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Introduction

Problem-solving is the process of applying acquired knowledge to different situations. It is the basic skill of mathematics and an integral part of the mathematics curriculum at all levels of instruction.

Figure it out is a series of booklets designed to teach strategies for solving mathematical problems. As students work through a booklet, they learn to read problems carefully, to think about the content of problems, and to use what they know about numbers and mathematics to decide how to find solutions.

The problems included in each booklet are open-ended, non-routine problems. Their scope extends beyond that of routine problems, or those which students can solve merely by reading and identifying the necessary mathematical operation. Each problem in **Figure it out** has some unique quality that requires students to think carefully about how to solve it. Students can relate many of the problems to real life.

The most exciting aspect of teaching mathematics is the discoveries students make as they work through problems. Guide them with questions, encourage the use of manipulatives, and be sure to give students time and space to discover.

The Student Book

The student book consists of lessons that teach six different strategies that can be used to solve non-routine problems. In each lesson, **Problems 1, 2** and **4** are followed by **Questions** designed to help students think about the problem and how to solve it. After the **Questions**, students are given guidance on how to apply the strategy to solve the problem.

Though it is recommended that you direct all the problems in the strategy lessons, it is important that you carefully guide students through **Problems 1, 2** and **4** and their **Questions**. **Problems 3** and **5** in each lesson are practice problems that come under the heading **On your Own**. These may be solved with your direction or may be completed by students on their own. For more applications of the strategies, one page of **Mixed Practice** is presented after every three strategy lessons. Students can use any strategy they find helpful to solve the problems on these pages. The last section of the booklet contains **Reviews** for each of the six strategies. The booklet ends with a **Final Review** containing non-routine open-ended problems that can be solved using the strategies presented in the lessons.

Using the Student Book

Students should write on the answer lines provided. You should also encourage students to write in any blank spaces in their booklets so they can keep their computation and other work close to the problems they are solving.

The Teacher Guide

The teacher guide consists of procedures for teaching the strategy lessons and guidance for presenting the **Mixed Practice** and **Review** pages. The teacher guide also contains four blackline masters that you can duplicate and distribute to students for solving the problems.

Using the Teacher Guide

Young children come to school already problem solvers and they are capable of using a variety of strategies in learning to become better problem solvers. In many cases, students can solve problems even if they cannot read the problems by themselves. Therefore, it is hoped that this booklet will be used at all times with teacher direction. Since this kind of problem-solving will be new and different for primary students, they will need to be led through lessons very carefully. As a teacher, you know your students. Only you will be able to decide what and how much they can do on their own.

Suggestions for instruction are provided throughout the teacher guide. These include questions to ask students, teaching tips, and diagrams and tables for student use. The teacher guide also provides answers to questions and solutions to problems posed in the student book. It is recommended that you read through the teaching notes for each lesson before presenting the lesson to students.

Teaching Strategy Lessons

Direct students through **Problems 1, 2** and **4**. You should read the problems aloud or have a student volunteer read the problems. You should also read each of the **Questions** aloud and lead the class in a discussion about the students' answers. Explanations should be requested for correct and incorrect student responses. From students' answers, you will see the wide variety of ways in which students approach the same problem. You may also gain awareness of students' understanding or lack of understanding of mathematics concepts. After students answer the questions, help them use the strategy to solve the problem. The teaching notes provide guidance in this area.

After the **Answer** to **Problem 1**, the teaching notes contain a **Think about** question for students to answer. Sometimes this question gives students a chance to think about how they solved the problem. Other times it gives students a chance to think about how they can check their answers. You can ask students similar questions after they solve any of the problems in the student book.

The teaching notes also contain questions students may answer for help in solving **Problems 3** and **5** in the **On your Own** sections. These questions are optional.

Act it out



Acting out problems helps students to experience problems. Experiential learning is sometimes the best way to find solutions or to discover strategies that will lead to solutions. Acting out a problem can involve performing the roles of people mentioned in the problem. It can also mean manipulating concrete objects to mimic actions described in a problem. Young children enjoy this strategy because they like to be actively involved in their learning.

Materials:

- Student Book pages 1–3
- 30 small cubes for each student
- 1 large piece of paper for each student or for every 2 students
- 12 counters for each student or for every 2 students
- 20 real or play five-cent coins for each student
- 12 real or play ten-cent coins for each student

Introduce the Strategy: Tell students that they can work together to act out all the problems in this lesson. Explain that they will use objects to find the answers to the problems.

Problem 1

Use cubes to build a model of the tower shown in the student book. Display your model in front of the classroom. Then read the problem aloud and introduce the word *cube*. Tell students that the blocks in the tower are cubes. Hold up a cube and show students that it has 6 sides, or faces. Have students count the faces on one of their cubes. Point out that each face is a square and that all the faces are exactly the same shape and size. Have students locate and name some cube-shaped objects in your classroom.

Questions

Read each question aloud. Then work through the question with students. Students should use the picture in the student book rather than your model of the tower to answer the questions.

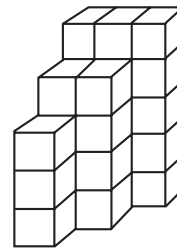
- (No. Explanations will vary. Sample answers: There need to be blocks underneath to hold up the blocks on top; there are some blocks behind the blocks I can see.)
- (3 blocks. Yes.)
- (Answers will vary. Accept all answers given.)

