Sample Page

hands-on problem solving

A Minds-On Approach

Grade 1

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Introduction to Hands-On Problem Solving Grade 1

Problem Solving

Problem solving is another of the "big ideas" in mathematics—the mathematical processes students need in order to achieve the goals of mathematics education and to support lifelong learning in mathematics. Students are exposed to a wide variety of problems in all areas of mathematics in ***Hands-On Problem Solving***. They explore a variety of methods for solving and confirming their solutions to different types of problems. They should also be encouraged to find multiple solutions for problems and to create their own problems.

What Is Problem Solving?

Problem solving refers to "mathematical tasks that have the potential to provide intellectual challenges for enhancing students' mathematical understanding and development" (Cai and Lester, NCTM). Problem solving is the application of mathematical knowledge, tools, and strategies to a wide range of math problems in order to solve them.

Problem solving:

- Is a life skill
- Creates a purpose for learning skills and concepts
- Motivates students by developing a sense of inquiry
- Allows students to demonstrate their understanding of mathematical concepts and skills in meaningful contexts
- Teaches perseverance.

Problem solving should be the main focus of mathematics instruction. The ability to apply their knowledge to solve problems is the goal for all students.

Best Practices in Teaching Problem Solving

Problem solving is often not viewed positively by students. In order to change this perception teachers should

- Use a problem-solving approach when introducing and teaching concepts and skills;
- Begin with simple problems so students can experience success;
- Include a balance of routine, non-routine, and extended exploration problems;
- Encourage the use of multiple strategies for solving problems;
- Provide opportunities for students to write their own problems;
- Use modelling (think aloud) to demonstrate the thinking processes involved in solving a problem. Students will be reluctant to attempt a problem if they do not know where or how to begin;
- Provide time for reflection (journaling, summarizing, and so on) in order to clarify mathematical ideas and relationships;
- Encourage discussion (turn-and-talk, whole class, and so on) to develop and reinforce critical and creative thinking skills.

Routine Problems

These are problems in which the way to a solution is generally straightforward. The solution usually involves one or two arithmetic operations.

Problem Types

Efforts are made to offer a variety of types of routine problems for students to solve in ***Hands-On Problem Solving***. As such, those problems focusing on number concepts include the following operations and problem types:

- Addition and subtraction: beginning unknown, middle unknown, and end result unknown

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- Multiplication: product unknown
- Division: quotitive and partitive division.

These problem types are described in detail in the Implementation of Routine Problems section (see page 26).

Non-Routine Problems

These problems are more challenging for students. Upon first reading, the path to a solution is not immediately evident. Students draw on a bank of strategies (teacher-presented and student-developed) to solve the problem. Possible strategies include

1. Act it out/use materials.
2. Draw a picture/diagram.
3. Look for a pattern.
4. Use logical reasoning.
5. Guess and check.
6. Make an organized list.
7. Make a table.
8. Work backwards.
9. Use an equation.
10. Use simpler numbers.

Some non-routine problem-solving strategies are more appropriate for use at specific grade levels than others. The chart below provides details about when each strategy is addressed in the ***Hands-On Problem-Solving*** program:

Strategy	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Act it out/use materials	✓	✓	✓	✓	✓	✓	✓	✓
Draw a picture/ diagram	✓	✓	✓	✓	✓	✓	✓	✓
Look for a pattern	✓	✓	✓	✓	✓	✓	✓	✓
Use logical reasoning	✓	✓	✓	✓	✓	✓	✓	✓
Guess and check		✓	✓	✓	✓	✓	✓	✓
Make an organized list		✓	✓	✓	✓	✓	✓	✓
Make a table			✓	✓	✓	✓	✓	✓
Work backwards					✓	✓	✓	✓
Use an equation					✓	✓	✓	✓
Use simpler numbers					✓	✓	✓	✓

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Descriptions of these strategies are provided in detail in the Implementation of Non-Routine Problems section (see page 124).

