma. For students with special needs who are not able to attain graduation standards, it is expected that they will get a School Completion Certificate, denoting that the student's learning plan has been achieved.

⇒ *Student transition to post-secondary and the workplace*: A third target is that following graduation all students will continue their studies at the post-secondary level or be prepared to successfully enter the work place.

## Principles and Beliefs

⇒ *High standards:* Students learn best in a school environment where all students are valued and are challenged by high standards and expectations.

⇒ *Student learning:* Students learn in different ways and at different rates; learning requires the active participation of the student; learning is both an individual and group process.

⇒ *Early intervention:* Early intervention to address student learning difficulties is more successful than responding to accumulated deficits at a later date.

⇒ *Instructional Strategies:* The diversity of student needs can be met through the implementation of a wide range of effective instructional strategies based on best professional practices.

⇒ *Parent and community support:* Improvements in student success rates are best achieved when teachers, parents and the community work collaboratively toward common education goals.

**Additional Beliefs**

The belief systems of teachers, students and parents have a profound effect on student achievement and success in mathematics learning. The beliefs students and their parents hold toward the importance of hard work, learning, and their own abilities influence their achievement and contribute to the individual differences teachers must accommodate in order to implement curriculum as intended. The following are beliefs that we have taken into account as we have developed our recommendations:

⇒ *Numeracy:* It is as important for people to be numerate as it is for them to be literate. All students can develop a sense of numeracy and need to be provided with opportunities to develop the numeracy skills necessary for life long learning. The public needs to be informed that numeracy is much more than the ability to perform arithmetic operations.

⇒ *Student readiness:* This includes variables that relate the abilities students possess and can apply to the mastery of learning outcomes set out in the IRP: prior achievement of students, maturational level, levels of motivation, and self-concept about their abilities and capacities to learn.

⇒ *Teachers' attitudes:* If teachers are enthusiastic about teaching mathematics and believe their students can master what is to be learned, their students are more likely to apply themselves in ways necessary to succeed.

⇒ *Learning environment:* The nature of the learning environment and the method of instruction influence the achievement and success of students. Achievement is associated with the amount of time students are engaged in the material in question.

⇒ *Mathematics instruction:* The requirements to develop numerate citizens have altered mathematics instruction so that it can no longer be defined as simply teaching content. Today's mathematics instruction includes three equally important components: content, processes, and the relevancy of mathematics in daily living.

⇒ *The sequential nature of mathematics:* As students progress through the curriculum, any cumulative deficit they develop in their mathematics understanding hampers their

mastering additional knowledge and skills.

⇒ *The gatekeeper:* Mathematics must not be a "gatekeeper" that prevents students from pursuing their educational and career goals.

## THE SIGNIFICANCE OF NUMERACY

As students progress through our education system, there is an expectation that the mathematical knowledge they develop will help prepare them for success in life. With so many different career paths available, the mathematical needs of students are varied. Despite this complexity, the provincial curriculum tries to:

⇒ identify what is valued in mathematics;

⇒ identify what mathematics is needed for the development of numerate citizens;

⇒ provide students with opportunities to fulfill their mathematical goals; and,

⇒ provide a foundation that will allow all students to develop the numeracy skills needed to conduct ''everyday mathematical activities''.

To facilitate our discussions on numeracy we have accepted the working definition outlined by the BC Association of Mathematics Teachers in their *'98 Numeracy Brochure*. This definition states that:

*Numeracy can be defined as the combination of mathematical knowledge, problem solving and*

*communication skills required by all persons to function successfully within our technological world. Numeracy is more than knowing about numbers and number operations.*

The BCAMT definition of numeracy embraces four mathematical senses: number sense, sense of relationship, spatial sense, and statistical sense. Each of these senses plays an important role in the life-long development of numerate citizens.

The Mathematics IRPs address the four senses through a set of learning outcomes grouped into curriculum organizers and sub-organizers (see Table I).

## Table I: IRP Organization

| Organizer | Sub-organizer |
|---|---|
| Number | |
| | −Number Concepts |
| | −Number Operations |
| Patterns and Relations | |
| | −Patterns |
| | −Variables and Equations |
| | −Relations and Functions |
| Shape and Space | |
| | −Measurement |
| | −3-D Objects and 2- D Shapes |
| | −Transformations |
| Statistics and Probability | |
| | −Data Analysis |
| | −Chance and Uncertainty |

As problem solving is an integral part of numeracy, it also requires a working definition. We accept the following definition for problem solving, first set out in the NCTM's *Curriculum and Evaluation Standards for School Mathematics* (1989), and recently restated in *Principles and Standards for School Mathematics: Discussion Draft* (NCTM, 1998):

*Problem solving is the process of identifying and using current understanding to formulate or adapt strategies to address a new situation. Problem solving should be the central focus of the mathematics curriculum. As such, it is the primary goal of all mathematics instruction and an integral part of all mathematical activity. Problem solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned.* (p. 186)

As students graduate from high school they should possess not only a variety of problem solving and mathematical skills and knowledge, but also an understanding of how mathematics is threaded deeply throughout their daily lives. The ability to assess the reasonableness of an answer or interpret information is a critical part of using mathematics in daily contexts. These abilities add meaning to common place activities such as calculating exchange rates and lottery odds, interpreting scale diagrams, and data interpretation. "Mathematics like literature, art, and music is a way of expressing our understanding of the world around us. Our lives can be enriched by appreciating the intrinsic value of mathematics and by investigating its existence in the natural world." (BCAMT, 1998)

Numeracy is part of literacy and adds value to our lives by allowing for greater independence and opportunity within our society. In order for students to reach their full potential, our education system must provide them with the confidence and desire to use mathematics outside of school.

**RECOMMENDATIONS**

We propose a number of recommendations to the Ministry, school districts, schools, teachers, post-secondary institutions, College of Teachers, Teacher Qualification Service, and the public to act upon to improve student participation and

success in Kindergarten to Grade 12 Mathematics programs.

On April 29, 1999 the Task Force posted a draft set of recommendations on the Internet and subsequently distributed them to all public and independent schools. Teachers, administrators, students, parents, and other educational partners were invited to review the draft recommendations and provide feedback to the Task Force during the month of May, 1999. We have considered this feedback and additional input received during regional meetings held around the province in preparing the final set of recommendations presented in this report. Appendix A contains a summary of the feedback received.

We see these recommendations as the starting point for the development of a comprehensive action plan to assist our students to develop the numeracy skills and concepts needed for the future. It is important for the reader to view these recommendations as a comprehensive package that will take five to ten years to successfully implement.

## 1. Strategies to improve the teaching and learning of mathematics at all grades.

It has been reported in various publications (e.g., *TIMSS Monograph No. 1: Curriculum Framework for Mathematics and Science,* Robitaille, 1993), as well as anecdotally, that there are differences between what is intended to be learned and taught,

as defined by the goals, learning outcomes and content set out in IRPs, and what is actually learned by students and taught by classroom teachers. This is not surprising and, is in fact, permitted by provincial policies. Teachers are expected, in their decision-making, classroom management and teaching methods, to accommodate wide differences in student readiness.

Understanding differences between the intended curriculum and what is actually taught and learned in classrooms helps define the issue of improving the teaching and learning of mathematics at each grade.

Many factors influence the mathematics achievement of students. The most frequently cited factors are: student readiness, methods of classroom grouping and instruction, and environmental or contextual conditions (e.g., *TIMSS Monograph No.2: Research Questions & Study Design,* Robitaille, 1996; *To Sum it Up: Case Studies of Education on Germany, Japan, and the United States,* Stevenson and Nerison-Low, 1999; *Principles and Standards for School Mathematics: Discussion Draft*, NCTM, 1998).

Strategies to improve the teaching and learning of mathematics must address the following issues:

⇒ belief systems are the driving force for action among teachers, students and parents. Some of the obstacles that prevent student attainment of the intended curriculum, even if it is ''fully'' implemented, have to do with particular belief systems.

---

⇒ the concept of numeracy is not nearly as well developed as literacy. There is far less attention paid to early or emergent numeracy as compared to early literacy. This has prevented teachers from making significant progress in how they address individual student differences at the primary grades. Students' cumulative deficits in ''number sense'' contribute to later difficulties they experience in mathematics. To our knowledge, no inventory of best or promising practices in developing early numeracy exists.

