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ABSTRACT

This program is for students of grades 8 and 9 who may function a year or two behind their age peers in mathematics. It is designed to develop concepts, skills, and attitudes required for effective computation and problem solving at home, in the classroom, in the workplace, and in the community. Other goals are to develop a positive self concept, critical and creative thinking skills, ability to use modern technology, and reading skills and other forms of communication required for learning mathematics and solving problems. Concepts taught include number systems and operations; ratio, proportion and percent; geometry and measurement; data investigation and display; and algebra. Themes are managing your money, world of work, using math at home, and travel and recreation. The curriculum guide includes learning objectives, related life skills, related applications across the curriculum, and suggested strategies and activities for each concept developed. (DC)

INTEGRATED OCCUPATIONAL PROGRAM

Program of Studies/Curriculum Guide
Grades 8 and 9

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Program of Studies/Curriculum Guide

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NOTE

CURRICULAR DOCUMENT FORMAT

To provide educators with a comprehensive overview of the Integrated Occupational Program, all I.O.P. curricular documents have adopted the format of combining the Program of Studies and Curriculum Guide into one document. The shaded statements or segments within this document indicate the prescriptive contents of the Program of Studies. All other advice and direction provided are suggested only.

The terminology and format used in this document reflect policy in effect when I.O.P. curriculum development began in 1987.

METRICATION POLICY

It is the policy of Alberta Education that "SI units become the principal system of measurement in the curriculum of the schools in the province". In preparing students for transition to the workplace where imperial/U.S. measurements may still be in use, both SI metric and other units of measurement are addressed in the practical arts/occupational component of the Integrated Occupational Program.

The comparison/teaching of metric units with other units of measurement should be restricted to those that are relevant to student needs as reflected by common usage in course-related workplaces.

ACKNOWLEDGEMENTS

The Integrated Occupational Mathematics 8 and 9 Program of Studies/Curriculum Guide has been developed through the cooperative efforts of many individuals. Each person's contribution is sincerely appreciated. The program has also benefited from the validation of a number of educators across the province. Their comments provided valuable assistance and direction.

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RATIONALE

The Integrated Occupational Program (I.O.P.), developed as an outcome of the *Secondary Education in Alberta Policy Statement* (1985), is a program for students who may function a year or more behind their age peers. The program consists of both core and complementary courses designed to develop skills necessary for everyday living.

I.O.P. Mathematics 8 and 9 is designed to provide for the development of essential concepts, skills and attitudes required for effective computation and problem solving at home, in the classroom, in the workplace and in the community. Determining the essential concepts, skills and attitudes relative to environmental demands and providing opportunities for students to negotiate their needs and wants for functioning in these environments are vital to ensure that students will become motivated to participate in the learning process. Traversing the span between the concepts, skills and attitudes required and the needs and wants of students is integral to a successful mathematics program.

The mathematics program has been developed to teach skills within contexts that are meaningful and relevant to students. Many opportunities are provided for instruction through "thematic study", through the integration of skills "across the curriculum", and through application of skills to "real life" situations. These approaches add a motivational dimension to the program, and provide students with the direct assistance they need to transfer specific skills to more generalized situations.

Students within the program are typically unaware of the strategies they may generate and employ to become more efficient in their cognitive functioning. Evidence supports, however, that students with learning difficulties can perform strategically if taught to do so. The strategies for computation, estimation and problem solving that are developed and applied throughout the program will provide students with a systematic and logical approach for dealing with unfamiliar situations. The processing strategies that have been emphasized will foster effective behaviours in planning, organizing and self-monitoring. When students learn that they can understand and control the outcome of tasks demanded of them, restored confidence in taking risks, accepting challenges, solving problems and making decisions will reverse the "learned helpless" syndrome and passive acceptance of failure so typical in many of their lives.

PHILOSOPHY

The Integrated Occupational Mathematics 8 and 9 program focuses first and foremost on the needs of the learner. As attitude and self-esteem are powerful influences over learning, the program must foster in each student a positive self-concept and a positive attitude toward learning. The concepts, skills and strategies delivered by the program must:

- provide meaningful and relevant experiences
- be appropriate to student ability
- provide for student success.

Students vary in the way they receive, process, recall, apply, and communicate information. Each student has a preferred learning style. Instructional planning and delivery must include careful assessment of each student's developmental characteristics, knowledge, skill, and learning style. Adjustments to instructional delivery may often be necessary to ensure that individual student needs are being met.

An integrated approach presupposes the linking together of various mathematical skills and strategies into meaningful activities and applications. Abstract concepts and ideas will take on new meaning and significance to students when applied to real life experiences. Organization of mathematics instruction into "themes" is intended to advance the notion of "holistic" learning, relative to both mathematics and the student. Discrete skill instruction must occur, but is de-emphasized through much of the program.

Although students are at various stages of cognitive development, most will continue to use concrete operational thinking. Students will depend on personal experience and personalized content to link ideas. As the process of analysis must be based on tangible experience, learning activities should begin at the concrete level. High emphasis should be placed on experiential learning involving manipulatives and hands-on activities. Specific skills and concepts should be developed after establishing a need for their use through instructional techniques involving three levels of cognition:

- concrete (e.g., use of models)
- transitional (e.g., pictorial representation)
- formal (e.g., symbolic representation).

Direct assistance must be provided to the learner in progressing from the concrete level of thinking to the more abstract thought processes. Appropriate strategies for providing this assistance have been included in this Program of Studies/Curriculum Guide and the *Teacher Resource Manual*.

Program development would not be complete without consideration of the context which a technological society sets for the application and use of skills learned in mathematics. Current and future demands of our rapidly changing society suggest that the mathematics program place increased emphasis on the:

- development of number sense and computational facility
- use of technologies such as the calculator and computer
- application of what is learned to a variety of situations within a changing society.

These goals provide the broader context for instruction in mathematics. Strategies that develop computational facility, promote the effective use of technology, and foster competence in problem solving have been provided throughout the program. Their use should become part of the teaching philosophy. The program must address the realities of a technological age in developing the concepts, skills and attitudes that students will use in everyday life and in the world of work. Community partnerships will provide opportunity for students to become involved in the community by way of meaningful activity linked to mathematics.

GOALS OF I.O.P. MATHEMATICS 8 AND 9

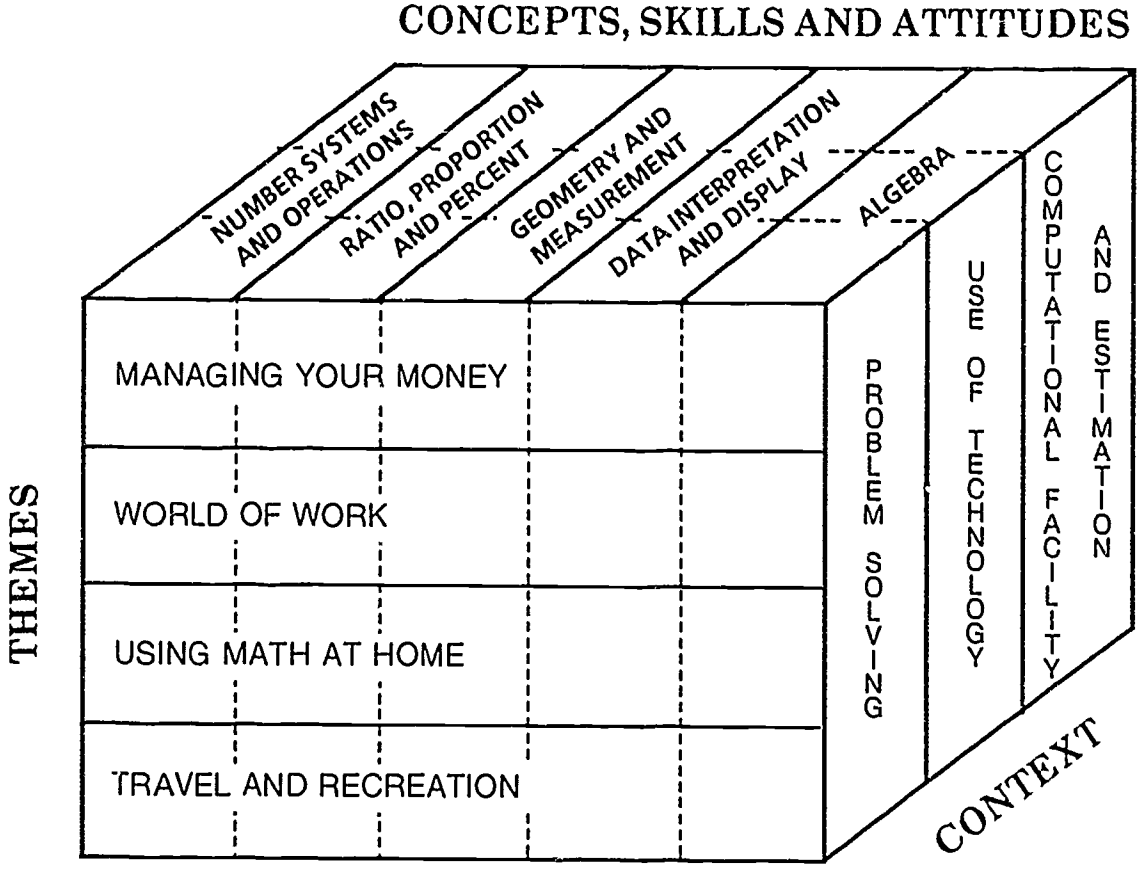
Within the Integrated Occupational Mathematics 8 and 9 program, students will be expected to.

- develop essential concepts, skills and attitudes of mathematics that are requisite to responsible participation in the home, the community and the workplace
- develop a positive self-concept and a positive attitude toward mathematics and lifelong learning
- apply mathematical concepts and skills to daily life and occupational situations that are experienced both within and outside the mathematics classroom
- develop critical and creative thinking skills, and apply these skills through a problem-solving process to a variety of real life situations
- develop the ability to use modern technology in its various forms
- develop reading skills and other forms of communication that are requisite to learning mathematics and solving practical problems.

MODEL FOR I.O.P. MATHEMATICS 8 AND 9

The model for the Integrated Occupational Mathematics 8 and 9 program illustrates an integration of program dimensions, thus emphasizing a "holistic" approach to instruction and learning. Three dimensions that provide a basis for program planning are represented on the cube

- Concepts, Skills and Attitudes
- Context for Instruction
- Themes



The themes have been deliberately placed on the "face" of the cube to highlight their importance in planning for relevant and meaningful learning experiences.

CONCEPTS, SKILLS AND ATTITUDES

Concepts, skills and attitudes reflect the content of I.O.P. Mathematics 8 and 9, and provide a structure to enable students to attain the desired mathematical learnings. Five major concept areas have been established on the basis of frequent task demands placed upon students in real life. These concept areas represent a consolidation of basic skills, and provide a foundation upon which more difficult concepts and skills may be built in the senior high school years.

This dimension of the program highlights the developmental nature of mathematical competencies, and promotes a diagnostic approach through the explicit identification and sequencing of prescribed skills. Skill deficits can be readily determined, and activities planned that will enable individual students to progress from their current level of operation to the next level of functioning.

Although it is essential that the program deliver the concepts, skills and attitudes that have been identified, it must be remembered they are not, in themselves, the ends of the program They are, rather, a type of "road map", providing guidance and direction in planning thematic instructional activities that will provide students with the knowledge and strategies required for responsible participation in everyday life.

Concepts, skills and attitudes are dealt with in further detail in the "Statement of Content" section of this guide.

CONTEXT FOR INSTRUCTION

The dimension of the model highlighting context provides for an element in teaching and learning that transcends and permeates all that is done within the concept areas and themes. The context for instruction is intended to foster positive attitudes, build appropriate mind sets, and develop strategies that will enable students to interpret and process information in their environment relative to the demands of everyday life.

The strategies that one deploys to interpret and process information are useful in life because of their generality and applicability to many problem-solving situations. However, students may not spontaneously generate such learning strategies for their own use. Research strongly supports the teaching practice of modelling appropriate strategies, discussing those strategies the student presently uses, and encouraging students to develop additional strategies. These techniques are beneficial as students may remember and utilize teacher taught strategies more often than those acquired incidentally

...e number of "tools" available to students for performing basic computational procedures has increased significantly in recent years. Students need to develop strategies for the use of all methods of computation (paper-and-pencil, mental arithmetic, estimation, calculator) and even more important, to discern when each method is most appropriately used. The program must recognize the pervasiveness of technology by de-emphasizing activities that are much more easily replicated by calculators, computers and, in the future, by as yet unknown technologies. Of greatest need, however, is provision of an atmosphere and structure that nurtures the learner's ability to use past experience and skill in new and perplexing problem situations. Because of the rapid pace at which change occurs in today's home and work environments, learning activities must provide for adaptation to change through a problem-solving context.

It is intended that all themes foster the development of strategic behaviours as they relate to computational facility, the use of technology and skill in problem solving. These topics are dealt with in further detail in following sections of this guide.

THEMES

Themes provide the setting in which discrete skills and strategies are linked together into meaningful activities. Such activities direct attention and inquiry to a particular topic or concern, and provide students with the experiences necessary for successful functioning at home, at school, in the workplace, and in the community.

Using themes facilitates the acquisition of skills in a way quite different from the "skills-based" approach favoured by many conventional curricula. For example, a skills-based unit on "Decimals" may focus instruction entirely on a particular set of skills within one concept area (e.g., operations with decimals). In contrast, a thematic unit on "Travel and Recreation" will include the use of skills from a variety of concept areas (e.g., decimals, linear measurement, ratio).

The thematic approach provides for the natural integration of a variety of skills, and allows the student to solve problems and make decisions that relate to real issues affecting their lives. A well-constructed theme also allows for activities in all levels of thinking (i.e., recall, application, analysis, synthesis, and evaluation). Other advantages of thematic planning and organization of content include:

- provision for cumulative development of background knowledge and skill, enabling students to relate and transfer learnings from one day to the next
- opportunity to remediate/reinforce skills already taught in new situations, thus avoiding repetitious drill and promoting transfer of the skill to many areas
- flexibility in responding to student interests and needs. Learning will be facilitated when students see activities as being worthwhile and meaningful
- opportunity to use a wide variety of activities, media and resources
- opportunity to develop strategies and skills in problem solving and decision making through investigations that reflect real issues and problems present in the local community.

While the thematic approach is clearly advocated in I.O.P. Mathematics 8 and 9, this is not to say that skills-based lessons or units are always inappropriate. Although thematic units provide an organizational structure for the content, sometimes specific skills may be taught equally effectively, or even more effectively, in discrete lessons. For example, while the need for instruction in division by two-digit divisors may be identified through a student's attempts to solve a thematic problem, specific strategies and skills necessary to remediate this problem may be taught as a discrete skill unit. In addition, while the need to make good estimates may become obvious as students engage in a variety of computations within each theme, instruction and practice in this skill might be provided through a separate sub-unit that focuses entirely on developing strategies that will assist students in making estimates. Teachers are encouraged to intervene in this way and to determine which skills should be removed from the thematic context and taught or reinforced in a more focused manner.

Four themes at each grade level have been developed that assure coverage of the required concepts, skills and attitudes. At the local level, teachers are encouraged to develop additional themes that will address the needs of students who require or have interest in specific mathematical competencies.

INTERPERSONAL SKILLS AND THE SOCIAL SPHERE

Junior high school students are in a transitional stage of life. Adolescence, which is characterized by rapid growth and the onset of puberty, is often a time of uncertainty and excessive concern about peer relationships. Responses in early adolescence may appear to be volatile and inconsistent, as students are developing the ability to reflect upon and analyze their emotions. Students at this age are practising to be adults.

Although schools are not the sole influences on the student's emotional, social and moral development, the instructional program does affect interpersonal learning.

The Goals of Secondary Education directly state the importance of affective, interpersonal and moral goals when they indicate that students should:

- learn about themselves and develop positive, realistic self-images
- develop constructive relationships with others based on respect, trust, cooperation, consideration and caring as one aspect of moral and ethical behaviour.

Students will vary in their emotional/social development and their ability to cope with personal problems. Behaviours viewed as "problematic" are often simply an indication of the adolescent's lack of sophistication in using adult skills. Classroom instruction must provide a variety of approaches that will encourage students to reflect upon their responses in social situations and to develop productive interpersonal skills. The guidelines which follow have been adapted from Alberta Education's monograph *Students' Interactions: The Social Sphere* (1988), and are intended to foster affective, interpersonal and moral learning within the classroom:

- Model appropriate behaviour for students. When teachers are polite and respectful of students' dignity, students will respond positively. Students imitate and thereby implicitly learn to deal with emotions, other people and moral issues by observing the consistency of adult behaviour.
- Encourage students to express their opinions and feelings, to ask questions and to accept emotions as they occur in day-to-day life. Through mediated learning, encourage students to examine emotional responses from different frames of reference, and to organize and interpret their own responses as well as the responses of others.
- Provide students with supportive comments, guidance and genuine expressions of concern. Set expectations that are firm and fair, and then believe in the students' ability to meet these expectations and do well. Develop "working agreements" to help tasks flow smoothly, and to ensure that students understand the nature of the instructional tasks they are asked to perform.
- Ensure that classroom management practices and rules are known, upheld, moderate in nature, negotiable, and consistently applied. Responding to the harmful or unjust effects/consequences of a moral transgression is more effective than reference to broken rules or unfulfilled social conventions.
- Recognize that experiential learning is a particularly effective vehicle for teaching interpersonal skills. Although some learning may occur through listening and reading, one best learns to live with other people by living with other people. Cooperative learning techniques are especially useful where students are actively involved in lessons linked to their own needs, interests or experiences.

- Be aware that although adolescents deal with a number of issues, they usually cope by managing one problem/issue in their lives at a time. Help students to integrate various aspects of their lives by encouraging them to recognize how various problems/issues/solutions are often interrelated.

- Assist students to learn skills that are more appropriate in differing contexts. Although some students are described as "lacking in social skills", socially maladapted students do not necessarily lack "either skills" or social involvement; rather, they use inappropriate skills in particular contexts. When directly teaching interpersonal skills, be as concrete as possible, and "build bridges" by linking situations with appropriate actions and behaviours.

- Assist students to focus on the need for a system of shared conventions. As students affirm the social system of conventions, they will view conventions more positively and will become less disruptive in their behaviour.

- Encourage students to interpret and evaluate the competing moral issues presented to them. Provide opportunities for open discussion and debate, where students interact with their peers. Discuss issues that are "real" to the student.

- Provide students with practical strategies for resolving interpersonal conflict. A framework for social problem solving is provided in the *Teacher Resource Manual*. This framework uses a problem-solving approach in helping students to identify:
  - reasons for the difficulty
  - strategies to avoid the conflict another time.

Student development in the affective, interpersonal and moral domains has been addressed in this curriculum through attitudinal learning objectives that accompany each cluster of concepts and skills in the program of studies. Instruction must include a balance of approaches appropriate to student development in each domain, as delivery of isolated content will not ensure the formation of desired attitudes. The *Teacher Resource Manual* provides additional strategies that facilitate attitudinal development within the context of themes suggested in the program.

PROBLEM SOLVING

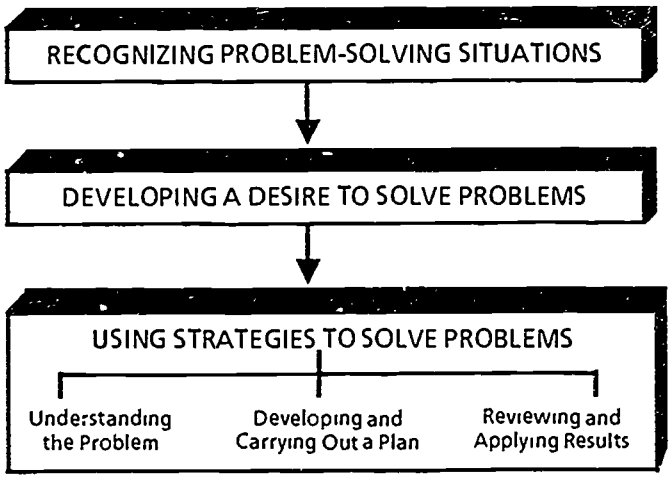
Learning to solve problems is probably the most important aspect of the mathematics program. Today's rapidly changing technological society demands that students are able to apply the mathematical skills learned to new and unfamiliar problem situations in life. Practice in finding answers to routine word problems in mathematics will not provide students with the problem-solving skills they require. Instead, strategies for solving problems must be acquired that foster the development of critical and creative thinking skills. Students must then be given ample opportunity to apply the strategies and skills acquired to a wide variety of problem situations in everyday life.

Problem solving should not be viewed as an isolated activity. Strategies and attitudes appropriate to problem solving must be integrated and applied throughout all themes and concept areas of the curriculum. The skills, strategies and attitudes required for problem solving should become part of the teaching philosophy. While a detailed framework for problem solving is outlined on the following pages, additional information can be obtained by referring to Alberta Education's monograph *Problem-Solving Challenge for Mathematics* (1985) and *Problem Solving in Mathematics. Focus for the Future* (1987). Classroom strategies and activities that may contribute to an understanding of the problem-solving process are provided in the *Teacher Resource Manual*

A FRAMEWORK FOR PROBLEM SOLVING

Critical to the development of thinking and problem-solving skills is the attitude with which students approach the task. A positive, open-minded approach is needed for thinking skills to develop. Attitudes cannot simply be taught, however. Their development must be nurtured through an atmosphere that fosters flexibility and acceptance. Students must be encouraged to take risks in the development of particular problem-solving strategies. Student understanding of problem situations and the problem-solving process should be made a priority through consideration of the context within which discussion and activity will take place. Problem situations should be selected from those that are within the range of student experience, interest and need.

The recommended framework for problem solving diagrammed below has been adapted from Alberta Education's *Junior High Mathematics Teacher Resource Manual* (1988). It provides an overall structure within which attitudes, mind sets and strategies can be modelled and developed



RECOGNIZING PROBLEM-SOLVING SITUATIONS

Problem solving must be viewed as encompassing more than finding answers to routine word problems. Students must realize that problem solving may involve applying one's knowledge, skill and experience in new and challenging situations. Problems may relate to situations where:

- no readily apparent solution or means to the solution is evident
- a person can be temporarily perplexed
- there may be no answer, a single answer, or many answers
- personal and societal factors are involved, as well as mathematical competencies.

Students should recognize situations at home, at school, in the workplace, and in the community that reflect these aspects of problem solving.

DEVELOPING A DESIRE TO SOLVE PROBLEMS

Although problems presented to students should be challenging, the solutions must be attainable to ensure that the learner experiences success. Students must learn to accept and appreciate that being perplexed and unsure is often normal when first encountering a challenging situation. The following strategies are useful in developing in students a positive attitude and desire to solve problems.

- Create a positive classroom atmosphere that allows students to foster their own ideas and approaches to problem solving.
- Be supportive and encourage risk taking in finding solutions.
- Encourage students to use creative approaches.
- Be willing to accept unconventional solutions, more than one solution, or no solution, where appropriate.
- Challenge students to think critically and justify strategies and solutions.
- Be enthusiastic and capable of recognizing the students' desire and perseverance to solve problems.
- Provide appropriate questions and modelling for students.
- Present problem situations that enable students to gain problem-solving experience that is transferable to other subject areas and everyday life.

USING STRATEGIES TO SOLVE PROBLEMS

Student performance in problem solving can be enhanced by making students conscious of their thought process (i.e., metacognitive awareness). They need to be aware of and discuss how they think in order to become more strategic in their learning repertoires, and to monitor their problem-solving efforts (e.g., checking their answers when in doubt). The teacher can foster this by thinking out loud as he or she solves problems, by asking questions, and by having students identify the strategies and processes used when solving problems. Consistent modelling by the teacher of a mind set to the stages and strategies outlined will provide a structure within which student problem-solving skills can develop

Questioning and modelling techniques that might be used to facilitate metacognitive awareness, thus helping the student to develop a repertoire of effective problem-solving strategies are provided in a following section of this document (see "Instructional Mediation").

UNDERSTANDING THE PROBLEM

During this stage of the problem-solving process, students must be encouraged to think about the problem before attempting a solution. The teacher can assist students to focus their attention on information and conditions set in the problem by asking appropriate chains of questions. Model and explicitly teach strategies that may be used by students in developing an understanding of a problem situation

Students will develop problem-solving strategies that include:

- reading the problem several times
- asking questions
- identifying key words and their meanings
- looking for patterns
- identifying wanted, given, and needed information
- identifying extraneous information
- internalizing the problem by restating in one's own words or by visualizing the problem
- drawing pictures/diagrams
- using concrete manipulatives
- interpreting pictures/charts/graphs
- relating the problem to other problems previously encountered
- simulating or modelling the problem situation.

Additional teaching strategies that may be useful in coaching students to read and interpret word problems are provided in a following section of this document (see "Use of Language in Mathematics").

DEVELOPING AND CARRYING OUT A PLAN

In this stage, students should plan strategies for solving the problem and then use these strategies to actually solve the problem. Students may lack the "strategic repertoire" required to develop a problem-solving plan. The explicit teaching of various strategies appropriate to specific problem situations may be necessary. Emphasize that there are often strategies other than computation that can be used effectively to solve the problem. Once appropriate strategies have been planned, the student simply "carries out the plan" to arrive at a solution.

Students will develop problem-solving strategies that include:

- guessing and checking the result (thus improving the guess)
- using logic or reason
- choosing and sequencing the operations needed
- sorting and classifying information
- applying selected strategies
- presenting ideas clearly
- selecting appropriate calculating/measuring devices and methods
- acting out or simulating the problem
- applying patterns
- estimating the answer
- documenting the process used
- working with care
- working in a group situation where ideas are shared
- visualizing the problem
- speaking to self with positive statements (e.g., "I can solve this")
- using a simpler problem (making an analogy)
- identifying factors relevant to the problem
- collecting and organizing data into diagrams, number lines, charts, tables, pictures, graphs or models
- experimenting through the use of manipulatives
- breaking the problem down into smaller parts.

