# OPEN SEARCH IN ELEMENTARY MATHEMATICS EXPERIENCES

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> The aim of elementary school mathematics is to foster continuous and maximum development of each child's potentialities in terms of the affective domain, the cognitive domain and the psychomotor domain.[1]

The teacher is challenged to be aware of the behaviorial domains and the child's need for growth in each of them. My purpose is to examine Bloom's plan for classifying educational objectives within the cognitive domain[2], to examine a modification of Bloom's taxonomy suggested by Avital and Shettleworth[3], and to make some suggestions that the teacher can follow. In a sense my purpose, on a small scale, is the same as that stated by Sanders[4], who used the social studies as the vehicle for the presentation of his ideas.

> The objective of this book is to describe a practical plan to insure a varied intellectual atmosphere in a classroom. The approach is through a systematic consideration of questions that require students to use ideas, rather than simply to remember them.[5]

Bloom's taxonomy postulates six major levels of educational objectives, the categories being named Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation. The categories are assumed to be arranged sequentially, in that performance in any given category depends upon mastery of related materials in the preceding categories. It is also understood that by virtue of different degrees of experience, two persons may place an objective into different categories.

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[1]Department of Education, Government of Alberta, *Elementary Mathematics*, September 1969. Edmonton, Alberta: The Queen's Printer, 1969.
(This is a preliminary statement in the process of publication, excerpts of which will form the mathematics section of the Program of Studies for the Elementary School.)

[2]Bloom, Benjamin S. (ed.), *Taxonomy of Educational Objectives*, Handbook I: Cognitive Domain. New York: David McKay Co., 1956.

[3]Avital, Samuel M., and Shettleworth, Sara J., *Objectives for Mathematics Learning*. The Ontario Institute for Studies in Education, Bulletin No. 3, 1968.

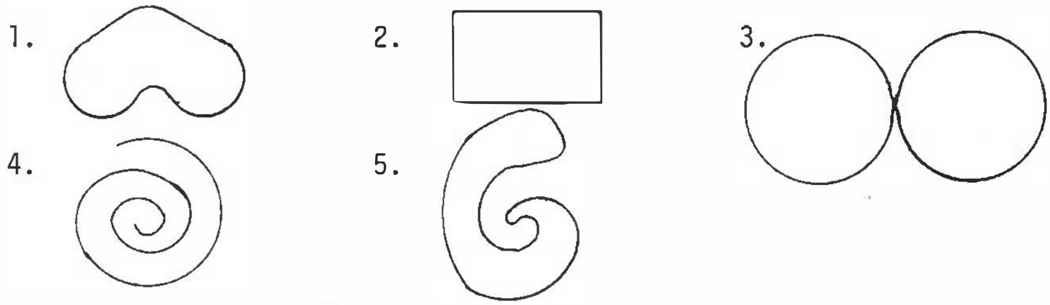
[4]Sanders, Norris M., *Classroom Questions: What Kinds?* New York: Harper & Row, 1966.

[5]Sanders, *op. cit.*, p.2.

A set of multiple-choice questions, each applicable at some stage in the elementary school, is presented to illustrate the first five categories. The level Evaluation is omitted because it is difficult to illustrate with mathematics as the vehicle.

Knowledge

Which of the pictures does not show a closed curve?




Comprehension

If 16 x 16 = 256, which product is equal to 25,600?

1. 160 x 160
2. 16 x 160
3. 256 x 10
4. 160 x 16
5. 530 x 520

Application

A merchant sold canned corn at 2 cans for 35 cents on Friday and at 3 cans for 50 cents on Saturday. How much would a shopper save if she bought 12 cans at the cheaper rate?

1. 20 cents
2. 10 cents
3. nothing
4. 15 cents
5. 5/6 of 1 cent

Analysis

A gardener has two plots of land of equal area. One is square and the other is rectangular with its length four times its width. What is the ratio of the two perimeters?

1. 5/4
2. 5/1
3. 1/1
4. 3/4
5. 3/1

Synthesis

Examine the pattern in these number sentences.

1 + 3 = 4
1 + 3 + 5 = 9
1 + 3 + 5 + 7 = 16
1 + 3 + 5 + 7 + 9 = 25

What is the last number in a set of this kind whose sum is 400?

1. 20
2. 39
3. 41
4. 72
5. 100

Avital and Shettleworth identify three levels of mathematical thinking which they associate with objectives that fit the five levels in the taxonomy. In tabular form they are[6]

| Thinking Process | Taxonomic Level |
|---|---|
| 1. Recognition, recall | 1. Knowledge |
| 2. Algorithmic thinking, generalization | 2. Comprehension, application |
| 3. Open search | 3. Analysis, synthesis |

It is the third thinking process that gives me the title to my presentation.

Among the mathematical experiences provided for elementary school children, all three thinking processes must be developed and practised. It is essential that children rocognize and recall mathematical concepts, facts, terms and symbols. They must be able to develop, understand and use algorithms; they should be asked to generalize from data. However, we teachers fail to provide enough opportunities for open search. We create the impression that in mathematics there is one correct answer for a question and the pupil's sole responsibility is to learn techniques for producing that answer. We attach considerable importance to the one technique we think is the best and tend to downgrade all others.

In open search the pupil should be permitted, encouraged, forced to use his ingenuity, and praised when he does so. In the synthesis example quoted earlier, the child who recognizes the pattern and simply writes the terms of the series, keeping a running total until the sum reaches 400, is using all three thinking processes. Do not worry about more sophisticated techniques; they will be developed in due course.

In open search there may be assumptions to be made, differences of opinion to be discussed, incomplete information to be supplemented. Consider the problem:

> A box contains steel bars, some weighing 4 pounds each and others weighing 6 pounds each. The total weight of the box and its contents is 50 pounds. If you removed all of the six-pound bars, what would the box and its contents weigh?

Let two or three alert children at any grade level from two up wrestle with the problem. If they have not been too severely conditioned by the mathematical training they have encountered to date, their solutions should be interesting.

It is difficult to provide a group of teachers with problems that meet the dual criteria of being applicable to the elementary school and demanding the open search. I have prepared three activities for you to consider. You will find these in a future issue of the Math Bin.

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[6]Sanders, *op. cit.*, pp. 6,7.