⇒ a significant number of elementary and secondary teachers of mathematics have reported that they lack broad understanding of content material (*1995 BC Assessment of Mathematics and Science: Technical Report*, 1996);

⇒ a significant number of elementary and secondary teachers of mathematics have reported that they are not comfortable with the processes of mathematical thinking as well as the instructional strategies that promote the development of mathematical thinking and understanding (*1995 BC Assessment of Mathematics and Science: Technical Report*, 1996; *To Sum it Up: Case Studies of Education on Germany, Japan, and the United States*, 1999);

⇒ the *1995 BC Assessment of Mathematics and Science: Technical Report (*1996), makes a number of recommendations related to improving secondary

mathematics teachers: use of assessment information for diagnosing student learning problems, teaching of problem solving, making greater use of manipulatives with hands-on activities, and exposing students to a variety of mathematics problems, involving various methods of finding solutions.

⇒ teachers must be freed from the belief that all students must be taught all of the learning outcomes, to the same extent, all of the time. What is important is the use of time. It is preferable to cover fewer topics in greater depth than to cover more topics in lesser depth. This change in belief would free teachers to devote more class time to concept development and the processes of understanding and thinking and allow students and teachers time for reflection.

⇒ teachers must have access to, and in-service on the use of appropriate learning resources.

## 1.1 Societal beliefs

In light of the significant effect that societal beliefs have on the education process, it is vital that students, teachers, parents, and the general public be informed concerning the issues related in this section.

We recommend:

1.1.1 *That the Ministry work with its education partners to develop and communicate to the public on the issues noted below.*

## 1.2 Early Numeracy

We believe that a successful start in mathematics education is essential to future success and that early intervention to ensure the best possible start is preferable to having to "remediate" in higher grades.

Although the majority of primary students are successful in achieving the prescribed learning outcomes set out in the mathematics curriculum, periodically some students require extra help and attention, particularly in the foundation learning area of numeracy. Without a firm understanding of the skills and concepts related to early (or emergent) numeracy, students will have difficulty attaining mathematics standards in later years.

Schools need assistance in developing innovative practices to suit the needs of individual students who are having difficulty acquiring emergent numeracy skills and concepts. These practices may include heterogeneous grouping, learning assistance, peer tutoring, cooperative learning, within-class grouping, pull-out programs, special classes, continuous progress, and group-paced mastery learning. These practices are intended to provide students with extra time for personalized attention, exposure to different teaching strategies and resources, or opportunities to succeed in alternative settings.

In addition to issues related to the development of emergent numeracy, students in Grades 7 - 9 may also struggle in the development of their sense of numeracy. Parents of these students often request advice from teachers on how they could help their son or daughter further develop their numeracy skills and concepts at home.

We recommend:

*1.2.1 That the Universities, in co-operation with education partners, develop pilot projects designed to:*

- *identify tools to assist teachers in the identification of children in the early school years, who are at risk with respect to developing their emergent numeracy skills and concepts.*

- *identify specific strategies that teachers and parents can use to address the deficiencies of children in the early school years and enhance their growth in numeracy.*

*1.2.2 That school districts identify teachers and/or administrators in each of their elementary schools who will provide strong leadership in initiating and fostering a mathematics rich school environment.*

*1.2.3 That our educational partners (e.g., BCTF, post-secondary institutions, business, etc.) mobilize the resources of the mathematics community to highlight and enhance the importance of mathematics culture in schools.*

*1.2.4 That the Ministry develop a parent handbook to assist parents in understanding the importance of numeracy and identify their role in enhancing their children's growth in numeracy.*

## 1.3 Teacher preparation (pre-service)

To help students develop a satisfactory sense of numeracy, teachers must have proper preparation in mathematical content and pedagogy.

At present, students pursuing an elementary teacher preparation program in British Columbia receive different levels of mathematical preparation depending on the institution where they are acquiring their training.

Mathematics content course requirements usually consist of one or two courses. These courses are taught through Mathematics departments and could be either general courses such as finite mathematics, or courses targeted specifically for elementary education majors. Mathematics education course requirements (curriculum and instruction) also consist of one or two courses. However, the credit hours attached to these courses range anywhere from 2 to 5. There is a lack of consistency in the mathematical requirements for prospective teachers.

There is a direct positive correlation between the number of required mathematics education courses and the level of satisfaction reported by pre-service teachers enrolled at the major universities (see Appendix B).

Despite the requirements for a minimum level of mathematics preparation, the *1995 BC Assessment of Mathematics and Science: Technical Report* reported that 19% of Grade 4 teachers and 21% of

Grade 7 teachers had no post-secondary mathematics courses. Similarly, 15% of Grade 4 teachers and 24% of Grade 7 teachers had no mathematics methods courses. In addition, less than a quarter of elementary teachers had attended 3 or more mathematics inservice sessions in the 4 year period prior to the 1995 provincial assessment.

Requirements for a secondary mathematics teaching program are more consistent. All three major universities (UBC, SFU, UVic) offering a secondary teaching program require 30 or more credit hours of senior level mathematics courses to complete a major teaching area in mathematics, or 18 or more credit hours of senior level mathematics courses to fill a concentration. They also all require one mathematics education course.

However, few students in secondary education programs are choosing mathematics as their major area of study or as a concentration. The number of graduates in secondary mathematics education averages as low as 8 to 15 students per year per institution. Many teachers of secondary mathematics classes have little or no post-secondary training in mathematics. The *1995 BC Assessment of Mathematics and Science* reported that 11% of Math 10A teachers and 2% of Math 10 teachers had no post-secondary mathematics courses. Further, 36% of Math 10A teachers and 19% of Math 10 teachers had no mathematics methods courses. Almost a third of Math 10A teachers had not attended any in-service activities in the 4 years prior to the 1995 assessment while 12% of Math

10 teachers did not attend any inservice.

Considering this evidence, the conclusion we draw is that there are significant differences among teachers of mathematics in their understanding of mathematical content and in their pedagogical preparation.  Teachers, who lack the appropriate mathematics content knowledge as well as the related knowledge of instructional processes and methodologies, often have difficulty deciding:

⇒ which topics are more important than others and must be covered;

⇒ which topics are not prerequisite to future mastery and may be excluded or delayed;

⇒ how students can be better managed or grouped; and,

⇒ what learning resources are available and how they can be used most effectively.

Pre-service teachers often rely heavily on their sponsor teachers during their practicum experience to provide mentoring and modeling of appropriate instructional practices.  Given the importance of the role of the sponsor teacher, we encourage schools to select sponsor teachers who are well versed in the mathematics curriculum and the use of current methodologies and materials for mathematics instruction.

We recommend:

1.3.1 *That the College of Teachers require all post-secondary institutions in BC offering elementary and/or secondary education programs leading to certification have equivalent requirements in both*

*mathematics methods and content courses.*

1.3.2 *That the College of Teachers require that pre-service elementary education programs include a minimum of 6 credit hours (2 courses) in mathematics content. These courses should cover mathematical concepts and processes relevant to the K - 12 Mathematics curriculum.  These courses should be designed and delivered by mathematics departments of post-secondary institutions in cooperation with mathematics education specialists.*

1.3.3 *That the College of Teachers require that pre-service elementary education programs include a minimum of 6 credit hours (2 courses) in mathematics pedagogy. Included in these courses should be: instruction on the teaching of the conceptual and procedural knowledge necessary to develop a sense of numeracy (including problem solving); teaching with technology; and, assessment, diagnosis and intervention techniques for students who experience learning difficulties in mathematics.*

1.3.4 *That the College of Teachers require that pre-service secondary mathematics education programs include a minimum of 6 credit hours (2 courses) in mathematics pedagogy.  Included in these courses should be: instruction on the teaching of the*

*conceptual and procedural knowledge necessary to develop a sense of numeracy (including problem solving); teaching with technology; and, assessment, diagnosis and intervention techniques for students who experience learning difficulties in mathematics.*

## 1.4 Teacher preparation (in-service)

*…more than any other single factor, teachers influence what mathematics students learn and how well they learn it.* (NCTM,1999)

Teachers view and act on the intended curriculum through the lens of attempting to accommodate individual differences among their students.  They apply professional judgment as they strive to provide the best for their students.  They alter pace of instruction, adapt instructional methods to match the readiness and learning style of students and modify expectations to increase opportunities for student success.

