DEVELOPING APPROPRIATE MATHEMATICAL EXPERIENCES FOR THE SLOW LEARNER IN THE REGULAR CLASSROOM: A GUIDE FOR PRIMARY TEACHERS

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DEVELOPING APPROPRIATE MATHEMATICAL EXPERIENCES FOR THE SLOW LEARNER IN THE REGULAR CLASSROOM: A GUIDE FOR PRIMARY TEACHERS

by

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ABSTRACT

Children with experientially impoverished backgrounds enter school possessing mathematical skills inferior to those of their more fortunate peers. Rather than expose these children to a second rate mathematics program which will perpetuate this retarded development and thereby accentuate differences through grouping, it is proffered that the Investigating School Mathematics series can be used with all students in a way which is cognitively in keeping with their development while simultaneously respecting and fostering their affective development.

To demonstrate how this can be done, a guide for working with slow learners in Kindergarten, Grade I and Grade II was developed. This guide draws heavily upon the developmental theory of Jean Piaget for its rationale while incorporating the teaching suggestions of the Investigating School Mathematics program and those of successful teachers in the Bay St. George R.C. School Board system.

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CHAPTER I

THE PROBLEM

Introduction

This study was motivated by a recommendation of the Provincial Mathematics Committee in 1976 that two mathematics series be used with children from Kindergarten to Grade VI in our Newfoundland schools. One series, Investigating School Mathematics published by Addison Wesley, was recommended for the average and above, while the second series, Mathematics for Individual Achievement published by Houghton Mifflin, was to be used by the below average.

The consequence of this decision would in effect stream children on the basis of their school-entering mathematical competencies. In view of the thinking of some teachers and parents as to what constitutes mathematical ability at this early age, it was foreseen that many children could unwittingly be locked into a program which would be detrimental to their growth in mathematics. Of special concern was that group of learners who begin school disadvantaged relative to the school mathematics curriculum because of their backgrounds. For them, many of the counting skills of their peers are not present. Because of this and other related skill deficiencies, these children are often diagnosed as 'slow learners'.

However, because of the inability of Houghton Mifflin to meet publication deadlines set by the Provincial Mathematics

Committee, Mathematics for Individual Achievement was eliminated as an option, leaving the Investigating School Mathematics series to be used with all the children in our schools.

The resolution of the streaming dilemma did not simultaneously obliterate the slow learning pupil from our schools. What it did do, however, was present a new challenge; that of ensuring maximum growth in mathematics for all students by utilizing a mathematics program which is sensitive to the learner.

In short, then, the problem has translated itself into one of adapting the Investigating School Mathematics series to the so-called 'slow learners' and endeavouring to provide them with every opportunity for optimum growth in mathematics, particularly during the first three years of school.

The Slow Learner

A pragmatic definition of the slow learner in mathematics would admit anyone who has difficulty in coping with the average course suggested in the teaching guides for Investigating School Mathematics. As such, then, 'slow learner' is a label which may apply to various children at different times depending on the mathematics topic.

In order to identify those children who form the core of our slow learners, let us avail of the research findings to restrict our definition as follows:

> A slow learner is one whose ability to learn is adversely affected by low intellectual capacity and/or slow intellectual development and/or a poor self-image.

The distinction between intellectual capacity and intellectual development in our definition is one which Richard R. Skemp delineates neatly in The Psychology of Learning Mathematics. Referring to Hebb's terms, 'intelligence A' and 'intelligence B', he defines intellectual capacity (intelligence A) as innate potential which amounts to possessing a good brain and a good neural metabolism. Intelligence B, on the other hand, ". . . is the cumulative total of the schemata* or mental plans built up through the individual's interaction with his environment, insofar as his constitutional equipment allows."[1]

While the culturally disadvantaged have been excluded superficially from our definition, it should be obvious that cultural impoverishment plays a dominant role in the way the child views himself as fitting into the school setting, i.e., his self-concept. Lack of social as well as school skills can further diminish the child's worth in the eyes of his classmates. In addition, unrealistic teacher expectations can isolate a child who, as Kagan (1966) points out, seeks recognition from 'significant others'.

