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PRIMARY PROBLEM SOLVING IN MATH

101 Activities

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Heuristic Problems

What Is a Heuristic Problem?

One objective for mathematics instruction is to enable students to solve problems that:

- represent situations never encountered before,
- have no ready-made algorithm for their solution, and
- require the creation of a unique series of solution steps.

We call these problems "heuristic." Though they are "non-routine" in nature and scope, they are well within the abilities of primary school children to solve.

The term "heuristics" refers to a series of steps and strategies that can be used to solve a problem. These steps do not guarantee the solution: they simply guide the student in the process. George Polya (1945) recommends the following heuristic:

- First, the student must understand the problem and be able to answer the questions:

  What is the question?

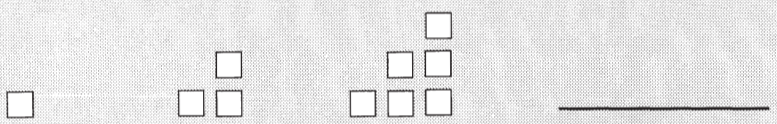
  What information is given?

  What are the conditions required by the problem situation?

- Second, the student must find the connection between the information given and the question being asked. The problem solver must devise a solution plan.
- Third, this plan must be carried out.
- Fourth, the solution must be checked.

Problems that require the use of such a general set of steps are called "heuristic problems" in this text. Here is an example of a heuristic problem at the primary level:

Look at the "stairstep numbers" below.
Use your blocks to show the next "stairstep number."



Problem solution: The children need to see the pattern of 1, then 1 + 2 = 3, then 1 + 2 + 3 = 6. The pattern can be extended to show 1 + 2 + 3 + 4 = 10. The next "stairstep numeral" is 10.

Instructional Considerations

What may be a heuristic problem to one child may not be for another. In the above example, a fourth-grade student may grasp the pattern immediately; a kindergarten student will not.

Practice with heuristic problems must emphasize the application of strategies to new or changing problems, not the repetitive application of a previously created solution pattern. Children need many experiences in solving heuristic problems. Their abilities to figure out a problem and create a solution will improve with experience.

Activity Objectives

The teaching suggestions and activities in this chapter are designed to help students:

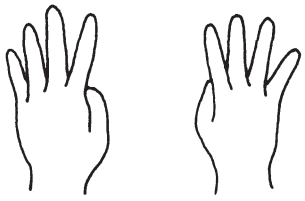
- Identify and apply strategies which can be used with heuristic problems in the primary grades. These strategies are taken from the following list:
  1. guess and check
  2. eliminate possibilities
  3. make a systematic list
  4. draw or use a picture
  5. look for a pattern
  6. make or use a table
  7. use logical thinking
- Use concrete objects or manipulatives to represent the problem and/or act out the problem.

Teaching Suggestions

FINGER ADDITION

ACTIVITY 1

Hold up four fingers on each hand. Show children that one group of four and another group of four is eight. Count the fingers on one hand and then the fingers on the other hand to illustrate the fours. Then count all the fingers to show the eight. Write the equation so children can see the numerals and the signs.



4 + 4 = 8

Then ask, "Can you think of another way to show eight with your fingers?"

Discussion:

Have children show their new addends with their fingers. See if they can say the number sentence; help if they can't. Most importantly, watch for the thinking that shows the act of creation or invention of a new idea.

Possible answer:

Variations:

Follow the same steps with the numerals 6, 7, or 9.

Name Date

CLUES TO THE UNKNOWN

ACTIVITY 2

Activity One Clue Cards:

Clue Card #1: ? ? ? ? ? ? ? **The number is odd.**	Clue Card #2: ? ? ? ? ? ? ? **The number is bigger than 13.**
Clue Card #3: ? ? ? ? ? ? ? **The number is smaller than 17.**	

Activity Two Clue Cards:

Clue Card #1: ? ? ? ? ? ? ? **The number is a multiple of 3.**	Clue Card #2: ? ? ? ? ? ? ? **The number is greater than 8 x 8.**
Clue Card #3: ? ? ? ? ? ? ? **The number is an odd number.**	Clue Card #4: ? ? ? ? ? ? ? **The number is less than 9 x 9.**
Clue Card #5: ? ? ? ? ? ? ? **The sum of the number's digits is an even number.**	

Teaching Suggestions

CLUES TO THE UNKNOWN

ACTIVITY 2

Divide the class into groups of 3 or 4. Cut out each set of "clue cards" on page 15. Tell children they will use these clues to find an unknown number. Only one number should fit all of their clues. Students should read their cards, but should not show them to other students. Later, they must share their clue and use it to check to see if a "possible answer" is a right answer.

