Introduction

INTRODUCTION

Rationale

During the last century, there has been a tremendous increase in mathematical knowledge. This is due to the collective influence of technology, the expansion of applications of mathematics, and the steady transition from an industrial to an information society. Consequently, there is a need for a change in the goals of mathematics education for all students.

In order to meet the challenges of society, Senior Years graduates must be mathematically literate. They must understand how mathematical concepts permeate daily life, business, industry, government, and our thinking about the environment. They must be able to use mathematics not just in their work lives, but also in their personal lives as citizens and consumers. They will need, additionally, to develop their cooperative, interactive, and communicative skills.

Senior 2 Consumer Mathematics has been designed to meet these challenges for those who may not use advanced mathematics in their careers, but who, nevertheless, will be consumers and active citizens.

Goals

The goals that guide the Senior Years have been influenced by the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989). Additionally, other mathematics curricula for Manitoba schools have conformed to the *Common Curriculum Framework for K-12 Mathematics: Grade 10 to Grade 12* (1996) prepared by the Western Canadian provinces and territories under the Western Canadian Protocol for Collaboration in Basic Education. In the case of *Senior 2 Consumer Mathematics*, the influence of these two documents is pervasive. However, the curriculum is not bound by the outcomes as set out in the Common Curriculum Framework.

The general goals established in the aforementioned documents underlie *Senior 2 Consumer Mathematics*. The incorporation of these goals into the curriculum ensures that more students will gain in mathematical power, thus increasing their ability to understand issues in a technological and informational society, as well as in their daily lives. In an appropriate mathematical context:

- **Students should learn to value mathematics.** They should be able to understand the impact that mathematics and its application have made on society and, consequently, how that impact influences their own lives.

- **Students should become confident in their mathematical abilities**. They should grow in their confidence and competence to solve problems and apply mathematical modelling to real-life situations.
- **Students should become mathematical problem solvers.** They should be able to solve a variety of routine and non-routine mathematical problems related to everyday life, and make connections between mathematics and other fields of study and work.
- **Students should learn to communicate mathematically.** They should justify and clarify their mathematical thinking, express ideas orally and in writing, and read mathematics with understanding. They should recognize that mathematics is a technical language.
- **Students should develop proficiency in basic skills and an understanding of fundamental concepts.** They should be able to perform basic mathematical skills and apply mathematical concepts mentally, where appropriate.
- **Students should become proficient users of technology.** They should be able to use calculators and computer software appropriate to the task at hand.

Mathematical Themes

Consumer Mathematics is built around nine ***themes***. These themes, sometimes labelled "standards" or "processes," are not mutually exclusive and should be seen as permeating all topic areas at each of Senior 2, 3, and 4 in much the same way as the processes of the Western Canadian Protocol are viewed. The themes are listed and briefly described in the following table. A more detailed description follows the table.

Themes	Students are expected to . . .
Communication [C]	communicate mathematical ideas
Connections [CN]	connect mathematical ideas to other concepts in mathematics and to real-world situations and contexts
Number Sense [NS]	have a sense of the magnitude of numbers and measurements, and the reasonableness of answers
Organization and Structure [OS]	apply mathematical structure to a situation or infer a structure from a situation
Patterns [P]	recognize, articulate, and develop patterns
Problem Solving [PS]	analyze problem contexts and solve problems by applying mathematical knowledge
Reasoning [R]	reason logically and justify thinking
Technology [T]	select and use appropriate technologies to solve problems
Visualization [V]	use visualization to assist in processing information, making connections, and solving problems

Communication

Students need to communicate mathematical ideas and problem situations clearly and effectively, orally and in writing. Communication will help students make connections among different representations of mathematical ideas, namely, "physical, pictorial, graphic, symbolic, verbal, and mental representations" (National Council of Teachers of Mathematics, 1989, p. 26). Students must be able to communicate effectively how a result was obtained. In other words, students need opportunities to read, to explore, to investigate, to write, to listen to, to discuss, and to explain ideas in their own language of mathematics.

Connections

Students need numerous and varied experiences in order to appreciate the usefulness of mathematics and, at the same time, to explore connections within mathematics to other disciplines, and from mathematics to their daily experiences. When mathematical ideas are connected to each other through concrete, pictorial, and symbolic representations, students begin to view mathematics as an integrated whole.

Number Sense

Students need to have an intuitive understanding of quantity and numerical relationships. It is useful in everyday living to know whether the measurements we make and the quantities we calculate are reasonable. This may include the ability to do simple calculations mentally and to estimate the results of calculations done electronically or of measurements to be made. It further suggests an understanding of basic arithmetic and its application to problems in the world of work and as a consumer. For example, does the Winnipeg stadium hold 30 000, 300 000, or 3 000 000 fans? How many metres high is a doorway?