Purpose, Justification and Limitations of the Project

Purpose of the Project

The purpose of the project is to develop some tangible source, a 'guide' if you will, which can be of help to the primary teacher of

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*This notion of schema, which is the central ingredient of intelligence B, is defined by Skemp as a mental structure which includes not only the complex conceptual structures of mathematics, but relatively simple structures which coordinate sensory-motor activity. Schemata originate from sensory experience of, and motor activity towards, the outside world. However, they quickly become detachable from their origins and develop further through interactions. A schema, once formed, has two main functions:
(1) it integrates existing knowledge, and
(2) it serves as a mental tool for the acquisition of new knowledge.

[1]Quoted in Richard R. Skemp, The Psychology of Learning Mathematics (Baltimore: Penguin Books Inc., 1971), p. 16.

the so-called slow learner in mathematics. Since the writer believes that such teachers will be most effective if they accept a basic rationale of instruction, the focus of the 'guide' will be upon the needs and capabilities of the slow learner as he develops physically, socially, emotionally and intellectually. To nurture this sensitivity to the learner in the mathematics content area, references will be made throughout the 'guide' to key topics of the Investigating School Mathematics program at the Kindergarten, Grade I and Grade II levels.

Justification of the Project

The various pressures upon primary school teachers to gravitate too early towards symbolism can be particularly devastating for the slow learner. The 'back to the basics' movement and the expectations of teachers at successive grade levels* are among the most restrictive of the primary teacher's flexibility. In addition, the problem takes on an even greater complexity when we realize that many slow learners come from backgrounds which are not consistent with that depicted in our curriculum content. To compensate for this, the teacher needs to implement new and varied teaching strategies to help these children make appropriate adaptations.

In view of these two interrelated factors, pressure upon the primary teacher and the needs of the slow learner, a guide is perceived as being essential if the teacher is to:

(i) be sensitive to the cognitive development of the slow learner;

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*To determine the extent of this pressure on teachers, an informal questionnaire was administered to the primary teachers of the Bay St. George R.C. School Board. Of the hypothesized pressures listed, the expectancy of the teacher in the succeeding grade was rated highest.

(ii) be able to adapt the Investigating School Mathematics texts to the needs and capabilities of the slow learner;

(iii) be able to integrate mathematical experiences with other subject areas;

(iv) be given tangible safeguards against the pressures referred to previously.

Limitations of the Project

In the main, the suggestions to be offered in the guide will have their basis in 'a priori' claims rather than on research documentation. In spite of this, a strong case can be made for the use of such a guide on the basis of the sound psychological findings endorsing such an approach and the fact that many of the suggestions to be offered are those which have been successfully implemented in classrooms of the Bay St. George R.C. School Board.

A further limitation of the guide is the fact that it will be designed particularly for teaching the slow learner at the primary level. In addition, its focus on having the child actively involved may meet with some opposition from those administrators and teachers who do not perceive the primary curriculum as being child-centred.

Overview

Chapter II will be devoted to a review of the literature pertaining to the cognitive and affective development of children with an emphasis upon concept formation. Chapter III will be the actual teaching guide suggested for slow learners in Kindergarten, Grade I and Grade II. The final chapter will recommend a strategy for implementing the guide and suggest how it can be expanded.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter deals with the cognitive and affective domains of the learner. In the cognitive domain, we look at the developmental theory of Jean Piaget as well as the process of concept formation. In the affective domain, we look at the pressures upon various types of slow learners which can adversely influence their progress.

Cognitive Considerations

The Cognitive Developmental Theory of Jean Piaget

Jean Piaget's theory of cognitive development provides an excellent framework within which we can view the child's intellectual growth. His theory distinguishes four periods through which individuals pass as they mature: the sensori-motor period, the pre-operational period, the period of concrete operations, and the period of formal operations. Since the fourth stage, that of formal operations, is beyond the scope of the slow learner in the primary school, we shall not deal with it here.

Sensori-motor period. This stage, which may last for the first few years of life for some slow learners, is basically preverbal in nature. Sensations and actions are the important thing in a child's daily experience and the means through which he learns about his physical environment. Although this stage is the foundational one in that the organization of simple movements develop into the mental structures of subsequent stages, we shall not consider it further in view of the age range it encompasses.