REVIEWING AND APPLYING RESULTS

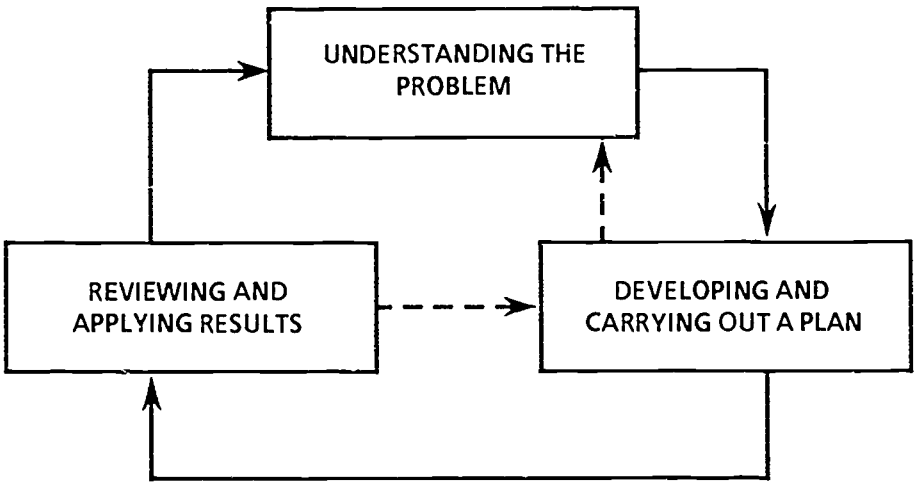
This stage encourages students to assess the effectiveness of their solution, and to consider the accuracy of their results. Students should be encouraged to relate answers to the question in the problem in order to verify that the problem has indeed been solved. Evaluation of the strategies used will increase awareness of their appropriateness and of other strategies that might have been used. Through discussion and reflection, encourage students to generalize and apply the strategies used to related situations.

Students will develop problem-solving strategies that include:

- stating an answer to the problem
- restating the problem with the answer
- explaining the answer in oral/written form
- determining if the answer is reasonable
- discussing the process used with others
- suggesting other ways of solving the problem
- checking the answer
- considering the possibility of other answers/solutions
- making and solving similar problems.

USING THE PROBLEM-SOLVING FRAMEWORK

The problem-solving framework outlined should not be interpreted as a model consisting of fixed and rigid stages and strategies. Its use will depend on individual problems and individual students. Students may not always use each stage of the problem-solving process, and will select only those strategies that are appropriate to the problem. Students should recognize problem solving, however, as a series of interrelated actions that lead to a solution.



The following guidelines may be of assistance in planning effective problem-solving activities.

- Share the problem-solving framework and strategies with all students. The model provides structure to the overall process, as well as specific strategies that might be used at each stage of the process. This will increase the students' strategic repertoire.

- Keep the framework and strategies for problem solving flexible and tentative. While useful in the support and structure they provide, students should be encouraged to be creative and experimental in their approach to problem solving.

- Select problem-solving activities that emerge from real life situations. Ensure that problems are relevant to student interest and experience, and that cognitive demands of the problem match developmental levels of the student.

- Modify and vary the approach used so as to ensure interest, participation, and some degree of success by all students. Most students have an inherent desire to undertake the challenge provided by a problem.

USE OF TECHNOLOGY

THE CALCULATOR

As the calculator has become an integral part of our way of life, students must become proficient and discerning in its use. All students should have calculators readily available for use throughout the program.

Effective use of the calculator requires an understanding of place value and the ability to judge the reasonableness of the results of calculations. Skills in estimation and mental arithmetic become increasingly important in enabling the student to anticipate and verify calculator results. Such experiences will be more effective in developing number sense and cognitive process than long and tedious computations with paper and pencil.

Some major benefits to the teaching and learning process that result from regular classroom use of the calculator are provided below.

- Calculator use decreases the time spent on tedious computation, thus allowing for an increase in emphasis and time spent on cognitive process and problem solving.
- Use of the calculator facilitates understanding of number patterns and concepts.
- Competence in mental arithmetic and estimation will improve through the frequent use of these skills in anticipating and verifying results obtained on the calculator.
- The calculator will provide the slower student with the assistance needed to complete certain tasks within the allotted time.
- Student levels of self-confidence, interest, motivation, and achievement can be expected to increase.

As with any technology, misuse of the calculator can create other problems. The guidelines that follow are intended to provide a classroom structure in which calculators can be used as valuable instructional and computational tools.

- The calculator does not reduce the need for basic arithmetic skills. Effective use of the calculator requires that instruction emphasizes an understanding of place value, number facts, and arithmetical operations.
- There will always be a need to possess limited paper-and-pencil computational skills. For most students, the calculator should be used after the mathematical concepts and algorithms are understood. Students who simply cannot master their basic facts or who have persistent problems with the skills of computation should use calculators more extensively.
- The calculator should always be used in situations where long and/or extended computations are required.

- Emphasis should be placed on estimation and mental arithmetic, on proper documentation of numbers and operations used, and on the reasonableness of answers when using the calculator in problem situations.

- Do not assume that students understand how to use a calculator. Be prepared to teach students how and when to use a calculator properly. Remember, however, that creating a situation just for the sake of using calculators will not develop understanding of their appropriate use.

THE COMPUTER

Due to the present development of microtechnology and the availability of low cost and effective microcomputers, computer technology is affecting everyone's life. The traditional meaning of the word "literacy" has taken on a new dimension. To be literate in our changing society, students need not only the ability to communicate through the written word, but also the skills of interacting with machine technology (i.e., the hand-held calculator and the microcomputer).

The knowledge, skills and attitudes required to be computer literate will vary according to student maturation and ability. Nevertheless, the Mathematics 8 and 9 program should provide opportunity for students to:

- describe the basic operation of a computer
  - identify major parts of a computer
  - distinguish between hardware and software
  - recognize that computers get their instructions from a program written by a person

- use a computer
  - use a prepared program on a computer
  - show respect and responsibility for hardware and software.

Classroom use of the computer provides opportunity for concepts to be presented visually through the use of graphics that can be manipulated according to input supplied by the learner. To the extent that facilities and equipment are available, students should be given opportunity to work independently with prepared software, and to use simple programs that have been written for particular purposes. These experiences will support concept and skill development, while at the same time enabling students to gain first-hand knowledge of how one interacts with a computer as well as becoming aware of its versatility and limitations.

The selection of computer software and programs should be determined by their value in:

- contributing to concept formation
- providing for drill and practice
- developing problem-solving skills.

Software supporting curriculum objectives has been identified (see "Learning Resources for I.O.P. Mathematics 8 and 9"). The *Teacher Resource Manual* provides suggestions on how these programs, as well as other computer-oriented activities, might be used in regular classroom instruction.

COMPUTATIONAL FACILITY AND ESTIMATION

Technology has caused emphasis in the skills required for computational competence to change over the last decade. Computational facility includes more than the knowledge and skills required to perform paper-and-pencil computation with standard algorithms. While these skills are important, responsible participation at home and work also requires facility in performing mental arithmetic, in the application of calculator skills, and in applying strategies of estimation. Surveys show that mental computation and estimation are used in more than 80 percent of all real life problem-solving situations outside the classroom. As important as each method of computation is in itself, even more important is the understanding of when each strategy is most appropriately used. Teaching should foster development of a mind set to the application of appropriate computational strategies in everyday problem-solving situations.

A brief description of each method of computation is provided below. Activities intended to develop student ability to compute with each method are provided in the "Program of Studies/Presentation of Content" section of this document, as well as in the *Teacher Resource Manual*.

PAPER-AND-PENCIL COMPUTATION

Instruction in paper-and-pencil computation should emphasize place value, basic facts, and the understanding of concepts prior to application of algorithms. Concrete and visual material will assist in concept development. Students who have not experienced past success with standard algorithmic procedures may react more favourably and experience more success with less sophisticated forms of algorithms.

Paper-and-pencil computation should emphasize the understanding of process and de-emphasize calculation with large numbers. Addition and subtraction should generally include numbers with no more than three digits. Multiplication and division should be performed on numbers containing up to three digits, using multipliers/divisors of no more than two digits.

MENTAL ARITHMETIC

The ability to perform mental computations is frequently required of students in a variety of situations. In addition to providing a fast solution to many everyday problems, this skill facilitates the ability to estimate and approximate. Experience with mental computation fosters the development of number sense and enables students to gain confidence in their ability to compute answers.

Activities in this area should encourage knowledge and recall of basic facts, as well as motivate students in the application of these facts to more sophisticated processes. Teachers are encouraged to identify mental arithmetic strategies that are most appropriate for their students and to schedule a period of time each week in which these skills can be taught and practised. Short drill and practice activities that become part of the daily routine will promote the development of mental arithmetic skills and foster a habit for their use. Ensure that competition in these activities is with self rather than others in order to avoid humiliation of those who find mental arithmetic difficult. Encourage students to share the personal strategies in mental arithmetic that they find useful with other members of the class.

CALCULATOR SKILLS

Use of the calculator enables students to investigate, see patterns and relationships, and solve problems that require higher levels of thought more readily. Many mathematical problems that would otherwise involve long and unmanageable calculations can be investigated with the calculator.

The calculator does not reduce the need for mastery of basic facts and processes. Students must recognize incorrect answers obtained on the calculator that result from incorrect numbers being entered or operations entered in the wrong sequence. In order to distinguish a reasonable answer from an unreasonable one, students need to know how to compute using basic facts and the four operations. A knowledge of basic computational procedures is essential to the effective use of the calculator.

Guidelines that foster the development of calculator skills are provided in the preceding section of this document (see "Use of Technology").

ESTIMATION

Skill in estimation is necessary for effective problem solving and calculator use. Students need to be able to determine if a particular result is precise enough for the purpose at hand, and be alert to the reasonableness of computational results. More often than not, problems in real life situations involve estimations rather than exact numbers. Estimation, not computation, gives answers to everyday questions like "Do I have enough cash to buy groceries?" and "How many hot dogs should I order for the party?"

Thinking skills and problem solving assume an important role in developing estimation skills. It should be recognized that the process of estimation:

- is performed mentally, usually without paper and pencil
- is done quickly
- produces answers that are not exact, but adequate for making necessary decisions
- reflects individual strategies and produces a variety of estimates as answers.

In order to be able to carry out rapid estimations, students must understand place value, have skill in single digit operations, be able to multiply and divide by powers of ten, and have facility in rounding whole numbers and decimals to the number of significant digits required by the situation. Instruction should focus on the development of specific estimation strategies, and should utilize the spiral approach to ensure that students can apply strategies developed to whole numbers, decimals, fractions, and percentages. Testing and evaluation must include assessment of the student's ability to estimate in a variety of practical situations.

REQUIRED AND ELECTIVE COMPONENTS

The required component of the Integrated Occupational Mathematics 8 and 9 program reflects the concepts, skills and attitudes that all students must acquire. These skills are generic in nature because of their broad application to other disciplines and to real life situations. The Program of Studies outlines the required component of the program.

In keeping with the philosophy that concepts, skills and attitudes are best taught in context, they have been embedded in four themes:

- Managing Your Money
- World of Work
- Using Math at Home
- Travel and Recreation.

Study of the topics outlined in these themes at each grade level will ensure coverage of the required component.

The elective component of I.O.P. Mathematics 8 and 9 permits the teacher to:

- remediate or reinforce skills from the required component that appear to be weak. Direct teaching of these skills may be appropriate if the "skills in context" approach has not been effective with certain students.
- extend or enrich the program by way of introducing additional concepts and skills considered appropriate to student interest and need.

Student interests and needs will largely determine how the elective time will be addressed Opportunities exist for experimenting with varying organizational and instructional strategies that facilitate learning and are appropriate to students' developmental stages and learning styles.

The instructional time for I.O.P. Mathematics 8 and 9 should be apportioned:

- 80% Required
- 20% Elective.

OVERVIEW OF THEMES COVERING THE REQUIRED COMPONENT

The required concepts, skills and attitudes described in the Program of Studies have been integrated into thematic units of instruction provided in the *Teacher Resource Manual*. Although study of each theme involves the use of skills from all major concept areas, emphasis may not always be equal among the concept areas used. The matrix indicates the concept areas emphasized within each theme.

	Number Systems and Operations	Ratio Proportion and Percent	Geometry and Measurement	Data Interpretation and Display	Algebra
MANAGING YOUR MONEY	X	X		X	X
WORLD OF WORK	X	X	X	X	X
USING MATH AT HOME	X		X	X	X
TRAVEL AND RECREATION	X	X	X	X	X

Topics included within each theme at the Grade 8 level will form a basis for more advanced investigations occurring at the Grade 9 level. Emphasis has been placed on student interest/need and cognitive development in sequencing thematic content throughout the two years of the program.

SUGGESTIONS FOR THE ELECTIVE COMPONENT

Several factors should be considered in choosing content for the elective component.

- curriculum objectives (adequacy in covering basic skills)
- student ability/interest/needs
- availability of suitable learning resources.

For some students, the elective component may be used to provide additional instructional time (extension and remediation) for study of the four themes that support the required portion of the program. In other instances, however, teachers may wish to develop enrichment themes using the elective component of the program. Themes of this nature might relate to:

- mathematical competencies required in another subject area (e.g., a practical arts course, science, social studies)
- a life experience or student interest topic
- a mathematical skills unit.

PLANNING

GENERAL COURSE PLANNING

Themes and their subsequent concepts, skills and attitudes may be sequenced at the teacher's discretion. Program planning should take into consideration the sequential and developmental nature of skills in mathematics as well as student interest, ability, and learning style. Four themes that cover the required components of the course have been provided in the *Teacher Resource Manual*. However, teachers may choose to replace these with other locally developed material in addressing individual student needs.

Through cooperative conferencing, teachers may find that students are required to use certain mathematics-related competencies in other courses before they are learned in mathematics class. Joint planning and negotiation with teachers of other courses will be required in establishing an integrated program that places consistent expectations upon the student. (For example, students may benefit from study of the theme "World of Work" early in the program as this theme addresses the skills frequently demanded of students in their practical arts courses.)

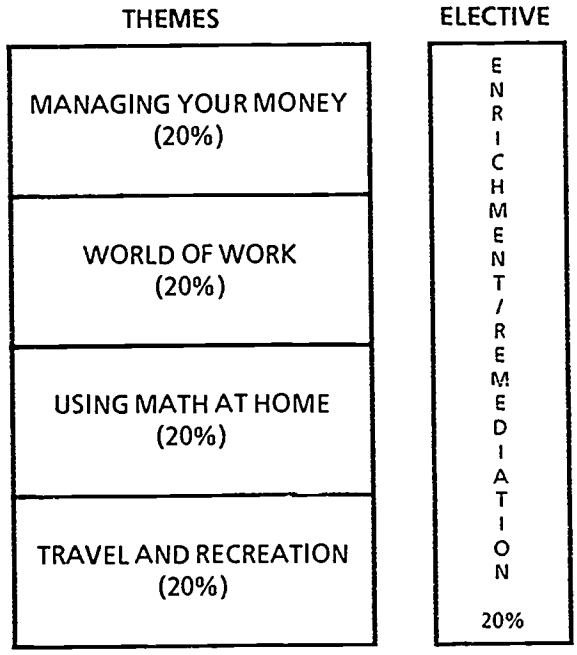
Program planning should emphasize the use of appropriate strategies for problem solving, as well as the development of computational facility and estimation skills. An understanding and appreciation of the "tools" of technology (e.g., the calculator and computer) should be developed through first-hand interaction with these technologies. The strategies and activities suggested throughout both the Program of Studies/Curriculum Guide and *Teacher Resource Manual* are numerous, but by no means exhaustive. Teacher use of these ideas will depend upon their appropriateness in meeting individual student's needs. Be prepared to add, delete, and modify activities in adapting a theme to the particular circumstances of the classroom and student.

TIME ALLOCATION

The Integrated Occupational Mathematics 8 and 9 program must be offered through a minimum of 100 hours of instruction at each grade level. In meeting student needs, however, schools may find it desirable to offer the course through a time structure that exceeds the 100 hour minimum requirement.

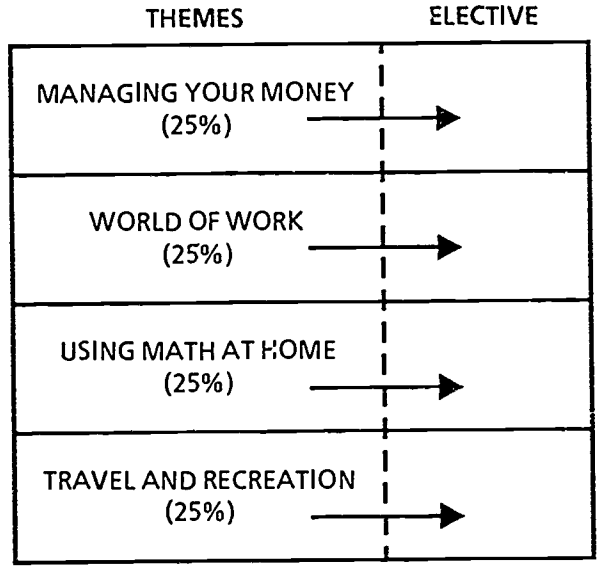
Minimum time allocations are recommended for the delivery of themes in the *Teacher Resource Manual*. These recommendations are intended to ensure that key concepts, skills, and processes outlined in the Program of Studies are adequately addressed within each theme.

Managing Your Money	20%
World of Work	20%
Using Math at Home	20%
Travel and Recreation	20%
Required Time	80%
Elective Time	20%
Total	100%



The elective component enables the teacher to spend 20% of the available instructional time on remediation and reinforcement (e.g., allowing students more time to meet learning expectations within the required component of the program), or on extension and enrichment (e.g., study of additional concepts/skills, introduction of a new topic). If student needs suggest that the elective component be used to enhance the learning process within the required component, time allocations for each theme might be increased to those indicated below.

Managing Your Money	25%
World of Work	25%
Using Math at Home	25%
Travel and Recreation	25%
Total	100%



Teachers may find it desirable to plan programs using time allocations that fall between those described in the two alternatives.

COMMUNITY PARTNERSHIPS

The concept of community partnerships is integral to all courses within the Integrated Occupational Program. Guest speakers, field trips, job "shadowing" and mentorship are but a few examples of inviting members of your community into the class, or having students involved in the community by way of meaningful activity linked to mathematics.

Suggestions for relevant community partnerships in the mathematics program might include.

- inviting guest speakers from local government, business and industry to discuss topics related to those studied in thematic investigations
- visits to local business, industry, and recreational facilities for first-hand observation and real life experience in areas related to the themes studied
- a walk into the community in search of applications made of the concepts and skills being studied (e.g., advertising billboards, information/direction signs, tools/units of measure, presence of geometric form)
- visiting the local TV station or newspaper plant in order to gather information related to mathematics and the media
- the investigation of career and employment opportunities in areas that require specific mathematical competencies (e.g., job shadowing, mock employment interviews).

Community agencies/groups/individuals that may provide meaningful contributions to the mathematics program include:

- businesses involved in retail sales and the promotion of consumer products/services (supermarket, drug store, department store, hardware store, sporting goods shop, fitness club, travel agency)
- financial institutions (banks, credit unions)
- individuals with knowledge and expertise in the field of sports and recreation
- government agencies (Consumer and Corporate Affairs, Labour and Employment Standards, Career Development and Employment)
- businesses and industries offering potential career opportunities (construction, decorating and repair service, retail sales and marketing, food production and service).

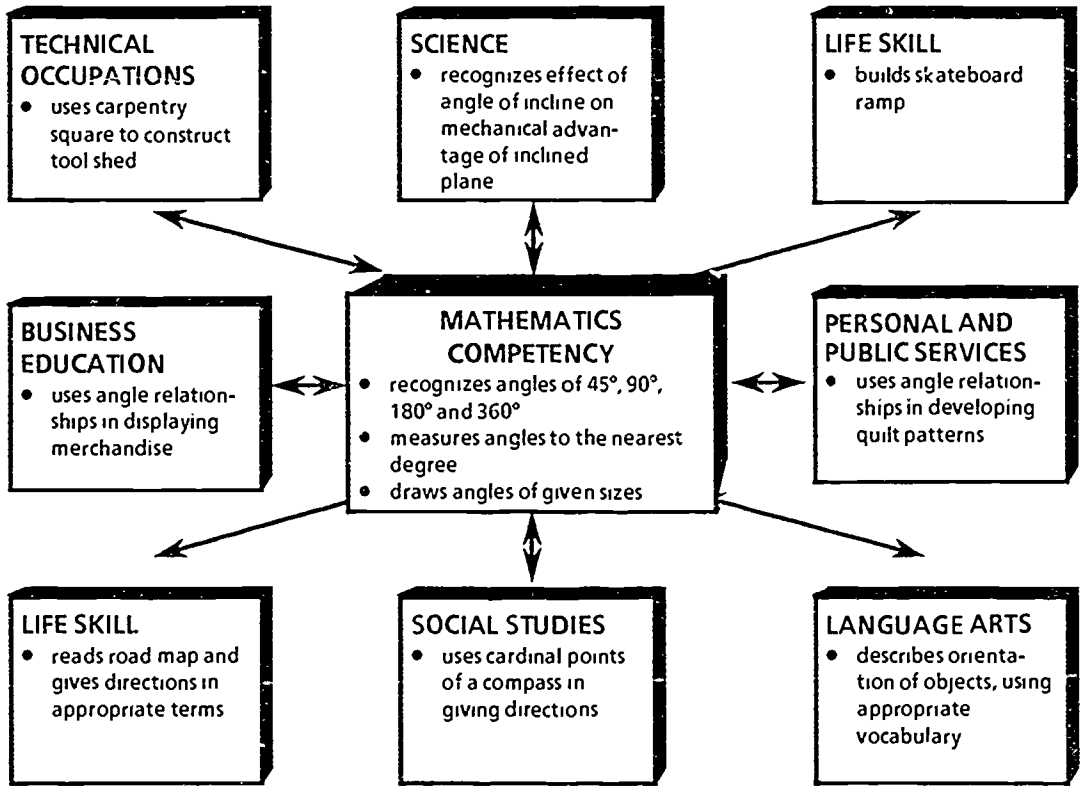
Additional suggestions for community partnerships are provided within the themes outlined in the *Teacher Resource Manual*. Activities have been selected on the basis of their value in furthering the objectives of each theme, as well as in reducing classroom barriers to real life experience.

CURRICULAR INTEGRATION

Emphasis has been placed on relating mathematical competencies to life skills and other applications across the curriculum. Curricular integration will become a motivating factor as students see the relevance of skills and concepts studied to real life situations. Student ability to transfer knowledge, skill and process to new and unfamiliar problem situations will improve as a result of multiple exposures to their application.

Instructional strategies should provide for the development of processes and skills within the context of their application to real life, the practical arts and other academic disciplines. Teachers must be familiar with the mathematical competencies required of students in these areas. Experience indicates that cooperative conferencing and planning among teachers will foster this familiarity and ensure consistency in expectations and learning outcomes. Heightened sensitivity to content of other subject areas will facilitate identification of generic skills and concepts required by students. Identification of generic skills will provide direction for program emphasis. Curricular integration of this nature increases opportunity for the provision of concrete and experiential learning activities.

The diagram below describes the curricular integration outlined. It illustrates possible outcomes of cooperative planning in respect to angle measure. While in this instance application is shown in all subject areas, some skills may have a more limited base for application.



Angle concepts, relationships and measurement are developed in mathematics and related to their applications in other areas. Subject areas across the curriculum will maintain and reinforce specific concepts and skills related to angles while they are being used within each discipline.

PLANNING AN INTEGRATED UNIT OF INSTRUCTION

A variety of factors need to be considered when expanding upon an existing theme or developing a new thematic unit. The guidelines that follow provide structure and direction for developing units of instruction.

1. Identify a possible theme, based on:
   - curriculum objectives (adequacy in covering basic skills)
   - student needs/interests/abilities
   - availability of suitable learning resources.

2. Develop a purpose for the theme. Include:
   - thematic objectives
   - a checklist of concepts, skills and attitudes that lend themselves to the theme. Identify those skills that may need some focused/direct teaching
   - a checklist of process objectives.

3. Consider suitable resources:
   - books, pamphlets, monographs
   - computer software and other technology
   - resources from the occupational program
   - community contacts
   - newspaper and magazine articles.

4. Design activities:
   - allocate activities to the purposes developed in STEP 2
   - break activities into lessons with general objectives
   - sequence the lessons.

5. Develop ongoing strategies to build community partnerships into your theme:
   - field trips
   - guest speakers.

6. Plan for evaluation:
   - student evaluation
   - teacher's ongoing and summative evaluation.

7. Share the unit:
   - other teachers need access to good work!
   - expand, keep current, re-work the unit every time it is used by any teacher
   - as others experiment and your unit enlarges, develop a mechanism for evaluating all the activities with different classes of students.

LEARNING RESOURCES FOR I.O.P. MATHEMATICS 8 AND 9

STUDENT RESOURCES

BASIC LEARNING RESOURCES

The textbooks listed below meet the majority of the goals and objectives identified in this curriculum (authorization pending).

Pogue, Paul, et al. *Mathbase I: Essential Math Skills* (second edition). Toronto, Ontario: Copp Clark Pitman, 1989.

Pogue, Paul, et al. *Mathbase II: Practical Skills and Applications* (second edition). Toronto, Ontario: Copp Clark Pitman, publication anticipated in 1990.

Mathbase I: Essential Math Skills provides for the focussed development of concepts and skills identified in the Grade 8 and Grade 9 Program of Studies. *Mathbase II: Practical Skills and Applications* will provide for thematic application of the prescribed concepts and skills in Grades 8 and 9. It is intended that appropriate sections of both *Mathbase I* and *Mathbase II* be used throughout the Grade 8 and Grade 9 programs. *Mathbase II* is scheduled for publication in the early spring of 1990.

TEACHER RESOURCES

RECOMMENDED LEARNING RESOURCES

Teacher manuals designed to support instructional use of the basic learning resources include.

