hands-on mathematics

Geometry, Mental Math, Measurement, Number Concepts, Number Operations, Patterns and Relations, Statistics and Probability
Program Implementation

Program Resources

*Hands-On Mathematics* is arranged in a format that makes it easy for teachers to plan and implement. Modules comprise the selected topics of study for the grade level, organized into lessons. The modules relate directly to the learning outcomes identified on page 5, which complement those established by the Western and Northern Canadian Protocol (WNCP).

The introduction to each module summarizes the general goals for the module and provides background information for teachers. Each module begins with a list of books for students that relate to the module; a list of related websites can also be found on page 24.

Modules are organized into lessons, based on the outcomes.

**Note:** This does not imply that a lesson can be covered in only one lesson period; many will carry over several lesson periods.

Lessons are arranged in the following format:

**Background Information for Teachers:**
Some lessons provide teachers with the basic mathematical knowledge they will need to present the activities. This information is offered in a clear, concise format, and focuses specifically on the topic of study.

**Materials:** A complete list of materials required to conduct the main activity or activities is provided. It includes classroom materials, equipment, and visuals. The quantity of materials required will depend on how you conduct activities and whether students are working individually or in groups.

**Activity/Activities:** This section details a step-by-step procedure, including higher-level questioning techniques and suggestions for encouraging active inquiry and discussion.

**Activity Sheets:** Reproducible activity sheets have been designed to correlate with the specific outcomes of the activity or activities. Many of these are used during the activity to record results of investigations. Others are used as follow-up to the in-class activities. Students may work independently on these sheets, in small groups, or you may choose to read through them together and complete them in a large group setting. Activity sheets can also be made into overheads or large experience charts. Since it is also important for students to learn to construct their own charts and recording formats, these activity sheets can be used by the teacher as examples of ways to record and communicate ideas about an activity. Students can then create their own sheets rather than use the ones provided.

**Note:** Activity sheets are meant to be used only in conjunction with, or as a follow-up to, the hands-on activities. The activity sheets are not intended to be the mathematics lesson in itself or the sole assessment for the lesson.

**Problem Solving:** Many lessons include suggestions for problem-solving activities that are directly related to the lesson’s outcomes. These problems may be presented orally, acted out with concrete objects, presented pictorially, or written out on chart paper. At the end of each module, many of these problems are presented again on black line masters. Teachers can copy these sheets onto overhead transparencies to present to students as daily problem-solving activities. Or, the masters can be copied for students and cut apart, problem by problem. Students can then paste the problems into their math journals or agendas for completion independently.

**Activity Centre:** Some lessons include independent student activities that focus on the outcomes.
Extension: Many lessons include optional activities to extend, enrich, and reinforce the outcomes.

Assessment Suggestions: Throughout each module, several suggestions are made for assessing student learning. These assessment strategies focus specifically on the learning outcomes of a particular activity topic. In the next section of the Hands-On Mathematics program, assessment is dealt with in detail. Keep in mind that the suggestions made within activities are merely ideas to consider; you may use your own assessment techniques or refer to the other assessment strategies on pages 11 and 12.

Classroom Environment
The classroom setting is an important component of the learning process. An active environment—one that gently hums with the purposeful conversations and activities of students—indicates that meaningful learning is taking place. While studying a specific topic, the room should display related objects and materials, student work, pictures and posters, maps, graphs, and charts made during activities, and summary charts of important concepts taught and learned. These reinforce concepts and skills that have been stressed during mathematics activities.

Timelines
No two groups of students will cover topics and material at the same rate. Planning the duration of modules is the responsibility of the teacher. In some cases, the activities described will not be completed during one block of time and will have to be carried over to another period. (Division of modules into lessons does not imply that lessons can be covered in only one period. Many lessons will, in fact, carry over several lesson periods.) In other cases, you may observe that your students are especially interested in one topic, and you may choose to expand upon it. The individual needs of your students should be considered, as there are no strict timelines involved in the Hands-On Mathematics program. It is important, however, to spend time on every module in the program so that students focus on all outcomes established for the grade level.

Classroom Management
Although active learning is emphasized throughout this program, the manner in which these experiences are handled is up to you. In some cases, you may have all students working with materials and resources individually; in others, you may choose to use small group settings. The latter encourages the development of social skills and enables all students to be active in the learning process; it also means less cost in terms of materials and equipment. Again, classroom management is left up to you, since it is the teacher who ultimately determines how the students in his/her care function best in the learning environment.

Planning Guidelines
Mathematics is a skills-based subject. In order to acquire these skills, students need to visit and revisit them over the course of the school year.