Organization and Structure

It is important that students be able to organize mathematical information and provide structure to this information in order to deal effectively with the data. Order and structure can give meaning to information that appears chaotic or random. Students may organize and apply structure based on their background knowledge, or they may develop structure to extend beyond their own experiences in order to provide meaning to a context. Organization and structure allow a student to develop connections and see patterns in mathematics. Conversely, the perception of connections and patterns in mathematics may allow students to develop organizational skills and to apply structure.

Patterns

Patterns exist throughout mathematics. A major portion of any study in mathematics will involve looking for patterns. Patterns exist in many forms, within and without mathematics:

Numeric	2, 3, 6, 8, . . .
Visual	tessellations
In nature	a snowflake

An arithmetic algorithm is a pattern. In solving problems, students should be encouraged to look for patterns. When patterns are established, concepts are more easily understood and applied. "Seeing" a pattern will enable students to develop a mathematical structure and better understand relationships among concepts and/or processes. It is beneficial to individual student learning that the seeking of patterns becomes innate.

Problem Solving

"Problem solving — which includes the ways in which problems are represented, the meanings of the languages of mathematics, and the ways in which one conjectures and reasons — must be central to schooling so that students can explore, create, accommodate to changed conditions, and actively create new knowledge over the course of their lives" (National Council of Teachers of Mathematics, 1989, p. 4).

Problem solving is a focus of mathematics at all grades. The development of each student's ability to analyze and solve problems is essential. Students develop a true understanding of mathematical concepts and procedures when they solve problems, both routine and non-routine, in meaningful contexts. Problem solving provides an opportunity for students to be active in constructing mathematical meaning, to learn problem-analysis skills and problem-solving strategies in a meaningful context, and to communicate mathematical ideas effectively. Problem solving is to be embedded throughout all the units in *Senior 2 Consumer Mathematics*.

Reasoning

Students need to develop confidence in their ability to reason and to justify their thinking within and outside of mathematics. The power of reasoning helps students to make sense of mathematics, to be logical in their thinking, and to convince others of the validity of their arguments. Inductive reasoning helps students to explore and to make conjectures from activities which allow generalizations from observed patterns. Deductive reasoning helps students test conjectures and build arguments that serve to validate thinking.

Technology

Improvements in technology, and its increased availability in schools, have helped to change the focus of mathematics education. The time saved by using calculators or computers to perform complex calculations can be used to help students better understand mathematical concepts and processes.

Calculators and computers can be used as tools to:

- develop concepts
- explore and demonstrate mathematical relationships and patterns
- organize and display data
- assist with solving problems and thus promote self-confidence
- encourage students to become inquisitive and creative
- decrease the time spent on tedious computations
- reinforce the learning of basic number facts and properties
- develop an understanding of computational algorithms
- create geometric displays
- simulate situations

In some cases, technology will allow teachers to ask questions requiring higher levels of thinking, and will allow students to solve complex, multifaceted problems which would otherwise be impossible for them. Technology can foster environments in which the curiosity of students can lead to rich mathematical discoveries.

Visualization

Images are useful in describing the physical and mathematical environment. Visualization involves thinking in pictures and images, and the ability to perceive, transform, and re-create different aspects of the visual-spatial world. The use of images in the study of mathematics provides students with the opportunity to understand mathematical concepts and to make connections among them.

The physical environment is full of images. The images are of 3-D objects, 2-D shapes, and 1-D lines. In geometry, the study of a 3-D object is assisted by visualizing either a net of 2-D shapes or a skeleton of 1-D lines required to construct the object. Mathematical and statistical ideas are communicated through the use of graphic and other images.

Pedagogical Considerations

It is predicted that today's Senior Years graduate will change careers at least four or five times. If a flexible workforce capable of lifelong learning is required, Senior Years mathematics must emphasize a dynamic form of literacy and broader outcomes for all students. Experiences must be provided that enable students to develop problem-solving abilities, to gain confidence in their mathematical ability, to enjoy mathematics, to reason and to communicate mathematically, and to develop positive attitudes toward the uses and values of mathematics in our society.

These needs can be developed by a curriculum taught with the following considerations:

- **Knowing mathematics is doing mathematics.** It must be stressed that mathematics is more than just a collection of skills and concepts to be mastered. Educational research offers compelling evidence that students learn mathematics when they construct their own mathematical understanding. To understand what they learn, students must "examine," "represent," "transform," "solve," and "apply." This happens most readily when students are in groups engaging in discussion, and making presentations. Mathematics instruction must emphasize "doing" rather than just "knowing."
- **Mathematics has broad content applications in many fields and in everyday life.** Some aspects of doing mathematics have changed in the past decade. The computer's ability to process large quantities of information has made quantification and the logical analysis of information routine in such areas as business, economics, biology, medicine, and sociology. Although traditional topics remain important parts of the curriculum, there is a shift away from procedures and proficiency with pencil-and-paper algorithms, and more of an emphasis on conceptual understanding and connections, mathematical modelling, and problem solving. Nonetheless, this should not be seen as negating the importance of automaticity in basic arithmetic and mathematical knowledge.
- **Changes in technology and the broadening of areas in which mathematics is applied have resulted in growth and changes in the discipline of mathematics itself.** The impact of technology on the mathematics curriculum can be perceived at all grades and can be summarized as follows:
  - — some mathematics applications become more important because technology requires them
  - — some mathematics applications become less important because technology replaces them
  - — some mathematics applications become possible because technology allows them

