

Introduction

INTRODUCTION

Rationale

During the last half-century there has been a tremendous increase in mathematical knowledge. This, in turn, has influenced the growth 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, high school 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 in their personal lives as citizens and consumers.

The Consumer Mathematics curriculum has been designed to meet these challenges for those who may not use advanced theoretical mathematics in their careers, but who, nevertheless, will be consumers and active citizens. They will need, additionally, to develop their co-operative, interactive, and communicative skills.

Goals

The goals that guide Senior Years Consumer Mathematics 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* prepared by the western Canadian provinces and territories under the Western Protocol for Collaboration in Basic Education (1993). In the case of Consumer Mathematics, the influence of these documents is pervasive. However, the course is not bound by the outcomes set out in the Western and Northern Canadian Protocol.

The general goals established in the aforementioned documents underlie *Senior 4 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 information society as well as in their own lives. In an appropriate mathematical context:

- Students should learn to make reasoned decisions and to support those decisions mathematically. They should be able to understand the impact that mathematics and its applications have made on society and how this 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 in all three Consumer Mathematics curricula in much the same way the processes of the Western Canadian Protocol are viewed. The themes are listed and briefly described in the table on the next page. A more detailed description follows the table.

Themes	Students are expected to . . .
<i>Communication</i> [C]	communicate mathematical ideas to support decision making
<i>Connections</i> [CN]	connect mathematical ideas to other concepts in mathematics, and to everyday situations and contexts
<i>Number Sense</i> [NS]	have a sense of the magnitude of numbers and measurements, and the reasonableness of answers
<i>Organization and Structure</i> [OS]	apply mathematical structure to a situation or infer a structure from a situation
<i>Patterns</i> [P]	recognize, articulate, and develop patterns
<i>Problem Solving</i> [PS]	analyze problem contexts and solve problems by applying mathematical knowledge
<i>Reasoning</i> [R]	reason logically and justify thinking
<i>Technology</i> [T]	select and use appropriate technologies to solve problems
<i>Visualization</i> [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 and why a particular decision is appropriate. 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, from 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, e.g., are the correct order of magnitude, are realistic. 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 we face as workers and as consumers. 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 are able to organize and structure mathematical information in order to deal effectively with the decision making emphasized in Consumer Mathematics. 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 students to develop connections and see patterns in mathematics. Conversely, the perception of connections and patterns in mathematics may allow students to develop skills in organizing and applying 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, e.g.:

Numeric	2, 4, 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. Students benefit when the seeking of patterns becomes innate.

Problem Solving

“Problem solving—which includes the ways in which problems are represented, the meanings of the language 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 embedded throughout all the units in *Senior 4 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 decision making. Inductive reasoning helps students to explore and to make conjectures from activities that 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

- encourage students to become inquisitive and creative in their decision making
- develop concepts
- explore and demonstrate mathematical relationships and patterns
- organize and display data
- assist with solving problems and thus promote self-confidence
- 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 recreate 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 high school graduate will change careers at least four or five times. A flexible workforce capable of lifelong learning is required. Senior Years mathematics must emphasize a dynamic form of decision making and broader learning 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 value of mathematics in 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 that.”
- **Mathematics has broad content applications in many fields and in everyday life.** Some aspects of doing mathematics have changed in the past decade. Computers, capable of processing large quantities of information, have 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 in emphasis from procedures and proficiency with pencil-and-paper algorithms to one that emphasizes 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 felt at all levels 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 also has changed the nature of the problems important to mathematics and to which mathematics can be applied. It is essential that students at all levels have access to calculators and computers with appropriate software in order 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 the teacher and 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 content.

Mathematics instruction should vary and include opportunities for group and individual assignments, co-operative 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 4 Consumer Mathematics*, teachers are encouraged to use a variety of techniques and to provide students with alternative ways to demonstrate their learning. It is recommended that assessment not be limited to pencil-and-paper tests, and that teachers be flexible in their weighting of various elements that constitute a term mark. The recommendations here are intended to help create flexibility and a sense of ownership on the part of students. The following list is certainly not exhaustive. These statements on assessment have been influenced by *Assessment Standards for School Mathematics* (National Council of Teachers of Mathematics, 1995).