Hands-On Mathematics is organized into strand- or topic-focused modules. This organization allows teachers to follow the development of concepts from introduction to mastery within a given grade level. To ensure that students have opportunities to develop their mathematical skills in all topics throughout the year, it is recommended that teachers address concepts from each of these modules in every reporting period or school term. For example, teachers may choose to begin the year with the Patterns and Relations module (module 1) but should continue to develop students’ skills in this area throughout the entire school year.
through review, continued practice, and new mathematical challenges. In the same way, although the Geometry module (module 6) is presented last in the *Hands-On Mathematics* program, students should be provided with opportunities to review, practise, and investigate geometry concepts throughout the school year. Planning in this way gives students the time needed to solidify their understanding and, at the same time, helps to keep the concepts and vocabulary in the forefront throughout the year.

**Note:** Developing a year plan will ensure that topics are dealt with throughout the school year. Teachers can design the plan to meet their students’ specific needs and to fit into their school calendars. On the following two pages, a sample year-plan template is provided. Teachers can use the template to record the skills from each module that they will teach during each month. There is also additional space for briefly noting other curriculum connections and themes that may relate to the overall math plan. Teachers can divide the bottom row of the chart according to the duration of the curriculum connection and related theme, which may be less than or greater than one month.
Mental Math Activities
Grades 1-4
Western and Northern Canadian Protocol (WNCP) Edition

hands-on mathematics

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Grade 4

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Introduction

The goal of the number operations module is to enhance students’ computational fluency with addition, subtraction, multiplication and division. In keeping with this goal, the activities in this module promote the use of various strategies for computation.

As students develop a set of strategies and explore how they work in other settings, they need opportunities to explain their thinking to their peers. This gives students several windows of thinking to explore, validation of their own strategies, and new strategies to use later on in their learning. Throughout the module, suggestions are made for partner and class sharing. This is an important component of each lesson as the dialogue will allow students opportunities to articulate their understanding and gain new understanding from others.

Think time is very important for students. Be sure to provide it throughout the subsequent lessons, allowing students who think at different paces a chance to formulate their responses. As students respond, record their thinking on chart paper or on the chalkboard/whiteboard for other students to see. This validates their thinking and gives other students access to a variety of strategies to add to their existing collection.

To encourage student reflection, self-assessment, and communication skills, have students keep math journals. Suggestions for use of the math journals are provided within the module.

Mathematics Vocabulary

A mathematics word wall for displaying new vocabulary is a valuable reference for students. Dedicate a classroom bulletin board to your math word wall, and display the letters of the alphabet along the top. Use index cards to record math vocabulary introduced in each lesson, attaching these to the board under the appropriate letter. Encourage students to refer to the math word wall during classroom activities and assignments.

Terms to Know

Digit Value: A number is made up of digits from 0 to 9. The digit value of any digit within a number is dependent on the place it holds (its place value) within the number. For example, 3792 is made up of four digits; the digit 7 has a value of 700.

Expanded Notation: The representation of a number in a mathematical sentence that shows the value of each digit (the sum of the value of each digit). For example:

5683 is written as 5000 + 600 + 80 + 3
or as (5 x 1000) + (6 x 100) + (8 x 10) + (3 x 1)

Array: An arrangement of objects (tiles, bingo chips, and so on) in a rectangle or square.

Mathematical Properties

Commutative Property: With addition, this refers to the fact that changing the order of the addends does not change the sum. With multiplication, this refers to the fact that changing the order of the factors does not change the product. For example:

Addition

\[ 3 + 6 = 6 + 3 \]

Multiplication

\[ 5 \times 3 = 3 \times 5 \]
Compatible Numbers

Background Information for Teachers
Compatible numbers are numbers that are easy to add, subtract, multiply, or divide mentally. For example, the numbers 53 and 17, for which the ones add up to 10, would be compatible.

Materials
- sticky notes in two colours
- chart paper
- markers
- adding machine tape

Activity: Part One

Note: Before beginning this activity, create a number line from 30 to 50 using adding machine tape and two colours of sticky notes: one colour for numbers 31–40 and a second colour for numbers 41–50 (the two different colours will help students visualize and use the benchmark to the next 10 strategy). Reserve a sticky note to be labelled with the number 30 in the same colour as the blank note at the end, and attach the 30 to the beginning of the number line. Record 50 on the last (end) sticky note, as in the following diagram:

Remind students that friendly numbers are ones that are usually easier to use, such as numbers said when skip counting by 5 or 10. Ask:
- What are some friendly numbers that we can identify on this empty number line?
- Where are the friendly numbers located?

As students identify some of the friendly numbers, record them on the sticky notes, as below:

Ask:
- Where is the halfway number?
- What is the middle number?