Recommendations made in the *1995 BC Assessment of Mathematics and Science: Technical Report* (1996) indicate that secondary mathematics teachers, in general, do not use a wide variety of instructional and assessment strategies in the classroom.  The report states that:

*At this level* [Grade 10], *the instruction and classroom organization activities reported as occurring most frequently were, again, working from worksheets or textbooks (87%), and the teacher showing students how to do math problems (81%).  The activity*

*occurring least frequently was working on math projects; only 10% reported that it occurred frequently, and 62% said it never happened at all in class.* (p. 48)

For more detailed information concerning the teaching and assessment strategies reported by teachers, see section 3.3 (*Activities in the Classroom and Perceptions of Mathematics*) of the *1995 BC Assessment of Mathematics and Science: Technical Report* (1996)

It is therefore essential that school districts provide and encourage teachers, including Teachers on Call, and Learning Assistance and Resource Teachers, to participate in in-service activities that develop and maintain their understanding of current mathematics curricula and pedagogy.

School districts will find it increasingly difficult to recruit and assign new teachers with the requisite post-secondary mathematics education to meet future curricular and graduation requirements.  We also believe that districts' reliance upon in-service preparation and/or training will increasingly become a more common and necessary practice.

We recommend:

*1.4.1 That school districts create a comprehensive in-service plan that promotes the appropriate use of learning resources and the three essential elements of mathematics instruction: content, a variety of instructional strategies and processes, and a variety of assessment and evaluation strategies.*

*1.4.2 That all teachers participate in professional development activities that promote the development of their understanding of mathematics and/or a variety of mathematics teaching strategies.*

*1.4.3 That the Teacher Qualification Service recognize alternatives to a masters degree (such as diploma programs or a series of institutes with appropriate required assignments) as a way to achieve a Level 6 salary increment, as long as courses are curriculum and instruction based and related to the teaching assignments of the teacher.*

*1.4.4 That school districts be encouraged to develop incentive programs where teachers provide support for student teachers and in-service training for beginning teachers.*

*1.4.5 That school districts develop plans to ensure that secondary teachers without a mathematics specialization, who are asked to teach mathematics, have a minimum of two post-secondary courses (6 credits) which integrate mathematics pedagogy and mathematical concepts and processes up to university entrance standards.*

*1.4.6 That school districts develop plans to ensure that teachers transferring from elementary to secondary assignments are supported so that they can attain the minimum pre-service qualifications outlined in Recommendation 1.4.5.*

*1.4.7 That school districts develop plans to ensure that teachers transferring from secondary to elementary assignments are supported so that they can attain the minimum pre-service qualifications outlined in Recommendation 1.3.3.*

*1.4.8 That school districts encourage and assist schools to develop organizational structures that encourage teachers to collaborate and network with each other.*

*1.4.9 That the Ministry establish a special fund to support school districts in implementing the recommendations for minimum elementary and secondary teacher in-service requirements as set out above.*

## 1.5 Use and management of resources

Resources are the materials, people, money and time needed to implement an education program. The availability of these resources and how they are used influence students' success in mathematics.

While the number of prescribed learning outcomes appear to some to be more than a teacher could cover adequately within a school year, teachers need to be reminded that they are not required to address all outcomes with equal emphasis at all times. Integrated Resource Packages provide teachers with greater flexibility to address specific concepts in greater or lesser detail than previous curriculum documents. The trend is towards reducing the number of topics covered at any particular grade in favor of allocating more time for greater in-depth exploration of those remaining topics.

There is some evidence (e.g., *To Sum it Up: Case Studies of Education in Germany, Japan, and the United States*, 1999; *1995 BC Assessment of Mathematics and Science: Technical Report*, 1996) to suggest that student achievement in mathematics is influenced by how instruction is organized (timetabled) in secondary schools. We believe that the effect of various timetable systems (i.e., full year, semester, quarter) on how mathematics is taught and how much students learn warrants serious examination.

*We recommend:*

*1.5.1 That school districts utilize the Learning Resource and Implementation Training Trust*

*Funds in a planned and timely fashion so as to support teachers in the implementation of the mathematics curriculum as intended.*

Specifically, this is to ensure that teachers have support for:

⇒ the implementation of the curriculum using strategies consistent with the rationale and philosophy of the IRP;

⇒ the purchase of new learning resources to support implementation of the IRP; and,

⇒ the continued familiarization and study of the current IRP.

*1.5.2 That school districts communicate their Learning Resource Trust Fund and Implementation Fund plan to all education partners.*

*1.5.3 That the Ministry, in order to support teachers in the implementation of the mathematics curriculum as intended, ensure that appropriate learning resources are available prior to implementation.*

*1.5.4 That pursuant to the principles set out in the K to 12 Education Plan, the Ministry include in each IRP a section which clearly informs teachers of the amount of flexibility and autonomy they have when it comes to making decisions regarding teaching issues such as time allocation and depth of topic coverage.*

*1.5.5 That the Ministry identify, within the Mathematics Integrated Resource Packages for Kindergarten to Grade 9, the learning outcomes that are appropriate and necessary for a program that focuses on the development of numeracy.*

*1.5.6 That the Ministry, in cooperation with the Faculties of Education, investigate and report to school districts the effects of timetable organization on how mathematics is taught and how students achieve.*

**2. Strategies to increase the number of students engaged in high level secondary school mathematics.**

Mathematics requirements for students who seek entry to post secondary disciplines such as Engineering, Science and Mathematics are well met by Principles of Mathematics.  Students who wish to enter post secondary education to study in areas related to the practical aspects of mathematics may find their needs better met by Applications of Mathematics.  Unfortunately, post-secondary institutions have been slow to recognize Applications of Mathematics as an appropriate pre-requisite for many of their programs that do not have calculus as part of the program of study.

Most educators, parents, and post-secondary instructors see the present Mathematics 9A, 10A and 11A as "dead end" courses that do not equip students for either the workplace or for the demands of every day life.  As a result of these factors, the needs of two groups of students remain unmet:

⇒  those who do not currently aspire to post-secondary education, but who may decide to pursue further education later on; and,

⇒  those who need an appropriate level of mathematics for success in the workplace and every day life.

The increasing demand for high school graduates to be numerate requires that they have access to recognized courses that will not only leave the door open to further educational opportunities, but will equip them to be functional members of our society.

The complex issues surrounding the educational needs of the approximately 20% of students in British Columbia who experience difficulties in learning, but are not **either students with special needs who are following an Individual Education Plan (IEP)** or ESL students, have been examined in *Addressing Student Differences: Setting a Direction* (Province of British Columbia, 1996), and *Addressing Student Differences: Next Steps* (Province of British Columbia, 1997).  Such students are often referred to as "students in the grey area".

In Appendix 1 of *Addressing Student Differences: Next Steps* it was **noted that educators felt there was a need for at least one mathematics pathway that would enable many of the students in the grey area to attain graduation.** It was also noted that many educators felt that curricula needed to be organized into different pathways or alternate routes that would  accommodate students'

future goals.

Research on the issue of student ability grouping in mathematics does not provide a consistent set of guidelines that can be used for all students. This conflicting research makes it very difficult to arrive at a simple answer to the question of whether or not streaming is beneficial to students (M$^c$Askill, 1997). The only conclusion that we could arrive at was that a flexible and equitable mathematics program is required which will accommodate and meet the needs of a varied student population.

Implementation of different curricula designed to meet the needs of a range of students is a practice that is in place in a number of jurisdictions outside of British Columbia and Canada.

In Japan, students follow a common course of studies until the end of grade nine. About one-quarter of the students then enter a vocational or technical school while the rest continue with an academic program. Those students in the academic high schools then choose between a science and liberal arts track.
Starting at age ten, children in Germany are transferred into one of three types of schools that have varying emphasis on theoretical and applied studies and on the number of years students stay in school.

Many jurisdictions in Canada (e.g., Yukon, Alberta, Manitoba, Northwest Territories, and Ontario) offer courses that are equivalent to Applications of Mathematics and Principles of Mathematics. In addition, each of these jurisdictions have developed, or are in the process of developing, a third pathway designed for students whose needs, interests and abilities focus on basic mathematical understanding.

Beginning in 1995, the K - 12 Mathematics curriculum in British Columbia underwent revision. In 1996 a two-path secondary mathematics course structure was introduced that, like the previous course structure, was intended to meet the needs of a broad range of students (see Appendices C & D). Students were to be offered a choice of two programs: Applications of Mathematics 9 to 12 or Principles of Mathematics 9 to 12.

The very existence of the Applications of Mathematics and Principles of Mathematics pathways reflects the viewpoint that a common curriculum at the secondary level would not meet the needs of all students.