Pogue, Paul, et al. *Mathbase I: Essential Math Skills, Teacher's Edition* (second edition). Toronto, Ontario: Copp Clark Pitman, publication anticipated January, 1990.

Pogue, Paul, et al. *Mathbase II. Practical Skills and Applications, Teacher's Edition* (second edition). Toronto, Ontario: Copp Clark Pitman, publication anticipated in 1990.

The *Teacher Resource Manual* (1989) for I.O.P. Mathematics 8 and 9 developed by Alberta Education contains strategies and sample student activities intended to structure and support.

- development of the concepts, skills and attitudes as outlined in the Program of Studies
- development of the processing strategies used in computation and problem solving
- delivery of thematic instruction in the four theme areas described as covering the required components of the program.

TECHNOLOGY AND MEDIA

COMPUTER COURSEWARE

The subsequent learning resources have been approved by Alberta Education because they contribute significantly to the development of specific goals and objectives within this curriculum.

Title: *Fast Facts*
By: EduSoft, Berkeley, California, 1985
Components: 1 disk, guide (2 pp.)
Objectives: To provide timed drills on whole number facts.

Title: *Math Strategies: Problem Solving*
By: Science Research Associated (Canada) Ltd., Willowdale, Ontario, 1985
Components: 2 disks, teacher's guide (28 pp.), 20 student texts (108 pp.)
Objectives: To provide instruction and practice in solving multiple-step problems using four problem-solving strategies: simplifying a problem, breaking a problem into parts, identifying needed additional information, and making a model of the problem.

An annotated list of additional courseware available in mathematics is provided in Alberta Education's catalogue of *Computer Courseware Evaluations* (Curriculum Support Branch, Student Programs and Evaluation Division, Alberta Education, 1986) and yearly supplements.

METHODOLOGY

OVERCOMING MATHEMATICS ANXIETY

Anxiety about mathematics may represent a major barrier to learning for many students. Previous experiences, perceptions of the value of mathematics, and the fear of being wrong or making a mistake are all factors which may cause the student to look upon mathematics class as a place where personal inabilities are exposed. To assist students in dealing with their anxieties, a supportive environment should be provided where meaningful learning activities ensure each student successful experiences. The program must be varied in materials, content and instructional method in order to meet individual student interests and abilities.

A supportive classroom environment which decreases anxiety levels may be fostered through use of the following strategies:

- Begin instruction well below the "frustration" level. Provision of "warm-up" activities enables the anxious learner to build on previous success. Instruction should begin at the student's current operational level, not the level at which it is considered the student should be working.

- Relate mathematical concepts and skills to the learner's own experiences. Make an effort to ensure that terminology commonly used is part of the student's working vocabulary. Focus attention on what the student considers interesting or important. Familiar problem situations will "make sense" to the student more readily than unfamiliar situations.

- Be patient, receptive and understanding. Avoid unnecessary tension in the classroom. Ensure that students recognize that making a mistake is acceptable, and that such occurrences provide valuable learning experiences. Urge students to ask questions, and to accept that "there is no such thing as a stupid question". Remember that an offhand remark about a problem being "easy" may be interpreted by the student as "if it's easy and I'm confused, then I must be stupid". Recognize and accept alternative solutions that students may devise.

- Provide abundant opportunity for learning at the concrete level. Tactile experiences with base-ten blocks, geoboards, fraction pieces and cuisenaire rods will assist concept formation and application to problem situations. Encourage students to verbalize and discuss relationships discovered. Assist students to translate relationships discovered in the concrete to the abstract symbols used in mathematics.

- Match the reading level of resources and materials used to that of the students. Steps should be taken to ensure that reading deficiencies do not prevent students from learning mathematics. Additional strategies are provided in a later section entitled "Use of Language in Learning Mathematics".

- Group for instruction through a variety of organizational patterns that will facilitate meeting the needs of individual students. Ensure that grouping patterns remain flexible, allowing student movement from group to group. Include some learning activities that involve the whole group, small groups, and one-to-one (teacher to student and/or student to student).

- Use a variety of assessment and evaluation strategies. While paper-and-pencil tests are an effective way of evaluating some learning outcomes, their use does not always enable students to demonstrate their strengths and provide for successful experiences. In such cases, provide students with opportunity for retesting if necessary. Effective evaluation should draw upon information gathered from a number of sources, including teacher observation, student demonstration and project work. Additional strategies for student evaluation are provided in a later section entitled "Evaluation".

- Recognize that while most anxiety symptoms are brought on by natural apprehension associated with new or challenging situations, there are other displays of anxiety that may well be related to deeper personal or social problems. Personal interviews with students may assist in identifying such instances, and may also establish a need for consultation (or referral) with counsellors who have expertise in dealing with such problems.

EXPERIENTIAL APPROACHES TO MATHEMATICS

Student learning styles and developmental levels suggest a multisensory approach to learning, involving real life situations that may be experienced or simulated by the student. Investigations should be chosen on the basis of their familiarity and relevance to the student. Understanding of abstract concepts can be best developed through a variety of tactile experiences involving manipulative and visual materials. An experiential approach of this nature suggests that instruction in mathematics include:

- active student involvement
- activities that involve the concrete, transitional and formal levels of cognition
- activities that address individual developmental levels
- deliberate observation and questioning that promote thinking.

Practical experiences and real life situations are emphasized throughout the "themes" provided in the *Teacher Resource Manual*. Each theme relates the concepts and skills being studied to practical situations that are familiar to the student. Activities are suggested that will assist students in simulating real life situations within the classroom. The "community partnership" suggestions provided in each theme will further assist teachers in decreasing classroom barriers to real life experience.

Suggestions regarding the use of manipulative and visual materials in developing abstract concepts and skills have been provided in both the Expanded Statement of Content and the *Teacher Resource Manual*. Every student should have direct access to the use of manipulatives while a new concept is being developed. Cautionary notes have been provided where it is anticipated there may be a lack of congruence between cognitive demands of the curriculum and the developmental level of students (e.g., fractions, ratio, percent, two- and three-dimensional geometry). In such instances, the use of manipulative materials will become increasingly important in providing students with meaningful learning experiences.

Manipulative activities suggested in the *Teacher Resource Manual* involve the use of:

- base ten blocks
- cash register tapes
- coloured chips
- cuisenaire rods
- dominoes
- fraction circles/wheels
- geoboards
- geometric solids
- grid paper
- LOGO software
- miras
- pentominoes
- popsicle sticks
- straws
- tangram pieces
- algebra tiles.

These materials need not be expensive, and in most instances can be improvised through the use of other materials that are readily available (e.g., blackline masters, strips of coloured paper, checkers, empty household containers).

Encourage students to observe, verbalize and discuss the relationships being investigated, and to eventually translate relationships into the abstract symbols of mathematics. While the purpose of manipulatives is to help students understand and remember, there comes a time when each student should become efficient in making application of concepts in their abstract form. It is important to stop using manipulatives when their purpose has been served, and before they interfere with further cognitive development.

USE OF LANGUAGE IN MATHEMATICS

The strands of language (listening, speaking, reading, writing, viewing) play an important part in the teaching and learning of mathematics. Not only is language a means of communication, but it is also part of the thinking process used to combine ideas, find relationships, ask questions and solve problems. Language development in mathematics should parallel its development in language arts by the use of similar strategies.

A distinction should be made between the skills necessary to understand mathematics as a technical language in itself, and the use of general language skills in understanding mathematics and related problem situations. Instructional planning should include strategies that facilitate language development in both of these areas.

MATHEMATICS AS A TECHNICAL LANGUAGE

The precision of mathematical vocabulary and symbols is often a source of difficulty for students. The everyday meanings associated with words often interfere with an understanding of the specialized meanings words may have in a mathematical context. Each theme within the program should be analyzed in order to identify demands relative to vocabulary and symbolic content. Questions such as the following will be useful in planning lessons that will provide an understanding of the technical vocabulary used.

- How does this vocabulary relate to everyday usage?
- How does it conflict with everyday usage?
- How does it relate to previously studied mathematical terms?

The role of experience in developing concepts must be recognized and accounted for in vocabulary development activities. Definitions may be developed as summarizing statements of ideas that have been understood, but should not be used as introductions to new vocabulary or symbols. The following instructional sequence might be used to foster meaningful vocabulary development, and ensure that each word or symbol introduced becomes part of the students' active or "working" vocabulary.

- Discuss real life examples from the students' environment where the word/symbol might be used.
- Simulate concrete and transitional models where the word/symbol might be appropriately used.
- Discuss and list distinguishing characteristics of the word/symbol.
- Record the word/symbol and its distinguishing characteristics (meaning) in a personal mathematics "glossary".

USING LANGUAGE TO UNDERSTAND MATHEMATICS

The role of language in the study of mathematics can be strengthened through the use of questions that probe for explanations rather than stimulate recall of information. Students should frequently be asked "Why?" and encouraged to use language in expressing their ideas, interpretations and answers to questions asked. Opportunity should be provided for students to engage in:

- writing activities that describe mathematical relationships/patterns investigated and the results of problem solving
- speaking and listening activities where thinking and reasoning skills are used with their peers
- reading and viewing activities that are required for problem solving and gathering content or information.

Students might be guided in their reading/viewing for content and information through a sequenced approach that includes the following steps:

- Decide on a purpose for reading/viewing. State the purpose as a question.
- Skim the whole section to get an idea of how it is organized.
- Notice various "aids" to reading/viewing that have been used in the material (e.g., headings, colour, bold print, charts).
- After reflecting on purpose, decide which sections need intensive study and which may be delayed or skipped.
- Engage in "active" reading/viewing of the material (e.g., ask questions, think of examples, rephrase in everyday language).

Problem solving necessitates quite a different kind of reading, wherein relationships and patterns often need to be identified and analyzed before solutions can be attempted. Cognitive demands placed upon the student in these situations can be a source of frustration. Instruction must provide support, encouragement and assistance. Model strategies that will guide and facilitate the development of reading skill in this area. The following steps might be used in structuring activities that will develop the reading skills required for effective problem solving:

- Read rapidly to grasp the general idea.
- Read again to determine facts and their relationships.
  - What facts are given?
  - What facts are not given?
  - How does each fact influence other parts of the problem?
- Read again to check facts and relationships.
- Determine the steps required for a solution.
  - What do I know?
  - What do I need to know?
  - How can I use what I know to find out what I need to know?
- Provide a comprehension check by attempting to estimate an answer to the problem.
  - Considering all information, is this answer reasonable?

INSTRUCTIONAL MEDIATION

A great deal of recent research has focussed on instructional mediation and "teacher talk" in the classroom. Instructional mediation is an interactive process wherein teachers refine their interpretation of tasks to students, as students construct their own interpretations of the tasks and processes being learned. This back and forth exchange stimulates the development of thinking skills by allowing both sides to contribute to a meaningful learning situation. Lectures, or one-sided explanations, rely on students to be "self-mediating" and to supply their own meaning to processes. Unfortunately, most students are not yet able to do this.

Instructional mediation regulates the students' behaviour in terms of the use of strategies and heuristics on tasks. Emphasis on a strategic view of tasks will encourage students to become independent in the tasks they perform and the processes they use. For example, a strategy for attacking mathematics problems will enable more students to solve problems on their own. In addition, such a strategy enables the student to identify for the teacher at what point they need assistance if they are unable to completely solve the problem.

A further use of mediation is in developing the students' feeling of competency. Students need to see themselves as competent and able to do things. Students who feel competent, and who recognize their effort as being effective in learning, are more likely to be persistent in attempting new tasks that are difficult. On the other hand, students who require frequent praise for their effort come to have limited performance goals and are hesitant to engage in any task at which they cannot quickly become successful. Teachers can encourage students to extend their learning goals by focussing mediation on the role of effort and strategy in achieving success, rather than in praising performance.

In creating a classroom environment that will stimulate strategic behaviour and thinking skills, the teacher should:

- identify, but not correct errors
- encourage students to correct their own errors
- pause and clarify, but not interrupt
- demand constant vocalization of student thought processes that are used, and model these to students
- encourage persistence.

The mediation process can also be enhanced through the use of appropriate "questioning techniques" and the "modelling" of complete processes and thought patterns. These instructional methods are described in the paragraphs that follow.

QUESTIONING TECHNIQUES

Questioning techniques should include the use of chains of questions that lead students to discover their own answers. Question chains should begin with focus questions such as:

- What is the goal of this problem?
- What do we want to do?
- What are we looking for?
- What is stopping us?
- Who can we ask?
- Where can we look?
- What should we do first?
- What is this process called?

Once students have established the significant pieces of information necessary to solve the problem, the focus is expanded through questions like:

- What can we do?
- Have we got enough ideas yet?
- What is our next step?
- How will we do that?
- What is the relationship between . . . and . . .?
- How are . . . and . . . related?
- How can we simplify . . .?

When students have succeeded with the problem, questions should be asked that encourage students to review the process used and evaluate their work. Such questions may include:

- Have we finished?
- How can we decide if . . . is a reasonable solution?
- How can we check this solution?
- Is there a better solution?
- How do you know that we have solved the problem?
- What are different ways we can approach the problem?
- How could we make our work easier another time?
- When might you use this process again?
- What should we tell others?

Questions that probe and prompt students to process information, rather than fixate at the simple recall level, will make students aware that they are expected to be actively involved in thinking processes. When students experience success with problems through use of the teacher's questioning chain, they will discover the importance of the thought processes used, and be encouraged to develop personal strategies that direct their efforts in related tasks.

MODELLING

Modelling, as opposed to demonstrating, involves "talking through" a complete process in order to expose thinking processes to the student. While in a demonstration everything turns out as it should, modelling should include false starts, trouble spots, and having to deal with errors. Modelling requires teachers to express their thinking processes out loud so that students can see not only how the process is done, but also how difficulties and ambiguities are addressed.

While teachers often model when explaining processes and problems, knowledge and awareness of the value of modelling can serve to sharpen this process. Asking students where to begin in a problem situation makes a good starting point. If the reply is "I don't know!", an area of difficulty is determined. The "mini process" of determining a starting point might then be modelled.

DIRECT SKILL INSTRUCTION

Research suggests that certain processes and skills can be more effectively mastered through direct or discrete instruction, rather than through incidental learning within context. Direct instruction has been particularly effective in teaching strategies used in problem solving and estimation. The student experiencing difficulty with basic number skills may also benefit from direct skill instruction in areas of difficulty.

It should be emphasized, however, that direct instruction does not mean repetition. Rather, it means leading students through a developmental sequence of learning steps, and enabling the learner to use this process in attempting other tasks. The basic components of direct instruction include.

- identification of the concept/skill/process to be learned
- presentation of a series of planned learning activities
- questioning techniques that prompt the use of thinking skills and provide a check on student understanding
- opportunity to practise and apply what has been learned in a variety of situations.

Although the Integrated Occupational Mathematics 8 and 9 program is intended to develop basic concepts and skills in thematic contexts, there are often "gaps" in the students' repertoire of skills that do not lend themselves to instruction within a thematic approach. In such cases, the "Mathematics Profile" can be used as a diagnostic tool in identifying skill deficiencies that will require remediation. Plans should then be made for direct instruction in these skill areas when appropriate, or for embedding the concept/skill into another theme for reinforcement.

USING THE MATHEMATICS PROFILES

Mathematics profiles for Grade 8 and Grade 9 have been provided in the Statement of Content The profiles have several uses within the mathematics program. They provide:

- a "snapshot" or convenient overview of the basic skills to be addressed in I.O.P. Mathematics 8 and 9

- an overview of the processes (e.g., problem solving, use of technology, computational facility and estimation) to be addressed in I.O.P. Mathematics 8 and 9

- a reminder of basic skills that need to be covered when planning thematic units of instruction. Different concept/skill areas lend themselves more/less well to the context identified by certain themes

- assistance in the diagnosis of individual student strengths and weaknesses. Areas of skill deficiency can be identified and noted on the profile. Teachers may then choose to provide direct instruction in these areas, or decide to embed such skills into a different context (theme)

- accountability for the mathematics program. Schools are often asked to demonstrate coverage of the "basics". The profile provides an instructional link between daily classroom activities and the skills demanded of students in today's society.

EVALUATION

Evaluation should be viewed as an ongoing part of the teaching and learning process, providing feedback to the student, the teacher, and the parent. Major functions served by the process of evaluation include:

- provision of feedback to the student relative to his or her success in the learning process. Students have difficulty in monitoring and regulating their learning behaviours, and require a great deal of external feedback as to their progress. Feedback and encouragement must be provided on a regular basis
- provision of information to the teacher concerning the appropriateness of learning goals and objectives, and the effectiveness of learning strategies and materials that have been used. Such information enables the teacher to modify the program as required with respect to pacing, learning resources, teaching methods or objectives
- provision of information to the parent regarding the student's progress. Where possible, reports to parents should be interpreted through an interview so that the implications of the evaluation are understood. While useful in communicating student progress to parents, the interview is also valuable in identifying individual needs that may be met through program planning and delivery.

Evaluation should serve diagnostic purposes in identifying student strengths and weaknesses, as well as summative needs in measuring overall growth. Because evaluation is an integral part of all aspects of the instructional process, information used in the evaluation of a student should be gathered from a variety of sources using a variety of methods. The evaluation program in mathematics must consist of more than paper-and-pencil tests. While such tests may be an effective way of evaluating the learning outcomes of specific computational skills and applications, an effective system of evaluation should include, to some degree, the use of all of the following sources of information:

- observation of attitudes and performance
- oral and written presentations of solutions to problems/mathematical applications
- personal interviews with students
- attitude scales
- project work
- feedback from parents
- teacher rating scales/checklists/inventories
- self-rating/self-marking
- peer marking
- records of previous achievement
- quizzes related to specific objectives
- diagnostic tests
- pre-tests and post-tests on topics or units
- suitable standardized examinations.

STRATEGIES FOR EFFECTIVE EVALUATION

Evaluation was, in the past, the process by which many students within the program were identified as "failures". Many students will go to extreme measures to avoid being "tested" again. Absence from examinations; feigning an "I don't care anyway" attitude, or not giving their best effort so that the anticipated failure can be combatted with "I didn't try my best", are all common behaviours. Although evaluation is a fact of daily life and necessary to the program, efforts must be made to provide variation in the procedures used so as to draw upon students' strengths and provide for their success in the evaluation process.

The strategies provided here are intended to serve as guidelines to the teacher in developing a system of evaluation that will improve both student learning and the quality of the mathematics program offered to students.

- Provide frequent drills that involve the use of basic facts, mental arithmetic and estimation. In addition to providing encouragement and feedback to students in the use of these skills, such practice enables the teacher to monitor student achievement in this area.

- Provide opportunities for students to "demonstrate" their understanding of concepts and skills studied, through discussion, project work and group activities.

- "Observation" of the student in small group situations often provides insights as to the student's:

  - level of independence with the work
  - method of attacking problems
  - ability to apply concepts and skills to new situations.

- Structured interviews with students following completion of an assignment/project provides opportunity to evaluate student understanding of concepts/processes/applications. Such interviews may also suggest more effective ways of structuring future assignments.

- Evaluation should emphasize the "synthesis" of a variety of knowledge and process objectives, rather than isolated skills. Provide students with informal situations where they can demonstrate their application of basic facts, algorithms, calculator skills, and estimation skills in solving a problem.

- Over-dependence on paper-and-pencil techniques often does not permit students with learning difficulties to do well. When planning formal evaluation procedures, caution should be exercised with regard to the over-use of:

  - multiple choice exams
  - difficult wording and vocabulary
  - simple recall of information without understanding and application.

- Provide encouragement by asking questions and making statements that will prompt students to evaluate their work and learning. Some examples might include:

  "You did a good job of ____(be specific)_____."
  "What steps did you find most difficult?"
  "How could you improve your work in this question?"

  Such techniques will encourage students to be less "reward dependent" and more responsible for their own learning.

- Provide opportunity for the use of self and peer evaluation techniques.

- When planning formal evaluation (e.g., a quiz or a test), students should be given plenty of advance notice and a study guide to highlight the areas that need review. Students rarely do their best when caught off guard by "surprise" quizzes.

- Students with learning difficulties often do not do their best under time pressure. Provide plenty of time for students to complete their work.

The *Teacher Resource Manual* contains additional guides and checklists for evaluating student performance and growth in mathematics.

SCOPE AND SEQUENCE

The scope and sequence chart provided on the following pages outlines the mathematical process and skill that is developmentally addressed throughout Grades 8 and 9. In recognizing that students differ in the rate at which they acquire mathematical competencies, the chart is intended to assist teachers in:

- assessing present levels of student performance
- diagnosing particular areas of skill deficiency
- sequencing instruction in a manner that will suit individual needs and growth patterns.

In using the scope and sequence, it should be noted that:

- effort has been made to arrange process and skill in a linear sequence according to cognitive demand at each grade level
- the skills are developmental through Grades 8 and 9 (i.e., the spiral approach). Students will reinforce and extend their understanding of skills developed in Grade 8 through their application in more sophisticated and complex settings at the Grade 9 level. (The *Teacher Resource Manual* provides for the application of skills in Grades 8 and 9 through themes of increasing maturity and complexity.)
- the skills are interdependent and are not meant to be taught in isolation. Although some skills may be mastered more effectively through discrete instruction, this approach is not advocated as a primary focus of instruction. The thematic structure permits a more holistic view of instruction through the linking of strategies and skills.

Teachers may also wish to examine a scope and sequence chart for the high school mathematics program (Mathematics 16 and 26). An understanding of the developmental progression of the process and skills occurring beyond Grade 9 will facilitate articulation between the junior and senior high school mathematics programs.

PROBLEM SOLVING

GRADE 8	GRADE 9
Recognizes problem-solving situations at school, at home, and in the community where: • no readily apparent solution or means to the solution is evident • a person may be temporarily perplexed • there may be no answer, one answer or many answers • personal and societal factors may be involved as well as mathematical competencies.	→
Demonstrates a desire to solve problems by: • asking questions/showing interest and curiosity • attempting to apply/transfer knowledge to problem situations • taking risks • displaying perseverance • using creative approaches/unconventional strategies • thinking critically/justifying strategies and solutions.	→
Uses a variety of strategies to solve problems. • understands the problem – reads the problem several times – asks questions – identifies key words and their meanings – looks for patterns – identifies wanted, given, and needed information – identifies extraneous information – internalizes the problem by restating it in one's own words or by visualizing the problem – draws pictures/diagrams – uses concrete manipulatives	Uses a variety of strategies to solve problems • understands the problem – interprets pictures/charts/graphs – simulates or models the problem situation – relates the problem to other problems previously encountered
• develops and carries out a plan – guesses and checks the result (thus improving the guess) – uses logic and reason – chooses and sequences the operations needed – sorts/classifies information – applies selected strategies – presents ideas clearly – selects appropriate calculating/measuring devices and methods – visualizes the problem – acts out or simulates the problem – applies patterns – estimates the answer – documents the process used – works with care – works in a group situation, sharing ideas – speaks to self with positive statements (e g , "I can solve this ")	• develops and carries out a plan – uses a simpler problem (makes an analogy) – identifies factors relevant to the problem – collects and organizes data into diagrams, number lines, charts, tables, pictures, graphs or models – experiments through the use of manipulatives – breaks the problem down into smaller parts
• reviews and applies results – states an answer to the problem – restates the problem with the answer – explains the answer in oral/written form – determines if the answer is reasonable – discusses the process used with others – suggests other ways to solve the problem – checks the answer – considers the possibility of other answers/solutions.	• reviews and applies results – makes and solves similar problems.

	GRADE 8	GRADE 9
USE OF TECHNOLOGY	Develops an ability to effectively use the calculator • identifies appropriate and inappropriate uses of the calculator • identifies and uses basic functions on the calculator (+, −, x, ÷, =, decimal, clear) • clears and corrects entry errors • uses a calculator to add, subtract, multiply, and divide whole numbers and decimals • enters numbers in correct sequence for subtraction and division • determines whole number remainders for division • follows order of operations • selects from calculator display the number of decimal places appropriate to the context of a calculation • checks the reasonableness of answers obtained on the calculator.	Develops an ability to use the calculator effectively. • identifies and uses the percent function on the calculator • generates sets of multiples for a given number using the calculator
COMPUTATIONAL FACILITY AND ESTIMATION	Performs computations using paper-and-pencil algorithms within the parameters provided in this Scope and Sequence for whole numbers, decimals and fractions. Performs computations using a calculator with whole numbers and decimals (magnitude of numbers determined by the nature of the problem situation). Performs computations using mental arithmetic that are based on: • all single-digit operations • sequences of operations • doubling and halfing • multiplying and dividing by powers of 10 • application of the commutative, associative and distributive properties • properties of zero. Develops skills in estimation in order to determine: • the range of numbers within which a solution must lie • whether a solution in problem solving is reasonable • the reasonableness of computational results obtained using paper and pencil algorithms or the calculator. Applies estimation strategies that include. • stating the largest and smallest reasonable answer to a problem before solving the problem • predicting whether a computation will result in a larger or smaller number • forecasting an order of magnitude for the result of computation (e.g., 10's, 100's, 1 000's) • predicting the magnitude of the result of a computation by rounding numbers to one significant digit. Selects a method of computation (paper and pencil, calculator, mental arithmetic, estimation) that is appropriate to the nature of the problem, and provides reasons for the method chosen.	Performs computations using paper-and-pencil algorithms within the parameters provided in this Scope and Sequence for whole numbers, decimals, fractions and percent Performs computations using a calculator with whole numbers, decimals, fractions and percent whose magnitude are determined by the nature of the problem situation. Performs computations using mental arithmetic with increased emphasis on the development of formal strategies: • compensation • computing from left to right. → Applies estimation skills to the results of computation and problem solving, with increased emphasis on the development of formal strategies: • front-end estimation • clustering • rounding • compatible numbers →

NUMBER SYSTEMS AND OPERATIONS

WHOLE NUMBERS

GRADE 8	GRADE 9
Recognizes place value to one hundred thousands place	
Reads and writes whole numbers to one hundred thousands place in context.	Uses a calculator to generate a set of multiples for a given number.
Compares/orders whole numbers to one hundred thousands place in applications.	Determines the lowest common multiple for pairs of numbers less than 10.
Rounds numbers to nearest 10, 100, 1000.	
Counts by multiples of 2, 3, 4, 5, 6, 10 and 12.	
Applies the associative, commutative and distributive properties to "mental exact" computations.	Determines pairs of factors related to basic multiplication facts up to 100.
Calculates/estimates sums and differences of numbers containing up to four digits (without the use of the calculator).	Determines prime factors up to 50.
Recalls products for numbers up to 10 x 10.	Expresses numbers up to 50 as the product of prime factors.
Determines "mental exact" products when multiplying by 10, 100 and 1000.	Determines the greatest common factor for pairs of numbers less than 50
Recalls division facts for dividends up to 100.	
Recognizes different methods of representing division.	
Calculates/estimates products and quotients of numbers up to 3 digits by 1 digit (without the use of a calculator).	Calculates/estimates products and quotients of numbers up to 3 digits by 2 digits (without the use of a calculator)
Applies rules for the order of operations (brackets, multiplication, division, addition and subtraction)	
Applies whole number skills to problem-solving situations	

DECIMALS

Recognizes place value to thousandths.	
Reads and writes decimals to thousandths in context	
Compares/orders decimals to thousandths in applications.	
Rounds to nearest whole number, tenth and hundredth.	
Calculates/estimates sums and differences of numbers with 1 or 2 decimal places (without the use of a calculator).	
Calculates/estimates products of decimal numbers to thousandths, using 1-digit multipliers (without the use of a calculator)	Calculates/estimates products of decimal numbers to thousandths, using 1- or 2-digit multipliers (without the use of a calculator).
Calculates/estimates quotients for 2 decimal place numbers divided by 1-digit whole number divisors (without the use of a calculator)	Calculates/estimates quotients for 2 decimal place numbers divided by 1- or 2-digit whole number divisors (without the use of a calculator).
Determines "mental exact" products/quotients when multiplying or dividing decimals by 10 and 100	Determines "mental exact" products/quotients when multiplying or dividing decimals by 10, 100 or 1000
Applies decimal skills to problem-solving situations.	