Rather than deal with the pre-operational and concrete operational as two distinct entities, let us use the stage system Piaget (1964) delineates from his observations. Thus, we shall replace the pre-operational period and the period of concrete operations by a three stage system since this is more in keeping with our purposes.

Stage I. The Period of Representation.

At this point the child begins to use words to represent the composite pictures and the patterns of action formed in the mind during the sensori-motor stage. The use of words greatly increases the range of mental activity a child can carry out. As Williams and Shuard (1970) note, "He is no longer limited to mental pictures as the tools of his thinking" (p. 14).

The child is very egocentric during this stage and is governed by his perceptions. He uses imaginative play to act out experiences which have been important for him. In like fashion, his reproduction of objects, with blocks or drawings, represents his unique way of perceiving things.

The child's perceptual constraints often puzzle us adults. He can in fact hold two contradicting ideas at the same time since he focuses on the products of transformations rather than on the transformations themselves. Thus, he makes judgments on the basis of how things look to him rather than attempting to apply some form of reason or logic to the physical situation.

Stage II. The Period of Intuitive Thinking.

This period is one of transition and elaboration. The child's thinking is still dominated by his perceptions. However, his intellectual development is beginning to place his perceptions in conflict with his knowledge. For example, the child at this stage is able to do one-to-one correspondence. However, having done this, he is confused when one of his matching sets is spread out. Thus, since perception is still dominant in his cognition, and since perception is not reversible, thinking that depends on perception is often erratic or inconsistent.

Stage III. The Period of Concrete Operations.

Once this stage is reached we find the child less self-centred. He can now discover and consider relationships between things without being dominated by his own viewpoint. As such, he can perform logical operations, but such operations must have concrete referents. This notion of an operation is fundamental to Piaget's developmental theory. For Piaget (1963), "An operation may be defined as an action which can return to its starting point, and which can be integrated with other actions also possessing this feature of reversibility" (p. 36). As such, it is as Piaget (1964) states ". . . an interiorized action which modifies the object of knowledge" (p. 177).

The child at this stage is now able to conserve since his logical thought processes allow him to reverse actions on objects mentally. As such, logic dominates over perception. The child is now able to understand numerical quantity independent of appearances or arrangement, i.e. he is now in a position to understand the true meaning of number.

No attempt was made to place time references on the various stages depicted because of the great variety of slow learners admitted by our definition. However, by observing the time ranges Piaget sets up for 'average' children in his culture, we can adjust our time spans accordingly. For Piaget's subjects, Stage I corresponds from 1½/2 years to 4 years, Stage II from 4 years to 7/8 years, and Stage III from 7/8 years to 11/12 years.

Since children enter the kindergarten program of our schools between the ages of 4 years 8 months and 5 years 8 months, it is obvious that Stage I and Stage II will be the important periods for us to consider. Moreover, the research done with the mentally retarded, in particular, allows us to view these stages as developmental ones for the slow learner as well as for the more advantaged. The research of McManis (1969a, 1969b, 1969c, 1970), Lister (1970), and Stephens, Manhaney and McLaughlin (1972) support the view that children of lesser ability pass through the early developmental stages theorized by Piaget. In addition, as Johnson (1970) notes, children of low socioeconomic backgrounds pass through similar stages, albeit at a slower pace than their more advantaged peers.

Research relating to those learners who are behind their peers because of cultural differences is also well substantiated by cross-cultural studies. The research of Laurendeau and Pinard (1970), Brace (1974), and Ginsberg (1978) suggests that the culture in which the child grows up may delay the development of certain cognitive abilities while fostering others. As Ginsberg (1978) notes, "To the extent that people are similar, they share basic cognitive capacities. To the extent that they are different, subgroups may possess distinct patterns of skills adaptive to the local environment" (p. 42).

It has been an all too common practice for teachers working with these slow learners to abandon the development of concepts and processes in favour of drill on computational skills, often euphemistically called 'functional mathematics'. While Connally (1973) substantiates that the mentally retarded, in particular, perform best on computation and poorly on conceptualization, it is suspect that the curriculum offerings and instructional practices may be the determining factors. As Cawley (1970) points out, it is the acceptance of the notion that the mentally handicapped are only concrete learners that has led to a de-emphasis on the development of arithmetical principles and understandings and to a concentration on the development of computational skills.