Have students locate various numbers on the number line. Ask:
- If I want to place an arrow above the number 34, where should it go?
- If the arrow is above the number is 34, how do we jump to 47?
- What is the value of the jump from 34 to 47? (13)
- What would the addition sentence be? (34 + 13 = 47)

Now, discuss various strategies for showing this addition sentence on the number line.
Ask:
■ Instead of jumping 13 tiny steps, how else could we make the 13 jumps?

Record the following two strategies on chart paper:

1. \[34 \quad 35 \quad 45 \quad 47\]
   \[\text{Value jumped} \quad 1 + 10 + 2 = 13\]

2. \[34 \quad 44 \quad 47\]
   \[\text{Value jumped} \quad 10 + 3 = 13\]

Repeat the process for several different numbers, such as:
■ jump from 37 to 49
■ jump from 33 to 50
■ jump from 31 to 46
■ jump from 35 to 50
■ jump from 41 to 46

Be sure to ask students for the \textit{value} of the total jump between the two numbers and for the addition sentence. Have students share their various strategies for jumping from one number to another.

\textbf{Note}: placing the number line on the floor and having students physically jump to the specified number is another way of conducting the activity. While students are explaining their thinking or acting it out on the number line, record their strategy on an empty number line on chart paper.

Repeat this activity using different start and end numbers, such as: 50 to 70, 120 to 140, 165 to 185, 233 to 253, 1250 to 1270, and so on.

\textbf{Assessment for Learning}
Observe students to determine the number ranges with which they are comfortable. Be sure to use number ranges that are within a student’s comfort zone, and build skills from that range.

Also, repeat this activity with two jumps from the first number as in the second of the preceding two figures.

\textbf{Note}: This activity can be done as a quick warm-up exercise: each day, have a few students present their strategies by drawing an empty number line that shows the jumps between two numbers. This is an effective way of revealing the different strategies students use.

\textbf{Activity: Part Two}
Before beginning the lesson, record, on sticky notes, several compatible numerals for a specific target number. For example, if the target number is 50, compatible numbers could be 25 and 25, 20 and 30, or 27 and 23. Randomly stick the numerals onto a bare wall, a piece of chart paper, or the chalkboard as in the diagram below:

\begin{center}
\begin{tabular}{|c|c|c|c|}
\hline
Target & 15 & 16 & 26 \\
\hline
25 & 24 & 35 & 30 & 34 \\
20 & 25 & \\
\hline
\end{tabular}
\end{center}

Gather students in front of the numerals on sticky notes, and explain that on the wall in front of them are several pairs of compatible numbers. Together, each pair of numbers adds up to 50. You would like them to help you find each pair of compatible numbers.

Take this opportunity to discuss strategies students could use to find compatible numbers to 50. For example, if one of the numbers is 23, which has a 3 in the ones place, look for a number that has a 7 in the ones place.
Invite one student to select one of the numbers. Then, have a different student find the number that is compatible to the first one. Encourage students to carry out the task without talking. Continue until all compatible numbers have been found.

**Note:** This can be a good activity for students who are apprehensive and do not feel comfortable taking risks. For those students, choose a low target number and simpler compatible numbers such as 2 and 18 for a target of 20. This can also be a great warm-up activity at the beginning of a lesson.

**Next Steps**

- Record triads of compatible numerals on sticky notes. For example, for a target number of 50, three compatible numbers would be 20, 15, and 15, or 12, 28, and 10. Have students explain their thinking as they identify compatible triads.
- Make target numbers more challenging by increasing their value, working up to 3- to 4-digit numbers.

Distribute Activity Sheet A (5.2.1), and have students draw lines between sets of compatible numbers to 20. Then, have students complete Activity Sheet B (5.2.2) (compatible numbers to 50) and Activity Sheet C (5.2.3) (compatible numbers to 100).

**Activity Sheet A**

**Directions to students:**

Draw lines between sets of compatible numbers to 20 (5.2.1).

**Activity Sheet B**

**Directions to students:**

Draw lines between sets of compatible numbers to 50 (5.2.2).

**Activity Sheet C**

**Directions to students:**

Draw lines between sets of compatible numbers to 100 (5.2.3).

**Activity Centres**

- **And How Many More?:**
  
  At an activity centre, place a 10-sided number cube, and a collection of coins to $1. Also, include copies of the “And How Many More Cents?” game boards (there is one version for 20¢, one for 50¢, and one for $1) and copies of the recording sheet. Have students work in pairs or individually to play “And How Many More Cents?” a game in which students find compatible numbers to 20¢, 50¢, and $1.

  Have students begin with the “And How Many More Cents? to 20 Cents” game board. If they are playing in pairs, ask them to take turns rolling the 10-sided number cube and using coins to build that number on the left side of the game board. Then, on the right side of the game board, have the same student use coins to build a compatible number for the first number, to 20¢. Ask each student to record which coins he/she used for each turn on his/her own recording sheet (5.2.4, 5.2.5, 5.2.6, 5.2.7).

