INNOVATIVE USES OF CUISENAIRE RODS IN A THIRD GRADE AS A LEARNING TOOL FOR LOW ACHIEVERS

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CHAPTER ONE

INTRODUCTION

Statement of Problem

This paper is a creative study describing an innovative program using the Cuisenaire rods to teach the material presented in Addison Wesley Elementary School Mathematics Book Three to third grade children who entered in the fall achieving below grade equivalent on the basis of Metropolitan Achievement Test scores in sub-tests Mathematics: Computation and Mathematics: Concepts. Inquiry is made into the misconception and confusion which leads to underachievement in arithmetic in the third grade. An attempt is made to clarify some of the steps that must be broken down into smaller components for assimilation before real understanding comes to a slow learner. The use of Cuisenaire rods as a heuristic device is an integral part of the procedure.

Significance

In little more than a decade the teaching of mathematics in elementary schools has undergone serious scrutiny and revision. The need for a sound understanding of mathematical processes in our highly technological society and the need for mathematics as a tool for science has prompted educators and mathematicians to review, evaluate, and propose changes in the methodology and content of mathematics programs.

Following the launching of Sputnik in 1957 the National Science Foundation was created by the federal government. Its function is to provide funds for the retraining of teachers, for mathematics curriculum research and for supporting curriculum research. New programs, new methods and new materials have been developed for both the elementary teacher and elementary pupil with federal funds sponsoring such projects as the School Mathematics Study Group (SMSG), Greater Cleveland Mathematics Study (GCMP), University of Illinois Arithmetic Project (UIAP), Madison Project, Ball State Project and Minnesota Elementary Curriculum Project. These programs have differed uniquely from most curriculum revision studied in that professional mathematicians have been the leaders with professional educators and psychologists taking a lesser role.[1]

D'Augustine states that the general acceptance of research findings in the areas of meaning, methods, and curriculum has profoundly influenced the elementary mathematics curriculum. Recent readiness research by such researchers

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[1]Charles H. D'Augustine, Multiple Methods of Teaching Mathematics in the Elementary School (New York: Harper Row, 1968), p. 6.

as Robert Davis, Newton Hawley, William Hull, Anthony Kallet and Jean Piaget has discredited the theory that there is an ideal time to teach each concept.[1] Instead, readiness is seen as a fluid concept. The child's readiness to grasp a concept can be influenced by physical maturation as well as by the depth of his previous experiences relating to the idea. Therefore the ability to gain new concepts is directly related to the teaching techniques employed and the level of abstraction on which it is presented.[2]

One effect of this new interpretation of readiness has been to develop a more flexible curriculum. Topics are no longer considered appropriate to a grade level and some concepts are being taught in the elementary grades which had hitherto been presented in junior and senior high school.

Another area of research has centered on the development of meanings. Experimenters such as William Brownell, Harold Moser, Esther Swenson, Henry Van Engen and Glenadine Gibb have demonstrated that teaching the meaning behind algorithms leads to a better transfer to new situations and to better insight into existing relationships.[3] Implicit in these findings is the fact that the teacher must be

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[1]Ibid., p. 19.

[2]Ibid., p. 19.

[3]Ibid., p. 20.

knowledgeable in mathematics if the students are to gain these understandings. Reliance on the teachers' guide of a text is not enough. The teacher must be aware of the logical sequential development of a topic and understand the meanings of the algorithms taught. This means more depth in the study of mathematics for elementary teachers than was formerly considered necessary.[1]

Today there are a variety of curriculums in effect in the United States ranging from the more traditional programs to experimental modern mathematics programs. All of the arithmetic textbooks found on the market today have some of the "new math" principles incorporated in them. The distinguishing elements of modern elementary mathematics are emphasis on structural properties and patterns; student involvement and discovery; provision for individual differences; a unified and consistent approach; precision of language; greater stress on concepts; and the use of recent educational and psychological research on learning.

Purpose

In any classroom there are always a number of slow mathematics students. Some of these may have emotional blocks related to school failure which hinders progress. Many, however, are of average mental ability with no apparent

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[1]Ibid., p. 20.

emotional problems. These children make only limited progress in a year and are a source of discouragement to the teacher. After some apparent learning they often revert back to their earlier errors. Some teachers prescribe more drill, others go over the concept involved using either a teaching aid or a verbal explanation to convey. Too often the child fails to understand the basic relationships and structure involved in a concept.