  The new technology has not only made calculations and graphing easier, it has changed the nature of the problems that are important to mathematics and to which mathematics can be applied. It is essential that students at all grades have access to calculators and computers with appropriate software so that they can benefit from the modelling and visualization of mathematical processes and problems.

- **The teaching and learning of mathematics have changed.** What students learn is fundamentally connected to how they learn it. The view of learning mathematics as an integrated set of intellectual tools for making sense of situations has created a need for new forms of classroom organization, communication patterns, and instructional strategies. The teacher is no longer the sole dispenser of information, but, rather, a facilitator and educational conductor whose major roles include:
  - — creating a classroom environment to support the teaching and learning of mathematics
  - — setting goals and selecting or creating mathematical tasks to help students reach these goals
  - — stimulating and managing classroom discourse so that students are clearer about what is being taught
  - — analyzing student learning, the mathematical tasks, and the environment in order to make ongoing instructional decisions

  Good mathematics teaching and learning take place in a range of situations. Instructional settings and strategies should create a climate that reflects a constructive, active view of learning. This means that learning does not occur simply by passive absorption, but, rather, by students actively assimilating new information and constructing their own meanings.

  Opportunities for students to learn are a function of the setting, the kinds of tasks, and the discourse in which they participate. What students learn about particular concepts and procedures, and their own mathematical thinking, depends upon the ways in which they engage in mathematical learning experiences* in their classrooms. Their dispositions toward mathematics are shaped by such experiences. Consequently, the goal of developing students' mathematical power requires careful attention to pedagogy as well as to curriculum.

  Mathematics instruction should vary and include opportunities for group and individual assignments, cooperative learning, discussion between and among teacher and students, appropriate project work, practice on mathematical methods, and exposition by the teacher.

* Mathematical learning experiences may be referred to as activities, exercises, tasks, or problems elsewhere in this document.

Assessment

In assessing students in *Senior 2 Consumer Mathematics*, teachers are encouraged to use a variety of techniques and to provide students with some flexibility in the methods of evaluation, and to give consideration to the weighting of various elements which constitute a term mark. It is suggested that assessment not be limited to pencil and paper only. Suggestions here are intended to help create flexibility and a sense of ownership of their learning on the part of students. This list is certainly not exhaustive. These statements on assessment have been influenced by the *Assessment Standards for School Mathematics* (National Council of Teachers of Mathematics, 1995).

It is anticipated that student assessment could include the following:

- homework
- classwork
- portfolios
- projects/investigations
- use of rubrics (particularly in nonquantitative work)
- informal discussion
- interviews
- structured observations
- written tests/examinations

In every unit, several of the above approaches should be used.

1. Projects/Investigations

The *Senior 2 Consumer Mathematics* material provided for students and teachers recommends hands-on activities and projects in which students may work individually or in groups. Reports and assignments from these learning experiences will be assessed and may be included in the student's portfolio.

2. Portfolios

A portfolio may contain a variety of samples of student work including journal entries, solutions to problems, diagrams, responses to open-ended questions, homework, and explanations of algorithms or processes. Students should be actively involved in the maintenance of their portfolios, giving them a sense of control and ownership of their own learning and progress.

3. Testing

Testing will occur from time to time, but need not be done with every unit.

Course Structure and Description

Senior 2 Consumer Mathematics is divided into two half courses, I and II, with time allotments as indicated in the table. The time allotted for each half course is 55 hours, which provides time for teaching, reviewing, and testing. Review of the previous year's work is not an explicit part of the curriculum and is not recommended for starting a new half course.

Each of the two *Senior 2 Consumer Mathematics* half courses are worth a half credit. The designation of two half courses accommodates students who may find a portion of *Senior 2 Consumer Mathematics* difficult. Instead of having to repeat an entire full-credit course, students could receive a half credit for the half course they successfully completed, and concentrate, instead, on a second attempt at the half course that presented them with difficulty.

Designing *Senior 2 Consumer Mathematics* as two half courses also accommodates students who are interested in particular topics, and wish to study the half course that contains those topics, rather than the entire course.

