A COORDINATED REVIEW OF RECENT RESEARCH CONDUCTED IN THE DEPARTMENT OF ELEMENTARY EDUCATION UNIVERSITY OF ALBERTA RELEVANT TO MATHEMATICS EDUCATION

Part III

W.G. Cathcart and W.W. Liedtke

There are some practical applications of Piaget's theory for mathematics education. Piaget says that thinking is an internalized action which has been developed as a result of physical actions. Therefore, it is important that children be given an opportunity to actively explore and manipulate physical objects in their environment. This implies that manipulative materials should be an important part of the mathematics program.

A recent study by Scherer[1] (University of Alberta, 1968) examined the role of manipulative materials in problem-solving at the Grade III level. Four classes were given concrete materials consisting of 50 counting sticks, 50 little tile squares, and 50 rectangles. Four other classes were chosen as a control group. Verbal problems presented consisted of the six types of additive and subtractive problems as outlined by the *Seeing Through Arithmetic* program. The experimental group used the concrete materials to represent the problem situations, while the control classes only discussed the problems. The treatment covered eight lessons at the rate of one lesson a day.

Scherer found that the use of manipulative materials was no more effective in developing ability to solve verbal problems than the use of discussion and printed materials. However, a number of methodological weaknesses may account for this lack of significant gain by the experimental group. The major weakness was the short duration of the experiment. Eight days may be an inadequate length of time in which to observe change. Furthermore, Grade III students may have passed the age when concrete materials are most useful, at least for the type of problems they were working with. We still must maintain with Almy[2] (1966) that Piaget's theory strongly suggests the importance of learning through activity. Certainly this is an area that requires more research.

From the research conducted in the Department of Elementary Education, a number of practical applications have arisen out of the concept of conservation. There is the need for teachers to be aware of the child's status with respect to conservation as it may be a clue to the cause of many difficulties. For example, teachers could be guilty of classifying a child as dull when, in

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[1] R. Scherer, "Manipulative Materials in the Teaching of Problem Solving". Unpublished Master's thesis, University of Alberta, Edmonton, 1968.

[2] M. Almy, with E. Chittenden and P. Miller, *Young Children's Thinking*. New York: Teachers College Press, Teachers College, Columbia University, 1966.

actual fact, he does not yet conserve the properties of the subjects that are being examined. This suggests that there may be a close relationship between achievement in mathematics and conservation.

Reimer[3] (University of Alberta, 1968) gave a test of conservation of number, quantity, and length to a group of 81 Grade I subjects. He found that both intelligence and conservation were closely related to achievement on the *Seeing Through Arithmetic* test; furthermore, achievement on this test was highly predictable for conservers - that is, conservers generally had high achievement scores. However, the achievement of non-conservers could not be predicted on the basis of their conservation scores.

Another implication of the principle of conservation is that it may be affected by experiences unique to certain children. Liedtke[4] (University of Alberta, 1968) studied the conservation of distance and length in a sample of 50 bilingual and 50 monolingual Grade I students. A bilingual student was defined as a student who could converse as well in French as in English. Liedtke found that the concept of conservation of length was developed to a greater extent in the bilinguals, who also demonstrated a greater ability to make linear measurements. Perhaps there exist other unique experiences in our cultural setting that may affect the ability of young children to converse.

A practical application arising out of Pelletier's[5] (1966) study of Grade I children's concepts of linear measure is that the ability to verbalize measurement terms or identify measuring instruments is no assurance that the child understands the underlying concepts of linear measures. The implication is that before we teach a child to use a ruler to mark off inches, we need to be sure he understands the underlying principles such as transitivity, segmented length, and subdivisions.

A somewhat similar implication results from Brace's[6] (1963) study of the preschool child's concept of number. He found that young children tend to confuse spatial relationships with number. Therefore, they must be given experiences with, and manipulation of, physical objects so that they can abstract the true concept of number apart from the physical properties of the objects. A variety of objects needsto be used in developing the concept of number so that number will not get confused with a particular shape, color,

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[3]A. Reimer, "A Study of First Grade Mathematics Achievement and Conservation." Unpublished Master's thesis, University of Alberta, Edmonton, 1968.

[4]W.W. Liedtke, "Linear Measurement Concepts of Bilingual and Monolingual Children." Unpublished Master's thesis, University of Alberta, Edmonton, 1968.

[5]J.D. Pelletier, "A Study of Grade One Children's Concept of Linear Measurement." Unpublished Master's thesis, University of Alberta, Edmonton, 1966.

[6]A.T. Brace, "The Pre-School Child's Concept of Number." Unpublished Master's thesis, University of Alberta, Edmonton, 1963.

or size. This may point to one major weakness in teaching devices such as Cuisenaire rods, at least in the early grades.

Another study done in mathematics education in this department that does not fit the Piagetian framework deserves mention.

Seward[7] (University of Alberta, 1966) attempted to determine if exposure to the mathematical concept of ratio in Grades V, VI, and VII affected students' success with tasks involving verbal analogies. Seward formed five groups on the basis of the amount of exposure to ratio instruction. The groups were

1. ratio instruction in Grades V, VI, and VII

2. ratio instruction in Grades VI and VII

3. ratio instruction in Grades V and VI

4. ratio instruction in Grade VII only, and

5. no ratio instruction.

Each group was subdivided into three groups on the basis of intelligence, making a total of 15 groups. The only significant difference in achievement on a verbal analogies test was within the five groups of average intelligence. Using a Newman-Keuls comparison of ordered means, Seward found that the group who had ratio instruction in Grades V, VI, and VII, and the group who had it in Grade VII only did significantly better than the group who had no formal ratio instruction. A non-statistical examination of the data enabled Seward to conclude that the study of ratio enables students of average intelligence to perform almost as well as high intelligence students on a verbal analogies test. In contrast, the average student who had no ratio experience did little better than the student of lower intelligence.

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[7]R.K. Seward, "Relationship of Mathematical Ratios to Verbal Analogies." Unpublished Master's thesis, University of Alberta, Edmonton, 1966.