Extended Exploration Problems

Extended exploration problems are meant to provide a thought-provoking challenge for students. These problems may present mathematical situations that are slightly beyond the grade-level curricular outcomes/expectations, may take the form of an investigation, or may require an extended period of time to solve. In all cases, students are encouraged to use their own strategies to arrive at (a) solution(s).

Extended exploration problems are open ended, can be investigative in nature, and have multiple entry points to allow for differentiation. They often

- Have more than one solution/answer
- Can be solved using a variety of strategies
- Require students to gather their own data
- Require creative and critical thinking
- Require more/extended time to solve
- Make connections to the real world.

Extended exploration problems support the other six "big idea" mathematical processes: communication, connections, mental math, estimation, reasoning, technology, and visualization. The engaging nature of these problems helps students develop perseverance and critical thinking.

Examples and procedures for extended explorations are described in detail in the Implementation of Extended Exploration Problems section (see page 214).

Implementing the Hands-On Problem-Solving Program

Hands-On Problem Solving is arranged in a format that makes it easy for teachers to plan and implement, with tasks that relate to specific outcomes/learning expectations established in Canadian curriculum documents.

Program Format

Problem-solving tasks are presented as daily mathematics activities and are organized according to the approximate number of weeks in the school year. As such, there are 40 weeks-worth of problem-solving tasks, consisting of

- 40 routine problems that focus on math topics including number, patterns, measurement, and geometry. These problems are identified as problems 1A through 40A.
- 40 non-routine problems that focus on specific strategies for the grade level. These problems are identified as problems 1B through 40B.
- 10 extended explorations that offer in-depth, real-life contexts as the basis for problem solving. These problems are identified as problems 1C through 10C.

Planning Your Year of Problem Solving

The three types of problems (routine, non-routine, and extended explorations) are presented in three separate sections of this book, each with its own detailed introduction on implementation. However, it is essential that students focus on all three types of problems throughout the school year. Therefore, it is recommended that teachers do one routine and one non-routine routine problem with students each week, and one extended exploration each month.

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In the following section of ***Hands-On Problem Solving*** a correlation chart identifies the math concepts presented in each lesson of the book. Teachers can refer to this chart to plan problem-solving activities that correspond with other math activities occurring in the classroom. For example, if students are focusing on 2-D shapes in math, the correlation chart will show which problems herein connect to that topic.

Curricular Connections

Efforts have been made to correlate ***Hands-On Problem-Solving*** problems with other curricular areas, such as language arts, science, and social studies. For example, children's literature is referenced in some problems to provide a context. Other problems connect specifically to a science or social studies topic or to a general area of emphasis such as social justice. As teachers become familiar with the problems, they will find opportunities to connect these problems to specific units or topics of study.

Supporting Literacy During Problem Solving

To support beginning grade 1 students, many of whom will be emerging readers, activity sheets for the first 13 routine and non-routine problems are presented in rebus format, meaning that some words are displayed with pictorial representations. These illustrations, however, are not displayed on the corresponding lesson plans for teachers.

It is important that all students, regardless of reading ability, have the opportunity to participate and succeed in problem solving. As such, some will require additional supports to read and understand the problems presented. To help support students' literacy skills, consider the following options:

- Read the problem aloud, and have students follow along.
- Read the problem as a class.
- Have students work with partners or in small groups to read and discuss the problem.
- Introduce, discuss, and review related math vocabulary, and display pictorial representations in the classroom (for example, display labelled illustrations of triangles, squares, and rectangles during a lesson in which students must draw on knowledge of 2-D shapes).

The Questioning Process

During the problem-solving process, it is important for teachers and students to pose questions and to consider various strategies for solving the problem. To encourage these processes, blackline masters of guiding questions have been included for teacher and student use (see page 10). These two templates (one for teacher use and the other for student use) provide suggested questions that can be asked during the problem-solving process.