NUMBER SYSTEMS AND OPERATIONS (continued)

	GRADE 8	GRADE 9
FRACTIONS	Illustrates the use of fractions by describing part of a whole, group, or point on a number line. Illustrates the relationship between whole numbers, decimals and fractions using a number line. Describes proper/improper fractions and mixed numbers through the use of objects, pictures and diagrams. Converts improper fractions to mixed numbers and vice versa. Compares and orders fractions in applications. Identifies and determines equivalent fractions (emphasis on 1/2, 1/3, 1/4, 1/5, 1/8 and 1/10). Recognizes and expresses fractions in basic form. Demonstrates addition and subtraction of proper fractions/mixed numbers with like denominators through the use of objects, pictures and diagrams. Writes number sentences to describe the addition and subtraction of fractions with like denominators. Applies fraction skills to problem-solving situations.	Relates fractions to division, converting fractions into decimal equivalents using a calculator. Recalls decimal equivalents for commonly used fractions (e.g., one-half, quarters, tenths). Determines common denominators for frequently used fractions (emphasis on 1/2, 1/3, 1/4, 1/5, 1/8 and 1/10). Demonstrates addition and subtraction for proper fractions/mixed numbers with unlike denominators through the use of concrete manipulatives. Writes number sentences to describe the addition and subtraction of fractions with unlike denominators. Demonstrates the multiplication and division of proper fractions/mixed numbers by whole numbers through the use of concrete manipulatives. Writes number sentences to describe the multiplication and division of fractions/mixed numbers by whole numbers.
INTEGERS		Recognizes the need for integers, and ways in which they are used. Uses vocabulary related to integers (e.g., positive, negative, plus, minus, above, below, gain, loss). Places integers on the number line. Compares and orders positive and negative numbers in applications Demonstrates addition of pairs of integers between –25 and +25 through concrete manipulation/diagramatic representation Writes number sentences to describe the addition of integers undertaken in the concrete mode. Applies integer skills to problem-solving situations.

	GRADE 8	GRADE 9
RATIO, PROPORTION AND PERCENT	Recognizes ratios as ordered pairs of numbers showing comparison of two quantities in the same unit. Uses concrete manipulation to construct ratios in the forms a:b, a is to b, and a/b. Generates equivalent ratios using single-digit whole number constants. Verifies the equivalence of two ratios using common multiples or factors (e.g., $\frac{14}{6}\ \frac{(\div 2)}{(\div 2)} = \frac{7}{3}$) Recognizes proportions as statements about equivalent ratios. Describes practical problem situations by writing proportions. Determines the value of the missing component in a given proportion using the common factor/multiple method (e.g., $\frac{3}{4}\ \frac{(\times 25)}{(\times 25)} = \frac{?}{100}$) Demonstrates the concept of percent as ratio indicating parts out of 100. Applies skills in ratio, proportion and percent to problem-solving situations, using concrete manipulations/diagramatic representations.	Recognizes "rates" as ratios showing comparison of two numbers with different units (e.g., 90km/2h, 3 items for $1.00). Describes practical problem situations involving rates by writing proportions Determines the value of the missing component in a proportion involving rates using the common multiple/factor method Converts whole number percents to ratios/decimals. Expresses ratios as percents and decimals (e.g., $\frac{a}{b} = \frac{?}{100}$, where b = 2, 4, 5, 10, 20, 25 or 50) Expresses 1- and 2-place decimals as percents (e.g., 0.5, 0.75, 0.4). Recalls fraction, decimal and percent equivalents for halves, quarters and tenths. Determines other fraction, decimal and percent equivalents through use of the calculator. Calculates/estimates a percent of a number in relevant applications.
GEOMETRY AND MEASUREMENT **GEOMETRY**	Identifies and distinguishes between horizontal, vertical, perpendicular, parallel and intersecting lines. Identifies/classifies/describes basic two-dimensional figures (rectangle, square, triangle, circle). Uses geometric tools (e.g., protractor, compass, straightedge, ruler, computer) to construct rectangles, squares, triangles and circles according to given specifications. Identifies and constructs models of basic three-dimensional figures (rectangular prism, cube, cylinder). Applies knowledge of geometric figures and relationships in practical situations.	Identifies and recalls characteristics of the parallelogram, hexagon and octagon Uses geometric tools (e.g., protractor, compass, straightedge, ruler, computer) to construct the parallelogram, hexagon and octagon Identifies and describes the relationship between the radius and diameter of a circle. Draws a circle, given either radius or diameter. Constructs geometric patterns/designs, using tools that may include the straightedge, compass, ruler, protractor, mira or computer.

	GRADE 8	GRADE 9
GEOMETRY AND MEASURE-MENT (continued) LENGTH	Recognizes common metric units of length (mm, cm, m, km). Estimates and measures length, selecting metric units and tools appropriate to the situation. Draws lines according to given specifications, using metric units and tools. Converts measurements of length among commonly used metric units: - among mm, cm and m - between m and km. Illustrates the concept of perimeter, and explains its application to problem-solving situations. Estimates/measures/computes the perimeter of figures bounded by line segments.	
AREA		Illustrates the concept of area, recognizing common metric units (cm^2, m^2) and their application in problem situations. Approximates the area of two-dimensional geometric figures using a square grid. Recognizes strategies/formulae for finding the area of rectangles and squares. Estimates/calculates the area of rectangles and squares, using units and strategies appropriate to the situation.
MASS	Describes mass, and recognizes common metric units (g, kg, t). Estimates and measures mass, selecting metric units and tools appropriate to the situation. Converts between g and kg, also between kg and t.	
CAPACITY	Describes capacity, and recognizes common metric units (mL, L). Estimates and measures capacity, selecting metric units and tools appropriate to the situation. Converts between mL and L.	
TIME	Uses a calendar, recognizing the relationship between days, weeks, months and years. Uses National Standards for numeric dating. Estimates/measures/records time on the 12-hour and 24-hour clock (using traditional and digital timepieces).	Converts between hours and minutes, and between minutes and seconds. Adds/subtracts hours and minutes in applications.
TEMPERATURE		Estimates and measures temperature on the Celsius scale. Recalls important temperatures on the Celsius scale (e.g., boiling/freezing points of water, normal body/room temperature). Determines temperature change, including changes from below zero to above zero.
ANGLE		Recognizes an angle and the degree as a unit of measure. Recognizes angles of 45°, 90°, 180° and 360° Measures/draws angles from 0° to 180° using a protractor. Applies skills of angle measure in the construction of geometric figures/patterns/designs

	GRADE 8	GRADE 9
DATA INTERPRETATION AND DISPLAY	Recognizes the use of statistics in real life situations, and its effects on everyday activities Reads and interprets information presented in list, table and chart form. Collects and records data using tally sheets and frequency tables. Uses tables and charts to group/sort numerical data and information according to specified criteria. Reads and interprets information presented in picture graphs, bar graphs and line graphs.	Interprets and determines arithmetical average in practical situations. Recognizes when and how to display data in the form of picture graphs, bar graphs and line graphs. Reads and interprets information presented in circle graphs. Recognizes how graphs may sometimes provide misleading information or distort the "true picture".
ALGEBRA	Distinguishes between the use of variables and constants in concrete situations. Uses variables to describe concrete situations (e.g., number of coins in a jar). Uses variables to write mathematical expressions that describe practical situations (e.g., if the regular price of an item is reduced by five dollars, the sale price could be represented as R – 5). Evaluates mathematical expressions for given whole number values of the variable. Uses variables to write linear equations/formulas that describe practical situations (e.g., if each person at a party eats three hotdogs, the relationship between number of hotdogs and number of people can be described as H = 3 x P). Interprets formulas related to practical situations as word statements Performs substitution into formulas in determining outcomes/solutions to routine problems.	Uses concrete manipulatives to demonstrate the concept of equality. Uses estimation and guess/check strategies to solve linear equations describing practical situations that have been written in any of the following forms. - x + a = b - ax = b - ax + b = c - x/a = b/c. Verifies solutions to linear equations by substitution.

STATEMENT OF CONTENT

An Integrated Occupational Program "Mathematics Profile" has been included for Grade 8 and Grade 9. These profiles provide an overview of the basic skills to be addressed throughout each year of the program, and will assist teachers in:

- identifying skills that must be included in thematic units of instruction
- diagnosing individual student needs relative to skill development
- planning for the evaluation of both program delivery and student development.

The "Program of Studies/Presentation of Content" follows each profile. This section describes the essential concepts, skills and attitudes identified for Grade 8 and Grade 9, clustered into five major concept areas:

- Number Systems and Operations
- Ratio, Proportion and Percent
- Geometry and Measurement
- Data Interpretation and Display
- Algebra.

Prescriptive statements in this section (i.e., the Program of Studies, Column One) have been shaded.

Learning objectives stated in the Program of Studies/Curriculum Guide (Column One) have been supported with:

- Related Life Skills (Column Two)
- Related Applications Across the Curriculum (Column Three)
- Suggested Strategies/Activities (Column Four).

The advice and direction offered throughout Columns Two, Three and Four is not prescriptive, and is offered only as a service to teachers. Column Two, Related Life Skills, establishes an immediate need or use for each skill being studied and suggests ways of planning relevant learning experiences. Further suggestions for relating mathematical competencies to applications in the practical arts program and other academic disciplines are provided in Column Three, Related Applications Across the Curriculum. The references provided in this column will facilitate curricular integration by establishing a base for cooperative planning among other subject areas/teachers in the program. A variety of strategies, useful in addressing developmental characteristics and learning styles of the student are provided in Column Four, Suggested Strategies/Activities.

While the Statement of Content represents the provincial curriculum for the majority of students within the program, it may be necessary to make local adjustments to the design and development of this curriculum in order to meet individual needs, abilities and learning styles.

MATHEMATICS PROFILE, I.O.P. GRADE 8

		1	2	3	4
01	PROBLEM SOLVING	Recognizes problem solving situations at school, at home and in the community	Demonstrates a desire to solve problems	Applies strategies required in understanding a problem	Applies strategies required in developing and carrying out a plan for problem solving
		5			
		Uses appropriate strategies in reviewing and applying the results of problem solving			
		1	2	3	4
02	USE OF TECHNOLOGY	CALCULATOR Identifies appropriate and inappropriate uses of the calculator	Identifies and uses basic functions on the calculator (+, −, x, ÷, =, decimal, clear)	Clears and corrects entry errors	Uses a calculator to add, subtract, multiply and divide whole numbers and decimals
		5	6	7	8
		Enters numbers in correct sequence for subtraction and division	Determines whole number remainders for division using the calculator	Follows order of operations when using a calculator	Selects the number of decimal places appropriate to the context of the calculation
		9			
		Checks the reasonableness of answers obtained on the calculator			
		1	2	3	4
		COMPUTER Identifies the major parts of a computer	Distinguishes between hardware and software	Recognizes that computers get their instructions from programs written by a person	Uses a prepared program on a computer
		5			
		Shows respect and responsibility for hardware and software			
		1	2	3	4
03	COMPUTATIONAL FACILITY AND ESTIMATION	Performs computations through use of paper-and-pencil algorithms (within limited parameters)	Performs computations through use of the calculator	Performs computations through the use of mental arithmetic	Performs computations that are based on the application of skills in estimation
		5	6		
		Uses estimation skills in checking the reasonableness of computational results	Selects a method of computation that is appropriate to the nature of the problem at hand		

MATHEMATICS PROFILE, I.O.P. GRADE 8 (cont'd.)

04 **NUMBER SYSTEMS AND OPERATIONS**

1	2	3	4
WHOLE NUMBERS Recognizes whole number place value to 100 000	Reads and writes whole numbers to 100 000 in context	Compares/orders whole numbers to 100 000 in applications	Rounds whole numbers to nearest 10, 100, 1000
5	6	7	8
Counts by multiples of 2, 3, 4, 5, 6, 10 and 12	Applies associative/ commutative/ distributive properties to "mental exact" computations	Calculates/estimates sums and differences of numbers containing 4 digits or less (without calculator)	Recalls products for numbers up to 10 x 10
9	10	11	12
Determines "mental exact" products when multiplying by 10, 100 and 1000	Recalls division facts for dividends up to 100	Recognizes different methods of representing division	Calculates/estimates products and quotients of numbers up to 3 digits by 1 digit (without calculator)
13			
Performs a sequence of operations using correct order			

1	2	3	4
DECIMALS Recognizes decimal place value to thousandths	Reads and writes decimals to thousandths in context	Compares/orders decimals to thousandths in applications	Rounds decimals to nearest whole number, tenth and hundredth
5	6	7	8
Calculates/estimates sums and differences of numbers with 1 or 2 decimal places (without calculator)	Calculates/estimates products of numbers to thousandths using 1-digit multipliers (without calculator)	Calculates/estimates quotients to hundredths with 1-digit whole number divisors (without calculator)	Determines "mental exact" products/ quotients when multiplying or dividing by 10 and 100

1	2	3	4
FRACTIONS Illustrates the use of fractions	Illustrates the relationship between whole numbers, decimals and fractions using a number line	Describes proper/ improper fractions and mixed numbers by using objects, pictures and diagrams	Converts improper fractions to mixed numbers and vice versa
5	6	7	8
Compares/orders fractions in applications	Identifies and determines equivalent fractions (emphasis on 1/2, 1/3, 1/4, 1/5, 1/8, 1/10)	Recognizes and expresses fractions in basic (simplest) form	Demonstrates addition/subtraction of proper fractions/mixed numbers with like denominators
9			
Writes number sentences to describe the addition/ subtraction of fractions with like denominators			

MATHEMATICS PROFILE, I.O.P. GRADE 8 (cont'd.)

		1	2	3	4
05	RATIO, PROPORTION AND PERCENT	Recognizes ratios as ordered pairs of numbers showing comparison in the same unit	Uses concrete manipulation to construct ratios in the forms a:b, a is to b, and a/b	Generates equivalent ratios using single-digit whole number constants	Verifies the equivalence of two ratios using the common factor/ multiple method
		5	6	7	8
		Recognizes proportions as statements about equivalent ratios	Describes practical problem situations by writing proportions	Determines the missing component in a proportion using the common factor/ multiple method	Demonstrates the concept of percent as ratio indicating parts out of 100
		2	2	3	4
06	GEOMETRY AND MEASUREMENT	GEOMETRY Identifies/distinguishes between different kinds of lines.	Identifies/classifies/ describes basic two-dimensional figures (rectangle, square, triangle, circle)	Uses geometric tools to construct rectangles, squares, triangles and circles according to given specifications	Identifies and constructs models of basic three-dimensional figures
		1	2	3	4
		LENGTH Recognizes common metric units of length (mm, cm, m, km)	Estimates/measures length, selecting metric units and tools appropriate to the situation	Draws lines according to given specifications, using metric units and tools	Converts measurement of length among commonly used metric units
		5	6		
		Illustrates the concept of perimeter, and explains its application to problem situations	Estimates/measures/ computes the perimeter of figures bounded by line segments		
		1	2	3	
		MASS Describes mass, and recognizes common metric units (g, kg, t)	Estimates/measures mass, selecting metric units and tools appropriate to the situation	Converts between g and kg. Also between kg and t	
		1	2	3	
		CAPACITY Describes capacity, and recognizes common metric units (mL, L)	Estimates/measures capacity, selecting metric units and tools appropriate to the situation	Converts between mL and L	
		1	2	3	
		TIME Recognizes the relationship between days/weeks/months/ years	Uses National Standards for numeric dating	Estimates/measures/ records time on the 12-hour and 24-hour clock (using traditional and digital timepieces)	
		1	2	3	4
07	DATA INTERPRETATION AND DISPLAY	Recognizes the use of statistics in real life situations, and its effects on everyday activities	Reads and interprets information presented in list, table and chart form	Collects and records data using tally sheets and frequency tables	Uses tables and charts to group/sort numerical data and information according to specified criteria
		5			
		Reads and interprets information presented in picture graphs, bar graphs and line graphs			

MATHEMATICS PROFILE, I.O.P. GRADE 8 (cont'd.)

		1	2	3	4
08	ALGEBRA	Distinguishes between the use of variables and constants in concrete situations	Uses variables to describe concrete situations (e.g., number of coins in a jar)	Uses variables to write mathematical expressions that describe practical situations	Evaluates mathematical expressions for given whole number values of the variable
		5	6	7	
		Uses variables to write linear equations/ formulas that describe practical situations	Interprets formulas related to practical situations as word statements	Performs substitution into formulas in determining outcomes/ solutions to routine problems	

PROGRAM OF STUDIES/PRESENTATION OF CONTENT

MATHEMATICS (I.O.P. GRADE 8)

NUMBER SYSTEMS AND OPERATIONS

CONCEPTS:

- Recognizes routine problem-solving situations and those where no readily apparent solution or means to a solution are evident. Develops an understanding of appropriate strategies for problem solving, and how these strategies can be applied in practical everyday situations.

- Understands the need for computational competence in daily life activities. Recognizes that while computation may involve the use of paper-and-pencil algorithms, computational competence also requires facility in estimation, mental arithmetic and use of the calculator. Develops an understanding of each method of computation and its application in the problem-solving process.

- Recognizes that technology, in the form of calculators and computers, has influenced the nature of the computational processes and procedures we frequently use. Develops an understanding of procedures followed in the use of these technologies and recognizes their influence on our lives.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics. Develops the confidence to work independently, as well as effectively with others in group situations.

- Demonstrates a desire to solve problems by asking questions, showing interest/curiosity, taking risks and displaying perseverance.

- Recognizes the value of an organized approach to problem solving. Appreciates the role of critical and creative thinking in problem solving, and acknowledges unconventional strategies and alternative solutions.

- Appreciates the usefulness of computational competence and problem-solving skill within the home, the community and the workplace.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

- Demonstrates an understanding of familiar number systems and operations in solving real life problems that require quantitative thinking and computational facility.

  Applies problem-solving strategies that relate to:

  - understanding the problem
  - developing and carrying out a plan
  - reviewing and applying results.

- Performs computations through the use of:

  - mental arithmetic
  - paper-and-pencil algorithms
  - the calculator
  - estimation.

  Selects a method of computation that is appropriate to the nature of the problem, and provides reasons for the method chosen.

- Uses skills in mental arithmetic that are based upon:

  - all single-digit operations
  - sequences of operations
  - doubling and halving
  - multiplying and dividing by powers of 10
  - applications of the commutative, associative and distributive properties
  - properties of zero and one.

- Uses paper-and-pencil algorithms within the parameters provided for whole numbers, decimals and fractions.

Uses whole numbers/decimals/fractions to solve real life problems that relate to:

- travel/sport/recreation
- home maintenance/repair
- personal finance/management.

Applies appropriate problem-solving strategies to routine situations involving the application of specific concepts/skills:

- determines quantity and cost of food/beverages required for a group gathering
- computes the number of metres of baseboard that are required to go around a room that is being redecorated.

Applies appropriate problem-solving strategies to situations that are non-routine and open-ended, requiring the use of creative thinking and ability to recognize different solutions:

- makes plans (within a limited budget) for a two- or three-day trip, choosing destination/travel route/method of travel/accommodation
- selects the most appropriate store for purchase of sportswear after considering selection/quality/cost/service at a number of competing stores.

Recognizes the importance of estimation and mental arithmetic in daily activities:

- Do I have enough money for both the tape and the shirt?
- Have I received the correct amount of change?
- About how long will the trip take if I travel at 100 km/h?
- Is the answer on my calculator "in the ball park"?

Related Applications Across the Curriculum

General

The use of appropriate strategies for problem solving is emphasized throughout all subject areas. A problem-solving model similar to the model used in mathematics is frequently applied to real life situations in:

- language arts
- science
- social studies
- the practical arts.

Science

Uses appropriate thought processes and strategies when:

- conducting scientific inquiry
- solving technological problems
- making responsible decisions in society.

Social Studies

Uses problem-solving and decision-making strategies to address personal development decisions.

Practical Arts

Uses problem-solving and decision-making strategies to:

- design/produce a product
- provide a service.

Suggested Strategies/Activities

Apply the problem-solving strategies identified in a previous section of this guide (see "Problem Solving"), as well as those provided in the *Teacher Resource Manual*, to real life situations involving the use of whole numbers, decimals and fractions.

While some instructional activities will include the use of routine problems that require the application of familiar techniques, students should also experience unfamiliar and challenging problem situations that require creative application of a variety of strategies and skills. Be aware that a situation that is routine for one student may well pose a challenge for another student. All students should experience and solve problems that are appropriate to their level of ability.

Model the problem-solving process for students. Facilitate active involvement in problem solving by encouraging students to:

- ask questions
- manipulate materials
- discuss and share ideas/strategies in small groups
- verbalize ideas and discoveries
- devise personal strategies/solutions
- think of related problems from everyday experience
- apply what has been learned to new situations that may be encountered.

Activities should develop student confidence/ability in the use of all methods of computation (e.g., mental arithmetic, paper-and-pencil algorithms, the calculator and estimation). Coach students in the discerning use of each method in the problem-solving process, thus avoiding singular emphasis on the use of paper-and-pencil algorithms.

Mental arithmetic skills should be developed/ maintained on a regular basis. Use timed challenges and games at the beginning of each class (see *Teacher Resource Manual*: Computational Facility and Estimation). Identify and discuss "easy to use" strategies that will enable students to compute exact answers mentally. Encourage students to share with other members of the class personal strategies they find useful.

LEARNING OBJECTIVES	Related Life Skills
• Uses the calculator to perform computations with whole numbers and decimals whose magnitude are determined by the nature of the problem situation: – identifies appropriate and inappropriate uses of the calculator – identifies and uses basic functions on the calculator (+, −, x, −, =, decimal, clear) – clears and corrects entry errors – uses a calculator to add, subtract, multiply and divide whole numbers and decimals – enters numbers in correct sequence for subtraction and division – determines whole number remainders for division using the calculator – follows order of operations – selects from calculator display the number of decimal places appropriate to the context of a calculation – checks the reasonableness of answers obtained on the calculator.	Uses a calculator in situations where mental arithmetic would be difficult, or when paper-and-pencil computation would be inefficient: • determining quantity and cost of materials required for a decorating/ repair project • monitoring total cost of a number of items being selected for purchase • determining unit price and "best buy" • verifying sales slips/invoices/bills • maintaining bank account balances.
• Uses estimation skills in order to determine: – the range of numbers within which a solution must lie – whether a solution in problem solving is reasonable – the reasonableness of computational results obtained using paper-and-pencil algorithms or the calculator.	Makes a habit of using estimation to check the reasonableness of computational results obtained using paper-and-pencil or the calculator. Uses estimation skills in daily life situations where approximate numbers or answers are more appropriate than exact numbers: • Is there enough gas in the car? • How much should I tip? • How many people were at the game?
• Applies estimation strategies that include: – stating the largest and smallest reasonable answer to a problem before solving the problem – predicting whether a computation will result in a larger or smaller number – forecasting an order of magnitude for the result of a computation (e.g., 10's, 100's, 1000's) – predicting the magnitude of the result of a computation by rounding numbers to one significant digit.	Applies techniques of estimation in counting and computations: • cars in the parking lot/people in a crowd • total cost of groceries selected for purchase • checking accuracy of sales receipts • anticipating change due when making a purchase.

Related Applications Across the Curriculum

General

Computational procedures are used to varying degrees throughout all subject areas. The following pages of this document will describe:

- the context in which computation is used in other subject areas
- the nature of the skills used by students.

Science

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator in a variety of classroom/lab situations.

Social Studies

Uses knowledge of number systems and place value when interpreting statistical information.

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator in map work.

Practical Arts

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator to complete thematic learning activities.

Suggested Strategies/Activities

Instruction in paper-and-pencil computation should emphasize understanding of process (i.e., place value, re-grouping, borrowing) and why algorithms are constructed in particular forms. Students should develop these understandings by working with one- and two-digit numbers. Tedious paper-and-pencil computations with numbers containing more than three digits are discouraged. Such computations are time-consuming, and are generally ineffective in facilitating the development of number sense and problem-solving ability.