It is the thesis of this writer that slow learners should not be deprived of good mathematics instruction but should be led into understanding concepts and principles in keeping with their intellectual development. Thus, while our slow learners may remain at the pre-operational stage longer than their more advantaged peers, our goal must be to give them good quality mathematical experiences but at a level which capitalizes on the strengths of the stages within the pre-operational period. To shunt them over into a computational program because they cannot "keep up" with the class in their concept formation is to deprive them of those experiences necessary for mathematical development while simultaneously stifling their motivation and affective development.

The concerns of the writer are well expressed in the Final Report of the Task Force on Education (1979) which suggests ". . . that the first aim of education should be to allow the person to reach the highest level of intellectual achievement of which he is capable" (p. 27). In accord with this, then, it is incumbent upon us to strive for maximum development for all our students utilizing mathematical topics valued for their logico-mathematical meaningfulness rather than the rote memorization of cumbersome terms and symbols. It is only by so doing that we can begin to help all students along in their intellectual development.

Factors Affecting Cognitive Development

Since the research literature substantiates the stages of intellectual development for all ability groups, let us turn our attention to those factors which facilitate transition along the development continuum. Piaget identifies four determinants.

(a) Maturation. Physical maturity, neurological development and mental maturity all play an important role in determining when the child is ready for various mathematical experiences. Ogletree (1974) argues that premature formal instruction will rob the physical body of the growth forces needed to develop the brain to its fullest potential, and may contribute to later frustration and anxiety in learning.

This observation of Ogletree may be somewhat reflected in the correlation between the age of school entry and subsequent school mathematics performance. From the research of Carroll (1963), Carter

(1956), Dickenson and Larson (1963), Gott (1963), and Ilika (1963), comes the conclusion that chronologically older children do better on standardized tests in arithmetic over young children when given the same school experiences. This age factor is more significant for boys. However, of special concern for us is the fact that a child of below average intelligence has an increasingly better chance of achievement the older he or she is. Sister Margaret Pittman (1969) in a related study concerning reading recommends that age 6 be minimal for entry into Grade I. In addition, in recognizing the needs of children of low socioeconomic status, Sister Pittman says that "it is necessary . . . that arrangements be made for supplementary learning experiences either preceding, or in conjunction with, the kindergarten program" (p. 93). In short, then, the problem translates itself either into an administrative one of school entry or of providing appropriate experiences for the early entrants of low ability which are in accord with their physical and mental development.

At the present time it would appear that the second strategy is the only one we can activate readily. However, it is important that we exercise caution in the manner in which we apply Piaget's theory of maturation. For example, in the concept of "number readiness" the existence of a well-delineated dichotomy between non-conservation and conservation is open to question. As noted by William A. Brownell, "The fact is that children do not move from level to level in an all-or-none way, but that at any age they reveal the characteristics of several levels of thinking as they deal with different kinds of problems."[2]

Baker and Sullivan (1970) support Brownell's contention by their study which suggests that motivation and aggregate size may be determining factors on conservation and non-conservation. For example, conservers were found when the task object was candy rather than grey crackers and when the number of objects was small.

(b) Experience. The experience factor consists of a physical dimension and a logical mathematical one, both of which are very important from a pedagogical viewpoint. For Piaget, physical experience refers to acting on objects in order to discover the properties of the objects themselves while logical mathematical experiences refer to the actions carried out by the child on objects.

