ment and pre-natal studies we can safely conclude that the environmental influences—biological, psychological and cultural—begin to operate from the moment of conception. Of these influences, malnutrition is the most detrimental. The human environment of the newborn child is restricted practically to a single person—the infant's mother or her substitute. This limitation in the infant's habitat is fortunate insofar as it permits one to have close control over the biological and psychological factors that are operative during the early part of the child's life. The pivot of all development in this circumscribed environment is the quality of the mother-child relation during the early stages of the growth. Therefore, this relationship is seen by Anisa as a central ecological factor in the growth and development of the child.

The ultimate objective of any intervention program should be prevention. The Anisa Model makes provision for intervening in the anticipated life of a child a year or so before his conception by insuring that the nutritional status of the parents-to-be will maximize the likelihood of conceiving a fully-functioning, healthy child. Since the provision of adequate nutrition remains important throughout life, the Model provides for collaborative efforts of community, school and home to maintain an optimum nutritional status in all students and staff.

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MATHEMATICS INSTRUCTION: AN ANISA APPROACH

By DR. DONALD T. STREETS

A first grade youngster came home from school one day with a perplexed look on his face. Before either of his parents could respond to his expression, he volunteered an explanation. "Well, we have to do times problems (meaning multiplication exercises). But if I have to do times problems, then I have to know what 'times' means. If I know what 'times' means, then I can work all of the problems. But if I don't know what 'times' means, then I can't work any of them," he concluded.

This simple observation made by a first-grader highlights the fundamental issue that all children confront in attempting to understand number relations. And yet, while acknowledging the legitimacy of addressing the issue of meaning in number relations, most teachers would be sorely pressed to describe what constitutes the underlying "meaning", let alone how to go about assisting children to comprehend it.

Most of the better attempts, to date, center on the identification and organization of examples of the basic operations of mathematics (addition, subtraction, multiplication and division) in terms of their progressive complexity and the algorithms pertinent to finding the solution to each example. More traditional approaches continue to center on the mere manipulation of symbols—exercises in the use of abstractions in the absence of comprehending the underlying meaning on the part of the student.

Modern Math: Its Success and Failure

Math educators hoped that the "new math" would usher in the kind of reform that would address this fundamental need for the establishment of meaning prior to the handling of symbolic abstractions in the form of numbers. While significant progress was made in (1) identifying the levels of complexity characteristic of the four basic mathematical operations, and (2) deriving a standardized language for describing those operations consistent with the logical propositions upon which they are based—a fundamental mistake was committed. It was a mistake of omission, namely, the disregard for the developmental stages, particluarly in the area of cognition, that the child goes through as he thinks about the world in general and as he contemplates quantitative relationships in particular.

In other words, the pervasive error that characterizes all of education, particularly math instruction, has been the presumption that children learn mathematical concepts with the logical thought structures of an adult, which, of course, they do not yet have.

For over 30 years a significant body of research has been developed by Jean Piaget and his colleagues at the Center for the Study of Genetic Epistomology in Geneva regarding the development of logical thought in humans. That formidable body of information has laid to rest the erroneous views of the maturational determinists, as well as the proponents of operant conditioning, that the development of logical thought is, on the one hand, the sole function of maturation—growing older—or, on the other hand, the consequence of the reinforcement of cognitive behavior.

The passage of time devoid of experience has been demonstrated through various deprivation experiments to result in little or no growth. And although the probability of certain kinds of learning occurring might be increased through reinforcement, the kind of learning required to comprehend the meaning underlying number relations occurs through a variety of interactions with a rich environment, a process which results in the creation of more complex cerebral structures that in turn enables the child to address reality with increasing effectiveness.

Furthermore, while some systems of math instruction rely very heavily on associative learning, (i.e., remembering one event because it occurred simultaneously or in contiguity with another event already known), such associations do not necessarily result in the establishment of meaning because the mere simultaneous occurrence of things does not enable the child to ascertain the logical operations which explain their relationship.

Process Prerequisites to Understanding Number Relations

What are the logical operations on which the understanding of number relations depends and how are they attained? A full explication of their nature still requires further research. However, the significant progress that has been made in understanding them has yet to be translated into educational practice. Because of the work done by Piaget and a number of others who have built upon his theoretical perspective, a partial answer is emerging. But there is yet a more fundamental issue which must be addressed as well, namely, what is learning (in its broadest sense)? How does it take place? And from this broader definition of learning, how does the child come to understand number relations? That larger issue, concerning

the nature of learning which is addressed by the Anisa Model provides the theoretical perspective on the development of the mathematics curriculum.