Calculator skills must be developed and their use encouraged when the primary purpose of an activity is the development of problem-solving or other skill in which computation is of secondary importance. Be prepared to provide instruction on how and when to use the calculator in problem-solving contexts. Activities with the calculator should focus attention on:

- knowledge and use of place value, basic facts and related number skills
- development of estimation skills and ability to judge the reasonableness of computational results.

Estimation involves application of a set of skills that are developed over time through much opportunity for practice. Appropriate strategies for the development of estimation skills are provided in the *Teacher Resource Manual*. Model these strategies and "think out loud" with students. Encourage the use of estimation skills on a daily basis in activities involving:

- applications
- problem solving
- the use of calculators.

Encourage students to develop the habit of always asking themselves:

- Is my answer reasonable?
- Within what range of numbers must my answers lie?

Evaluation of student competence in estimation is best done through informal observation. Formal assessment tends to encourage the student to make an approximation after obtaining an exact answer.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

Whole Numbers

Applies whole number concepts and skills to practical problem situations that are appropriate to student age and maturity level.

- Recognizes place value to one hundred thousand.
- Reads and writes whole numbers to one hundred thousand in context.
- Compares/orders whole numbers to one hundred thousand in applications.
- Rounds numbers to nearest 10, 100 and 1000.
- Counts by multiples of 2, 3, 4, 5, 6, 10 and 12.
- Calculates/estimates sums and differences of numbers containing up to four digits (without the use of a calculator).
- Recalls products for numbers up to 10 x 10.
- Determines "mental exact" products when multiplying by 10, 100 and 1000.
- Recalls division facts for dividends up to 100.
- Recognizes different methods of representing division.
- Calculates/estimates products and quotients of numbers up to three digits by one digit (without the use of a calculator).
- Applies the properties of numbers and operations to computational activities (e.g., properties of zero and one, commutative/associative/ distributive properties).
- Applies the rules for the order of operations (brackets, multiplication, division, addition and subtraction).

Sequences and ranks whole numbers when working with:

- information provided in tables/graphs
- sports data
- library cards
- tickets of chance.

Reads/interprets/records numerical patterns and codes used for:

- house numbers/room numbers
- lock combinations
- highway routes/bus routes
- stadium seats
- telephone numbers
- postal codes.

Counts by multiples in determining:

- numbers represented on a graph
- time indicated on a traditional timepiece
- seats in a stadium/cars in a parking lot
- value of currency (coins and bills)
- total inventory on hand.

Reads and interprets whole numbers/ calibrations on familiar meters, gauges and scales:

- kitchen measuring tools
- thermometer
- furnace thermostat
- odometer
- natural gas/electric/water meter.

Applies appropriate computational strategies (i.e., mental arithmetic, paper-and-pencil, caiculator, estimation) in determining:

- game scores (sports, board games, cards)
- purchase requirements (total items = items per package x number of packages)
- appropriate amounts for sharing (amount per person = total amount ÷ number of people)
- materials required for decorating and repair projects undertaken around the home (number of tiles/bricks/ panels/litres of paint/metres of trim required).

Uses the correct order for operations in answering skill-testing questions used in contests and promotions.

Related Applications Across the Curriculum

Language Arts

Recognizes order/place value for whole numbers in using the Dewey Decimal System.

Science

Reads and interprets whole number calibrations on meters/gauges/scales.

Uses whole number skills when interpreting information related to:

- use of environment and resources
- plant/animal distribution
- local pollution factors.

Social Studies

Uses whole number estimation skills in determining:

- distances between locations on an Alberta map
- populations of a variety of provincial areas.

Recognizes order/place value of whole numbers when interpreting:

- immigration patterns
- population trends
- climate patterns
- employment statistics of major industries.

Practical Arts

Uses whole number computational skills in solving problems that involve:

- counting, calculating, and recording movement of inventory
- reading and interpreting numbers represented on various measuring devices
- reading and interpreting temperatures.

Suggested Strategies/Activities

Select instructional activities that stress the process of "doing" rather than singular results. Encourage students to discover patterns and relationships for themselves by:

- exploring/experimenting
- simulating problem situations
- working in small groups
- discussing/sharing ideas.

Concept development must be based upon the use of concrete and visual materials. Ask chains of questions (see "Instructional Mediation") that will assist students in making a connection between the concrete and abstract. A question such as "Why did you think that way?" will often reveal important insights into a student's thought patterns.

Graph paper arrays are useful in reinforcing multiplication/division facts. Explicitly teach "patterns" in each set of facts. Students who experience persistent difficulty in recalling their basic facts (addition/subtraction/multiplication/division) will need to employ other strategies (e.g., calculator, tables, repeated additions/subtractions, finger math) in order to develop an understanding of process and consolidate needed computational skills. Avoid humiliating those who have not mastered their basic facts by emphasizing self-competition rather than team competition.

Students often experience difficulty in understanding the abstract processes involved in:

- rounding beyond 10's and 100's (e.g., 1000's, 10 000's, 100 000's)
- three-digit and four-digit subtraction that involves regrouping over a zero digit
- mental multiplication/division of numbers by 10 and multiples of 10
- division containing zeros in the quotient.

Strategies that are effective in developing these concepts must be identified and frequently modelled as the related skills are used in a variety of contexts.

Additional strategies that might be used to enhance understanding of whole number skills are provided in the *Teacher Resource Manual*: Computational Facility and Estimation.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills
Decimals Applies decimal concepts and skills to practical problem situations, with emphasis on computations involving money. • Recognizes place value to thousandths. • Reads and writes decimals to thousandths in context. • Compares/orders decimals to thousandths in applications. • Rounds to nearest whole number, tenth and hundredth. • Calculates/estimates sums and differences of numbers with one or two decimal places (without the use of a calculator). • Calculates/estimates products of decimal numbers to thousandths, using one-digit multipliers (without the use of a calculator). • Calculates/estimates quotients for two decimal place numbers divided by one-digit whole number divisors (without the use of a calculator). • Determines "mental exact" products/quotients when multiplying or dividing decimals by 10 and 100.	Reads meters, gauges and scales found in the home that are calibrated in tenths and hundredths. Establishes a practice of rounding calculations that represent money to the nearest cent. Multiplies/divides by multiples of 10 in converting metric units of measure. Makes correct change using the "subtractive" or "add-on" methods. Applies appropriate computational strategies (i.e., mental arithmetic, paper and pencil, calculator, estimation) to consumer transactions: • determines unit price/multiple price of consumer items • determines the "best buy" by comparing the unit price of competing brands • maintains a running total of the cost of items being selected for purchase • determines the total cost of items purchased • determines change due on purchases made • checks the accuracy of sales-slip calculations. Reads and interprets a restaurant menu, estimating total cost of a meal. Determines the cost of leisure time activities. Considers factors such as: • admission • transportation • snacks. Compares the cost of renting videotapes with the cost of movie attendance. Plans and estimates the cost of a trip. Considers factors such as: • transportation • meals • accommodation • incidentals. Compares equipment and participation costs for different sports: • hockey • skiing • swimming • tennis.

Related Applications Across the Curriculum

Language Arts

Recognizes order/place value for decimals in using the Dewey Decimal System.

Science

Reads and interprets decimal calibrations on meters, gauges and scales.

Uses whole number/decimal computational procedures when:

- mixing solutions of given strength
- monitoring temperature change
- monitoring duration of time
- determining work accomplished by machines
- determining appropriate amounts of food/growth supplements for plants
- determining energy consumption/costs.

Practical Arts

Uses whole number/decimal computational skills in situations that involve:

- reading and interpreting numbers in the context of purchasing/selling/inventory control
- modifying quantities of supplies/ ingredients to suit variable needs (e.g., increasing or decreasing recipe ingredients/chemical mixtures)
- preparing bills/invoices (e.g., prepares work orders/bills for services rendered and merchandise sold)
- processing cash/credit transactions (e.g., makes change and balances cash receipts)
- reading and interpreting measurements from diagrams/blueprints/recipes
- calculating unit costs
- calculating wages earned on an hourly, daily, weekly, monthly or annual basis.

Suggested Strategies/Activities

Reinforce place value concepts by relating tenths and hundredths to parts of the dollar:

- one cent = .01 = 1/100 of a dollar
- one dime = .10 = 1/10 of a dollar.

Although students must recognize place value to thousandths for purposes of rounding, most activities at this level will involve numbers containing one or two decimal places.

Some students may reverse or misplace numbers in performing algorithmic procedures. These errors are often avoided if difficult paper-and-pencil computations are performed in a tic-tac-toe configuration on graph paper. Encourage students to develop personal strategies that will assist them to place the decimal correctly in the computational results they obtain.

Calculators should be used on a regular basis in applications and problem-solving situations involving large numbers and tedious calculations. Develop strategies that will enable students to determine 'how many are left over' when division is performed on the calculator. Estimation skills must be developed and used in checking the reasonableness of answers obtained on the calculator.

Estimation frequently requires proficiency in multiplication/division by powers of 10. Discuss and develop 'first-letter mnemonic strategies' that will assist students in accurately performing these thought processes. (An example of the use of 'first-letter mnemonic strategies' is provided in the *Teacher Resource Manual*: Use of Technology.)

Provide frequent opportunity for students to practise mental arithmetic skills when computing with decimals. Simulate consumer situations where students are required to use mental arithmetic in determining:

- the total cost of several items purchased
- change due, given amount offered in tender
- unit price/multiple price.

The *Teacher Resource Manual*: Using a Math Lab provides additional strategies for developing decimal concepts and skills that include the use of.

- number line activities
- diagrammatic representation
- manipulative materials
- computer programs of instruction.

LEARNING OBJECTIVES	Related Life Skills

Fractions

Demonstrates an understanding of basic concepts and skills related to fractions through the use of real life models and concrete manipulatives (with emphasis on fractions having denominators of 2, 3, 4, 5, 8 and 10).

- Illustrates the use of fractions in describing part of a whole, group, or point on a number line.
- Illustrates the relationship between whole numbers, decimals and fractions using a number line.
- Describes proper fractions, improper fractions and mixed numbers through the use of objects, pictures and diagrams.
- Converts improper fractions to mixed numbers, and vice versa.
- Compares/orders fractions in applications.
- Identifies and determines equivalent fractions.
- Recognizes and expresses fractions in basic form.
- Demonstrates addition and subtraction of proper fractions/mixed numbers (with like denominators) through the use of objects, pictures and diagrams.
- Writes number sentences to describe the addition and subtraction of fractions with like denominators.

Recognizes the everyday use of fractions:

- three-quarters of an hour
- half a dozen
- two-thirds of a cup
- one-fifth of the class
- one-quarter of a dollar
- half-price sale.

Reads and interprets fractions represented on frequently used scales and gauges.

- inch ruler
- kitchen measures of capacity and mass
- fuel gauge.

Measures/draws figures and objects to the nearest half, quarter and eighth of an inch. Uses the inch unit in taking measurements for various home maintenance and repair projects.

Recognizes the use of equivalent fractions in describing parts to be shared:

- two-eighths (or one-quarter) of a pizza
- three-sixths (or one-half) of a pie
- two-tenths (or one-fifth) of a chocolate bar.

Follows recipes and directions that involve the use of fractional units of measure.

- two and three-quarter cups
- one and one-half teaspoons
- one-third of a package
- one-half a block
- one-quarter of a turn.

Related Applications Across the Curriculum

Science

Reads and interprets fractional calibrations on meters, gauges and scales.

Uses basic concepts/skills related to fractions when interpreting:

- mechanical advantage/efficiency of machines
- germination rates/growth rates for plants.

Practical Arts

Uses basic concepts/skills related to fractions in activities and projects that involve:

- interpreting fractional measurements that are provided in diagrams/blueprints/ recipes
- reading/interpreting fractional calibrations on various measuring devices
- reading charts to determine equivalent fraction/decimal sizes for mechanical fasteners and tools.

Suggested Strategies/Activities

The abstract thought processes required in understanding fractions are often a source of frustration to students The cognitive demands of these concepts make it necessary that instruction include the extensive use of manipulative and visual materials.

Structure activities using a "math lab" approach, giving students the opportunity to manipulate materials and see tangible outcomes. De-emphasize the use of activities that yield similar results through the application of computational rules not yet understood by students. Activities should be selected that encourage students to:

- work with real models/pictures/diagrams
- experiment/explore
- ask questions
- verbalize ideas and discoveries
- make associations/draw conclusions.

Keep arithmetical computation simple, working only with fractions commonly encountered in real life situations. Concept and skill development might be limited to work with the fractions included in the following families:

- 1/2, 1/4th's, 1/8th's
- 1/2, 1/3rd's, 1/6th's
- 1/2, 1/5th's, 1/10th's.

Operations with fractions should be demonstrated through concrete manipulation and pictorial representation. Translation to numbers and symbols should occur only after the processes have been understood. By asking appropriate chains of questions (see "Instructional Mediation"), students can be encouraged to discover relationships and generalize the results of their investigations.

The Imperial ruler offers many opportunities for students to reinforce/extend their understanding of fractions through application in practical contexts. Measuring/drawing figures and objects to the nearest 1/2, 1/4 and 1/8 of an inch will enhance student ability to recognize equivalence and order for fractions. Simple operations can also be demonstrated on the ruler.

Strategies that support concept development through a "math lab" approach are provided in the *Teacher Resource Manual*: Using a Math Lab.

MATHEMATICS (I.O.P. GRADE 8)

RATIO, PROPORTION AND PERCENT

CONCEPTS:

- Recognizes appropriate strategies for solving problems. Applies problem-solving strategies and skills to practical everyday situations that are routine in nature, and to situations where no readily apparent solution or means to the solution are evident.

- Demonstrates an understanding of concepts relating to ratio, proportion and percent at a concrete level, and within the context of meaningful everyday situations.

- Performs computations through the use of mental arithmetic, paper-and-pencil algorithms, the calculator and estimation. Selects computational methods that are appropriate to the nature of the task being performed.

- Recognizes that technology, in the form of calculators and computers, has influenced the nature of the computational processes and procedures we frequently use. Develops an understanding of procedures followed in the use of these technologies and recognizes their influence on our lives.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - works independently, as well as effectively with others in group situations
  - demonstrates/shares that which has been learned in group discussions and activities.

- Demonstrates a desire to solve problems by asking questions, showing interest/curiosity, taking risks and displaying perseverance.

- Recognizes the value of an organized approach to problem solving. Practises critical and creative thinking in problem solving and accepts unconventional strategies and alternative solutions.

- Appreciates the usefulness of computational competence and problem-solving ability within the home, the community and the workplace.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: RATIO, PROPORTION AND PERCENT

LEARNING OBJECTIVES	Related Life Skills

Demonstrates an understanding of concepts related to ratio, proportion and percent at the concrete level through the use of objects/models/ diagrams. Relates skills to everyday applications and a strategy for solving problems.

- Recognizes ratios as ordered pairs of numbers showing comparison of two quantities in the same unit.
- Uses concrete manipulation to construct ratios in the forms a:b, a is to b, and a/b.
- Generates equivalent ratios using single-digit whole number constants.
- Verifies the equivalence of two ratios using common multiples or factors (e.g., $\frac{14}{6}\frac{(\div 2)}{(\div 2)} = \frac{7}{3}$).
- Recognize proportions as statements about equivalent ratios.
- Describes practical problem situations by writing proportions.
- Determines the value of the missing component in a proportion using the common factor/multiple method (e.g., $\frac{3(\times 25)}{4(\times 25)} = \frac{?}{100}$).
- Demonstrates the concept of percent as ratio indicating parts out of 100.

Interprets and writes ratios that show comparison between two quantities in the same unit or in different units:

- sports statistics (wins to losses)
- price of consumer articles (2 for 99 cents)
- heart rate (70 beats per minute)
- blood pressure (120/80)
- travel rates (60 kilometres per hour)
- wage rates ($12.00 for 3 hours of work).

Applies the concept of equivalent ratios when:

- building an actual model
- preparing a scale drawing
- interpreting distances on a map.

Uses equivalent ratios in determining appropriate ingredients for mixtures and solutions (e.g., two parts water to one part of concentrate). Increases/decreases recipes through the application of ratio skills.

Uses equivalent ratios in determining unit cost and multiple cost of consumer items. Evaluates calculations in determining the "best buy".

Interprets the meaning of percent in applications that relate to:

- personal budgeting
- discounts/sale prices
- price increase
- school marks
- cost of borrowing money.

Related Applications Across the Curriculum

Science

Uses ratio, proportion, and percent in order to:

- prepare solutions of given strength (e.g., a 5:1 strength)
- modify ingredients used in a mixture or solution (e.g., increasing/decreasing quantity)
- determine increase/decrease in force and speed for mechanical systems
- understand mechanical advantage and efficiency ratings
- construct gear and pulley applications
- determine germination rates
- understand numerical ratings on fertilizers/growth supplements.

Social Studies

Uses ratio, proportion, and percent in comparing communities in relation to.

- population
- industry/business base

Practical Arts

Uses ratio, proportion, and percent in.

- working with solutions and mixtures
- increasing and decreasing recipes/scales
- calculating profit/loss, discount/mark-up, and entrepreneurial success.

Suggested Strategies/Activities

The developmental level of many students will inhibit their understanding of ratio and proportion in an abstract way. Develop concepts through the use of concrete and visual representation. Keep number relationships simple, and emphasize relevant application rather than tedious computation.

The *Teacher Resource Manual*: Using a Math Lab provides sequenced activities for developing ratio/proportion concepts. Activities are based on the use of manipulative and visual materials (e.g., real objects, cuisenaire rods, diagrams), and emphasize understanding of:

- the "per unit" idea of ratio
- equivalent integral ratios
- equivalent non-integral ratios.

Difficulties are often based on misconceptions held by students about ratio. Through discussion/questioning/activity, ensure that all students recognize that:

- ratio is a relationship between two variables (students often focus on only one of the elements that form the ratio)
- the relationship between variables is multiplicative rather than additive (students often incorrectly conclude that 3/1 and 5/3 are the same because $3 - 1 = 5 - 3$).

Provide frequent opportunity for students to develop and apply new problem-solving strategies when working with situations involving ratio. Encourage the use of real models and diagrammatic representation in problems, and the per-unit approach or common multiple/factor method of finding the unknown. The use of algebraic procedures (e.g., cross-products) in solving proportions should be discouraged at this level.

While skill in paper-and-pencil computation must be maintained, encourage students to use the calculator in applications and problem solving. Develop mental facility with ratio concepts by spending short periods of time each day asking students to provide verbal response to statements such as:

- What are two equivalent ratios for . . . ?
- Express the ratio . . . in three other ways.
- Explain two ways of finding the unknown in $3/4 = ?/20$.

Develop the concept of percent through visual representation on the "100 grid". Illustrate given percents (and the equivalent ratios) by drawing and shading on 10 x 10 grid paper.

MATHEMATICS (I.O.P. GRADE 8)

GEOMETRY AND MEASUREMENT

CONCEPTS:

- Recognizes geometry as a visual approach to organizing and interpreting our perceptions of the environment and the real world.
- Examines the basic concepts, patterns and relationships associated with one-, two- and three-dimensional geometric figures.
- Illustrates the measurable attributes of an object that can be quantified through the process of measurement.
- Recognizes the iterative and comparative nature of estimation and measurement.
- Devises a mental frame of reference for the size of standard units of measure, relative to each other and to real objects.
- Recognizes how concepts/skills in geometry and measurement can be used in everyday applications and problem solving.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - communicates personal difficulties/successes with tasks that are undertaken
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.
- Gives attention to geometric patterns/designs present in the environment.
- Appreciates the ways in which geometry and measurement affect our daily activities, and may contribute to the problem-solving process.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills

Note: It is the policy of Alberta Education that SI units be the principal system of measurement in the curriculum of the schools in the province. The study of specific Imperial units should be related only to those that are relevant to student needs (as dictated by the demands of the workplace/community partnership sites) and should be kept to a minimum.

- Displays an understanding of the attributes and properties of familiar shapes and objects:
  - examines the size and shape of familiar one-, two- and three-dimensional figures through the use of concrete materials
  - recognizes examples of one-, two- and three-dimensional figures as they occur in the environment
  - applies knowledge of geometric figures and relationships in practical situations.

- Estimates/measures length, mass, capacity and time within the context of everyday applications and problem-solving:
  - selects units and tools that are appropriate to the situation
  - estimates and measures
  - makes conversions as required among commonly used units.

Recognizes/appreciates geometric form found in:

- the natural environment
- architecture
- floor coverings/fabrics/wallpaper.

Applies knowledge of the properties of geometric figures in order to interpret/ construct:

- scale diagrams (e.g., floor plans, maps)
- graphs and charts
- patterns and designs.

Recognizes how measurement is used in:

- providing information on product labels
- home maintenance/repair
- sporting events
- travel schedules.

Uses estimation and measurement in order to answer everyday questions such as.

- How long will it take to finish this homework?
- About how much juice will we need for the party?
- Will the desk fit between the two cabinets?

Geometry

- Identifies and distinguishes between horizontal, vertical, perpendicular, parallel and intersecting lines.

- Identifies/classifies/describes basic two-dimensional figures (rectangle, square, triangle, circle).

- Uses geometric tools (e.g., protractor, compass, straightedge, ruler, computer) to construct rectangles, squares, triangles and circles according to given specifications.

- Identifies and constructs models of basic three-dimensional figures (rectangular prism., cube, cylinder).

Recognizes geometric shapes/ relationships that are used on:

- street signs
- maps/scale drawings
- fabric care labels
- hazardous product labels.

Applies geometric relationships when giving or following directions on a map Uses map coordinates to locate points on city street maps and Alberta road maps.

Uses geometric shape in designing and constructing various home and hobby projects. Plans the project by constructing a scale drawing or model.

Related Applications Across the Curriculum	Suggested Strategies/Activities
Science Uses concepts of one-, two- and three-dimensional geometry when. • investigating principles that govern the operation of simple mechanical technologies • designing and constructing simple mechanical technologies.	Geometry should emphasize the visual perception of pattern and form present in the student's personal environment. Knowledge of geometric figures/ relationships can be developed by modelling various aspects of the physical world, and by providing frequent opportunity for work with concrete materials. Teaching strategies that are inductive and experimental will enable students to recognize patterns and develop an understanding of the more abstract concepts in geometry. Activities must place emphasis on observation, manipulation and construction.
Social Studies Uses concepts of one-, two- and three-dimensional geometry when. • observing geometric shapes used in the community • developing an appreciation of the use of patterns and shapes in improving the aesthetic quality of a community.	Measurement must be understood as a process of comparison to some arbitrary unit. Students need to recognize the repetition of identical units that occurs in measurement, and the need to combine/subdivide selected units into larger/smaller units when describing length, mass and capacity. Initial experiences should be based on the use of non-standard units (e.g., body referents, objects in the classroom). Through discussion and activity, an understanding of the need for standardized units and tools can be developed.
Practical Arts Applies knowledge of geometric figures and relationships when completing projects in. • graphics • metalwork • woodwork • personal grooming.	Concepts of one-dimensional space are usually well understood by students. Learners, however, find two-dimensional and three-dimensional ideas considerably more difficult and require much concrete support for successful experience in these areas. Actual manipulation and construction will assist students in recognizing the spatial relationships inherent in these figures. Observe and discuss geometric figures and relationships present in the real world through the use of pictures/photographs/nature walks/filmstrips/ videos. Encourage students to relate their observations to abstract concepts of the two-dimensional plane and three-dimensional space. A variety of instructional activities that may assist students to interpret and organize their visual perceptions are provided in the *Teacher Resource Manual*: Using a Math Lab. Activities include the use of: • geoboards/dot paper/grid paper • tangrams/tessellations • LOGO computer programs • line design/model construction.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills
Linear Measure	
• Recognizes common metric units of length (mm, cm, m, km).	Reads and interprets scales on rulers and tape measures.
• Estimates and measures length, selecting metric units and tools appropriate to the situation.	Applies knowledge of the measurement process to a variety of everyday situations that require estimation rather than exact measurement: • "about" how long? • "about" how far? • "about" how wide? • "about" how tall? • "about" how far around?
• Draws lines according to given specifications, using metric units and tools.	
• Converts measurements of length among commonly used metric units: – among mm, cm and m – between m and km.	Uses skills of estimation and measurement in determining materials required for various decorating/construction/repair projects, and in performing activities necessary to the completion of these projects: • determines length of fabric required in sewing project • carefully marks desired length before cutting piece of wood in carpentry project.
• Illustrates the concept of perimeter, and explains its application to problem-solving situations.	Calculates perimeter in order to determine the quantity of materials required for. • trimming • fencing • panelling.
• Estimates/measures/computes the perimeter of figures bounded by line segments.	
E • Recognizes Imperial units of length still in use (inch, foot, yard, mile).	Takes body measurements, using tools and units appropriate to the task. Relates body measurements to clothing size.
E • Estimates and measures length, selecting Imperial units and tools appropriate to the situation.	Develops a "frame of reference" for the kilometre, and relates familiar travel distances to the kilometre.
E • Draws lines according to given specifications, using Imperial units and tools.	Converts units of measure as required in determining: • unit price and "best buy" for consumer items sold by length • cost of materials purchased by length (e.g., 75 cm of fabric at a cost of $15.98 per m).
E • Compares cm to inch, m to yard, and km to mile.	

E – Elective Content

Related Applications Across the Curriculum

Science

Makes accurate observations by estimating/measuring length, selecting units/tools appropriate to the phenomena investigated.

Uses linear measure when investigating:

- plant growth
- the operation of simple machines/mechanical technologies
- environmental factor/relationships.

Social Studies

Uses measurement skills in:

- estimating and measuring distances between home/school/shopping area, etc.
- estimating the perimeters of recreational areas (e.g., parks, golf courses, pools, bicycle paths).

Practical Arts

Recognizes units/tools of linear measure that are appropriate for specific purposes, and converts among units as required.

Reads scales on tape measures, rulers and other measuring devices in order to produce a product or provide a service.

Uses linear measure and the concept of perimeter in:

- project work
- woodwork
- metalwork.