Have students work through the problem. They can work individually, in pairs, or in groups of 4. Allow students time to build their towers. Some students will need help. Others may want to come to the front of the classroom to look at your model or to take it apart. Give students the necessary guidance. If students have difficulty counting blocks while they are building their towers, suggest that they count the blocks after the towers are built or that they take apart the towers to count the blocks.

Answer: You need 11 blocks to build the tower.

Think about: Did you count all of the blocks – even those you could not see in the picture? (Answers will vary.) This question should serve as a reminder if students forgot to count the blocks they could not see in the picture. To help them check, have students position themselves in front of their towers so that they can view the towers from the perspective given in the picture. At this point, you may also want to have students refer back to Question c to find whether they had thought there were 3 blocks they could not see in the tall part of the tower.

Challenge: How many blocks would you need to build this tower? (26 blocks)



Use cubes to build a model of this tower. Display your model in front of the classroom. Have students use their own cubes to duplicate your model. Allow students time to explore various methods of counting the cubes in their models.

Problem 2

Before you read the problem aloud, be sure students understand the meaning of *half*. If necessary, explain that if a whole thing, like a piece of paper or a circle, is divided into 2 pieces, 1 of the 2 pieces is a *half*. If appropriate, introduce the symbol $\frac{1}{2}$ and show students how it stands for 1 out of 2 pieces.

Questions

Read each question aloud. Then work through the question with students. Students can act out the questions to help them find the answers.

- (2 children. Explanations will vary. Sample answers:
Each child needs half a piece of paper, so 2 children can share 1 piece; *half* means 2 parts; 2 halves make a whole thing.)
To help students answer the question and better understand the problem, cut a piece of paper in half and fold each half to show children how to make a card.
- (2 pieces of paper)
- (Answers and explanations will vary.)
This question is intended to help students think about the size of their answer before they solve the problem. Some students will easily notice that the answer will be less than 20. Others will need to act out the problem to find this information.

Alternatives: Students can use Blackline Master 1 (page 26) to solve the problem. As students work through the questions, have them draw the boys' and girls' faces in each row.

Students can also work together in a large group and act out the problem to find the answer. Before the students begin, set up 5 rows of 5 chairs. Then have students place pieces of paper labelled with a *B* for Boy or *G* for Girl on the chairs to correspond with the information in the problem. Students can then count the two kinds of paper labels to find the answer.

Answer: There are 10 boys and 15 girls in Mrs Thayer's class.

Think About: Add the number of boys and girls in your answer. What is the sum? (25 children) This question should serve as a means for students to check their answers. Ask several students to say their sums aloud. If the sums vary, review the process of counting the boys' and girls' faces in each row of a drawing.

Challenge: If there were 50 children in Mrs Thayer's class, and the children sat with 2 boys and 3 girls in each row, how many boys and girls would be in the class? (20 boys and 30 girls)

To solve this problem, students can use 2 copies of Blackline Master 1 (page 26) and proceed as they did with Problem 1. Some students may see that 50 students is double the 25 students in the original problem and that they may double the answers to that problem to find this answer.

Problem 2

Read the problem aloud. Have students look at the picture on the student book page. Have students count the pencils in the picture. Point out that in the problem, Frank got 5 free pencils. Tell students that there are more notebooks in the picture than they will need to solve the problem.

Questions

Read each question aloud. Then work through the question with students.

a. (1 pencil)

Have a volunteer read from the problem the sentence that answers the question. (He gets 1 free pencil for every 3 notebooks he buys.)

b. (6 notebooks)

Students can use the picture to help them answer the question. Have them circle 3 notebooks and draw a line from the 3 notebooks to 1 pencil.

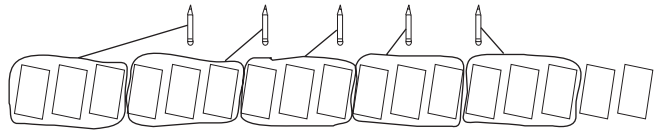
Remind students that Frank gets 1 pencil for every 3 notebooks he buys. Ask how many notebooks he would have to buy to get another pencil. (3 notebooks) Have students circle 3 more notebooks and connect these to 1 pencil. Students should count the circled notebooks to find how many Frank bought if he got 2 free pencils.

c. (Answers and explanations will vary. Sample answers:

He got only 2 pencils for 6 notebooks, so he has to buy a lot more notebooks to get 5 pencils; he got 2 pencils for 6 notebooks, so he has to buy only a few more notebooks to get 5 pencils.)

Have students work through the problem.

Sample use of drawing:



Alternatives: Students can use two colours or types of counters to work through the problem. They should use 5 counters of one colour to stand for the pencils and at least 17 counters of another colour to stand for the notebooks. Have them group 3 'notebook' counters with each of the 'pencil' counters. They can then find the total number of 'notebook' counters they have used.

Answer: Frank bought 15 notebooks.

On your Own

Problem 3

Read the problem aloud or have a volunteer read the problem. Guide students as they use the drawing to solve the problem.

Questions to think about:

- How many burgers will the Turners need to buy to get 1 free drink? (4 burgers)
Have students find the sentence in the problem that answers the question. (Roshi's Burgers gives away 1 free drink if a family buys 4 burgers.)
- How many free drinks will the Turners get if they buy 8 burgers? (2 free drinks)
Have students use the picture in the student book to answer the question. Encourage them to use the picture in any way that is helpful.
- Do you think the Turners will get 10 or more free drinks if they buy 24 burgers? Why or why not? (Answers and explanations will vary. Sample response: 10 or more free drinks are too many for only 24 hamburgers since you only get 1 free drink for 4 burgers.)

Sample use of drawing:

