Mary E. Wilsberg

Freeing Children in Primary Arithmetic

An example of emphasis on structure

CHILDREN begin to understand arithmetical concepts and operations and develop structure as they attempt to solve the practical problems of their experience. They have greater motivation and learning takes place more readily when they have a real need for discovering the solution to a problem.

Discovery of structure in arithmetic takes off from an idea-situation and comes through experimentation for organization with real and representational materials. Verbalizing these discoveries, and describing the operations leading to them by using concrete materials, have significance for the child making the discovery and for others in the group who may have approached a solution to the problem in another way. Sharing ideas stimulates interest and thinking and helps clarify process for some children who are slower to take the initiative or who have a lower capacity to learn.

Still another important aspect of verbalization is that it can be one way to lead the child to an awareness that he is building his own structure in arithmetic. An awareness of the whole number system can evolve from this very early experience-based program. The use of idea-situations as a base for such learning is often in contrast to the contrived situations found in the usual graded materials.

Use of Idea-Situations

Such is the position that has characterized the work done over the past several years by the present writer and her colleague, Esther Schatz, at University School, in consultation with Professor Nathan Lazar of the Department of Education at The Ohio State University. The new program can be described as finding its base in five major approaches:

1. Eliminating strict adherence to a prescribed content that seldom takes into account real idea-situations and always risks the presentation of fragments of concepts
2. Encouraging children to tackle arithmetical problems met in their daily living and valuing the discovery of generalizations that result
3. Providing a classroom setting in which children have many opportunities to discover structure by organizing data for themselves
4. Delaying the use of written symbolism by children until beginning concepts have developed real meaning and need
5. Developing from the beginning an understanding of the scope of the number system by presenting the basic concepts in as whole a fashion as possible.[1]

What this means in general is that children from the beginning are given help in bringing to their experience the expectation that they would learn as much as they could about how to deal with it arithmetically.

[1] A report of the experience will be published early in 1962 through the Division of Publications, College of Education, The Ohio State University, Columbus.

For example, in our work we have found that many if not most of the fundamental concepts of arithmetic can and should be presented in the primary arithmetic program, beginning in the first grade. Children are helped to understand the experiences they are having with such concepts as these:

1. One to one correspondence . . . each member of the group has a chair, a checker, a nose

2. Quantitative vocabulary . . . such as small (smaller, smallest), short, tall, many-few, greater than-less than

3. Idea of set and theory of sets . . . from 0 to as high as the situation demands—a set of spoons, chairs, children

4. Cardinal numbers . . . a common property and symbol given to sets or equivalent groups

5. Ordinal numbers . . . numerical position in a series

6. Ordered sequence of number symbols . . . by intervals of one, two (odd and even), five, ten, hundred, thousand

7. The number system . . . role of base ten, place value, zero as a place holder, bases other than ten

8. Addition . . . process of combining two or more sets into one set . . . concept of sum

9. Subtraction . . . process of separating one set into two or more sets . . . concept of difference

10. Multiplication . . . process of combining two or more equivalent sets into one set . . . concept of product

11. Division . . . process of separating one set into two more equivalent sets . . . concept of quotient

12. Fractions . . . one or more equal parts of a unit

13. Estimation . . . comparison of size, worth, cost, distance, amount without counting or computing with units of measure

14. Measurement and approximation . . . need for units of measure—application of units of measure

15. Proof . . . variety of approaches to the solution of a problem and to verify a solution . . . questioning "why" to process.

Building Structure Through an Idea-Situation

Any one idea-situation stemming from a child's experience usually has built-in opportunity for multiple concept development. Attendance taking is one situation that could occur in any classroom. The description to follow took place in the first grade as children determined the attendance each day for the absence report.

Understanding of fundamental concepts began and developed from this idea-situation as it was repeated, with new learnings and relationships being made. The children, rather than representational materials, were used first to find the solution to the problem. Children were seated by tables so this made a natural arrangement to begin with for sets. Then unorganized manipulative materials were introduced to represent children. For demonstration purposes a large metal board with magnetic checkers made an excellent device. Beads, checkers or sticks were used by children working independently.