Suggested Strategies/Activities

Encourage students to develop a "feel" for standard units of length through the use of referents and visual imagery:

- mm (width of a dime)
- cm (width of little finger)
- m (width of a table in the room)
- km (distance between two familiar points).

Consider the following guidelines in planning activities in estimation and measurement:

- skill in estimation is best developed by having students first make an estimate and then check their estimate through direct measurement
- although some experience in direct measurement may immediately follow the introduction of a particular unit, only a few measurements of this nature should be taken before students are asked to make estimates prior to performing direct measurement
- encourage good estimates, but do not provide penalties for inaccurate ones
- the ability to estimate is based on previous experience, and must be practised on a regular basis throughout the program (games intended to develop and maintain skill in estimation are provided in the *Teacher Resource Manual*: Using a Math Lab.

Relate activities in estimation and measurement to situations encountered in the real world:

- body measurements
- size of familiar objects/pieces of furniture
- dimensions of windows/doors/rooms
- distances in the community.

Develop the concept of perimeter through activities provided in the *Teacher Resource Manual*: Using a Math Lab that involve the use of geoboards/dot paper/grid paper. Applications and problem solving should emphasize the use of diagrams/models and estimation.

Business and industry have reached varying stages in their conversion from Imperial units to metric units. Some occupations/life skills still require the use of Imperial units. Community needs will determine the extent to which elective content dealing with Imperial measure will be developed. If developed, students should compare only, and not convert corresponding units from the Imperial system to the metric system:

- Is three metres of fabric more than three yards of fabric?
- Is my waistline measurement 30 inches or 30 cm?

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills
Mass Measure	
• Describes mass, and recognizes common metric units (g, kg, t).	Uses estimation skills in: • discriminating between objects of "greater" and "lesser" mass • approximating the mass of familiar household and consumer items.
• Estimates and measures mass, selecting metric units and tools appropriate to the situation.	Selects items for purchase that are sold by mass. Estimates and measures the mass of consumer items, using tools and units appropriate to the situation. • produce and deli goods • bulk goods.
• Converts between g and kg, and between kg and t.	Interprets product labels that provide information relating to mass: • boxed/canned goods • medications.
E • Recognizes Imperial units of mass still in use (ounce, pound).	Monitors personal weight, using appropriate units.
E • Estimates and measures mass, selecting Imperial units and tools appropriate to the situation.	Converts units of measure as required in: • adjusting recipes/directions that involve mass • determining unit price and "best buy" for consumer items sold by mass
E • Compares the kg to the pound.	
Capacity Measure	
• Describes capacity, and recognizes common metric units (mL, L).	Recognizes the use of capacity in practical situations that involve fluid measure: • cooking/baking • beverage containers • paints/cleaners • automobile fuel.
• Estimates and measures capacity, selecting metric units and tools appropriate to the situation.	Uses estimation skills in: • discriminating between containers of "greater" and "lesser" capacity • determining if a container is "large enough" for the purpose at hand.
• Converts between mL and L.	Interprets product labels that provide information relating to capacity: • canned/bottled/jar goods • medications
E • Recognizes Imperial units of capacity still in use (cups, gallons).	Converts units of measure as required in: • adjusting recipes/directions that involve capacity measure • determining unit price and "best buy" for consumer items sold by capacity.
E • Estimates and measures capacity, selecting Imperial units and tools appropriate to situation.	
E • Compares mL and L to cups, also L to gallons.	

E – Elective Content

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Estimates/measures mass and capacity in a variety of inquiry-related activities:

- measures household chemicals by mass and capacity
- prepares mixtures/solutions using appropriate measures of capacity
- measures force/mass when investigating principles that govern the operation of simple machines and mechanical systems
- measures fertilizers and other plant growth supplements by mass and capacity.

Practical Arts

Recognizes appropriate units and tools for measuring mass, and converts between units as required when:

- following recipes
- preparing mixtures and solutions
- purchasing goods by weight.

Recognizes appropriate units and tools for measuring capacity, and converts between units as required when:

- following recipes
- preparing mixtures and solutions
- purchasing goods by capacity.

Assist students to develop a "feel" for standard units through the use of referents and visual imagery:

- g (mass of a raisin)
- kg (mass of an adult pair of shoes)
- mL (amount of liquid in an eyedropper)
- L (amount of milk in a carton).

Develop the concepts of "mass" and "capacity" through activities that involve estimation, before providing instruction in direct measurement. Guidelines provided in the previous section on linear measure should be considered in planning activities related to the measurement of mass and capacity.

Techniques for making initial estimates of mass/capacity may include:

- comparing the whole object to be estimated with a familiar object of known size
- using a referent of known size as a given unit and mentally or physically marking off/filling the object to be estimated.

Be sure to accept a range of estimates, and encourage students to share the techniques they have used in obtaining their estimates.

Create a bulletin board display of everyday objects and their measures. Some suggestions for the display include:

- dollar bill (about 15.5 cm × 6.5 cm)
- teaspoon (about 5 mL)
- nickel (about 5 g).

Provide multiple opportunities for students to estimate/measure through activities that simulate real life situations:

- determining the mass of familiar bulk/packaged supermarket and hardware items
- determining the capacity of kitchen/workshop containers of varying size and shape
- investigating the nature and use of various measurement tools used in the home/community
- working with recipes/directions that involve capacity measure and conversion.

Community needs will determine the extent to which elective content dealing with Imperial measure will be developed. If developed, students should compare only and not convert corresponding units from the Imperial system to the metric system:

- Is a 5 kg bag of apples larger than a 5 pound bag of apples?
- Does a one-gallon container hold more than a one-litre container?

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills
Time Measure	Uses calendar and dating skills in a variety of everyday situations:
• Uses a calendar, recognizing the relationship between days, weeks, months and years.	• recognizes the difference between past, present and future dates on a calendar • recognizes due dates on bills and library books • dates letters, cheques and application forms appropriately • denotes special dates on the calendar (e.g., pay days, holidays, test dates).
E • Recognizes the dates of major Canadian holidays.	
• Uses National Standards for numeric dating.	Appreciates the importance of time measure in relation to:
• Estimates/measures/records time on the 12-hour and 24-hour clock (using traditional and digital timepieces).	• school/work • social engagements • appointments • travel departures.
	Organizes personal time and develops schedules for completing tasks:
	• test preparation • homework • leisure activities • part-time work.
E – Elective Content	Recognizes the minute equivalents of $\frac{1}{4}$ hour, $\frac{1}{2}$ hour, and $\frac{3}{4}$ hour and estimates the passage of each.
	Estimates and makes allowance for the passage of time in a variety of everyday situations:
	• long-distance telephone calls • frequently used travel routes • daily chores.
	Reads and interprets 24-hour time stated on:
	• train, bus and plane schedule • traffic/parking signs (e.g., no parking between 16:00h and 18:30h).

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Measures intervals of time as required in conducting scientific investigation. Monitors:

- rate of chemical reactions
- speed of dissolution
- growth rates of plants.

Social Studies

Uses time measurement skills in determining time differences between given locations in Canada and/or other countries.

Practical Arts

Maintains a personal record of attendance and punctuality for classroom activities and field experiences:

- time-in/time-out
- hours worked
- recording time of telephone contacts
- record of appointments.

Measures intervals of time required for various processes/procedures:

- cooking/baking time
- drying time
- keyboarding.

Applies time management skills in accepting project and service work.

Most students should have already mastered skills involving the use of the calendar and 12-hour clock. Pre-tests could be given in order to determine the need for instruction/remediation in these areas.

Activities should encourage students to recognize the importance of time in their everyday pursuits. Skills can be maintained by incorporating the use of the calendar, stopwatch, digital clock, and traditional 12-hour and 24-hour clocks into daily activities throughout the program.

Assist students to estimate time by comparing time intervals to the duration of a familiar event:

- counting
- length of a song/television program
- length of a school day.

Provide opportunity for students to estimate both active and passive periods of time:

- one minute of silence
- five minutes of silent reading
- fifteen minutes of work
- time required to get to school.

Encourage students to interpret time schedules (e.g., travel/telecast schedules) through questions such as:

- How long does it take to travel from point A to point B?
- How often does the bus depart from point C?
- What sports events are telecast between 18:00h and 21:00h on weekdays?

A variety of projects that involve the use of time measure are provided in themes developed in the *Teacher Resource Manual*. Projects require students to interpret and use:

- personal time schedules
- bus/train/plane schedules
- radio/television schedules.

MATHEMATICS (I.O.P. GRADE 8)

DATA INTERPRETATION AND DISPLAY

CONCEPTS:

- Understands procedures used in reading and interpreting data presented in tables, charts and graphs.
- Uses tally sheets, tables and charts to collect, organize and display data.
- Recognizes that inability to interpret numerical data in real life situations may result in decisions that are inappropriate and consequences that are not desired.
- Applies strategies for problem solving and decision making that involve the use of relevant information obtained from tables, charts or graphs.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - demonstrates self-confidence through independent work
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.
- Recognizes the value of tables, charts and graphs in summarizing numerical data and in communicating ideas.
- Appreciates the need to evaluate data displayed in simple statistics/charts/graphs before using the information to make decisions or choose courses of action.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: DATA INTERPRETATION AND DISPLAY

LEARNING OBJECTIVES	Related Life Skills

Collects, organizes, interprets and displays numerical data in order to solve problems and make decisions in practical everyday situations.

- Recognizes the use of statistics in real life situations, and its effects on everyday activities.
- Reads and interprets information presented in list, table and chart form.
- Collects and records data using tally sheets and frequency tables.
- Uses tables and charts to group/sort numerical data and information according to specified criteria.
- Reads and interprets information presented in pictographs, bar graphs and line graphs.

Recognizes how numbers and statistics are used in everyday situations:

- weather reports (probability of precipitation)
- consumer reports (average price of an item)
- opinion polls (popularity of a television program or political figure)
- performance in sports (batting average)
- personal development (average height/weight charts)
- health risks (frequency of lung cancer in smokers)
- lottery outcomes (odds of winning the jackpot).

Uses tally sheets/frequency tables in recording information:

- sporting scores/achievements
- points in a card game
- research data.

Interprets information provided in books, pamphlets, newspapers and magazines that is displayed in table/chart/graph form:

- television/travel schedules
- telephone/postal/utility rates
- highway distance charts
- population trends
- measurement conversion charts
- income/expense
- price increase/price decrease
- spending patterns/budgets.

Uses tables/charts that are intended to provide direction and sequence for activity:

- assembly instructions
- recipe ingredients.

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Related Applications Across the Curriculum	Suggested Strategies/Activities

Language Arts

Interprets statistical information as required in research activities.

Science

Uses tally sheets and frequency tables in collecting/recording data obtained through observation and experimentation.

Obtains information by reading and interpreting data provided in tables, charts, and graphs.

Social Studies

Gathers and displays survey data using a variety of methods:

- lists
- tables/charts
- graphs.

Practical Arts

Reads and interprets data that has been presented in a variety of graphic forms.

Reads and interprets tables and charts in order to perform required tasks:

- specifications chart
- tables of pattern size.

Organizes data to show relationships between procedures, outcomes, products, and events

Activities that involve the interpretation and display of numerical data should be integrated throughout each theme of the math program The discrete development of related concepts and skills is discouraged. Select tables/charts/graphs from a variety of available sources that relate to the topics investigated within each theme. Projects undertaken in other subject areas may provide additional opportunity for the application of skills being developed.

Emphasize and model the use of tables/charts/graphs as useful strategies in solving problems:

- interpreting problem information provided in table/chart/graph form
- manipulating/organizing problem information into charts/graphs in order to make patterns and relationships more discernable.

Provide students with first-hand experience in collecting/organizing/displaying information through the use of tally sheets, tables and charts. Information might be collected from the newspaper or through personal interview/observation, and should relate to areas of study within particular themes:

- consumer prices/spending habits
- daily temperatures
- weight/height of a sample population
- preferred music/recreational activities within a sample population
- other research data.

Encourage students to draw conclusions/make predictions that are based on the information they have collected and displayed.

Ask chains of questions that will assist students to interpret the information displayed in pictographs, bar graphs and line graphs. Discuss the characteristics and comparative strengths/weaknesses of each type of graph

Instruction at this level should emphasize ability to interpret rather than display data in graphic form. Extension activities that provide first-hand experience in the actual construction of graphs are worthwhile, and might be provided as part of the elective component in Grade 8.

Activities provided in the *Teacher Resource Manual* focus attention on the development of skills in data interpretation/display at appropriate points within each theme.

MATHEMATICS (I.O.P. GRADE 8)

ALGEBRA

CONCEPTS:

- Identifies arithmetical p .terns and relationships that are present in concrete situations.

- Uses algebraic symbols to write expressions/formulas/linear equations that describe arithmetical patterns and relationships.

- Recognizes the basic properties of number systems and operations:
  - properties of zero and one
  - commutative/associative/distributive properties
  - order of operations.

- Applies knowledge of the basic properties of number systems and operations in manipulating symbols and solving practical problems.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - demonstrates self-confidence through independent work
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.

- Appreciates the usefulness of algebra in generalizing number patterns/relationships, and in apply ng generalizations to practical situations in real life.

COURSE: MATHEMATICS (I.O.P. Grade 8)
CONCEPT: ALGEBRA

LEARNING OBJECTIVES

Displays an understanding of algebraic thought and process by:

- generalizing arithmetical patterns and relationships represented in concrete situations
- representing patterns and relationships through the use of symbols
- transferring generalizations to related applications and problems in real life.

- Distinguishes between the use of variables and constants in concrete situations.
- Uses variables to describe concrete situations (e.g., number of coins in a jar).
- Uses variables to write mathematical expressions that describe practical situations (e.g., if the regular price of an item is reduced by five dollars, the sale price could be represented as R – 5).
- Evaluates mathematical expressions for given whole number values of the variable.
- Uses variables to write linear equations/formulas that describe practical situations (e.g., if each person at a party eats three hotdogs, the relationship between number of hotdogs and number of people can be described as $H = 3 \times P$).
- Interprets formulas related to practical situations as word statements.
- Performs substitution into formulas in determining outcomes/solutions to routine problems.

Related Life Skills

Recognizes number patterns and relationships that are present in practical situations:

- travel/sport/recreation
- home maintenance/repair
- personal finance/management.

Uses formulas to solve routine problems involving previously established number patterns and relationships. Practical situations to which formulas might be applied include:

- travel problems involving distance travelled, rate of travel and travel time
- consumer problems where unit price or multiple price must be determined
- consumer problems where purchase decisions are determined by considering number of items in each package and the number of packages required
- discount problems involving regular price, amount saved and sale price
- problems where appropriate amounts for sharing are determined (e.g., amount per person = total amount ÷ number of people)
- problems where money earned is determined by considering rate of pay and time worked
- problems where adjustments are made in recipes/directions (e.g., increasing or decreasing a recipe)
- problems that require a strategy for finding perimeter
- problems involving the conversion of measurements (e.g., conversions among units of length, mass, capacity, or time).

Related Applications Across the Curriculum

Science

Converts between various metric units of measure by generalizing number relationships (e.g., mL = L x 1000).

Uses formulas to summarize major principles/relationships that have been discovered.

Substitutes into formulas to solve a problem (e.g., W = F x d, MA = R/E).

Social Studies

Uses the concepts of variable and constant in community-related situations:

- a constant population
- a variable economy.

Practical Arts

Uses formulas in solving problems that involve:

- food requirements for a variable number of people
- stock requirements based upon past sales
- conversion among units of measure
- adjusting a recipe/mixture to variable needs.

Suggested Strategies/Activities

Encourage the use of algebraic thought and process throughout the mathematics program. Concepts and skills should not be developed discretely, but rather within the context of each theme studied Activities should foster an understanding of:

- the notion of a variable
- the order of operations
- number patterns/relationships present in real life situations
- procedures for evaluating expressions and formulas.

Be aware that an understanding of the concept of variables develops slowly. Select concrete situations within each theme to demonstrate the use of variables and operations in describing relationships:

- the length of a room is increased by 60 cm ($\ell \rightarrow \ell + 60$)
- the cost of a sweater is reduced by eight dollars ($c \rightarrow c - 8$)
- my wages are doubled ($w \rightarrow 2w$).

Encourage students to generalize patterns and relationships in practical situations through the use of tables. For example, if movie admission is $2.50, provide a table showing the relationship between number of people and cost of admission.

Number	Cost
1	$2.50
2	$5.00
3	$7.50
P	$2.50 × P

Provide opportunity for students to evaluate expressions/formulas through the use of a variety of strategies:

- mental arithmetic
- the calculator
- formal substitution
- tables/charts
- computer programs.

Formulas should be developed by students as a consequence of patterns/relationships that have been observed. Although the application of formulas to routine situations is a useful strategy, their use as "a means to an end" should not occur until the relationship between variables is well understood

MATHEMATICS PROFILE, I.O.P. GRADE 9

		1	2	3	4
01	PROBLEM SOLVING	Recognizes problem-solving situations at school, at home and in the community	Demonstrates a desire to solve problems	Applies strategies required in understanding a problem	Applies strategies required in developing and carrying out a plan for problem solving
		5			
		Uses appropriate strategies in reviewing and applying the results of problem solving			
		1	2	3	
02	USE OF TECHNOLOGY	CALCULATOR Uses previously developed skills (see Grade 8)	Identifies and uses the percent function on the calculator	Generates sets of multiples for a given number using the calculator	
		1			
		COMPUTER Uses previously developed skills (see Grade 8)			
		1	2	3	4
03	COMPUTATIONAL FACILITY AND ESTIMATION	Performs computations through use of paper-and-pencil algorithms (within limited parameters)	Performs computations through use of the calculator	Performs computations through the use of mental arithmetic	Performs computations through application of estimation skills
		5	6		
		Uses estimation skills in checking the reasonableness of computational results	Selects a method of computation that is appropriate to the nature of the problem at hand		
		1	2	3	4
04	NUMBER SYSTEMS AND OPERATIONS	WHOLE NUMBERS Uses previously developed skills (see Grade 8)	Uses a calculator to generate a set of multiples for a given number	Determines the lowest common multiple for pairs of numbers less than 10	Determines pairs of factors related to basic multiplication facts up to 100
		5	6	7	8
		Determines prime numbers up to 50	Expresses numbers up to 50 as the product of prime factors	Determines the greatest common factor for pairs of numbers less than 50	Calculates/estimates products and quotients of numbers up to 3 digits by 2 digits (without calculator)
		1	2	3	4
		DECIMALS Uses previously developed skills (see Grade 8)	Calculates/estimates products of numbers to thousandths, using 1- or 2-digit multipliers (without calculator)	Calculates/estimates quotients to hundredths with 1- or 2-digit whole number divisors (without calculator)	Determines "mental exact" products/quotients when multiplying or dividing by 10, 100 or 1000

MATHEMATICS PROFILE, I.O.P. GRADE 9 (cont'd.)

		1	2	3	4
04	NUMBER SYSTEMS AND OPERATIONS (cont'd.)	FRACTIONS Uses previously developed skills (see Grade 8)	Relates fractions to division, converting fractions into decimal equivalents using a calculator	Recalls decimal equivalents for commonly used fractions (one-half, quarters, tenths)	Determines common denominators for frequently used fractions (1/2, 1/3, 1/4, 1/5, 1/8, 1/10)
		5	6	7	8
		Demonstrates +/− with unlike denominators through use of concrete manipulatives	Writes number sentences to describe the +/− of fractions with unlike denominators	Demonstrates x/÷ of fractions by whole numbers through use of concrete manipulatives	Writes number sentences to describe the x/÷ of fractions by whole numbers
		1	2	3	4
		INTEGERS Recognizes the need for integers, and ways in which they are used	Uses vocabulary related to integers (positive, negative, plus, minus, above, below, gain, loss)	Places integers on the number line	Compares/orders positive and negative numbers in applications
		5	6		
		Demonstrates addition of pairs of integers between −25 and +25 in the concrete mode	Writes number sentences to describe the addition of integers undertaken in the concrete mode		
		1	2	3	4
05	RATIO, PROPORTION AND PERCENT	Uses previously developed concepts/skills (see Grade 8)	Recognizes "rates" as ratios showing comparison of two numbers with different units	Describes practical problem situations involving rates by writing proportions	Determines the missing component in a proportion using common multiple/ factor method
		5	6	7	8
		Converts whole number percents to ratios/decimals	Expresses ratios as percents and decimals	Expresses one- and two-place decimals as percents	Recalls fraction, decimal and percent equivalents for one-half, quarters and tenths
		9	10		
		Determines other fraction, decimal and percent equivalents through use of the calculator	Calculates/estimates percent of a number in relevant applications		
		1	2	3	4
06	GEOMETRY AND MEASUREMENT	GEOMETRY Uses previously developed skills (see Grade 8)	Identifies/recalls characteristics of the parallelogram, hexagon and octagon	Uses geometric tools to construct the parallelogram, hexagon and octagon	Identifies/describes the relationship between the radius and diameter of the circle
		5	6		
		Draws circles, given either radius or diameter	Constructs geometric patterns/designs, using a variety of geometric tools		
		1			
		LENGTH Uses previously developed concepts/ skills (see Grade 8)			

MATHEMATICS PROFILE, I.O.P. GRADE 9 (cont'd.)

		1	2	3	4
06	GEOMETRY AND MEASUREMENT (cont'd.)	AREA Illustrates the concept of area, recognizing common metric units	Approximates the area of two-dimensional geometric figures using a square grid	Recognizes strategies/formulae for finding the area of rectangles and squares	Estimates.calculates the area of rectangles and squares, using appropriate units and strategies
		1			
		MASS Uses previously developed concepts/ skills (see Grade 8)			
		1			
		CAPACITY Uses previously developed concepts/ skills (see Grade 8)			
		1	2	3	
		TIME Uses previously developed concepts/ skills (see Grade 8)	Converts between hours and minutes, also between minutes and seconds	Adds/subtracts hours and minutes in applications	
		1	2	3	
		TEMPERATURE Estimates and measures temperature on the Celsius scale	Recalls important temperatures on the Celsius scale	Determines temperature change, including changes from below zero to above zero	
		1	2	3	4
		ANGLE Recognizes an angle and the degree as a unit of measure	Recognizes angles of 45°, 90°, 180° and 360°	Measures/draws angles from 0° to 180° using a protractor	Uses angle measure in the construction of geometric figures/ patterns/designs
07	DATA INTERPRETATION AND DISPLAY	1 Uses previously developed concepts/ skills (see Grade 8)	2 Interprets and determines arithmetical average in practical situations	3 Recognizes when and how to display data in the form of picture graphs, bar graphs and line graphs	4 Reads and interprets information presented in circle graphs
		5 Recognizes how graphs may sometimes provide misleading information or distort the "true picture"			
08	ALGEBRA	1 Uses previously developed concepts/ skills (see Grade 8)	2 Uses concrete manipulatives to demonstrate the concept of equality	3 Uses estimation and guess/check strategies to solve linear equations that describe practical situations	4 Verifies solutions to linear equations by substitution

PROGRAM OF STUDIES/PRESENTATION OF CONTENT

MATHEMATICS (I.O.P. GRADE 9)

NUMBER SYSTEMS AND OPERATIONS

CONCEPTS:

- Recognizes routine problem-solving situations, and those where no readily apparent solution or means to the solution are evident. Develops an understanding of appropriate strategies for problem solving, and how these strategies can be applied in practical everyday situations.

- Understands the need for computational competence in daily life activities. Recognizes that while computation may involve the use of paper-and-pencil algorithms, computational competence also requires facility in estimation, mental arithmetic and use of the calculator. Develops an understanding of each method of computation and its application in the problem-solving process.

- Recognizes that technology, in the form of calculators and computers, has influenced the nature of the computational processes and procedures we frequently use. Develops an understanding of procedures followed in the use of these technologies, and recognizes their influence on our lives.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics. Develops the confidence to work independently, as well as effectively with others in group situations.

- Demonstrates a desire to solve problems by asking questions, showing interest/curiosity, taking risks and displaying perseverance.

- Recognizes the value of an organized approach to problem solving. Appreciates the role of critical and creative thinking in problem solving, and acknowledges unconventional strategies and alternative solutions.

- Appreciates the usefulness of computational competence and problem-solving skill within the home, the community and the workplace.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

- Demonstrates an understanding of familiar number systems and operations in solving real life problems that require quantitative thinking and computational facility.

  Applies problem-solving strategies that relate to:

  - understanding the problem
  - developing and carrying out a plan
  - reviewing and applying results.

- Performs computations through the use of :

  - mental arithmetic
  - paper-and-pencil computation
  - the calculator
  - estimation.

  Selects a method of computation that is appropriate to the nature of the problem, and provides reasons for the method chosen.

- Uses previously developed skills in mental arithmetic (single digit operations, sequences of operations, doubling/halving, multiplying/dividing by powers of 10, commutative/associative/distributive properties, properties of zero and one).

  Devises non-standard techniques for performing computations with mental arithmetic:

  - compensation
  - computing from left to right.

- Uses paper-and-pencil algorithms within the parameters provided for whole numbers, decimals, integers and fractions.

Uses whole numbers/decimals/fractions to solve real life problems that relate to.

- travel/sport/recreation
- home maintenance/repair
- personal finance/management.

Applies appropriate problem-solving strategies to situations that are routine, involving the application of specific concepts/skills:

- uses a map to determine travel distance and approximate travel time for a short car trip
- determines the number of square metres of carpet required to redecorate bedroom.

Applies appropriate problem-solving strategies to situations that are non-routine and open-ended, requiring the use of creative thinking and ability to recognize different solutions:

- prepares a personal budget based on anticipated income and expenses, that will provide for the purchase of a stereo in several months' time
- selects the most appropriate store for purchase of sportswear after considering selection/quality/cost/service at a number of competing stores.

Recognizes the importance of estimation and mental arithmetic in daily activities.

- Do I have enough money for both the tape and the shirt?
- Should I buy the tennis balls in packages of three or six?
- Have I received the correct amount of change?
- About how long will it take to get there if I travel at 100 km/h?
- Is the answer on my calculator "in the ballpark"?