It is anticipated that in assessing and evaluating students' achievements, teachers would use the following approaches:

- | | |
|---|----------------------------|
| Homework | Informal Discussion |
| Classwork | Interviews |
| Portfolios | Structured Observations |
| Projects/Investigations | Written Tests/Examinations |
| Use of Rubrics, particularly in non-quantitative work | |

In every unit several of the above approaches should be used. It is also important to be aware of the requirements for provincial assessment of *Senior 4 Consumer Mathematics*.

Current provincial policy provides for external assessment for Senior 4 students in mathematics. There are two major components in a student's final course grade: classroom work contributes 70%; the remaining 30% comes from a provincial assessment.

Document Structure and Description

Senior 4 Consumer Mathematics is structured in two half courses, V and VI, with time allotments as indicated in the table on page 12. The time allotted for each half course is 55 hours, which allows time for teaching, review, and testing. Review of the previous year's work is not an explicit part of the course and is not recommended to initiate a new half course.

The designation of two half courses accommodates students who may find a portion of *Senior 4 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 complete, and concentrate, instead, on a second attempt at the half course that presented them with difficulty.

Designating *Senior 4 Consumer Mathematics* as two half courses also accommodates students from either applied or pre-calculus mathematics who are interested in particular topics, and who wish to study the half course that contains those topics, rather than the entire course.

Schools may record students' marks as one full course, *Senior 4 Consumer Mathematics (40S)* or two half courses, *Senior 4 Consumer Mathematics, Half Course V (45S)* and *Senior 4 Consumer Mathematics, Half Course VI (45S)*, whichever is most advantageous to the students.

Senior 4 Consumer Mathematics

Half Course V		Half Course VI	
Unit	Hours	Unit	Hours
A. Problem Analysis B. Analysis of Games and Numbers	7	A. Problem Analysis B. Analysis of Games and Numbers	7
C. Personal Finance	11	C. Career/Life Project	11
D. Design and Measurement	11	D. Investments	12
E. Government Finances	11	E. Taxation	9
F. Statistics	10	F. Variation and Formulas	11
G. Investigative Project	5	G. Completing a Portfolio	5

Notes on the units listed in the above table:

- Both Problem Analysis and Analysis of Games and Numbers should be embedded throughout the course.
- The Life/Career project should be started early and be carried on as you work on other units.
- Taxation should be done at the most appropriate time relative to the taxation year and filing date.
- Projects associated with provincial assessment or with any unit(s) may necessitate additional time, both inside and outside class, and/or may carry on as students work on other units.

Included in this curriculum are statements of General Learning Outcomes and Specific 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 "Suggested Learning Resources" sections because they have been found by pilot teachers to be useful and well developed, a teacher may wish to use other materials because he or she finds them helpful.

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.
Personal Finance	✓		✓			Tables	Guest speakers would enhance this unit.
Design and Measurement		✓					
Government Finances				✓			
Statistics	✓		✓	✓			
Investigative Project	✓	✓	✓	✓			
Career/Life Project				✓		Budget Forms	
Investments	✓		✓	✓			Guest speakers would enhance this unit.
Income Tax							Order tax forms early. See page VI-E-5 for ordering information.
Variation and Formulas	✓	✓	✓				
Completing a Portfolio			✓	✓			

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

Consumer Mathematics

The courses that precede *Senior 4 Consumer Mathematics*, *Senior 2 Consumer Mathematics* and *Senior 3 Consumer Mathematics*, respectively, are designed with a parallel structure of two half courses. Problem Analysis and Analysis of Games and Numbers continue as units of material to be embedded throughout the courses. The tables below give an overview of these courses.

Senior 2 Consumer Mathematics

Half Course I	Half Course II
Unit	Unit
A. Problem Analysis B. Analysis of Games and Numbers	A. Problem Analysis B. Analysis of Games and Numbers
C. Wages and Salaries D. Spreadsheets E. Trigonometry F. Spatial Geometry	C. Consumer Decisions D. Geometry Project E. Personal Banking F. Probability and Sampling

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

Cautionary Note

Some of the experiences or problems in these documents 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, reword activities or problems to include numbered index cards, number cubes, and points or credits.