The initial Applications/Principles course structure proposal assumed that Mathematics 9A, 10A, and 11A would be phased out as the newly developed Applications of Mathematics courses were implemented. Although educators agreed that there was a need for more than one curriculum pathway to meet students' needs, they were concerned that the Principles and Applications pathways would not adequately meet those needs. It was argued that Mathematics 9A, 10A, and 11A were still required because the standards of the new courses were too high for some students.

The Ministry subsequently decided to retain Mathematics 9A, 10A, and 11A until this Task Force could study and make recommendations on the issue.

Regardless of the mathematics pathway chosen, students need to come to understand how mathematical concepts permeate their work and personal lives. In order to function within a technological world, students need to be able to combine mathematical knowledge with problem solving and communications skills.  The goal is to provide all students with opportunities to participate in mathematics programs that help them develop these skills and prepare them for the future.

## 2.1  Grades 7 to 9: Transition years

Attention on the development of numeracy skills and concepts should not be limited to just the primary years.   As students grow and develop in different ways, they can experience learning difficulties at later stages of their development. It is important that a variety of strategies to adapt instruction also be in place for the late intermediate years.

The mathematics curriculum at Grades 7, 8 and 9 provides a base of knowledge that is required for anyone to develop a sense of numeracy.  Presently there is a single mathematics course for each of Grade 7 and 8, while at the Grade 9 level there are two (Applications of Mathematics 9 and Principles of Mathematics 9).

The two Grade 9 courses are based upon common content but differ in terms of their instructional approaches. We believe that students at these grades would benefit from the opportunity to explore mathematics from both an applications and principles perspective.

We recommend:

*2.1.1 That the Ministry replace the current Principles of Mathematics 9 and Applications of Mathematics 9 with a single Mathematics 9 course.*

This single Mathematics 9 course is to include the key elements of both an applications and principles perspective on instruction while retaining the content that is common to the WCP Framework.  As a result, this Mathematics 9 course will not require the development of new learning resources.

As we make this recommendation, we are sensitive and respectful of the arguments presented in support of retaining Mathematics 9A (or creating Essentials of Math 9).

Many schools presently have adapted mathematics programs that they have designed for students in Grades 8 and 9 who are unable to complete the full curriculum.  We expect that schools will continue to adapt instruction, learning resources, time, setting, or any other factors required to address the needs of their students. The goal for students in these programs should always be that they attempt to complete the full program of studies.

With this in mind we believe that in order to effectively maintain these programs, educators will continue to require guidance including: the identification of the learning outcomes necessary and suitable for a program that develops numeracy, appropriate learning resources, and instructional and assessment strategies.
We recommend:

*2.1.2 That, once the Ministry has identified the learning outcomes necessary and appropriate for a program that focuses on the development of numeracy in Mathematics 9, Mathematics 9A no longer be a provincially authorized course.*

We believe that this recommendation is a positive step toward the target of a common curriculum (K - 10) described in *The Kindergarten to Grade 12 Education Plan* (Province of British Columbia, 1994) and it is in harmony with the principle that students learn best when they are challenged by high expectations. Arguably, much additional effort, preparation and support will be required to enable all students to participate successfully in a common curriculum (K - 10) and to meet the higher standards expected by this recommendation. It is our intent that these recommendations on strategies to improve the teaching and learning of mathematics at each grade promote this additional effort, preparation and support.

## 2.2 Grade 10- 12 course structure

At present, the Applications of Mathematics and Principles of Mathematics pathways provide two viable options for students. We believe that a third pathway, Essentials of Mathematics, is needed to help students develop mathematics not just for their work lives, but also for their personal lives as citizens and consumers (see Appendix E).

We recommend:

*2.2.1 That the Ministry develop a curriculum for a third pathway (Essentials of Mathematics 10, 11, and 12). This pathway should be distinct from both Applications of Mathematics and Principles of Mathematics.*

*2.2.2 That the Ministry implement the Essentials of Mathematics 10, 11, and 12 courses over a 3 year period.*

*2.2.3 That the Ministry develop a provincial examination component for Essentials of Mathematics 12 worth 40% of students' final mark.*

*2.2.4 That the Ministry ensure that the provincial examinations for all Grade 12 Mathematics courses be consistent with the philosophy and rationale of each course.*

Table II outlines possible topics that could make up the Essentials of Mathematics 10 - 12 curriculum. These topics were adapted from *Senior 2 Consumer Mathematics: A Foundation for Implementation* (Manitoba Education and Training,1999):

## Table II: Possible Topics for Essentials of Mathematics 10 - 12

| Essentials of Mathematics 10 | Essentials of Mathematics 11 | Essentials of Mathematics 12 |
|---|---|---|
| Problem Analysis | Problem Analysis | Problem Analysis |
| Analysis of Games and Numbers | Analysis of Games and Numbers | Analysis of Games and Numbers |
| Wages & Salaries | Income & Debt | Taxation |
| Spreadsheets | Linear Relations | Relations & Formulas |
| Trigonometry | Data Analysis/ Interpretatio n | Statistics |
| Spatial Geometry | Measuremen t Technology | Design & Measuremen t |
| Personal Banking | Personal Income Tax | Personal Finance |
| Probability & Sampling | Applications of Probability | Investments |
| Consumer Decisions | Operating a Vehicle | Government Finances |

## Bridging Courses

The IRPs and provincial policies presently allow schools to create bridging courses. At the Grade 11 and 12 level, these bridging courses can qualify for graduation credit.

For example, the following is one example of how schools can create a bridging course for students wishing to transfer from Applications of Mathematics 11 to Principles of Mathematics 12.

The WCP aligned Principles of Math 11 and Applications of Math 11 curricula have been designed so that 40% of the topics (by time) are common to both courses. These topics include:

- Consumer Problems;
- Linear Inequalities;
- Systems of Linear Equations (2 variables);
- Graphing Nonlinear Equations (using technology), and;
- Characteristics of Quadratic Functions.

Students choosing to take Principles of Math 12, should first acquire the mathematical skills and processes unique to the following Principles of Math 11 topics:

- Mathematical Reasoning;
- Solving Nonlinear Equations;
- Systems of Linear Equations (3 variables);
- Function Notation;
- Solving Quadratic Functions;
- Graphing Polynomials;
- Solving Absolute Value, Radical, and Rational Equations and Inequalities;
- Circle Geometry (proofs & problem solving).

These topics can be packaged into a course that requires approximately 60% of the time of a regular course. A school may elect to offer the course as a half course or a full course (if they wish to provide students with additional time). Accordingly, students who successfully complete this locally developed bridging course can receive 2 graduation credits (or 3 if it is offered as a full course)

The result is that schools have the flexibility to create bridging courses and are thus better able to meet the needs of their students.

## 2.3  Mathematics graduation requirements

We considered carefully, and at length, the feedback received on our draft recommendation that current graduation requirements be amended to include the successful completion of one of Principles of Math 12, Applications of Math 12 or Essentials of Math 12.  While this recommendation is consistent with the Framework for Action reported earlier in this report and is in keeping with our views respecting the importance and significance of numeracy, we believe that such a significant adjustment to graduation requirements (and the resulting implications) requires discussion and debate at a broader and more inclusive level than our current procedures and timelines permit.

We recommend:

*2.3.1 That the Ministry investigate the desirability and feasibility of amending current graduation requirements to include a Grade 12 Mathematics course as a means to better enable all students to become numerate.*

*2.3.2 That, when the Essentials of Mathematics 11 curriculum is implemented, the Ministry change the graduation requirement to one of Applications of Mathematics 11, Principles of Mathematics 11 or Essentials of Mathematics 11.*

## 3. The role of Mathematics 10A, and 11A and Introductory Mathematics 11 as provincial curriculum.

As a consequence of our prior recommendations concerning the secondary mathematics course structure there is no longer a need to maintain the A-stream courses as provincial curriculum.

We recommend:

*3.1    That as the Essentials of Mathematics 10 - 12 courses are implemented over a 3 year period, the Ministry phase out Mathematics 10A, 11A, and Introductory Mathematics 11 as provincially authorized courses.*

## 4.  Implementation of curricula

The successful implementation of mathematics curricula requires the involvement of all our education partners.  The philosophy, rationale and goals of each of the three pathways must be understood and valued by all.

All students are entitled to equitable access to learning resources and instruction.  It is imperative that appropriate learning resources be developed for the Essentials of

Mathematics courses. In addition, schools and school districts should ensure that the teachers in the three pathways meet the recommendations outlined for the preparation of teachers. Teachers with a strong background in mathematics and mathematics education are required for all courses.