The blackline masters can be photocopied onto sturdy tag board and laminated for long-term use. Teachers may choose to use these resources during lessons, as they support students in their problem solving. Students can glue their cards into problem-solving file folders or notebooks, or the cards can be placed on desks or tables for use during problem-solving activities.

Additional Resources

For some problem-solving tasks, students might use strategies requiring specific materials, such as hundred charts, number lines, graph paper, dot paper, and so on. These materials can be found in the Appendix at the back of the ***Hands-On Problem-Solving*** book (see page 243); teachers are encouraged to photocopy these resources and distribute them to students as needed.

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Mathematics Correlation

The ***Hands-On Problem-Solving*** series has been designed to complement the mathematics program at any given grade level. Lessons (problems) in this book address the various mathematics topics and concepts focused on in grade 1. The following chart indicates how lessons (problems) in the program connect to these math topics and concepts.

The following correlations are based on an in-depth review of mathematics curriculum documents from across Canada, including the Western/Northern Canadian Protocol (WNCP), Ontario, and Atlantic Canada.

Grade 1 Correlation Chart

MATHEMATICS TOPIC	LESSON (PROBLEM) NUMBER
Number	
Counting forward	1A, 17A, 19A, 37A, 1B, 8B, 9B, 10B, 21B, 30B, 31B, 33B, 34B, 36B, 37B, 40B, 1C, 8C
Counting backward	9A, 10A, 11A, 12A, 13A, 24A, 10B, 37B, 39B, 40B
Subitizing	16A
Counting on	1A, 7A, 8A, 17A, 19A, 24A, 37A, 1B, 9B, 31B, 40B
Skip counting by 2s	2A, 15A, 18A, 19A, 29A, 14B, 6C
Skip counting by 5s	3A, 16A, 17A, 23A, 10B
Skip counting By 10s	4A, 26A
Comparing sets	5A, 6A, 12A, 13A, 15A, 22A, 23A, 25A, 2B, 3B
Part-part-whole relationships	6A, 10A, 11A, 12A, 16A
Equal groups	2A, 3A, 4A, 18A, 23A, 25A, 3B, 4B, 5B, 8B, 10B, 22B, 25B, 28B, 30B, 32B, 34B, 1C, 3C, 5C, 6C
+1 −1 +2 −2	14A, 23B
Screened tasks	12A, 13A
Operations	
Addition	1A, 2A, 3A, 4A, 6A, 7A, 8A, 15A, 16A, 17A, 18A, 19A, 21A, 22A, 23A, 24A, 25A, 27A, 29A, 37A, 1B, 9B, 21B, 22B, 23B, 25B, 26B, 28B, 30B, 31B, 34B, 37B, 40B, 1C, 2C, 4C, 6C, 7C, 10C
Subtraction	9A, 10A, 11A, 12A, 13A, 15A, 20A, 24A, 23B, 37B, 40B, 10C
Mental math	1A, 7A, 8A, 9A, 10A, 11A, 12A, 13A, 14A, 15A, 29A, 15B, 2C
Patterns and Relations	
Recognizing patterns	13B, 14B, 15B, 21B, 28B, 33B, 36B, 39B, 3C
Repeating patterns	30A, 31A, 32A, 11B, 12B, 13B, 15B, 21B, 24B, 26B, 3C
Equality	28A, 4C

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Measurement	
Length	34A, 8C
Area	33A
Mass	35A
Geometry	
2-D shapes	36A, 37A, 38A, 7B, 15B, 16B, 24B, 9C
3-D objects	39A, 9C
2-D shapes and 3-D objects	37A, 40A, 16B, 9C

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Routine Problems

1A Cole Finds Seashells

Math Topic

Number

Math Concepts

- Counting on
- Addition

Problem Type

Addition: End result unknown (a + b = ?)

Problem

Cole is at the beach.

He finds 5 seashells.