Related Applications Across the Curriculum

General

The use of appropriate strategies for problem solving is emphasized throughout all subject areas. A problem-solving model similar to the model used in mathematics is frequently applied to real life situations in:

- language arts
- science
- social studies
- the practical arts.

Science

Uses appropriate thought processes and thinking strategies when:

- conducting scientific inquiry
- solving technological problems
- making responsible decisions in society.

Social Studies

Uses problem-solving and decision-making strategies to investigate:

- stereotyping
- environmental problems
- land use.

Practical Arts

Uses problem-solving and decision-making strategies to:

- design/produce a product
- provide a service.

Suggested Strategies/Activities

Apply the problem-solving strategies identified in a previous section of this guide (see "Problem Solving"), as well as those provided in the *Teacher Resource Manual*, to real life situations involving the use of whole numbers, decimals, fractions and integers.

While instructional activities will continue to include the use of routine problems that require the application of familiar techniques, increasing emphasis should be placed on the use of non-routine and open-ended problem situations. Students must be given opportunity to exercise creative/divergent thinking skills and to recognize different solutions in the problems they experience. Individual differences must be considered in providing students with problems that are appropriate to their level of ability

Model the problem-solving process for students. Facilitate active involvement in problem solving by encouraging students to:

- ask questions
- manipulate materials
- discuss and share ideas/strategies in small groups
- verbalize their ideas and discoveries
- think of related problems from personal experience.

Provide opportunity for students to increase their proficiency in the use of all methods of computation (i.e., mental arithmetic, paper-and-pencil, calculator, estimation). Coach students in the discerning use of each method in the problem-solving process, thus avoiding singular emphasis on the use of paper-and-pencil algorithms.

Maintain and develop mental arithmetic skills on a regular basis through timed challenges and games that are appropriate to student ability (see *Teacher Resource Manual*: Computational Facility and Estimation). Avoid embarrassing the student who experiences difficulty with these challenges by emphasizing self-competition and improvement, rather than team competition. Model "easy to use" strategies that will assist students to compute mental exact answers in situations of increasing difficulty. Encourage students to share strategies they find useful with other members of the class.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills
• Uses the calculator to perform computations with whole numbers, decimals and fractions whose magnitude are determined by the nature of the problem situation: – identifies and uses basic functions (+, −, x, ÷, =, decimal, clear) – enters numbers in correct sequence for subtraction and division – determines whole number remainders for division using the calculator – follows order of operations – generates sets of multipies for a given number – selects from calculator display the number of decimal places appropriate to the context of a calculation – checks the reasonableness of answers obtained on the calculator.	Uses a calculator in situations where mental arithmetic would be difficult, or when paper-and-pencil computation would be inefficient: • determining quantity and cost of materials required for a construction/ repair project • monitoring total cost of a number of items being selected for purchase • determining unit price and "best buy" • verifying sales slips/invoices/bills • maintaining bank account balances.
• Uses estimation skills in order to determine: – the range of numbers within which a solution must lie – whether a solution in problem solving is reasonable – the reasonableness of computational results obtained using paper-and-pencil algorithms or the calculator.	Makes a habit of using estimation to check the reasonableness of computational results obtained using paper-and-pencil or the calculator. Uses estimation skills in daily situations where approximate numbers or answers are more appropriate than exact numbers. • Is there enough gas in the car? • How much should I tip? • How many people were at the game? • Can I pay for these items with a twenty dollar bill?
• Applies estimation strategies that include: – stating the largest and smallest reasonable answer to a problem before solving the problem – predicting whether a computation will result in a larger or smaller number – forecasting an order of magnitude for the result of a computation (e.g., 10's, 100's, 1000's) – predicting the magnitude of the result of a computation by rounding numbers to one significant digit – predicting the magnitude of computational results by comparing/clustering numbers – using compatible numbers that are easily manipulated using mental arithmetic.	Applies techniques of estimation in counting and computation: • cars in the parking lot/people in the gym • total cost of items selected for purchase • checking accuracy of sales receipts • anticipating change due when making a purchase • comparing the unit cost of competing consumer items

Related Applications Across the Curriculum

General

Computational procedures are used to varying degrees throughout all subject areas. Following pages of this guide will describe.

- the context in which computation is used in other subject areas
- the nature of the skills used by students.

Science

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator in a variety of classroom/lab situations.

Social Studies

Uses knowledge of number systems and place value when interpreting statistical information.

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator in map work.

Practical Arts

Uses mental arithmetic, estimation, paper-and-pencil algorithms and the calculator to complete thematic learning activities.

Suggested Strategies/Activities

Instruction in paper-and-pencil computation should continue to emphasize understanding of process (i.e., place value, re-grouping, borrowing) and why algorithms are constructed in particular forms. Develop these understandings through work with one-, two- and three-digit numbers. Tedious paper-and-pencil computations with numbers containing more than three digits is discouraged. Such computations are time-consuming, and are generally ineffective in facilitating the development of number sense and problem-solving ability.

Students should use calculators when the primary purpose of an activity is the development of problem-solving or other skill in which computation is of secondary importance. Continue to provide instruction on how and when to use the calculator in problem-solving contexts. Activities must focus attention on the development of estimation skills and ability to judge the reasonableness of results obtained on the calculator.

Estimation involves application of a set of skills that are developed over time through much opportunity for practice. Appropriate strategies for the development of estimation skills are provided in the *Teacher Resource Manual*. Model these strategies and "think out loud" with students. Encourage the use of estimation skills on a daily basis in activities involving:

- applications
- problem solving
- the use of calculators.

Students must develop the habit of always asking themselves:

- Is my answer reasonable?
- Within what range of numbers must my answer lie?

Estimation skills are best evaluated through daily questioning and informal observation. Formal assessment of these skills can be counter-productive, as it may encourage students to make an approximation after obtaining an exact answer.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

Whole Numbers

Applies whole number concepts and skills to practical problem situations that are appropriate to student age and maturity level.

- Uses previously developed concepts and skills (numeration, place value, order, rounding, operations, order of operations, properties).
- Uses a calculator to generate a set of multiples for a given number.
- Determines the lowest common multiple for pairs of numbers less than 10.
- Determines pairs of factors related to basic multiplication facts up to 100.
- Determines prime numbers up to 50.
- Expresses numbers up to 50 as the product of prime factors.
- Determines the greatest common factor for pairs of numbers less than 50.
- Calculates/estimates products and quotients of numbers up to three digits by two digits (without the use of a calculator).

Sequences and ranks whole numbers when working with:

- information provided in tables/graphs
- invoices/bills
- serial numbers
- tickets of chance.

Reads and interprets sports information:

- schedules
- rankings
- game results.

Reads/interprets/records numerical patterns and codes:

- highway routes/bus routes
- map reference numbers
- catalogue numbers
- bank account numbers.

Counts by multiples in determining:

- numbers represented on a graph
- value of currency (coins and bills)
- total inventory/stock on hand
- chairs in gymnasium/stalls in parking lot.

Reads and interprets whole numbers/ calibrations on familiar meters, gauges and scales:

- household/shop measuring tools
- natural gas/electric /water meter
- gas pump meter
- tire gauge.

Interprets and uses numerical terms:

- pair/triplet
- dozen
- decade/century.

Applies appropriate computational strategies (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) in determining:

- map and travel distances
- approximate distance travelled for given speeds and travel times
- approximate travel times for given distances and speeds
- recipe ingredients (e.g., halving, doubling)
- materials required for construction and repair projects around the home.

Uses the correct order for operations in answering skill-testing questions used in contests and promotions.

Related Applications Across the Curriculum

Language Arts

Recognizes order/place value for whole numbers in using the Dewey Decimal System

Science

Reads and interprets whole number calibrations on meters/gauges/scales.

Uses whole number skills when interpreting information related to:

- the use of environment and resources
- plant and animal distributions
- pollution factors.

Social Studies

Uses whole number estimation skills when predicting the effects of:

- population increase/decrease
- the depletion of a natural resource
- pollution.

Uses the calculator in related situations when an exact answer is required.

Practical Arts

Uses whole number computational skills in solving problems that involve:

- counting, calculating and recording movement of inventory
- reading and interpreting numbers represented on various measuring devices
- modifying quantities of supplies/ ingredients to suit variable needs.

Suggested Strategies/Activities

Select instructional activities within the context of personal and practical situations. Encourage students to discover whole number patterns and relationships by:

- exploring/experimenting
- simulating problem situations
- using the calculator
- working in small groups
- discussing/sharing ideas.

Provide frequent opportunity for the development, review and application of basic number facts. With practice, most students should be able to recall their basic facts for whole numbers. Students who continue to experience difficulty with these facts will need to employ other strategies (e.g., calculator, tables, repeated additions/subtractions, finger math) in order to develop an understanding of process and consolidate needed computational skills.

Be aware that students often experience difficulty in understanding the abstract processes involved in:

- rounding beyond 10's and 100's (e.g., 1000's, 10 000's, 100 000's)
- three-digit and four-digit subtraction that involves re-grouping over a zero digit
- mental multiplication/division of numbers by 10 and multiples of 10
- multiplication when the multiplier contains zeros
- division containing zeros in the quotient
- division by two-digit divisors.

Strategies that are effective in developing these concepts must be identified and frequently modelled as the related skills are used in a variety of contexts.

Avoid evaluation techniques that over-emphasize the use of paper-and-pencil algorithms While important, evaluation should also assess student ability to:

- effectively use the calculator
- compute with mental arithmetic
- estimate computational results
- use concepts/skills in applications and problem solving.

Activities that might be used to enhance understanding of whole number skills are provided in the *Teacher Resource Manual*: Computational Facility and Estimation.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills
Decimals Applies decimal concepts and skills to practical problem situations, with emphasis on computations involving money. • Uses previously developed concepts and skills (numeration, place value, order, rounding, operations, order of operations, properties). • Calculates/estimates products of decimal numbers to thousandths, using one-digit or two-digit multipliers (without the use of a calculator). • Calculates/estimates quotients for two decimal place numbers divided by one-digit or two-digit whole number divisors (without the use of a calculator). • Determines "mental exact" products/quotients when multiplying or dividing decimals by 10, 100 and 1000.	Reads meters, gauges and scales found in the home (or workshop) that are calibrated in tenths, hundredths and thousandths. Establishes a practice of rounding calculations that represent money to the nearest cent. Multiplies/divides by multiples of 10 in converting metric units of measure Makes correct change using the "subtractive" or "add-on" methods. Applies appropriate computational strategies (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) to consumer transactions: • determines unit price/multiple price of consumer items • determines the "best buy" by comparing the unit price of competing brands • maintains a running total of the cost of items being selected for purchase • determines the total cost of items purchased • determines change due on purchases made • checks the accuracy of sales slip calculations. Recognizes different types of income and expenses. Interprets and prepares simple budgets. Identifies different bases for wages (e.g., hourly, weekly, monthly, contract). Recalls the current minimum wage, and appropriate wage rates for a variety of part-time jobs. Determines gross pay when given wage rate and time worked. Recognizes different kinds of deductions made on pay cheques. Determines take-home pay given gross earning and deductions. Applies decimal skills to frequently used banking procedures. • writing a cheque • making a deposit • making a withdrawal Uses a mail-order catalogue Completes the order form using appropriate codes, and determines the total cost of the order

Related Applications Across the Curriculum

Language Arts

Recognizes order/place value for decimals in using the Dewey Decimal System

Science

Reads and interprets decimal calibrations on meters, gauges and scales.

Uses whole number/decimal computational procedures when:

- mixing solutions of given strength
- monitoring temperature change
- monitoring duration of time
- monitoring energy consumption and costs
- determining appropriate amounts of food/growth supplements for plants and animals.

Practical Arts

Uses whole number/decimal computational skills in situations that involve.

- reading/interpreting measurements provided in diagrams/blueprints/recipes
- calculating unit costs
- reading and interpreting numbers in the context of purchasing/selling/inventory control
- modifying quantities of supplies/ ingredients to suit variable needs
- reading and interpreting decimals as represented on meters, gauges, and other measuring devices
- preparing bills/invoices, and processing cash/credit transactions
- calculating wages earned on an hourly, daily, weekly, monthly or annual basis.

Suggested Strategies/Activities

Although students must recognize place value to thousandths in order to round computations involving money to the nearest cent, most activities will involve numbers containing one or two decimal places. Relate the numbers being used to real life situations (e.g., amounts of money, metric measures).

Some students may continue to reverse or misplace numbers in performing algorithmic procedures. These errors are often avoided if difficult algorithms are performed in a tic-tac-toe configuration on graph paper. Encourage students to develop personal strategies that will assist them to place correctly the decimal in the computational results they obtain.

Calculators should be used on a regular basis in applications and problem solving that involve large numbers or tedious calculations. Assist students to interpret the multi-digit decimals that may be displayed as the result of certain computations performed on the calculator. Estimation strategies must continue to be developed and used in checking the reasonableness of answers obtained on the calculator.

Model techniques for mental arithmetic that include the use of compensation strategies and computing from left to right (see *Teacher Resource Manual*: Computational Facility and Estimation). Simulate consumer situations where students are required to use these techniques in mentally computing:

- the total cost of several items purchased
- change due, given amount offered in tender
- unit price/multiple price.

Evaluation techniques should focus attention on student ability to use all methods of computation in applications and problem solving. While paper-and-pencil tests may be an effective way of evaluating some skills, assessment should also include:

- informal "demonstration" of understanding through discussion/project work
- observation of attitudes and performance
- participation in small group activities
- personal interviews.

The *Teacher Resource Manual*: Using a Math Lab provides additional strategies that support the development of decimal concepts and skills.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

Fractions

Demonstrates an understanding of basic concepts and skills related to fractions through the use of real life models and concrete manipulatives (with emphasis on fractions having denominators of 2, 3, 4, 5, 8 and 10).

- Displays an understanding of previously developed concepts and skills at a concrete level (concept of a fraction, equivalent fractions, basic fractions, order, addition/subtraction with like denominators).
- Illustrates the relationship between whole numbers, decimals and fractions using a number line.
- Relates fractions to division, converting fractions into decimal equivalents using a calculator.
- Recalls decimal equivalents for frequently used fractions (one-half, quarters, tenths).
- Determines common denominators for fractions having denominators of 2, 3, 4, 5, 8 and 10.
- Demonstrates addition and subtraction of proper fractions/mixed numbers with unlike denominators through the use of concrete manipulatives.
- Writes number sentences to describe the addition and subtraction of proper fractions/mixed numbers with unlike denominators.
- Demonstrates the multiplication and division of proper fractions/mixed numbers by whole numbers through the use of concrete manipulatives.
- Writes number sentences to describe the multiplication and division of proper fractions/mixed numbers by whole numbers.

Recognizes the everyday use of fractions to represent part of a whole:

- three-quarters of an hour
- "one-third off" sale
- one-quarter of a dollar
- half a dozen.

Reads and interprets fractions represented on frequently used scales and gauges.

- inch ruler
- kitchen measures of capacity and mass
- workshop tools.

Measures/draws figures and objects to the nearest half, quarter and eighth of an inch. Uses the inch unit in taking measurements for various home-maintenance and repair projects.

Interprets fractional measurements provided on diagrams and blueprints. Finds missing dimensions by adding and subtracting fractional parts of an inch.

Follows recipes and directions that involve the use of fractional units of measure:

- two and three-quarter cups
- one-third of a package
- one-half a block
- one-quarter of a turn.

Adjusts recipes that involve the use of fractional units of measure:

- increases a recipe for four servings to provide for eight servings
- decreases the ingredients required for six dozen to two dozen.

Relates fractional discounts to their decimal equivalents (e.g., one-half off, one-quarter off). Calculates and estimates discounts that are expressed as fractions.

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Reads and interprets fractional calibrations on meters, gauges and scales

Uses basic concepts/skills related to fractions when interpreting:

- growth rates for plants and animals
- the concentration of solutions/ environmental pollutants (e.g., parts per 1000).

Practical Arts

Uses basic concepts/skills related to fractions in activities and projects that involve:

- interpreting/reading fractional calibrations on various measuring devices
- using fractional measurements provided in diagrams/blueprints/recipes
- reading charts to determine equivalent fraction-decimal sizes for mechanical fasteners and tools.

The cognitive demands of concepts related to the use of fractions make it necessary that instruction include the extensive use of manipulative and visual materials.

Structure activities using a "math lab" approach, giving students the opportunity to manipulate materials and see tangible outcomes. De-emphasize the use of activities that yield singular results through the application of computational rules not yet understood by students Activities should be selected that encourage students to:

- work with real models/pictures/diagrams
- experiment/explore
- ask questions
- verbalize ideas and discoveries
- make associations/draw conclusions.

Keep arithmetical computation simple, working only with fractions commonly encountered in real life situations. Concept and skill development might be limited to work with the fractions included in the following families:

- 1/2, 1/4th's, 1/8th's
- 1/2, 1/3rd's, 1/6th's
- 1/2, 1/5th's, 1/10th's

Operations with fractions should be demonstrated through concrete manipulation and pictorial representation. Translation to numbers and symbols should occur only after the processes have been understood. By asking appropriate chains of questions (see "Instructional Mediation"), students can be encouraged to discover relationships and generalize the results of their investigations.

The Imperial ruler offers many opportunities for students to reinforce/extend their understanding of fractions through applications in practical contexts. Measuring/drawing figures and objects to the nearest 1/2, 1/4 and 1/8 of an inch will enhance student ability to recognize order and equivalence among fractions. Operations can also be demonstrated on the ruler.

Strategies that support concept development through a "math lab" approach are provided in the *Teacher Resource Manual*: Using a Math Lab.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: NUMBER SYSTEMS AND OPERATIONS

LEARNING OBJECTIVES	Related Life Skills

Integers

Demonstrates an understanding of integer concepts within the context of practical situations.

- Recognizes the need for integers and ways in which they are frequently used.
- Uses vocabulary related to integers (positive, negative, plus, minus, above, below, gain, loss).
- Places integers on the number line.
- Compares/orders integers in applications.
- Demonstrates addition of pairs of integers between −25 and +25 through concrete manipulation/diagrammatic representation.
- Writes number sentences to describe the addition of integers undertaken in the concrete mode.

Interprets temperatures both above and below zero Determines temperature changes.

Recognizes applications of integers in score-keeping for games and sports.

- golf scores of above and below par
- yards gained and yards lost in football
- points gained and lost in a card game.

Uses integers in maintaining a bank account balance. Understands the concepts of an "overdraft" and "NSF cheque".

Recognizes the use of integers in describing:

- altitudes above and below sea level
- changes in the stock market
- time zone changes

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Applies knowledge of integer concepts in monitoring temperatures:

- reads and interprets temperatures above and below zero
- calculates temperature change.

Practical Arts

Applies knowledge of integer concepts to situations that involve:

- reading and interpreting temperatures above and below zero
- calculating temperature change
- calculating profit and loss in production/ service oriented entrepreneurial activities

Concepts and skills should be developed within the context of their real life applications. Encourage students to explore problem situations that require the use of integers:

- charting temperature changes
- keeping score in a card game.

Ask students to keep a temperature log for a week. Display the information collected in a graph. Use integers to describe daily changes in temperature and fluctuations throughout the week.

Graph the integers on a number line. Start by drawing the whole number line. Use a mira to find the image of each whole number, and hence the negative numbers. Discuss order for integers.

The abstract nature of integer operations makes it necessary that instruction involve the extensive use of manipulative and visual materials. Structure activities using a "math lab" approach, and encourage students to:

- work with real models/pictures/diagrams
- experiment/explore
- verbalize ideas and discoveries
- make associations/draw conclusions.

The concept of addition with integers should be demonstrated through concrete manipulation and pictorial representation. Activities undertaken can be summarized and described through translation into numbers and symbols. Formal addition through the application of rules is discouraged at this level of instruction.

Activities that are useful in developing an understanding of integer addition through the concrete mode are provided in the *Teacher Resource Manual*: Using a Math Lab.

MATHEMATICS (I.O.P. GRADE 9)

RATIO, PROPORTION AND PERCENT

CONCEPTS:

- Recognizes appropriate strategies for solving problems. Applies problem-solving strategies and skills to practical everyday situations that are routine in nature, and to situations where no readily apparent solution or means to the solution is evident.
- Demonstrates an understanding of concepts relating to ratio, proportion and percent at a concrete level, and within the context of meaningful everyday situations.
- Performs computations through the use of mental arithmetic, paper-and-pencil algorithms, the calculator and estimation. Selects computational methods that are appropriate to the nature of the task being performed.
- Recognizes that technology, in the form of calculators and computers, has influenced the nature of the computational processes and procedures we frequently use. Develops an understanding of procedures followed in the use of these technologies and recognizes their influence on our lives.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - works independently, as well as effectively with others in group situations
  - demonstrates/shares that which has been learned in group discussions and activities.
- Demonstrates a desire to solve problems by asking questions, showing interest/curiosity, taking risks and displaying perseverance.
- Recognizes the value of an organized approach to problem solving. Practises critical and creative thinking in problem solving, and accepts unconventional strategies and alternative solutions.
- Appreciates the usefulness of computational competence and problem-solving ability within the home, the community and the workplace.

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COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: RATIO, PROPORTION AND PERCENT

LEARNING OBJECTIVES

Demonstrates an understanding of concepts related to ratio, proportion and percent at the concrete level through the use of objects/models/diagrams. Relates skills to everyday applications and a strategy for solving problems.

- Displays an understanding of previously developed concepts and skills:
  - recognizes and constructs ratios
  - generates equivalent ratios
  - verifies equivalence of ratios using common multiples/factors
  - recognizes/writes proportions that describe problem situations
  - finds missing component in a proportion using common multiple/factor method
  - demonstrates concept of percent as ratio indicating parts out of 100.
- Recognizes "rates" as ratios showing comparison of two numbers with different units (e.g., 90km/2h, 3 items for $1.00).
- Describes practical problem situations involving rates by writing proportions.
- Determines the value of the missing component in a proportion involving rates using the common multiple/factor method.
- Converts whole number percents to ratios/decimals.
- Expresses ratios as percents and decimals (e.g., $\frac{a}{b} = \frac{?}{100}$ where b = 2, 4, 5, 10, 20, 25 or 50).
- Expresses one- and two-place decimals as percents (e.g., 0.5, 0.75, 0.4).
- Recalls fraction, decimal and percent equivalents for one-half, quarters and tenths.
- Determines other fraction, decimal and percent equivalents through the use of the calculator.
- Calculates/estimates a percent of a number in relevant applications.

Related Life Skills

Recognizes travel rate as a comparison of distance travelled and time required for the journey.

Applies ratio skills to travel situations, recognizing the relationship between distance travelled, travel rate and travel time. Uses equivalent ratios to solve related problems.

Uses equivalent ratios in determining unit cost and multiple cost of consumer items. Evaluates calculations in determining the "best buy".

Interprets the meaning of percent in applications that relate to:

- personal budgeting
- discounts/sale prices
- price increase
- school marks
- interest on loans/charge accounts/savings accounts
- tax rates
- commissions.

Recognizes fractional and percent equivalents for discounts advertised on consumer items (e.g., half-price sale means 50% off, 25% discount means one-quarter off).

Estimates/calculates money saved and the sale price on an article when given the percent discount rate.

Calculates simple interest. Recognizes the effect of interest rate on the payback amount of the loan (or interest accumulated from an investment).

Estimates interest in verifying bank account statements/charge account balances

Uses estimation in determining appropriate gratuities to be paid for service.

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Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Uses ratio, proportion, and percent in.

- understanding the concept of "concentration" as related to mixtures and solutions
- preparing solutions of given strength
- modifying ingredients used in a mixture or solution (e.g., increasing/decreasing the quantity of the solution being prepared)

Social Studies

Uses ratio, proportion and percent in comparing communities in relation to:

- population
- industry/business base.

Practical Arts

Uses ratio, proportion and percent in:

- working with mixtures and solutions
- increasing and decreasing scales/ recipes
- calculating profit/loss as a percent
- using percent discounts and mark-ups to provide a profit from entrepreneurial learning activities.

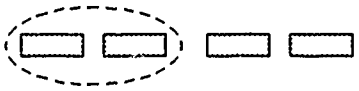
The abstract nature of ratio and percent suggests that students will benefit from a review of previously developed concepts Diagnose areas of student difficulty, and base remedial activities on the use of concrete and visual representations.

Develop the concept of "rate" using strategies similar to those outlined for ratio and proportion at the Grade 8 level. Review the concept of percent through visual representation on the "100 grid". After working multiple examples on the grid, encourage students to generate their own rules for expressing percent as a ratio (and vice versa).

Activities at Grade 9 should involve the use of whole number percents While students should understand that 100% refers to the whole, percents greater than 100 need not be considered at this time.

Discuss the notion that numbers have different equivalent forms (e.g., fraction, decimal and percent). Emphasize the use of simple number relationships and mental arithmetic in determining fraction, decimal and percent equivalencies. A variety of related activities are included in the *Teacher Resource Manual*: Using a Math Lab.

Encourage students to develop a rule for finding percent of a whole by examining a variety of concrete representations.
e.g., 50% of $4.00



Relate the calculations performed to real life situations. Collect newspaper articles or sale flyers involving percent (e.g., 20% discount, 50% increase, 10% interest). Using this information, solve simulated consumer problems involving percent of a whole.

Once rules and operations are understood, the calculator should be used in applications and problem solving. Provide instruction on using the percent key, and model the sequence of entries that are made in finding percent. Emphasize the use of estimation in checking the results of computation.

Maintain/develop mental arithmetic and estimation skills by providing frequent opportunity for oral work:

- 50% of $12.50
- a $20.00 shirt discounted by 10%
- 15 out of 20 = ___%.

