Popsicle sticks as a manipulative device

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The teacher of elementary school mathematics needs a supply of varied manipulative materials for her own demonstrations and the pupils' exploration of mathematical ideas. Two important criteria for the choice of manipulative aids are availability and versatility in use. Popsicle sticks are one type of aid which meets these two criteria admirably.

A popsicle stick of the kind discussed here is 11.5 cm. long, 1 cm. wide and 2 mm. thick. It is made of moderately soft wood, in natural color, and is quite well finished. Only very occasionally will it sliver and cause inconvenience to the user. The sticks are available from dairies which produce popsicles, at a price of approximately $1.35 per thousand, or from Moyer-Vico Ltd. for $1.65 per thousand. They are also available commercially in boxes of one thousand, under the trade name "Coffee Sticks" but the cost is nearly twice as much.

There are several physical embodiments of mathematical concepts that can be demonstrated with popsicle sticks. In this article, some suggestions are made for number, numeration and geometry. The ingenious teacher will discover other ways to develop these and other concepts.

NUMBER AND NUMERATION

One-to-one correspondence is an important part of the initial development of the whole number concept. Popsicle sticks form useful sets of objects because they lie flat on a child's desk and do not make excessive noise. The sticks may be used as elements of a set to be placed in one-to-one correspondence with the elements of another set, or they may serve as connecting lines between the elements of two different sets. The teacher can use the sticks to cast shadows on a screen with the overhead projector, thus demonstrating one-to-one correspondence between two other sets of shadow objects.

For numeration experiences, the teacher can provide the children and herself with popsicle sticks and rubber bands. To demonstrate the numeral necessary to indicate the number of sticks in a set, the teacher first of all groups by 10s, with a small rubber band around each 10 sticks, then groups the 10s into groups of 10, with a stronger rubber band around each 10-10, and so on until no further grouping is necessary. The numeral for the total number is easily determined by indicating the number of each kind of group, beginning with the largest kind of group and ending with the number of loose sticks left over.

Recognition of the number properties of sets, understanding of operations with whole numbers and use of the numeration system are woven together. The teacher must use her judgment as to when the sticks should be in loose sets and when they should be bundled in 10s and so on. Some examples of situations in which the sticks are loose follow.

1. The teacher sets out 6 paper cups. She asks a child to bring her enough sticks so that she has one stick for each cup.
2. Each child is asked to hold 3 sticks in one hand and 5 in the other. "How many sticks do you have all together?"
3. "Pick up 12 sticks. Lay them on your desk in sets of 3."
4. "Pick up 16 sticks. Make two equivalent sets with them."

Situations involving addition and subtraction where "carrying" and "borrowing" occur should be demonstrated with sticks bundled according to the numeration system. In such cases, the union and separation of sets provide the basis for the operations with numbers and the grouping provides the basis for the algorithms used. Two examples should help to clarify what is meant.

1. 87 + 45 = n

   In one place, the child has 8 bundles of 10 sticks and 7 loose ones. In another place, he has 4 bundles of 10 and 5 loose ones. If the two sets are put together, how many sticks will he have? The child is helped through the actions associated with the sentence as follows:

   7 + 5 = 1-10 and 2;
   8-10s + 4-10s and 1-10 = 13-10s;
   13-10s = 1-100 and 3-10s; and finally
   87 + 45 = 1-100, 3-10s and 2 = 132.

2. 105 - 59 = r

   The child has 1 bundle of 100 (10, 10s) and 5 loose sticks He must remove 5-10s and 9 loose sticks. The actions are associated with the sentences as follows:

   1-100 and 5 = 9-10s and 15;
   9-10s and 15 with 5-10s and 9 removed
   leaves 4-10s and 6 = 46.

When equivalent sets are involved, as in either multiplicative or divisive situations, the manipulation must demonstrate the distributive principle of multiplication and division over addition and subtraction. Again, two examples should help to clarify what is meant.

1. 4 x 35 = p

   The child has four equivalent sets of sticks, each set consisting of 3-10s and 5 singles. He is to combine them into one set and determine how many sticks there are. The actions are associated with the sentences as follows:

   4 sets of 5 singles = 20 singles = 2-10s;
   4 sets of 3-10s = 12-10s;
   12-10s + 2-10s = 14-10s = 1-100 and 4-10s, or more symbolically,
   4 x 35 = 4 x (30 + 5) = 4 x 30 + 4 x 5.

2. 42 ÷ 3 = q

   The child has 4-10s and 2 singles. The task is to separate them into 3 equivalent sets. One bundle of 10 can be assigned to each of the 3 sets. Then the remaining 10 is ungrouped and combined with the 2 singles. The 12 loose sticks are separated into 3 sets of 4, and each set of 4 goes with the one bundle of 10. Thus

4-10s and 2 = 3-10s and 12;
3-10s and 12 divided into 3 equivalent sets yields
1-10 and 4 in each set, or,
$42 \div 3 = (30 + 12) \div 3 = 30 \div 3 + 12 \div 3.$

GEOMETRY

Geometrical properties of equilateral polygons can be illustrated simply with popsicle sticks. Because the sticks lie flat on a plane surface, they can be manipulated easily. If permanent figures are desired, the sticks can be glued to railroad board or some other similar paper product.

The teacher can discover activities for the children through experimentation. Here are some suggestions:

1. Lay 3 sticks on the desk to form a triangle. Can you make triangles of different shapes?
2. Lay 4 sticks on the desks to form a quadrilateral. Can you make different shapes?
3. Can you use a fifth stick as a diagonal of the quadrilateral?
4. Can you make a figure consisting of several triangles fitted about a central point?

No attempt has been made to suggest the geometrical ideas that can originate from the activities. Any formalization of ideas might well ruin the effect of the experimentations.

CONCLUSION

In the teaching of mathematics, especially in the elementary school, it is important to look to simple materials for manipulative and illustrative purposes. Because popsicle sticks are economical, easy to obtain, relatively non-hazardous, easy to store and versatile, they should be in every elementary classroom.