Steps should be taken to promote the successful implementation of all of the mathematics curricula, and in particular the Essentials of Mathematics courses.

We recommend:

*4.1 That the Ministry efficiently develop or identify the learning resources for Essentials of Mathematics 10 to 12.*

*4.2 That the Ministry develop an information brochure that outlines the philosophy, rationale and goals of each of the mathematics course options available to students and the criteria for the selection of each pathway.*

It is important that this brochure include information that clearly outlines the implications of each option concerning students' possible post-secondary education plans. This publication should be made available to all school counselors mathematics educators, students, parents, employers, and post-secondary institutions.

Many of today's careers require some form of post-secondary education. The acceptance (or lack of acceptance) of a particular

mathematics course, for post-secondary admission purposes, has a significant impact on students' course selection. The recently developed Applications of Mathematics courses have been accepted by many, but not all, of the province's colleges, institutes, and universities as meeting their general entrance requirements. The resistance by some universities to accept Applications of Mathematics is still a significant impediment to their successful implementation at the high school level.

In many jurisdictions where a similar program is in place, the Applications of Math courses have been accepted as meeting general admission post-secondary entrance requirements. In Manitoba, a program of studies similar to the proposed Essentials of Mathematics pathway, has been implemented and accepted for entrance into a number of college programs.

We recommend:

*4.3 That all post-secondary institutions accept both Applications of Mathematics 11 and Principles of Mathematics 11 for general admission.*

*4.4 That the various departments in each post-secondary institution review their specific program requirements to determine which of Essentials of Mathematics, Applications of Mathematics, or Principles of Mathematics courses should be accepted for admission.*

## IMPLEMENTING THE RECOMMENDATIONS

We hope that our recommendations are considered and are acted upon. In a separate document, we have provided the Ministry with a summary of the recommendations and our advice as to how they might be addressed.

Without the support and action of teachers, parents, schools, school districts, universities, colleges and organizations such as the College of Teachers, Teacher Qualification Service, BC Teacher's Federation, BC Association of Mathematics Teachers, and Ministry of Education these recommendations can not effect change. By working together we can improve mathematics education so that all of our students are able to develop their full potential in numeracy and function as effective members of our society.

# APPENDICES

**Responses were by:**

  54  groups (22%)

193 individuals (78%)
247 submissions (+ 78 post-deadline responses = 325 in total)

**This represents:**

| | |
|---|---|
| 120 | elementary teachers (19.4%) |
| 19 | middle school teachers (3.1%) |
| 291 | secondary teachers (mathematics specialist) (47.0%) |
| 80 | secondary teachers (non-mathematics specialist) (12.9%) |
| 45 | school administrators (7.3%) |
| 9 | school board administrators (1.5%) |
| 3 | post-secondary mathematics education instructors (0.5%) |
| 5 | post-secondary mathematics instructors (0.8%) |
| 4 | students (0.6%) |
| 3 | parents (0.5%) |
| 8 | district support people (1.3%) |
| 32 | other or unknown (5.2%) |

**619  individuals (+ 197 post-deadline responses = 816 in total)**

Seventy-eight additional responses representing 197 individuals were received after the response deadline of June 4 (the official deadline was May 31, but responses received up till the afternoon of June 4 were incorporated into this summary). We have reviewed the additional responses and have concluded that they are consistent with those previously received.

FRAMEWORK FOR ACTION

**A. Do you agree with the Targets, Principles and Beliefs outlined in this section?**

**Agree  93%**                            **Disagree  7%**

DEFINITIONS OF NUMERACY, MATHEMATICAL LITERACY AND PROBLEM SOLVING

**B. Do you agree with this definition of numeracy?**

**Agree  96%**                            **Disagree  4%**

**C. Do you agree with this definition of problem solving?**

**Agree    99%**                                **Disagree 1%**

**Average: 96% in agreement**

RECOMMENDATIONS

**1. Strategies to improve the teaching and learning of mathematics at all grades.**

**1.1  Teacher preparation (pre-service)**

*1.1.1  That the College of Teachers require all post-secondary institutions in BC offering elementary and/or secondary education programs leading to certification have equivalent requirements in both mathematics methods and content courses.*

**Agree    91%**                                **Disagree  9%**

*1.1.2  That the College of Teachers require pre-service elementary education programs include a minimum of 6 credit hours (2 courses) in mathematics content. These courses should cover mathematical content up to university entrance standards and be taught by mathematics education specialists. At least two of these courses should be completed before acceptance into an education program.*

**Agree    87%**                                **Disagree  13%**

*1.1.3  That the College of Teachers require that pre-service elementary education include a minimum of 6 credit hours (2 courses) in mathematics pedagogy.  Included in these courses should be: instruction on the teaching of the conceptual and procedural knowledge necessary to develop a sense of numeracy (including problem solving); teaching with technology; and, assessment, diagnosis and intervention techniques for students who experience learning difficulties in mathematics.*

**Agree    91%**                                **Disagree  9%**

*1.1.4  That pre-service secondary mathematics education programs require a minimum of 6 credit hours (2 courses) in mathematics pedagogy.  Included in these courses* should be: instruction on the teaching of the conceptual and procedural knowledge necessary to develop a sense of numeracy (including problem solving); teaching with technology; and, assessment, diagnosis and intervention techniques for students who experience learning difficulties in mathematics.

**Agree    94%**                                **Disagree  6%**

### 1.2 Teacher preparation (in-service)

**1.2.1** *That school districts create a comprehensive in-service plan which includes the three essential elements of mathematics instruction: content, instructional strategies and processes, and assessment and evaluation strategies*

**Agree   96%**                    **Disagree  4%**

*1.2.2* That school districts provide teachers with incentives to participate in professional development activities that promote the development of their understanding of mathematics and/or mathematics teaching strategies.

**Agree   94%**                          **Disagree  6%**

*1.2.3* That the College of Teachers recognize alternatives to a masters degree (such as diploma programs or a series of institutes with appropriate required assignments) as a way to achieve a Level 6 salary increment, as long as courses are curriculum and instruction based and related to the teaching assignments of the teacher.

**Agree   90%**                          **Disagree  10%**

*1.2.4* That school districts be encouraged to develop incentive programs where experienced teachers provide in-service training for pre-service and beginning teachers

**Agree   91%**                          **Disagree  9%**

*1.2.5* That school districts develop a comprehensive plan to ensure that secondary teachers without mathematics specialization, who are asked to teach mathematics, should have a minimum of two post-secondary courses (6 credits) which integrate mathematics pedagogy and mathematical concepts and processes up to university entrance standards.

**Agree   78%**                          **Disagree  22%**

*1.2.6* That school districts develop a comprehensive plan to ensure that teachers transferring from elementary to secondary assignments are supported so that they can attain the minimum pre-service qualifications outlined in Recommendation 1.2.5.

**Agree   84%**                          **Disagree  16%**

*1.2.7* That school districts develop a comprehensive plan to ensure that teachers transferring from secondary to elementary assignments are supported so that they can attain the minimum pre-service qualifications outlined in Recommendation 1.1.3.

**Agree   87%**                          **Disagree  13%**

*1.2.8* That school districts assist schools to develop organizational structures which encourage teachers to collaborate with each other.