If it were somehow possible to get inside of a child's mind it would be a simple procedure to discover the errors in thinking and correct them. This is obviously not possible, nor is it always possible through words to discover the blocks, confusions, and misconceptions in a child's thinking which prevent him from seeing what should be a logical conclusion based on perceptions of the particular situation.

The Cuisenaire rods and their frequent use in the classroom often help in both diagnosing and alleviating some of these learning difficulties. For example it is possible to discover that a child does not understand the signs of operation if he falters and can not decide whether to make a train with the red and blue rods or to measure the difference when he is confronted with the equation $9 - 2 = \square$.

Although the Cuisenaire-Gattegno approach is specific, structured and has its own scope and sequence it is possible to use the rods effectively in a conventional mathematics program and still incorporate some of Gattegno's thinking. If one agrees with Gattegno that it is the concept of relationships and operations that is essential then it is imperative that children have experiences which enable them to understand that mathematics involves number relationships and operations are the action taken on them.

It is hoped that this paper will serve as an aid to primary teachers in the Englewood Public School system, Englewood, Colorado. Although Cuisenaire rods may be utilized in a myriad of ways too often their use is limited because teachers have had little or no experience with them and find the guides supplied by the Cuisenaire Company complex and confusing. A voluntary in-service course is tentatively planned to familiarize Englewood's teachers with the Cuisenaire rods. This study may provide additional techniques and insights.

Assumptions and Limitations

No attempt is made to prove statistically the effectiveness of the Cuisenaire rods as a method of instruction as opposed to a more traditional textbook. To do this it would have been necessary to establish a control group matching I.Q.'s and taught simultaneously by the same teacher.

It is hoped that this particular study, rather than providing definitive answers to specific techniques for using the Cuisenaire rods will serve as a guide for future research and further investigation into creative uses within a conventional textbook program for this flexible learning tool.

Definitions

Cuisenaire Rods. The Cuisenaire rods are the invention of Georges Cuisenaire, a primary school teacher from Thuin, Belium. In analyzing the difficulties his pupils had in understanding arithmetic concepts he discovered that children needed something to bridge the gap between concrete experience and the abstractness of mathematical relationships. As a musician he became aware of the fact that certain combinations of notes are more easily retained than others and that once given a keyboard a multiple of possible ways of combining notes are available. From this idea the rods developed.[1]

The rods are characterized by differences in color and length. They are one square centimeter in cross-section and range from one to ten centimeters in length. The colors differ with each length and are used to convey both size and relationships. However, a given length is never rigidly associated with a specific color as the length may be produced in many ways by a variety of groupings of the rods.

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[1] Caleb Gattegno. For the Teaching of Mathematics, Vol. III: For the Teaching of Elementary Mathematics (Mt. Vernon: Cuisenaire Company of America, Inc., 1963), p. 18.

The colors are as complexly conceived as a musical keyboard. The rods which are two, four, and eight centimeters long have a red pigment. Blue pigment characterizes the three, six, nine centimeter rods. The five and ten centimeter rods are in the yellow family and one and seven are white and black respectively. As the particular length increases the color deepens. Thus the doubles of a rod are in the same color family. One and seven are seen as more distinct in their relationships to the other numbers.

Conventional Programs. Although programs vary in emphasis, content and methodology there are certain similarities which are vastly different from the Gattegno-Cuisenaire approach. The conventional modern mathematics program bases instruction initially on counting. This is followed by experiences in grouping and regrouping of sets. Children's activities at first involve the manipulation of objects. The next step is the imaginative manipulation of pictorial representations. Finally, the child deals with abstract concepts involving number only.[1]

Emphasis on the basic number combinations starts early. By the second half of second grade stress is put on computational skills. Manipulative devices and visual aids are encouraged as a means of teaching concepts and

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[1]Calhoun C. Collier and Harold Lerch, Teaching Mathematics in the Elementary School (Macmillan Co., Toronto, 1969).

reinforcing learning. The number line, abacus, place value sticks, set figures for teaching set concepts and counting are only a few of the devices available and suggested as supplementary learning devices.