From the moment of conception, the human organism interacts with its environment and, over a span of time, comes to understand more and more of the surrounding world. Much of that understanding depends not only on knowing that things exist, but in the amounts that they exist. This predisposition to know is a consequence of man's capacity for consciousness—the ability to not only know, but to know that he knows, and *to know when he doesn't know* and *when he doesn't understand* something.

The early attempts of the child at "knowing" come largely from psycho-motor experiences which collectively enable him to gain mastery over his voluntary muscles, and through that capacity differentiate himself from the rest of his environment and gain a better understanding of his relationship to it. This interaction process results in the formation of increasingly more complex structures within the child in the area of psycho-motor, perceptual, and cognitive development. Furthermore, as the child's thought processes become integrated with psycho-motor and perceptual activities, they culminate in cognitive operations which enable the organism of his brain to abstract, from concrete experience, logical relationships involving quantity. The bedrock of meaning for number relations inheres in the cognitive operations of classification, seriation, transitivity, and conservation.

Classification

Classification involves identifying and grouping items on the basis of specified characteristics which they share. As D. Elkind points out in *Essays in Honor of Piaget,* classification responses help to maintain the psychic economy by eliminating the need for fresh adaptation every time a new experience is encountered. "Freshly adapting" in each encounter, in the absence of categories to represent those amounts, would render one unable to deal with quantity in any precise way. It's interesting to note that Maria Montessori considered classification very important and identified it with intelligence.

There are various levels of classification, from simple to complex, each having pertinence to understanding number relations. The least complex form of classification is simple sorting, putting things together on the basis of a shared attribute. This involves being able to abstract (differentiate) certain features and to generalize on the basis of them. Simple sorting is one of the critical classification processes fundamental to understanding what counting means, because counting, among other things, requires an understanding of one-to-one correspondence—matching items on the basis of number, using the attribute of "oneness" irrespective of other attributes.

Through experience, the youngster then progresses on to the next level—multiple classification—being able to classify on the basis of two or more defining attributes. An example of this is found in our decimal system (base 10) in math where the representation of quantity is a function of the numeral itself as well as the place it holds (i.e., in .05, the quantity is determined by the location of the numeral hundredth's column and the numeral itself. Therefore, the amount is five-hundredths).

The next level of classification is called "Some-All Relations." This is a very important concept because it defines the relationships between the whole and its parts and requires a consideration of quantity (oneness, noneness, allness, someness) as well as quality (i.e., attributes such as color or shape which function as criteria in determining class membership). Some-All Relations refer to the following: a) knowing when something is one of a kind (i.e., Empire State building); b) knowing when there are none of a particular class (i.e., a human 18 feet tall; c) knowing whether all items under consideration have the criterial attributes of a particular class (i.e., total membership of an organization); and, d) knowing if several items under consideration belong to a larger class (i.e., a relay team as part of whole track team). Therefore, all amounts of any given thing can be quantitatively classified under the categories of one, some, all, or none. Understanding these distinctions is fundamental to determining quantity. Ascertaining "Some-All Relations," according to Piaget, involves the coordination of the *"intensive"* and *"extensive"* properties of a group of objects. Intensive properties are those which are common to all members of a class and distinguish one class from another. These are the qualitative aspects of objects such as color or texture that are used to group objects. Extensive properties, in contrast, refer to the quantitative aspects of classification: all, some, one, none. For example, in an exercise involving ten circles, seven of which are red and three of which are yellow, understanding that there are more circles than red circles requires a comprehension of some-all relations.

The next level of classification is class inclusion—forming sub-classes of objects and including the sub-classes in a larger class (i.e., dogs refers to a sub-class that belongs to a larger class—animals). Because it is through classification that the precise notion of number (quantity) is attained, the ability to classify should precede or be

concomitant with learning to count and manipulate numerals as symbols.

Seriation

Seriation refers to the ability to group things on the basis of their ordered differences. If one is seriating on the basis of number, the order would be determined by the gradations in amount determined by quantitatively comparing the items in question. Prerequisite to being able to do this, and concomitant with the execution of the act of seriation, is transivity—the ability to infer the quantitative relationship between two items based on the relationship they respectively have with a third item. For example, if John is taller than George, and George is taller than Paul, then we may infer that John is taller than Paul.

Conservation

Conservation is a logical operation that enables the child to understand that some aspects of a substance remain unchanged or conserved even though other aspects may have been altered. For example, if two rows of six pennies each are placed directly across from one another and a young child five years of age is asked whether or not there are more pennies in one row than in the other, very likely he will say they are the same in both rows. With this physical arrangement, the one-to-one correspondence of the pennies is apparent. However, if the pennies of one row are spread out over a larger area and the same questisn is asked, he very likely will say that there are now more pennies in the spread-out row than in the row that remained the same even though the child can count them.