**Agree   96%**                          **Disagree  4%**

***1.2.9*** *That the Ministry establish a special fund to support school districts in implementing the recommendations for minimum elementary and secondary teacher pre-service requirements as set out above.*

**Agree   97%**                              **Disagree  3%**

**Average: 90% in agreement**

## 1.3  Use and management of resources

***1.3.1*** *That school districts utilize the Learning Resource Trust Fund in a planned and timely fashion so as to support teachers in the implementation of the mathematics curriculum as intended.  Specifically, this is to ensure that teachers have support for:*

⇒ *the implementation of the curriculum using strategies consistent with the rationale and philosophy of the IRP;*

⇒ *the purchase of new learning resources to support implementation of the IRP; and,*

⇒ *the continued familiarization and study of the current IRP.*

**Agree   96%**                              **Disagree  4%**

***1.3.2*** *That school districts communicate their learning Resource Trust Fund plan to all education partners.*

**Agree   99%**                              **Disagree  1%**

***1.3.3*** *That the Ministry, in order to support teachers in the implementation of the mathematics curricula as intended, ensure that appropriate learning resources are available prior to the implementation date.*

**Agree   100%**                             **Disagree  0**

***1.3.4*** *That pursuant to the principles set out in the K to 12 Education Plan, the Ministry include in each IRP a section which clearly informs teachers of the flexibility and autonomy they have when it comes to making decisions regarding teaching  issues such as time allocation and depth of topic coverage*

**Agree   82%**                              **Disagree  18%**

***1.3.5*** *That the Ministry identify, within the Mathematics Integrated Resource Packages for Mathematics Kindergarten to Grade 9, the learning outcomes which are appropriate for an adapted program that develops*

*numeracy.*

**Agree   85%**                              **Disagree  15%**

***1.3.6*** *That the effects of timetable organization on how mathematics is taught and how students achieve be investigated.*

**Agree   94%**                              **Disagree  6%**

**Average: 93% in agreement**

### 1.4  Societal beliefs and context

***1.4.1*** *That the Ministry work with its education partners to develop and communicate to the public on the following issues:*

⇒ *That it is as important for people to be numerate as it is for them to be literate;*
.
⇒ *That the public needs to be informed that numeracy is much more than the ability to perform arithmetic operations;*

⇒ *The requirements to develop numerate citizens have altered mathematics instruction so that it can no longer be defined as simply teaching content.  Today's mathematics instruction includes three equally important components: content, processes and the relevancy of mathematics in daily living;*

⇒ *That mathematics must not be seen as the "gatekeeper" which prevents students from pursuing their educational and career goals; and,*

⇒ *That all students need to be provided with opportunities to develop the numeracy skills necessary for life long learning.*

**Agree   98%**                              **Disagree  2%**

### 2. Strategies to increase the number of students engaged in high level secondary school mathematics.

### 2.1  Grade 8 & 9 course structure

***2.1.1*** *That the current Principles of Mathematics 9 and Applications of Mathematics 9 be replaced with a single course, Mathematics 9.  This course should include the key elements of both an applications and principles perspective on instruction while retaining the content that is common to the two courses.*

**Agree   56%**                              **Disagree  44%**

## 2.2  Grade 10 - 12 course structure

***2.2.1*** *That the Ministry develop a mathematics curriculum for a third pathway (Essentials of Mathematics 10, 11, and 12). This pathway should be distinct from both Applications of Mathematics and Principles of Mathematics.*

**Agree   72%**                              **Disagree  28%**

***2.2.2*** *That the Essentials of Mathematics 10, 11, and 12 courses be implemented over a 3 year period.*

**Agree   80%**                              **Disagree  20%**

***2.2.3*** *That the Ministry develop a provincial examination component for Essentials of Mathematics 12 worth 20% of students' final mark.*

**Agree   39%**                              **Disagree  61%\***

\*       The majority of respondents who disagreed with this draft recommendation indicated they did so because they felt that the provincial exam should be count as 40% of a student's mark (as all other provincial exams are.)

***2.2.4*** *That the Ministry ensure that the provincial examinations for all Grade 12 Mathematics courses be consistent with the philosophy and rationale of each course..*

**Agree   91%**                              **Disagree  9%**

**Average: 71% in agreement**

## D. Table I: Suggested Topics for Essentials of Mathematics 10 - 12

| Essentials of Mathematics 10 | Essentials of Mathematics 11 | Essentials of Mathematics 12 |
| --- | --- | --- |
| Problem Analysis | Problem Analysis | Problem Analysis |
| Analysis of Games and Numbers | Analysis of Games and Numbers | Analysis of Games and Numbers |
| Wages & Salaries | Income & Debt | Government Finances |
| Spreadsheets | Linear Relations | Relations & Formulas |
| Trigonometry | Data Analysis | Statistics |
| Geometry | Measurement Technology | Design & Measurement |
| Personal Banking | Personal Income Tax | Personal Finance |
| Probability & Sampling | Applications of Probability | Investments |
| Consumer Decisions | Operating a Vehicle | Life project |

## Do you agree with these suggested topics?

---

**Agree   84%**                    **Disagree   16%**

### 2.3  Mathematics graduation requirements

***2.3.1***  *That, at the end of the 3 year Essentials of Mathematics 10 - 12 implementation period, Principles of Mathematics 11, Applications of Mathematics 11, Mathematics 11A, Introductory Mathematics 11, and Accounting 11 no longer be accepted as meeting the mathematics graduation requirement.*

**Agree   36%**                    **Disagree   64%****

**\*\***     The majority of respondents who disagreed with this draft recommendation indicated that they did so because they also disagreed with draft recommendation 2.3.2 concerning the grade 12 mathematics requirement for graduation (very few indicated they wished to retain Accounting 11 as a possible graduation requirement)

***2.3.2***  *That, at the end of the 3 year Essentials of Mathematics 10 - 12 implementation period, the mathematics graduation requirement be the successful completion of one of Principles of Mathematics 12, Applications of Mathematics 12, and Essentials of Mathematics 12.*

**Agree   34%**                    **Disagree   66%**

> **Average: 35.8% in agreement**

### 3. The role of Mathematics 9A, 10A, and 11A and Introductory Mathematics 11 as provincial curriculum

**3.1**     *That as the Essentials of Mathematics 10 - 12 courses are implemented over a 3 year period, Mathematics 9A, 10A, 11A, and Introductory Mathematics 11 be phased out.*

**Agree   63%**                    **Disagree   37%**

### 4.  Implementation of curricula

***4.1***     *That the Ministry identify the learning resources for Essentials of Mathematics 10 to 12.*

**Agree   95%**                    **Disagree   5%**

***4.2***     *That the Ministry develop an information brochure which outlines the*

---

*philosophy, rationale, and goals of each of the mathematics course options available to students and the criteria for the selection of each pathway.*

**Agree   95%**                              **Disagree  5%**

**4.3**   *That the Ministry of Education and the Ministry of Advanced Education and Training collaborate with the secondary and post-secondary education communities to recommend to the Minister a policy and a standard set of procedures to regularly review and determine which mathematics courses are accepted for purposes of admission to public post-secondary institutions.*

**Agree   100%**                             **Disagree  0%**

**Average: 97% in agreement**

**Overall: 84% in agreement**

## APPENDIX B: REQUIRED MATHEMATICS COURSES
### FOR ELEMENTARY EDUCATION PROGRAMS IN B.C.

|  | Math Content Courses | | Math Methods Courses | |
|---|---|---|---|---|
|  | # Courses | Total Credits | # Courses | Total Credits |
| SFU | 1 | 4 | 1 | 4 |
| UBC | 1 | 3 | 1 | 2 |
| U Vic | 2 | 6 | 1* | 4* |
| Cariboo College | 1 | 3 | 2 | 5 |
| Malaspina College | 2 | 6 | 2 | 4 |
| Okanagan University College | 2 | 6 | 1 | 4 |

* A new elementary program beginning in Fall 1999 will change this requirement to 2 courses with a total of 5 credit hours.

The *Report of the 1997 Survey of Recent Graduates of B.C. Teacher Education Programs: Institutional Comparison* (British Columbia College of Teachers, 1997) indicates that undergraduate education students reported the highest level of satisfaction with their mathematics education courses at UVic (84.3% satisfaction level), followed by SFU (73.2% satisfaction level), and UBC (68.5% satisfaction level).