Activity One: Make groups of 3; the number is 15.

Help children list possible answers to the problem. For example, after the first clue is read ("the number is smaller than 17"), children can list numerals from 16 down to 0. After the next clue is read ("the number is odd"), children can cross out all the even numbers. After the final clue is read ("the number is bigger than 13") they can cross out all numbers 13 and smaller. The only number remaining is 15. Encourage children to think about which clue or clues will help them find the answer as quickly as possible.

Activity Two: Make groups of 5; the number is 75.

This activity is for the oldest and/or most skilled in the primary range, as it requires multiplication. Children should examine their clues to see which ones narrow their choices most quickly. A search through the clues should indicate the following:

1. We are looking for an odd number that is more than 8 x 8 (64) and less than 9 x 9 (81), so let's list all the odd numbers from 65 to 80.
   65 67 69 71 73 75 77 79

2. Now, which ones are multiples of three? Only the following:
   69 75

3. Which numeral, when you add the digits, gives an even number?
   6 + 9 = 15 Odd 7 + 5 = 12 Even

   The answer is 75.

Suggestion: By using (and varying) similar clues, you can make up additional problems of both types.

Name Date

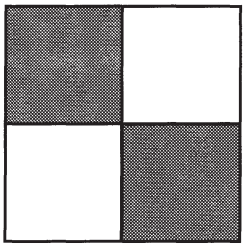
SQUARE CHALLENGE

ACTIVITY 3

How many squares can you find in each design below? Look carefully or you might be surprised!

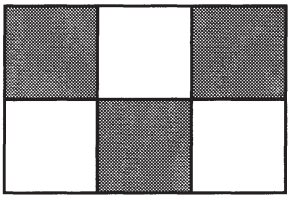
Tricky, but not too hard.

1. How many squares can you find in this picture?



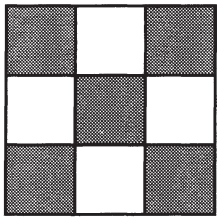
More difficult: Be careful.

2. How many squares can you find in this picture?



A real challenge!

3. How many squares can you find in this picture?



Teaching Suggestions

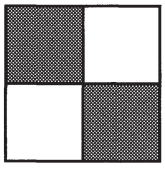
SQUARE CHALLENGE

ACTIVITY 3

Heuristic problem-solving activities should be given to all children at all grade levels. The entire act of learning involves inventing solutions for new situations (problems) and trying them out, re-using the ones that work while discarding those that don't. Even learning-disabled children need problem-solving instruction. Consider that one dimension of a learning "disability" may be that children invent and continue to use inadequate or inappropriate solutions to learning/social problems.

The task for the teacher is one of adapting heuristic problems to the children's grade and ability levels. Consider the examples below.

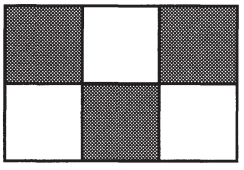
Easiest:



1. How many squares can you find in this picture?

Answer: 5. Four small squares and the entire figure is a square.

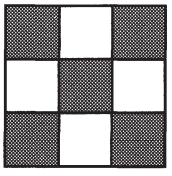
Harder:



2. How many squares can you find in this picture?

Answer: 8. Six small squares and then two 2 x 2 squares.

Still More Difficult:



3. How many squares can you find in this picture?

Answer: 14. Nine small, one large, and four 2 x 2 squares.

Note: Problems can be made easier or more difficult by adding squares to the given figure. Assign your children problems that they will find challenging but not frustrating.