Addition and subtraction facts with sums through eighteen are generally introduced by the end of grade one. However, in arithmetic books for grades two through four the same material is reviewed extensively which implies that mastery of the facts is far from inevitable by the end of the first year.

Addition is usually the initial mathematical process presented to children in an organized, formal way. This is preceeded by teaching the cardinal and ordinal value of numbers to one hundred, place value of the digits in a two place number and the reading and writing of all numerals representing numbers from zero to one hundred. The basic addition facts are generally taught in structured sequence with families studied (i.e. the decomposition table for five) as an entity. Frequently the corresponding subtraction combinations are included as well. Work on a flannel board with sets, or a paper in which the children can count the objects in each of the sets and find the number of objects in the union of the sets are generally the type of concrete experiences the children have before advancing to more abstract situations. While working with basic addition and subtraction facts the children are guided into a discovery of the properties of the operations.

<u>Gattegno-Cuisenaire Program</u>. The Gattegno-Cuisenaire approach differs fundamentally from the conventional textbook program. Counting is replaced by a study of relationships. Concepts of operations are met through algebra before formal number study begins. Stress is on discovery of structures rather than on early mastery of number combinations and early proficiency in computation.

After a period of free play to develop familiarity with the rods qualitative work with the rods is introduced. Operational signs for addition, difference and equivalence are taught as the child discovers more about the relationships that can be seen with the rods. At this point no number is assigned to a rod, letters stand for each color. Gattegno believes it is essential that children have these pre-number experiences in order to develop concepts necessary for an understanding of arithmetic.

> It follows that if we wish to use the rods properly we do not think of them as an apparatus for structural arithmetic as is the Stern, created to teach number only. The main characteristic of Numbers in Color is that we start with qualitative arithmetic, which is another name for algebra. Because pupils meet first the less structured entities, we can expect that they behave mathematically in an entirely different way from the way we do and from all who base their knowledge on counting. Instead of meeting operations incidently when studying number, we find that we can transform our newly acquired operational powers into a great

> many mathematical entities (of which number is only one example and perhaps not the most important) by specializing the situation offered by the rods.[1]

A study of numbers up to ten follows this algebraic experience. Situations are created in which the child can discover a great deal about the number system. As the child studies the decomposition of a number he meets multiplication and division as well as addition and subtraction and has an opportunity to discover the close relationship and properties of the operations. For example consider this pattern for dark green:

dark green		
red	red	red

The following statements may be made:

$2 + 2 + 2 = 6$	$6 \div 2 = 3$
$3 \times 2 = 6$	$6 - (3 \times 2) = 0$
$6 - 2 = 2 \times 2$	$6 - 2 - 2 - 2 = 0$

By studying the pattern the child realizes that multiplication and division are concerned with groups of magnitudes of equal size.

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[1] Caleb Gattegno, <u>For the Teaching of Elementary Mathematics</u> (Mt. Vernon: Cuisenaire Co. of America, 1965), pp. 103, 104.

The next step is to consider the numbers to one hundred. The child is led to see that the concepts he formed about small numbers applies to large numbers. Stress is not placed on memorization. Instead he is encouraged to calculate mentally with the help of the knowledge at his disposal. Thus to find the sum 8 + 7 he is encouraged to use operatory transformations appropriate to him. He might think 7 + 7 = 14 therefore (7 + 7) + 1 = 15 or 8 + 7 = 8 + (2 + 5) = (8 + 2) + 5 = 10 + 5 = 15.

Rods are used as long as the child needs them. When the situation is fully understood the rods are no longer necessary. As the child describes the patterns he has made with the rods he learns to express ideas in proper mathematical language. Later without the rods he is encouraged to use written symbols to express the mathematical concepts which he has discovered and understood.

Underachiever. The low achiever or underachiever described in this study refers to the child who has an I.Q. of ninety or more and who scores three months or more below grade equivalent on the Metropolitan Achievement Test in sub-tests Mathematics: Computation and Mathematics: Concepts. These children described in this study had previously been characterized by their former teachers as underachievers and because of this were specifically placed in this class.