During the mid - '80's a two-track course structure was developed (see below). This course structure is described in *Mathematics: Grade 7 - 12* (Province of British Columbia, 1987):

> In order to accommodate the needs of most students, the Curriculum Revision Committees have identified and arranged, into two different sets of courses, the concepts and skills that are prerequisites to Mathematics 11. The Mathematics 9A, 10A, and Introductory Mathematics 11 package allows students to cover the prerequisite material at a slower rate than that encountered in Mathematics 9 and 10; it also allows them to delay many of the more abstract concepts until their grade 11 year. (Page xiii)

```
                    ┌──────────────┐
                    │ Mathematics 8 │
                    └──────────────┘
                  ┌──────────┴──────────┐
                  ▼                     ▼
         ┌───────────────┐     ┌───────────────┐
         │ Mathematics 9A │     │ Mathematics 9 │
         └───────────────┘     └───────────────┘
                 │                     │
                 ▼                     ▼
         ┌────────────────┐    ┌────────────────┐
         │ Mathematics 10A │    │ Mathematics 10 │
         └────────────────┘    └────────────────┘
           ┌──────┴──────┐            │
           ▼             ▼            ▼
  ┌────────────────┐ ┌──────────────┐ ┌───────────────┐
  │ Mathematics 11A │ │ Introductory │→│ Mathematics 11 │
  └────────────────┘ │ Mathematics 11│ └───────────────┘
                     └──────────────┘    ┌─────┴─────┐
                                         ▼           ▼
                                  ┌──────────┐ ┌──────────────┐
                                  │  Survey  │ │ Mathematics 12│
                                  │Mathematics 12│ └──────────────┘
                                  └──────────┘
```
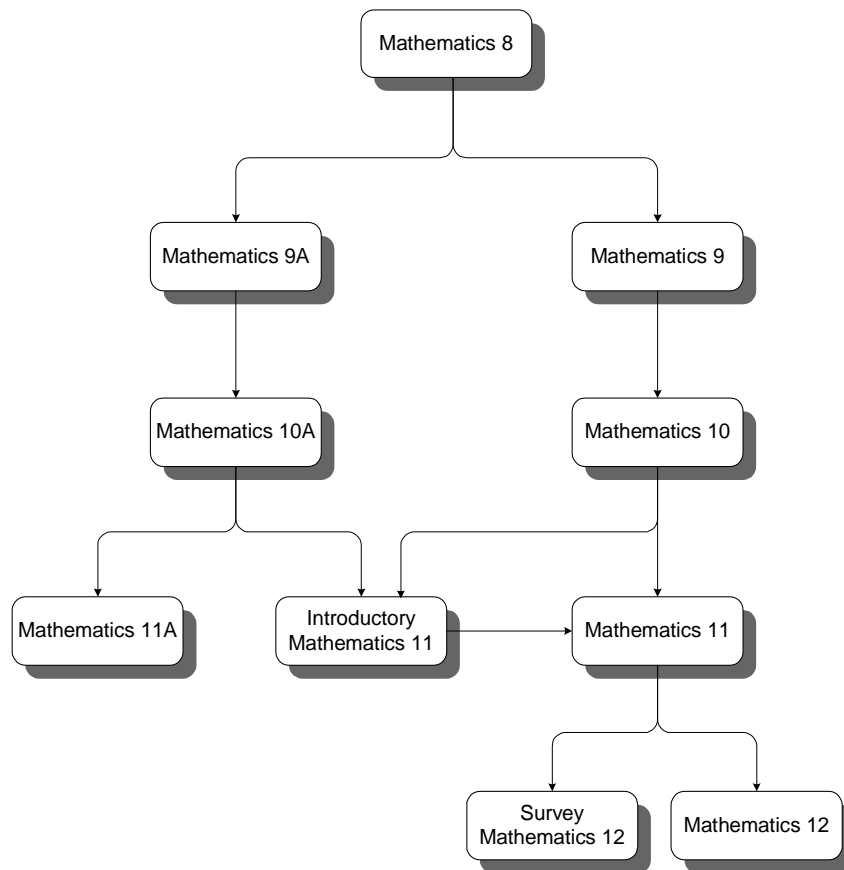
Anecdotal evidence indicates that the number of students who were successful in completing the transition from the A-stream to the "regular" stream was extremely small. Although many teachers can identify individual students who were successful in this transition, these individuals represent a

---

very small fraction of the 25% to 30% of the student population reportedly enrolled in the A-stream province wide.

Graduation requirements at this time required students to successfully complete one of Mathematics 11, Intro Mathematics 11, Mathematics 11A, or Accounting 11.  In 1996, the participation rates of all students enrolled in a Grade 11 Mathematics course (see Table III) indicates that, while this model intended that the majority of students would study the same mathematics, it actually resulted in over one-third of students experiencing a curriculum other than Mathematics 11.

**Table III:  Grade 11 Mathematics Course Participation Rates for 1996**

| Course | Part. Rate** |
|---|---|
| Mathematics 11 | 64.5% |
| Mathematics 11A* | 14.1% |
| Intro. Mathematics 11 | 18.1% |
| Accounting 11 | 15.8% |

∗   Enrollment in Math 9A & 10A is estimated at between 25% - 30% province wide.
**    The total participation rate is greater than 100% as a result of  students taking more than one grade 11  mathematics course

# APPENDIX D: B.C. SECONDARY MATHEMATICS
## COURSE STRUCTURE (1997 - PRESENT)
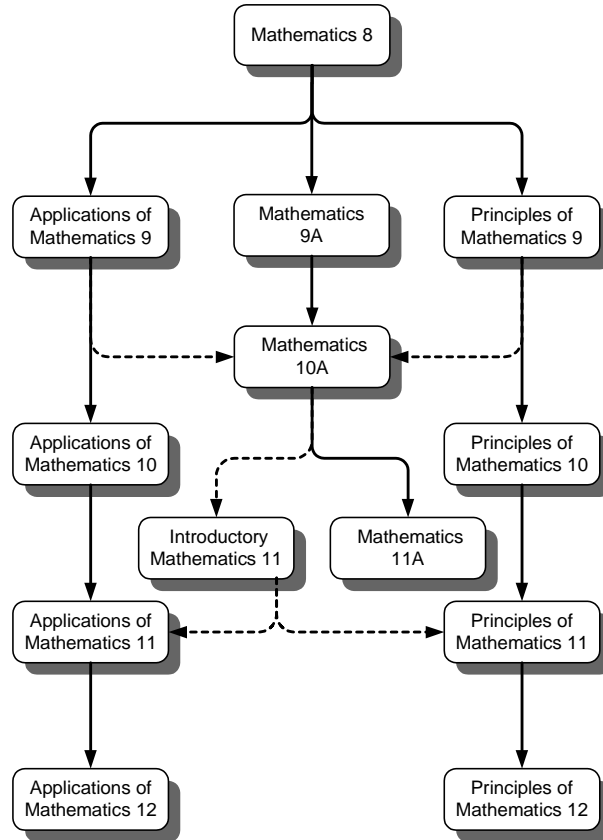
```
                          ┌──────────────┐
                          │ Mathematics 8│
                          └──────────────┘
                                 │
         ┌───────────────────────┼───────────────────────┐
         ▼                       ▼                       ▼
┌─────────────────┐    ┌─────────────────┐    ┌─────────────────┐
│  Applications of│    │  Mathematics    │    │  Principles of  │
│  Mathematics 9  │    │      9A         │    │  Mathematics 9  │
└─────────────────┘    └─────────────────┘    └─────────────────┘
         │                      │                       │
         │              ┌───────────────┐               │
         │ - - - - - -> │ Mathematics   │ <- - - - - -  │
         │              │     10A       │               │
         ▼              └───────────────┘               ▼
┌─────────────────┐            │              ┌─────────────────┐
│  Applications of│     ┌──────┴──────┐       │  Principles of  │
│  Mathematics 10 │     │             │       │  Mathematics 10 │
└─────────────────┘     ▼             ▼       └─────────────────┘
         │      ┌───────────────┐ ┌───────────────┐      │
         │      │ Introductory  │ │ Mathematics   │      │
         │      │ Mathematics 11│ │     11A       │      │
         │      └───────────────┘ └───────────────┘      │
         ▼                                                ▼
┌─────────────────┐                           ┌─────────────────┐
│  Applications of│ <- - - - - - - - - - - -> │  Principles of  │
│  Mathematics 11 │                           │  Mathematics 11 │
└─────────────────┘                           └─────────────────┘
         │                                                │
         ▼                                                ▼
┌─────────────────┐                           ┌─────────────────┐
│  Applications of│                           │  Principles of  │
│  Mathematics 12 │                           │  Mathematics 12 │
└─────────────────┘                           └─────────────────┘
```