**Next Step**

Once students are comfortable using coins to build numbers to 20¢, have then repeat the activity with a 20-sided number cube and building compatible numbers to 50¢, and then with a combination of number cubes with numerals to 100 (five 10-sided number cubes plus two 20-sided number cubes plus one 10-sided number cube; a 100-sided number cube, and so on) to $1.
At an activity centre, place a 10-sided number cube, a collection of bingo chips, copies of the “And How Many More? to 20” game board, and copies of the accompanying recording sheet.

Again, have students work in pairs or individually to play a game similar to the preceding one but using bingo chips on ten frames to build the numbers. Ask students to take turns rolling the 10-sided number cube and using bingo chips on ten frames to build that number on the left side of the game board. For example, if a student rolls 9, he/she uses bingo chips to cover nine squares on one of the ten frames. Then, on the right side of the game board, have students use bingo chips on ten frames to build a compatible number for the first number to 20. Returning to the previous example, the student would then cover one full ten frame and one more with bingo chips on the right-hand side. Have students record the two compatible numbers on the accompanying recording sheet provided (for example, 9 and 11 is 20) (5.2.8, 5.2.9).

At an activity centre, place a 20-sided number cube, copies of the “And How Many More? to 50” game board, copies of the accompanying recording sheet, and sets of the smaller ten frames.

Note: The smaller accompanying ten frames (5.2.12.) need to be cut out. Either cut them out ahead of time, or also include scissors at the centre, and instruct students to cut them out.

Next Step

As students progress with this activity, give them another 10-sided number cube so they can roll numbers to a maximum of 30 (still working with compatible numbers to 50). Continue to increase the maximum number that can be rolled by adding 10-sided number cubes until the maximum number that can be rolled is 50.

At an activity centre, place a combination of number cubes with numerals to 100 (six 10-sided number cubes, plus two 20-sided number cubes; a 100-sided number cube, and so on). Also, include copies of the “And How Many More? to 100” game board, copies of the accompanying recording sheet, and sets of the smaller ten frames.

Note: The smaller accompanying ten frames need to be cut out. Either cut them out ahead of time, or also include scissors at the centre, and instruct students to cut them out.

Again, have students work in pairs or individually to play a game similar to the preceding one except they use a combination of number cubes with numerals to 100 and they build compatible numbers to 100. If they are playing in pairs, ask them to take turns rolling the number cube(s) and building that number by placing smaller ten frames onto the larger one. For example, if a student rolls 47, he/she would place four full ten-frames and the frame with 7 dots onto the larger ten frame. Then, have students build the compatible number to the number rolled (five full ten-frames and the frame with three
dots) on a second copy of the game board. Finally, have students record the compatible numbers on the recording sheet provided (47 and 53 is 100) (5.2.13, 5.2.14, 5.2.12).

Assessment of Learning

While students are working on the lesson’s activities, observe them to determine the following:

- Which students still count on their fingers by 1s? By 2s?
- Which students use “friendly” benchmark numbers to help?
- Which students need support to use the empty number line?

Use the Anecdotal Record sheet, found on page 13, to record your results.
Compatible Numbers to 20

0 4 9 12
16 11 15 14
8 1 6 20
7 19 3 17
18 5 13 2
1 11 10 20
6 17 4 12
3 0 13 16
18
19 4 7
16 5 14 2
15 9 8
10

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Compatible Numbers to 50

Date: __________________________ Name: ______________________________

Sample Pages
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Compatible Numbers to 100

17  2  25  10
24   69
31  75  45  98
55  76  90  83
20  91  35
43  84
100  57  0
65  9  80
And How Many More Cents? to 20¢

Build it with
And How Many More Cents? to 50¢

Build it with

Coin designs © courtesy of the Royal Canadian Mint
Image des pièces © courtoisie de la Monnaie royale canadienne
And How Many More Cents? to $1

Build it with

Image designs © courtesy of the Royal Canadian Mint
Image des pièces © courtoisie de la Monnaie royale canadienne
# And How Many More Cents? Recording Sheet

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Date: ___________________________  Name: ___________________________

Activity Centre

Coin designs © courtesy of the Royal Canadian Mint
Image des pièces © courtoisie de la Monnaie royale canadienne
And How Many More? to 20
Activity Centre

And How Many More? to 20 Recording Sheet

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**And How Many More? to 50 Recording Sheet**
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Small “And How Many More?”
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NUMBER CONCEPTS
GRADE 4

Western and Northern Canadian Protocol (WNCP) Edition

hands-on mathematics
Grade 4

Project Editor
Jennifer E. Lawson

Writer
Colleen Foster

Mathematics Consultants
Meagan Mutchmor
Dianne Soltess
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