He walks down the beach.

He finds 4 more seashells.

How many seashells does Cole find?

Background Information for Teachers

At the beginning of grade 1, students should be provided with numerous opportunities to build number concepts through manipulation of materials, counting objects, matching, and comparing sets. As students explore the following rebus problems, they should begin to verbalize the number sentence or story orally before they are introduced to symbols and equations.

Students may use a variety of strategies to solve this problem, such as the following:

- Use manipulatives to act out the problem.
- Use counters to match pictures onto the rebus story.
- Draw a picture, and count on.

Students should have access to math materials (manipulatives, counters, or drawing materials) at all times to allow them to implement a chosen strategy.

Think

Provide time for students to read, think, and formulate ideas about the problem.

Talk

Discuss the problem with students. Ask:

- What do you need to find out? (how many seashells Cole finds)
- What is important in the problem? (Have students use coloured pencils or markers to highlight or circle the important information, or model this for them.)
- What is not important? (Have students use pencils to underline the unimportant information, or model this for them.)
- Can you name the answer? (seashells)
- How can you solve the problem?
- What materials can you use to solve the problem?
- What strategies can you use to solve the problem?

Discuss the problem as a class, in small groups, or in pairs. Encourage communication through the use of rich, probing questions and meaningful conversations with and among students. Be sure to have students share their ideas about the materials and strategies they could use to help them solve the problem. Encourage students to ask questions as well.

Solve

Cole finds 9 seashells.

Share

Have students share their strategies and solutions.

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1A

Extend

Have students bring seashell collections from home (or pick some up at a craft or dollar store). Challenge students to use the shells to create their own story problems. Problems can be acted out for the class and solved as a group.

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Date: _____ **Name:** _____

Cole Finds Seashells

Cole is at the beach.

He finds 5 seashells.

He walks down the beach.

He finds 4 more seashells.

How many seashells does Cole find?

Think

Talk

Solve

Share

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2A Jake Has Goldfish

Math Topic

Number

Math Concepts

- Counting by 2s
- Addition

Problem Type

Addition: End result unknown (a + b = ?)

Problem

Jake has a bowl of goldfish.

He has 6 goldfish.

How many eyes are there on all 6 goldfish?

Background Information for Teachers

Although they may use addition to solve this problem, students will likely focus on their counting skills, specifically counting by 2s. Some students may also count using one-to-one correspondence. To scaffold the problem and focus on counting by 2s, have students work in small groups of three to five students, and challenge them to count how many ears they have altogether. Vary the size of the groups, and have students count hands, feet, elbows, and so on.

Students may use a variety of strategies to solve this problem, such as the following:

- Use manipulatives to act out the problem.
- Use counters to match pictures onto the rebus story.
- Draw a picture, and count.
- Count by 2s orally.

Think

Talk

Discuss the problem with students. Ask:

- What do you need to find out? (how many eyes on all 6 goldfish)
- What is important in the problem? (Have students use coloured pencils or markers to highlight or circle the important information, or model this for them.)
- What is not important? (Have students use pencils to underline the unimportant information, or model this for them.)
- Can you name the answer? (eyes)
- How can you solve the problem?
- What materials can you use to solve the problem?
- What strategies can you use to solve the problem?

Discuss the problem as a class, in small groups, or in pairs. Encourage communication through the use of rich, probing questions and meaningful conversations with and among students. Be sure to have students share their ideas about the materials and strategies they could use to help them solve the problem. Encourage students to ask questions as well.

Solve

There are 12 eyes on the fish.

Share

Extend

Provide students with the following extension problem:

If Jake gets 3 more fish for his birthday, how many fish does he have now?

How many eyes are there on all Jake's fish?

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Date: _____ **Name:** _____

Jake Has Goldfish

Jake has a bowl of goldfish.

He has 6 goldfish

How many eyes are there on all 6 goldfish?

Think

Talk

Solve

Share

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