Senior 2 Consumer Mathematics			
Half Course I		**Half Course II**	
Unit	**Hours**	**Unit**	**Hours**
A. Problem Analysis	9	A. Problem Analysis	4
B. Analysis of Games and Numbers	5	B. Analysis of Games and Numbers	2
C. Wages and Salaries	15	C. Consumer Decisions	7
D. Spreadsheets	8	D. Geometry Project	17
E. Trigonometry	5	E. Personal Banking	7
F. Spatial Geometry	13	F. Probability and Sampling	18

In the table above, the units are presented in a recommended teaching sequence with the proviso that Problem Analysis and Analysis of Games and Numbers are best taught throughout. It is recognized that teachers may with good reason want to alter the presented sequence; pilot teachers have found it useful to intermix units or to teach a unit in more than one time block.

Included in this curriculum document are statements of General Student Learning Outcomes and Specific Student Learning Outcomes, together with teaching suggestions, assessment suggestions, and references to learning resources. While particular materials and references have been provided in the ***Suggestions for Instruction*** and ***Learning Resources*** sections because they have been found by pilot teachers to be useful and well developed, a teacher may want to use other materials.

List of Materials by Unit

Unit	Basics				Extra Student Materials	Materials for Printing	Miscellaneous Notes
	1	2	3	4			
Problem Analysis	✓	✓	✓	✓		Activities from Appendix I in both half courses.	See Appendix II for additional resources
Analysis of Games and Numbers	✓	✓	✓	✓		Activities from Appendix I in both half courses.	See Appendix II for additional resources
Wages and Salaries	✓		✓	✓	Payroll Deduction Tables 1-800-959-2221 <www.ccra-adrc.gc.ca>	Blackline Masters from Payday Project and eight-minute rule (optional)	CHOICES CBA booklets Local business — time cards, job applications, lateness rules Table of Diskette Manitoba Labour — 1-800-821-4307 Sample TD1 forms
Spreadsheets			✓			Blackline Masters	Set up templates ahead of time
Trigonometry	✓	✓	✓		Protractor	Graph paper	
Spatial Geometry		✓		✓	Rods or cubes Pencil crayons Miras/mirrors	Square-Dot paper Isometric paper Overheads (colour)	<www.eternity-puzzle.co.uk>
Consumer Decisions	✓		✓	✓	Store flyers	Blackline Masters	*Buyer Be Aware* video CBA booklets CHOICES Federal Business Development Bank
Geometry Project	✓	✓	✓	✓	Measuring tapes Geometric solids Volume Relation Kit Home building magazines Building materials catalogues Quilting magazines Home Building flyers Cardboard or ¼" plywood Architecture books		
Personal Banking	✓		✓	✓		Blackline Masters Overheads of cheques	CBA booklets
Probability and Sampling	✓	✓	✓	✓	Goldfish crackers, M&Ms, or skittles Dice Pennies	Graph paper	Applets for Probability <www.gis.psu.edu/geog121/takecens/cap_recap.html>(Java)

Note: Basics: 1 — Scientific Calculator; 2 — Ruler; 3 — Spreadsheet; 4 — Internet

Consumer Mathematics Curricula

The curricula which follow *Senior 2 Consumer Mathematics*, namely *Senior 3 Consumer Mathematics* and *Senior 4 Consumer Mathematics*, are built with a parallel structure of two half courses. The Problem Analysis and Analysis of Games and Numbers units continue to be embedded within the courses. The tables below give an overview of these courses.

Senior 3 Consumer Mathematics	
Half Course III	**Half Course IV**
Unit	**Unit**
A. Problem Analysis B. Analysis of Games and Numbers	A. Problem Analysis B. Analysis of Games and Numbers
C. Relations and Formulas D. Income and Debt E. Data Analysis and Interpretation	C. Measurement Technology D. Owning and Operating a Vehicle E. Personal Income Tax F. Applications of Probability

Senior 4 Consumer Mathematics	
Half Course V	**Half Course VI**
Unit	**Unit**
A. Problem Analysis B. Analysis of Games and Numbers	A. Problem Analysis B. Analysis of Games and Numbers
C. Personal Finance D. Design and Measurement E. Government Finances F. Statistics G. Investigative Project	C. Career/Life Project D. Investments E. Income Tax F. Variation and Formulas G. Completing a Portfolio

Cautionary Notes

Some of the experiences or problems in *Senior 2 Consumer Mathematics* may involve chance and probability. In some families and communities, the connection between probability and gambling may be problematic; for example, parents/guardians may not approve of playing cards, dice, or prize money. As an alternative, activities or problems can be reworded to include numbered index cards, number cubes, and points or credits.

Some sample activities and problems in *Senior 2 Consumer Mathematics* may be viewed as inappropriate by some community members. For example, the logic problem, Poplar Lane Mystery, found on page I-B-26, is in the context of a murder mystery which some families could view as promoting violence. As an alternative, such problems could be replaced or modified.