Note:  To simplify this diagram, not all possible student transitions between the Applications of Mathematics Pathway and the Principles of Mathematics Pathway have been shown.

```
                    ┌──────────────────┐
                    │   Mathematics 8  │
                    └────────┬─────────┘
                             │
                             ▼
                    ┌──────────────────┐
                    │   Mathematics 9  │
                    └────────┬─────────┘
                             │
        ┌────────────────────┼────────────────────┐
        ▼                    ▼                    ▼
┌───────────────┐   ┌───────────────┐   ┌───────────────┐
│ Applications of│   │  Essentials of │   │  Principles of │
│ Mathematics 10 │   │ Mathematics 10 │   │ Mathematics 10 │
└───────┬────────┘   └───────┬────────┘   └───────┬────────┘
        ▼                    ▼                    ▼
┌───────────────┐   ┌───────────────┐   ┌───────────────┐
│ Applications of│   │  Essentials of │   │  Principles of │
│ Mathematics 11 │   │ Mathematics 11 │   │ Mathematics 11 │
└───────┬────────┘   └───────┬────────┘   └───────┬────────┘
        ▼                    ▼                    ▼
┌───────────────┐   ┌───────────────┐   ┌───────────────┐
│ Applications of│   │  Essentials of │   │  Principles of │
│ Mathematics 12 │   │ Mathematics 12 │   │ Mathematics 12 │
└───────────────┘   └───────────────┘   └───────────────┘
```
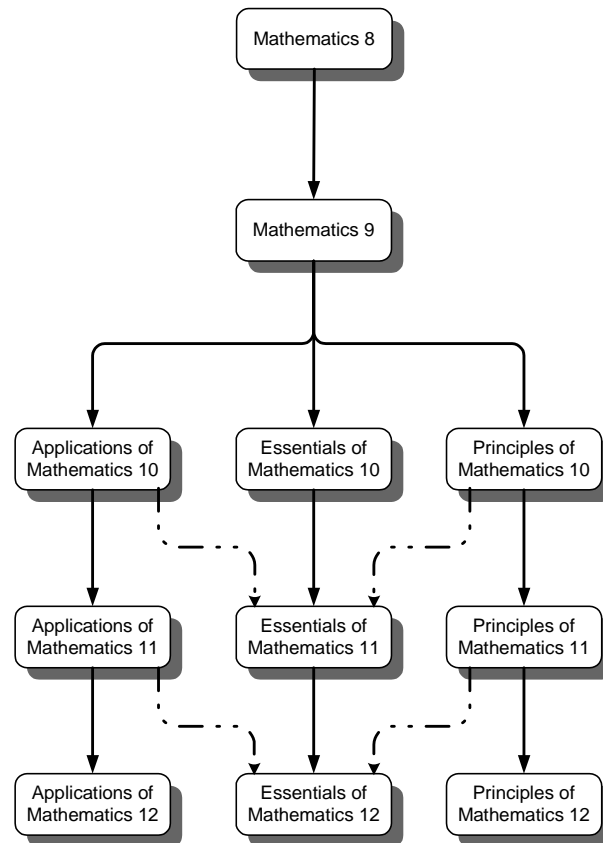
Note:  To simplify this diagram, not all possible student transitions between the
Applications of Mathematics Pathway and the Principles of Mathematics Pathway
have been shown. The new Provincial Calculus 12 course is not shown on this

diagram as the Task Force decided that recommendations concerning calculus were beyond its mandate.

# REFERENCES

British Columbia College of Teachers. (1997, December). <u>Report of the 1997 survey of recent graduates of B.C. teacher education programs: Institutional comparison</u>.  Vancouver: Author.

Marshall, M., Taylor, A., Bateson, D., Cardwell, S., Deeter, B., Martin, S. (1996, July). <u>The 1995 British Columbia assessment of mathematics and science: Technical report</u>. Vancouver: University of British Columbia, Applied Research and Evaluation Services.

McAskill, D. B. (1997, August). <u>Student streaming in secondary high school mathematics: A review of the literature</u>. (Working Draft). Victoria, BC: Ministry of Education.

National Council of Teachers of Mathematics. (1980). <u>An agenda for action: Recommendations for school mathematics of the 1980's</u>. Reston, Virginia: The National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics. (1989). <u>Curriculum and evaluation standards for school mathematics</u>. Reston, Virginia: The National Council of Teachers of Mathematics, Inc.

National Council of Teachers of Mathematics. (1998, Oct.). <u>Principles and standards for school mathematics: Discussion draft</u>. Reston, Virginia: The National Council of Teachers of Mathematics, Inc.

Province of British Columbia, Ministry of Education. (1987). <u>Mathematics: Grade 7 - 12 Curriculum Guide, (ED 90345)</u>. Victoria: Author.

Province of British Columbia, Ministry of Education. (1994). <u>The kindergarten to grade 12 education plan</u>. Victoria: Author.

Province of British Columbia, Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights. (1989). <u>Year 2000: A framework for learning</u>. Victoria: Author.

Province of British Columbia, Ministry of Education, Skills and Training. (June, 1997). <u>Addressing student differences: Next steps</u>. Victoria: Author.

Province of Manitoba, Manitoba Education and Training. (1999). <u>Senior 2 consumer mathematics: A foundation for implementation</u>. Winnipeg: Author.

Robitaille, D. F., (Ed.), (1993). <u>TIMSS Monograph No. 1: Curriculum frameworks for mathematics and science</u>. Vancouver: University of British Columbia, Pacific Educational Press.

Robitaille, D. F., (Ed.), (1996). <u>TIMSS Monograph No. 2: Research questions & study design</u>. Vancouver: University of British Columbia, Pacific Educational Press.

Stevenson, H. W. And Nerison-Low, R. (1999). <u>To Sum it Up: Case Studies of Education on Germany, Japan, and the United States</u>. National Institute on Student Achievement, Curriculum, and Assessment (http://www.ed.gov/offices/OERI/SAI). U.S. Department of Education.

## ADDITIONAL READING

Council of Ministers of Education, Canada, (1997). <u>School achievement indicators program: 1997</u>. Toronto: Author.

Hope, J. (1990). <u>Charting the course: a guide for revising the mathematics program in the Province of Saskatchewan</u>. Regina, Saskatchewan: Saskatchewan Instructional Development and Research Unit.

Neufeld, L. G. (1999, February). <u>Mathematics proficiencies for post-secondary mathematics/statistics courses: Project report</u>: Victoria: The Centre for Curriculum, Transfer & Technology.

Province of British Columbia, Ministry of Education. (1998). <u>Curriculum handbook for parents: Grades K to 3</u>. Victoria: Author.

Province of British Columbia, Ministry of Education. (1998). <u>Curriculum handbook for parents: Grades 4 to 7</u>. Victoria: Author.

Province of British Columbia, Ministry of Education. (1998). <u>Curriculum handbook for parents: Middle School Edition</u>. Victoria: Author.

Province of British Columbia, Ministry of Education. (1998). <u>Curriculum handbook for parents: Grades 8 to 10</u>. Victoria: Author.

Province of British Columbia, Ministry of Education. (1998). <u>Curriculum handbook for parents: Grades 11 to 12</u>. Victoria: Author.

Province of British Columbia, Ministry of Education, Skills and Training. (1996a). <u>Mathematics 11 and 12: Introductory mathematics 11, principles of mathematics 11 and 12 (IRP 026)</u>. Victoria: Author.

Province of British Columbia, Ministry of Education, Skills and Training. (1996b). <u>Mathematics 8 to 10 (IRP 031)</u>. Victoria: Author.

Province of British Columbia, Ministry of Education, Skills and Training. (1996c). <u>Mathematics 11 and 12: Applications of mathematics 11 and 12 (IRP 044)</u>. Victoria: Author.

Province of Ontario, Ministry of Education and Training. (1999). <u>Ontario secondary schools, grades 9 to 12</u>. (http://www.edu.gov.on.ca/eng/document/curricul/secondary/oss/oss.html) .

Robitaille, D. F., (Ed.), (1995). <u>TIMSS Monograph No. 3: Mathematics textbooks: A comparative study of grade 9 texts</u>. Vancouver: University of British Columbia, Pacific Educational Press.

Robitaille, D. F., (Ed.), (1998). <u>TIMSS Monograph No. 4: Assessing mathematics and science literacy</u>. Vancouver: University of British Columbia, Pacific Educational Press.

Robitaille, D. F., Taylor, A. R., Brigden, S. R., Marshall, M. A. (1997). <u>TIMSS - Canada report: Volume 3: Hands-on problem solving.</u> Vancouver: University of British Columbia, Department of Curriculum Studies.

Robitaille, D. F., Taylor, A. R., Orpwood, G. (1996). <u>TIMSS - Canada report: Volume 1: Grade 8.</u> Vancouver: University of British Columbia, Department of Curriculum Studies.

Robitaille, D. F., Taylor, A. R., Orpwood, G. (1997). <u>TIMSS - Canada report: Volume 2: Grade 4.</u> Vancouver: University of British Columbia, Department of Curriculum Studies.

Robitaille, D. F., Taylor, A. R., Orpwood, G., Donn, J. S. (1998). <u>TIMSS - Canada report: Volume 4: Senior secondary.</u> Vancouver: University of British Columbia, Department of Curriculum Studies.