This exercise can be shifted back and forth (changing the condensed row of pennies to a spread-out row, and vice-versa) and the youngster will change his answer based on his perception of the space that the pennies occupy rather than abstracting the quantity and basing his conclusion on that abstraction. If the child cannot abstract the attribute of "sixness," he will then rely on perceptual information rather than cognitive information, thus making the operations of addition, subtraction, multiplication, and division futile exercises involving the mere manipulation of symbols devoid of their underlying meaning. It is therefore not difficult to see why an inability to sense the ordered differences (seriation) in the amount between items and to make quantitative inferences about their relationships (transivity) renders the child incapable of having the power to deal effectively with experience in any degree of precision, effectiveness, and predictability.

Conclusion

Alfred North Whitehead said that those who fail to come to grips with the notion of quantity fail to come to grips with much of the fundamental reality of the universe. In other words, to fail to understand quantity is to be out of touch with reality to some degree. Traditionally taught math, which fails to address the issue of meaning, does not facilitate the understanding of reality in the child. Instead, it mitigates against it.

The relationship established by the following four operations are clear: addition refers to the combination of different and/or same quantities; subtraction refers to ascertaining the difference between two given quantities and represents an inverse relationship to addition; multiplication involves combining the same amounts; and division, the inverse of multiplication, involves the separation of one amount into smaller amounts which are equal.

Although the logical sequence and the order of complexity of the four basic mathematical operations have been reasonably well worked out, the psycho-motor, perceptual, and cognitive structures which collectively provide the individual with prerequisites for comprehending the quantitative relationships with respect to the four operations have yet to be clarified. This is one of the areas of research that the Anisa program proposes to undertake in the near future.

Teaching according to Anisa theory is defined as arranging environments and guiding the child's interactions with them to attain both the process and content goals of the curriclum. Because all environments are not equally rich (i.e., some environments have more objects and substances that can be seriated or classified, etc., than others), and not all interactions are equally powerful in drawing out those potentialities related to the fundamental processes underlying number relations (i.e., some interactions lead to differentiation, integration, and generalization more readily than others), it stands to reason that a carefully designed set of experiences characterized by rich interactions with carefully arranged environments (i.e., attribute blocks, golden beads, pink tower, cuisinaire rods, vessels of various shapes) would increase both the probability and the speed with which youngsters come to understand reality from a quantitative point of view. The development of the mathematics curriculum of the Anisa Model is based on this rationale.

A note about DR. STREETS *appears on page 20.*

THE ROLE OF THE ARTS IN THE RELEASE OF HUMAN POTENTIAL: AN ANISA PERSPECTIVE

By DR. DANIEL C. JORDAN

The Anisa theories of development and curriculum recognize three basic symbol systems: mathematics, language, and the arts. A symbol, according to Charles Sanders Peirce, is something that can stand for something else in some way for someone. Man's capacity to symbolize—to make something stand for something else—makes him unique among living creatures; it is the foundation of consciousness and self-awareness. To be conscious requires one to compare what is going on in the immediate present with the past in anticipation of the future. There is no way to make such a comparison unless that past, which is obviously a time gone by, can have some kind of representation in the present. For this, symbols are needed. Without them, memory of things past could not be brought to a level of consciousness in the present and there would be no continuity of self-awareness over time. One function of symbol systems is to sustain consciousness.

Symbolization is an important factor in the attainment of learning competence because as the Model defines it, learning competence depends on the *conscious* ability to differentiate, integrate, and generalize experience. Thus, to the extent that consciousness depends on symbolic activity, so will the attainment of learning competence.

Another important and related function of symbols is mediating the structuring of potentialities as they are actualized. One of the most direct influences in the structuring of actualized potentialities (i.e., forming patterns in the use of energy) is the self-ideal. If the self-ideal could not in some way be symbolized, it could not be present in consciousness and therefore be compared to the actual self. The gap between the ideal-self and the actual self creates much of the pressure for growth; it is the "principle of unrest," as Alfred North Whitehead would say, that impels us forward. Even that gap, if it is to be dealt with consciously, must be capable of symbolic representation. Dealing with anything requires the utilization of energy. Symbols are means of binding energy and assigning purpose to its use at an appropriate time, either in the present or the future. To be able to "reserve" energy for future use is an important factor in taking charge of one's destiny. Symbols are thus indispensable to the formation of values (i.e., the patterned utilization of energy