As children became adept at organizing these representational objects for themselves they moved on to manipulative materials or devices that had various degrees of organization in their own design. Simple rods with spacers between sets of five beads and stacked rods of sets of ten beads were materials with a slight degree of organization.

A more highly organized device, particularly good as applied to place value

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is the Abacounter,[2] with its counting frame of 120 beads on the left side—ten beads divided by a spacer into two sets of five on each of 12 rods—and on the right side vertical place value columns of 20 beads each with spacers at set intervals of five. As the children worked with real and representational materials. they heard and used the vocabulary of arithmetic and they saw number symbols and algorithms recorded by the teacher. When self-recording could have meaning, children recorded their described operation on the chalkboard and then on paper. Individual thinking coming from the child's organization of his own set of materials fed the group discussion. Discovery of structure for the development of concepts was based on the total experience rather than just on counting or number symbols.

Applying Concepts

Of the arithmetic concepts listed, all but the application of units of measure found a place for beginning development in this idea-situation.

One to one correspondence was ever present as children used representational materials such as a bead or a checker for a child, as they compared the size of two groups and saw equivalent groups.

Quantitative vocabulary ran through all discussion with questions like, "Are there more than four children or less than four at table two?" . . . "Which set is smaller?"

The theory of sets was present through all aspects of this problem as children experienced different sets of children or sets of checkers or beads.

A name for a *cardinal number* was given to a set. This was done immediately when a set of five children was given the name of the number five. Then the cardinal number was symbolized by recording the number symbol 5 on the chalkboard.

Ordered sequence of number symbols was present when one was added to the previous set as children grouped to count themselves. As the experience was repeated, the ordered sequence included counting by sets of two, five and ten.

Ordinal numbers were introduced as children began naming their place from a given starting point as first, second, third and so on. Questions followed, such as, "Who was the fifth person beginning from this end?" . . . "The third?" . . . "Does third mean you are three people?"

The number system began to take on meaning as sets of children or checkers were combined for a sum of ten. Using unorganized materials ten ones were exchanged for one ten. Checkers valuing one and ten were differentiated by color. Tens were added first followed by the ones. In this way children organized sets themselves and made the exchange. Then place value columns were introduced on the right side of the magnetic board. The place now determined the value rather than the color. The number symbols for the sum were recorded above the place value columns on the chalkboard.

The concept of sum was present constantly as sets were combined.

The concept of difference was present as children separated small table sets and also found the difference between how many should be present and how many actually were.

The concept of product was experienced as children combined equivalent table sets or equivalent sets of checkers arranged for such a purpose such as five sets of five for the total attendance.

The concept of quotient was intro-

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[2] Creative Playthings, Inc., 5 University Place, New York, New York.

structively to the improvement of the mathematics program in the schools, but that they had little effect on other teachers.

The School Mathematics Study Group is sponsoring research on factors that contribute to teaching success in mathematics. Consideration is being given to such factors as the teacher's preparation in mathematics and his enthusiasm for mathematics as a subject. Reports on these studies will be made at a later date.

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duced as a table set was separated into equivalent sets. Eight children at a table were separated into four sets of two. This led to finding the attendance that day by counting by two's.

The concept of fractions had a beginning by finding that half the children in the group were boys and half were girls. They saw that Billy was one out of five children at his table, that Billy and Pete were two children out of five at their table and so on.

Estimation was invited by the question, "Knowing how many children are here when everyone is present, *without counting,* how many children would you estimate are here today?" . . . "How many would you estimate are absent?"

The concept of proof ran through the attempts at solution of this idea-situation as children compared a variety of approaches and as the teacher questioned "why" to their process. The interrelationship of the concepts involved in the solution of the problem of attendance is obvious. The idea-situation provides the context for development of many concepts and insures a structure for relationships of concepts to take place.

Apart from problems arising from a group idea-situation, there are the child's individual idea-situations. He may need to figure out bus fare or make change. He may need to find out about units of measure as he works on a wood project, makes an aquarium, or plans refreshments for a party. Time must be given to help individuals work out their personal arithmetic problems. The teacher must become aware of problem possibilities in situations as he listens to children. He must teach by providing questions and materials to help the child solve his problems. Given this setting of group and individual idea-situations and a pattern to discover structure, children are free to develop broader and deeper understandings of basic arithmetic concepts.