MATHEMATICS (I.O.P. GRADE 9)

GEOMETRY AND MEASUREMENT

CONCEPTS:

- Recognizes geometry as a visual approach to organizing and interpreting our perceptions of the environment and real world.
- Examines the basic concepts, patterns and relationships associated with one-, two- and three-dimensional geometric figures.
- Illustrates the measurable attributes of an object that can be quantified through the process of measurement.
- Recognizes the iterative and comparative nature of estimation and measurement.
- Devises a mental frame of reference for the size of standard units of measure, relative to each other and to real objects.
- Recognizes how concepts/skills in geometry and measurement can be used in everyday applications and problem solving.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - communicates personal difficulties/successes with tasks that are undertaken
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.
- Gives attention to geometric pattern/design present in the environment.
- Appreciates the ways in which geometry and measurement affect our daily activities, and may contribute to the problem-solving process.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills

Note: It is the policy of Alberta Education that SI units be the principal system of measurement in the curriculum of the schools in the province. The study of specific Imperial units should be related only to those that are relevant to student needs (as dictated by the demands of the workplace/community partnership sites) and should be kept to a minimum.

- Displays an understanding of the attributes and properties of familiar shapes and objects:
  - examines the size and shape of familiar one-, two- and three-dimensional figures through the use of concrete materials
  - recognizes examples of one-, two- and three-dimensional figures as they occur in the environment
  - applies knowledge of geometric figures and relationships in practical situations.

Recognizes/appreciates geometric form found in:

- the natural environment
- architecture
- floor coverings/fabrics/wallpaper.

Applies knowledge of the properties of geometric figures in order to interpret/ construct:

- scale diagrams (e g., floor plans, maps)
- graphs and charts
- patterns and designs.

- Estimates/measures length, mass, capacity, area, time, temperature and angle within the context of everyday applications and problem-solving:
  - selects units and tools that are appropriate to the situation
  - estimates and measures
  - makes conversions as required among commonly used units.

Recognizes applications of measurement in:

- labels on food packages
- speedometer/odometer numbers
- sporting event distances
- travel schedules.

Uses estimation and measurement in order to answer everyday questions such as:

- How long will it take to finish this homework?
- About how much juice will we need for the party?
- Will the desk fit between the two cabinets?

Geometry

- Demonstrates an understanding of concepts and skills developed in Grade 8:
  - identifies line relationships
  - identifies/describes/constructs rectangles, squares, triangles and circles
  - identifies/constructs models of the rectangular prism, cube, cylinder.

Recognizes geometric shapes and relationships that are used:

- on street signs
- as symbols on maps
- on washing labels
- on warning labels.

- Identifies and recalls characteristics of the parallelogram, hexagon and octagon.

Applies geometric relationships when giving or following directions on a map. Uses map coordinates to locate points on city street maps and Alberta road maps.

- Uses geometric tools (e.g., protractor, compass, straightedge, ruler, computer) to construct the parallelogram, hexagon and octagon.

Recognizes three-dimensional objects from a sketch:

- perspective
- front, side and top views

Related Applications Across the Curriculum

Science

Uses concepts of one-, two- and three-dimensional geometry when:

- investigating the relationship between components of simple electrical technologies
- designing/constructing simple electrical technologies.

Social Studies

Uses concepts of one-, two- and three-dimensional geometry when:

- observing geometric shapes used in the community
- locating streets/avenues on a prepared grid
- drawing maps to scale.

Practical Arts

Applies knowledge of geometric figures and relationships when completing projects in:

- graphics
- metalwork/woodwork
- personal grooming.

Suggested Strategies/Activities

Geometry should emphasize the visual perception of pattern and form present in the student's personal environment. Knowledge of geometric figures/relationships can be developed by modelling various aspects of the physical world, and by providing frequent opportunity for work with concrete materials. Teaching strategies that are inductive and experimental will enable students to recognize patterns and develop an understanding of the more abstract concepts in geometry. Activities must place emphasis on observation, manipulation and construction.

Measurement must be understood as a process of comparison to some arbitrary unit. Students need to recognize the repetition of identical units that occurs in measurement, and the need to combine/subdivide selected units into larger/smaller units when describing particular attributes. Encourage students to develop a "feel" for standard units through the use of referents and visual imagery (e.g., body referents, objects in the classroom/home). Provide ample opportunity for students to develop skill in making reasonable estimates of measure before engaging in activities that involve actual measurement and precision.

Concepts of one-dimensional space are usually well understood by students. Learners, however, find two-dimensional and three-dimensional ideas considerably more difficult and require much concrete support for successful experience in these areas. Actual manipulation and construction will assist students in recognizing the spatial relationships inherent in these figures.

A variety of instructional activities that may assist students to interpret and organize their visual perceptions are provided in the *Teacher Resource Manual*: Using a Math Lab. Activities include the use of:

- geoboards/dot paper/grid paper
- tangrams/tessellations
- LOGO computer programs
- line design/model construction.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills
Geometry (cont'd)	
• Identifies and describes the relationship between the radius and diameter of a circle.	Enlarges or reduces patterns/scale drawings through the use of: • dot paper • grids • geoboards • measurement and ratio.
• Draws circles, given either radius or diameter.	
• Constructs geometric patterns/designs, using tools that may include the straightedge, compass, ruler, protractor, mira or computer.	Uses geometric shape in designing and constructing various home and hobby projects. Plans the project by constructing a scale drawing or model.
Linear, Mass and Capacity Measure	
• Demonstrates an ability to apply previously developed concepts and skills related to the use of metric measure in real life applications and problem solving: – recognizes metric units of length/mass/capacity in common use (mm, cm, m, km, g, kg, t, mL, L) – estimates and measures length/mass/capacity, using metric units and tools appropriate to the situation – draws lines according to given specifications, using metric units and tools – converts among units of length/mass/capacity as required in applications – determines the perimeter of figures bounded by line segments.	Reads and interprets scales on familiar measuring tools: • ruler/tape measure • kitchen/supermarket weigh scale • capacity measures used in the kitchen/workshop Uses estimation skills in: • discriminating between objects of "greater" and "lesser" length/mass/capacity • approximating the length/mass/capacity of familiar household and consumer items.
E • Demonstrates an ability to apply concepts and skills related to the use of Imperial measure in real life applications and problem solving. – recognizes Imperial units of length/mass/capacity still in use (e.g., inch, foot, yard, mile, ounce, pound, cup, quart, gallon) – estimates and measures length/mass/capacity, using Imperial units and tools appropriate to the situation – draws lines according to given specifications, using Imperial units and tools – makes comparisons between metric and Imperial measure (e.g., compares cm to inch, m to yard, km to mile, kg to pound, mL and L to cups, L to quarts and gallons).	Selects items for purchase that are sold by length/mass/capacity. Estimates and measures consumer items in relation to these attributes, using units and tools appropriate to the situation. Interprets product labels that provide information relating to length/mass/capacity. Converts units of measure as required in. • adjusting recipes/directions that involve measure of length/mass/capacity • determining unit price and "best buy" for consumer items sold by length/mass/capacity • determining the cost of materials purchased by length/mass/capacity (e.g., 250 g of meat at $4 98 per kg).
E – Elective Content	Calculates perimeter in order to determine the quantity of materials required for various decorating/construction/repair projects.

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Related Applications Across the Curriculum

Science

Measures length, mass and capacity in a variety of inquiry-related activities.

- measures chemical substances by mass and capacity
- prepares mixtures/solutions using appropriate measures of capacity
- monitors food and other essential growth requirements for plants/animals
- uses linear measure in designing/constructing simple electrical technologies.

Social Studies

Uses units of length, mass and capacity in:

- drawing maps to scale
- investigating "maximum loads" on provincial highways and secondary roads
- investigating containers used to transport primary/secondary products.

Practical Arts

Reads scales on tape measures, rulers and other measuring devices in order to produce a product or provide a service

Uses linear measure and the concept of perimeter in:

- project work
- woodwork/metalwork.

Recognizes appropriate units and tools for measuring mass/capacity, and converts between units as required when:

- following recipes
- preparing mixtures/solutions
- purchasing goods by mass/capacity.

Suggested Strategies/Activities

Provide opportunity for students to construct geometric patterns/designs/logos using a variety of tools and techniques. Such activities will reinforce the geometric concept under investigation, develop facility in the use of construction tools, and provide meaningful application of skills in linear and angle measure. Encourage students to be creative. Display student work in colourful and attractive arrangements.

Discuss your geometry and measurement unit with teachers of other programs, identifying projects for which students might create patterns or scale drawings.

Students who have not yet developed a frame of reference for associating standard units of measure with familiar objects, or who have difficulty in estimating/measuring should be provided with experiences similar to those suggested in the Grade 8 program

A variety of real life situations/projects that require the application of measurement skills are suggested in the *Teacher Resource Manual*: Using a Math Lab. Estimation strategies emphasized throughout these activities include:

- using a referent
- chunking
- unitizing.

Sequence activities so that students can improve the accuracy of the estimates they are making. Record for each student a "+" each time an estimate is larger than the corresponding measurement, and a "–" each time the estimate is smaller. Students who consistently have pluses (minuses) will then realize that they need to adjust their estimates by making them smaller (larger).

Business and industry use both Imperial units and metric units of measure. Some occupations/life skills still require the use of Imperial units. Community needs will determine the extent to which elective content dealing with Imperial measure will be developed. If developed, students should compare only and not convert corresponding units from the Imperial system to the metric system:

- Is three metres of fabric more than three yards of fabric?
- Is a five-kilogram bag of apples larger than a five-pound bag of apples?
- Does a one-gallon container hold more than a one-litre container?

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills

Area Measure

- Illustrates the concept of area, recognizing common metric units (cm^2, m^2) and its application in problem situations.
- Approximates the area of two-dimensional geometric figures using a square grid.
- Recognizes strategies/formulae for finding the area of rectangles and squares.
- Estimates/calculates the area of rectangles and squares, using units and strategies appropriate to the situation.

Time Measure

- Demonstrates an understanding of previously developed concepts and skills related to the measure of time:
  - uses a calendar, recognizing the relationship between days, weeks, months and years
  - uses National Standards for numeric dating
  - estimates/measures/records time on the 12-hour and 24-hour clock (using traditional and digital timepieces).
- Converts between hours and minutes, and between minutes and seconds.
- Adds/subtracts hours and minutes in applications.

Uses estimation/measurement/calculation in order to establish surface area to be covered and quantity of material required for various decorating/construction/repair projects around the home:

- painting
- carpet/lino
- wallpaper
- tiling.

Interprets product labels that provide information relating to area measure:

- lawn fertilizer
- paint.

Uses calendar and dating skills in a variety of everyday situations:

- recognizes due dates on bills and library books
- dates letters, cheques and application forms appropriately
- identifies current and post-dated cheques
- recognizes special dates on the calendar (e.g., pay days, holidays, test dates).

Organizes personal time and develops schedules for completing tasks:

- test preparation/homework
- leisure activities
- routine chores/part time work.

Reads and interprets 24-hour time stated on:

- train, bus and plane schedules
- traffic/parking signs (e.g., no parking between 16:00h and 18:30h).

Records start and finish times for tasks undertaken. Accurately determines/measures time required to complete various tasks:

- cooking and baking times
- hours and minutes worked.

Estimates and makes allowance for the passage of time in a variety of everyday situations:

- long-distance telephone calls
- frequently used travel routes
- daily chores.

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Measures intervals of time as required in conducting scientific investigations. Monitors.

- rate of chemical reactions
- speed of dissolution
- response rates of plants/animals.

Social Studies

Uses time measurement skills in determining time differences between given locations in Canada and/or other countries.

Determines/compares the areas of regions within the community.

Practical Arts

Recognizes and calculates area in order to determine materials required to produce a product or provide a service:

- construction projects
- maintenance tasks.

Measures time required for various processes/ procedures.

Maintains a personal record of attendance and punctuality for classroom activities and field experiences:

- time-in/out
- hours worked
- record of telephone contacts or appointments.

Students will require concrete support in developing an understanding of the two-dimensional concept of area. Activities must include the use of manipulative and visual materials (e.g., tiles, geoboards, dot/grid paper). Encourage students to develop a visual image of the standard units of area through construction of units used.

Area formulas should be developed as a consequence of the patterns/relationships observed in manipulations and constructions. Encourage students to deduce their own strategies for determining area that are based on the results of investigation.

Distinguish between area (surface covered) and perimeter (distance around). Illustrate this difference by referring to practical situations and identifying the concept involved:

- How much moulding do we need?
- How much carpet do we need?

Model the use of pictures/diagrams in applications and problem solving.

Appropriate activities for developing and applying area concepts are provided in the *Teacher Resource Manual*: Using a Math Lab.

Maintain skills in time measure by incorporating the use of calendar, stopwatch, digital clock, and traditional 12-hour and 24-hour clocks into daily activities. Pretests might be given in order to determine the need for instruction/remediation.

Develop ability to estimate time by:

- comparing time intervals to the duration of a familiar event (e.g., length of a song)
- providing opportunities for students to estimate both active and passive periods of time.

Projects that involve the use of time measure are provided in themes developed in the *Teacher Resource Manual*. These projects require students to interpret and use:

- personal time schedules/time cards
- travel/telecast schedules.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: GEOMETRY AND MEASUREMENT

LEARNING OBJECTIVES	Related Life Skills
Temperature	
• Estimates and measures temperature on the Celsius scale.	Estimates differences in temperature (e.g., "hotter – colder").
• Recalls important temperatures on the Celsius scale (e.g., boiling/freezing points of water, normal body/room temperature).	Appreciates the effect of outside temperature on personal safety: • travel conditions • recreational activities • frostbite/sunstroke.
E • Recognizes appropriate types of dress/activity for various temperature ranges on the Celsius scale (e.g., room temperature, a hot summer day, a cold winter day).	Recognizes that the type of thermometer used must be appropriate to the range of temperatures being measured. Interprets the scale on various types of thermometers: • oven thermometer • furnace thermostat • hospital thermometer • outside thermometer • refrigerator/freezer thermometer.
• Determines temperature change, including changes from below zero to above zero.	
E • Estimates and measures temperature on the Fahrenheit scale.	Monitors body temperature in times of illness.
E • Compares Fahrenheit and Celsius temperatures.	Reads the temperature scale on an oven. Converts cooking temperature from Celsius to Fahrenheit (and vice versa) using a chart.
Angle Measure	
• Recognizes an angle and the degree as a unit of measure.	Recognizes angle relationships found in the environment, and those used in everyday practical situations. Estimates the measure of angles formed by: • the hands of a clock • the corner of a table • the blades of scissors • two intersecting roads.
• Recognizes angles of 45°, 90°, 180° and 360°.	
• Measures/draws angles from 0° to 180° using a protractor.	Applies skills of angle measure when: • giving or following directions on a map • interpreting/constructing scale drawings • constructing patterns/designs.
• Applies skills of angle measure in the construction of geometric figures/patterns/designs.	

E – Elective Content

Related Applications Across the Curriculum	Suggested Strategies/Activities

Science

Measures temperature in order to monitor:

- factors that affect chemical reaction rates
- appropriate growth conditions for plants/ animals.

Social Studies

Compares temperature scales used on local and American weather broadcasts.

Uses angle relationships in locating streets and avenues on a prepared grid.

Practical Arts

Measures temperatures as required in:

- cooking/baking
- film developing
- food storage.

Applies knowledge of angle measure when completing projects in:

- graphics
- metalwork
- woodwork
- personal grooming.

Estimate and measure various temperatures in and around the classroom using appropriate types of thermometers:

- body temperature
- classroom temperature
- outside temperature
- temperature inside an oven/refrigerator
- temperature of water.

Examine the calibrations on different thermometer scales:

- How do numbers on the scale increase in size?
- How many intervals are there between numbers on the scale?
- How many degrees does each interval represent?

Investigate special-purpose thermometers used by students in their practical arts courses.

Gather information about local temperatures on a daily basis for a period of several weeks:

- record daily high/low temperatures
- illustrate temperature variations in chart/graph form
- determine temperature change.

Local needs will determine the extent to which elective content dealing with the Fahrenheit thermometer will be developed. If developed, emphasis should be placed on comparison (not conversion) of temperatures on the Fahrenheit and Celsius scales. Students should recognize the use of "temperature conversion charts" in real life situations that require an exact conversion of temperature.

Identify examples of various angles found in the environment. Relate angles of 45°, 90°, 180° and 360° to concrete examples that are familiar to students.

Provide opportunity for students to estimate angle measure, and to check estimation through actual angle measure with a protractor. Instruction on the use of the protractor should include discussion of:

- the purpose of the inside and outside scales
- strategies to follow in measuring an angle whose rays are too small.

Develop skill in angle measure through projects involving the construction of geometric figures, patterns/designs and scale drawings.

MATHEMATICS (I.O.P. GRADE 9)

DATA INTERPRETATION AND DISPLAY

CONCEPTS:

- Understands procedures used in reading and interpreting data presented in tables, charts and graphs.
- Uses tables, charts and graphs to collect, organize and display data.
- Recognizes that inability to interpret numerical data in real life situations may result in decisions that are inappropriate and consequences that are not desired.
- Applies strategies for problem solving and decision making that involve the use of relevant information obtained from tables, charts or graphs.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - demonstrates self-reliance in working independently
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.
- Recognizes the value of tables, charts and graphs in summarizing nume cal data and in communicating ideas.
- Appreciates the need to evaluate data displayed in simple statistics/charts/graphs before using the information to make decisions or choose courses of action.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: DATA INTERPRETATION AND DISPLAY

LEARNING OBJECTIVES

Collects, organizes, interprets and displays numerical data in order to solve problems and make decisions in practical everyday situations.

- Demonstrates an understanding of concepts and skills developed in Grade 8:
  - recognizes the use of statistics in real life situations
  - reads and interprets information presented in list/table/chart form
  - collects and records data using tally sheets/ frequency tables
  - uses tables and charts to group/sort information according to specified criteria
  - reads and interprets information presented in pictographs/bar graphs/line graphs.
- Interprets and determines arithmetical average in practical situations.
- Recognizes when and how to display data in the form of pictographs, bar graphs and line graphs.
- Reads and interprets information presented in circle graphs.
- Recognizes how graphs may sometimes provide misleading information or distort the "true picture".

Related Life Skills

Recognizes how numbers and statistics are used in everyday situations:

- weather reports (e.g., probability of precipitation)
- consumer reports (e.g., average price of an item)
- opinion polls (e.g., popularity of a television program or political figure)
- performance in sports (e.g., batting average)
- personal development (e.g., average height/weight charts)
- health risks (e.g., frequency of lung cancer in smokers)
- lottery outcomes (e.g., odds of winning the jackpot).

Uses tally sheets/frequency tables in recording information:

- sporting scores/achievements
- points in a card game
- research data.

Interprets arithmetical average in familiar situations:

- test marks/school achievement
- average age/height/weight
- bowling scores
- average temperature/rainfall.

Interprets information found in books, pamphlets, newspapers and magazines that is displayed in table/chart/graph form:

- television/travel schedules
- telephone/postal/utility rates
- highway distance charts
- population trends
- measurement conversion charts
- income/expense
- price increase/price decrease
- spending patterns/budgets.

Uses tables/charts that are intended to provide direction and sequence for activity:

- assembly instructions
- recipe ingredients.

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Related Applications Across the Curriculum

Language Arts

Interprets statistical information as required in research activities.

Science

Uses tally sheets and frequency tables to collect and record data obtained through observation/interview/experimentation.

Obtains information by reading and interpreting data provided in tables, charts, and graphs.

Social Studies

Gathers and displays data using a variety of methods:

- lists
- tables/charts
- graphs.

Practical Arts

Reads and interprets data displayed in a variety of graphic forms.

Organizes and displays information using flow charts, tables, and graphs.

Reads and interprets tables/charts in order to perform required tasks:

- specification charts
- tables of pattern size.

Suggested Strategies/Activities

Activities that involve the interpretation and display of numerical data should be integrated throughout each theme of the math program. The discrete development of related concepts and skills is discouraged. Select tables/charts/graphs from a variety of available sources that relate to the topics investigated within each theme. Projects undertaken in other subject areas may provide additional opportunity for the application of skills being developed.

Emphasize and model the use of tables/charts/graphs as useful strategies in solving problems:

- interpreting problem information provided in table/chart/graph form
- manipulating/organizing problem information into charts/graphs in order to make patterns and relationships more discernable.

Provide students with first-hand experience in collecting/organizing/displaying information through the use of tally sheets, tables, charts and graphs. Information might be collected from the newspaper or through personal interview/observation, and should relate to topics of investigation within each theme. Through the use of appropriate questioning techniques, encourage students to:

- draw conclusions/make predictions that are based on the information they have collected and displayed
- identify the characteristics and comparative strengths/weaknesses of pictographs, bar graphs, line graphs and circle graphs
- apply knowledge of the characteristics of each type of graph in choosing forms most suited to the display of different kinds of information
- recognize the misuse of different types of graphs and inaccurate interpretations that may result.

Instruction should develop an understanding of specific procedures and steps to be followed in constructing pictographs, bar graphs and line graphs. While students should recognize and interpret the circle graph, its construction is not required at this level. Such activities might be undertaken as part of the elective component if desired.

Activities provided in the *Teacher Resource Manual* focus attention on the development of skills in data interpretation/display at appropriate points within each theme.

MATHEMATICS (I.O.P. GRADE 9)

ALGEBRA

CONCEPTS:

- Identifies arithmetical patterns and relationships that are present in concrete situations.
- Uses algebraic symbols to write expressions/formulas/linear equations that describe arithmetical patterns and relationships.
- Recognizes the basic properties of number systems and operations:
  - properties of zero and one
  - commutative/associative/distributive properties
  - order of operations.
- Applies knowledge of the basic properties of number systems and operations in manipulating symbols and solving practical problems.

ATTITUDES:

- Displays a positive attitude toward self and the learning of mathematics:
  - demonstrates self-reliance in working independently
  - participates effectively in group discussions/activities
  - practises strategies for resolving interpersonal conflict
  - demonstrates an attitude of interest/curiosity, taking risks and displaying perseverance in problem situations.
- Appreciates the usefulness of algebra in generalizing patterns/relationships in arithmetic, and in applying generalizations to practical situations in real life.

COURSE: MATHEMATICS (I.O.P. Grade 9)
CONCEPT: ALGEBRA

LEARNING OBJECTIVES	Related Life Skills

Displays an understanding of algebraic thought and process by:
- generalizing arithmetical patterns and relationships represented in concrete situations
- describing patterns and relationships through the use of symbols
- transferring generalizations to related applications and problems in real life.

- Demonstrates an understanding of concepts/skills developed in Grade 8:
  - distinguishes between variables and constants
  - uses variables to write mathematical expressions that describe practical situations
  - evaluates mathematical expressions
  - uses variables to write linear equations/ formulas that describe practical situations
  - interprets formulas as word statements
  - performs substitution in formulas.
- Uses concrete manipulatives to demonstrate the concept of equality.
- Uses estimation and guess/check strategies to solve linear equations describing practical situations that have been written in any of the following forms:
  - $x + a = b$
  - $ax = b$
  - $ax + b = c$
  - $x/a = b/c$.
- Verifies solutions to linear equations by substitution.

Recognizes number patterns and relationships that are present in practical situations related to:

- travel/sport/recreation
- home maintenance/repair
- personal finance/management.

Uses formulas and simple linear equations to solve routine problems involving previously established number patterns and relationships. Practical situations to which formulas and equations might be applied include:

- "travel problems" involving distance travelled, rate of travel and travel time
- consumer problems where "unit price" or "multiple price" is determined
- "discount" problems involving regular price, sale price and amount saved
- problems where "money earned" is determined by considering rate of pay and time worked
- problems requiring the determination of money earned or paid in "interest"
- problems where adjustments are made in "recipes/directions" (e.g., increasing or decreasing a recipe)
- problems involving the use of "scale drawings" (e.g., blueprints, maps)
- problems that require a strategy for finding "perimeter" or "area"
- problems involving the "conversion of measurements" (e.g., conversions among units of length, mass, capacity, or time).

Related Applications Across the Curriculum

Science

Uses formulas to summarize major principles/ relationships that have been discovered in science.

Generalizes number relationships in order to convert among units of measure (e.g., mL = L × 1000).

Substitutes into simple formulas as required in order to solve problems.

Social Studies

Uses algebraic notation to demonstrate relationships among population flow, industry, and economic base of a community.

Practical Arts

Uses formulas in solving problems that involve:

- food requirements for a variable number of people
- stock requirements based on past sales
- conversions among units of measure
- distance in d = rt relationships
- adjusting a recipe/mixture to suit variable needs.

Suggested Strategies/Activities

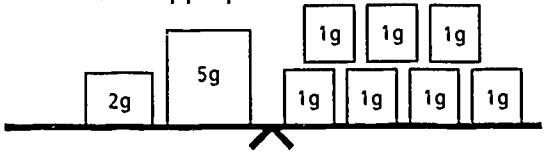
The use of algebraic thought and process should be encouraged throughout the mathematics program. Concepts and skills should not be developed discretely, but rather within the context of each theme studied. Emphasis on strategies/activities outlined in the Grade 8 program will assist students to maintain and extend skills already developed.

Tables and charts provide a useful method of displaying number patterns. Ask students to write expressions that describe simple relationships by looking for a pattern.

x	
1	6
2	7
3	8

(The expression is x + 5.)

Discuss the concept of "equality" as a statement of balance in number sentences where the left side equals the right side. Use the balance scale as a manipulative, and describe various states of balance on the scale with appropriate number sentences.



2 + 5 = 7

Relate "guess and check" strategies for solving equations to finding numbers that balance the left and right sides of the equation. Emphasize the need to organize work and document processes used through formal substitution procedures.

Example: Solve 2n + 3 = 15
Try x = 5 2x(5) + 3 = 13 (too small)
Try x = 8 2x(8) + 3 = 19 (too big)
Try x = 6 2x(6) + 3 = 15 (just right)

Encourage the use of the calculator (and the automatic constant function) as an aid to the process of finding solutions by guess/check.

The use of formulas as a "means to an end" in problem situations should not occur until the relationships between variables occurring in the formula are well understood. Facilitate an understanding of these relationships by:

- investigating how to substitute and solve for missing elements in a formula (e.g., in A = l × w, finding l when A and w are known)
- discussing the effect of doubling or tripling a selected element on other elements in the formula (e.g., in d = r × t, recognizing the effect that doubling r has on d).