Some insight into the essential role accorded to experience and actions by Piaget can be gleaned from a paper presented at the Second International Congress on Mathematics Education (Howson, 1973). In assessing Piaget's view on the importance of the experience factor, Taba (1966) notes that:

> According to data from . . . [Piaget], the full potential of abstract intelligence depends on the abundance of experience with concrete operations: manipulation of objects, processing concrete data, experimenting with spatial and time relationships and with the transformation of sizes and shapes. (p. 6)

It is thus stating the obvious when we conclude that action and experience play an essential role in the developmental theory of Jean Piaget. Piagetian-related research has substantiated this

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[2]Quoted in Leroy G. Callahan and Vincent J. Glennon, Elementary School Mathematics: A Guide To Current Research (Washington: Association for Supervision and Curriculum Development, 1975), p. 32.

contention. Brace and Nelson (1965), in attempting to determine the child's understanding of number concepts as revealed by the manipulation of objects, found that environmental factors play an important part in the child's development of a true concept of number. Children from homes of low socioeconomic level performed less well on the number tasks. Dunkley (1972), too, found the achievement of kindergarten children from disadvantaged backgrounds to be significantly below that of children in the middle class areas. Not only are these children unable to move at the same pace but many have not reached the same level of cognitive development as their more advantaged peers. An informal inventory done by the writer on the number of toys and books possessed by slow learners in two kindergarten classes of the Bay St. George R.C. School Board affirms the experiential impoverishment of these children.

Hendrickson's (1979) inventory of the mathematical thinking done by incoming first-grade children supports the need for appropriate experiences. He recommends that preschool and first-grade children should have much experience with counting objects and separating them into two or more parts. Since, as Denmark (1976) notes, systematic touching of objects being counted is the most successful strategy employed by first graders, objects that can be touched, rather than pictured objects, should be used.

In short, appropriate experiences indicate the opportunity to know in the Piagetian sense. Thus rote counting becomes very much secondary to the experience of touching objects while counting, of manipulating objects to indicate various numbers, etc. To accentuate the manipulatory phase is to work at a level more consonant with the child's cognition. Verbalizing numbers may be impressive but is, as the research indicates, very often meaningless for young children.

(c) Social Transmission. Once children have appropriate experiences, it is possible to transmit knowledge to them by language. This factor is important, but only when the child has a "structure" that allows him to understand the language being used. As Lovell (1966) notes, "Language seems to provide the means of pinning down and clarifying concepts once the cognitive structures are approaching the stage where the concepts can be elaborated" (p. 214). In a similar vein, Brearley et al. (1970) note that the role of language is to classify, refine and extend children's ideas and is crucial in helping children focus their thoughts on mathematical relationships. As they observe:

> Discussion, question and comment provide opportunities for a teacher to give accurate language appropriate to the level of understanding reached by a child and can promote further thinking. (p. 98)

Hilda Taba (1966) places the importance of the social transmission-experience dependency in focus as follows:

> Lack of opportunity for organized manipulation inhibits the development of conceptual schema with which to interpret the environment or to understand a symbolic representation of it. Deficiency of adult mediation decreases the child's capacity to convert the kaleidoscope of environmental stimulation into orderly perceptions and organized concepts. (p. 6)

In short, the factor of social transmission is an important one and one which can easily be overlooked in an activity-oriented classroom. For the slow learners, in particular, the linking of experience with its interpretation is mandatory if we expect them to convert objects and actions into verbal symbols.

It is important, moreover, that we make verbalization meaningful. The mathematics vocabulary both of the teacher and the text needs to be taught conscientiously. In addition, as Suydam and Weaver (1975) note, we must consider the needs of children even to the point of thinking carefully about the words they use when talking about mathematical ideas. The potential of such an approach is substantiated by Knight (1971) who found that using subculturally appropriate language enabled pupils to perform more successfully on a unit in geometry.

Prehm (1966), too, offers interesting support for the value of social transmission by his study which found that verbal pretraining on a conceptual task significantly affected the performance efficiency of culturally disadvantaged children. His conclusion that both attention to the pertinent aspects of the stimulus situation and verbalization have a positive effect on conceptual performance should alert us to the importance of verbal mediation in the concept formation of our slow learners.

We must be careful, moreover, that we give our children a variety of experiences in the social transmission mode. Obviously, pupil-pupil interaction must be promoted in addition to teacher-pupil and teacher-class. No matter what the form, however, it is important to realize that concept development can be greatly assisted through the verbal mode once the proper structure has been put in place for the learner through appropriate mathematical experiences.

(d) Equilibration. Equilibration is the fundamental factor in the development of intelligence in that it not only coordinates the factors of maturation, experience and social transmission but must itself be activated if true knowledge is to result. Stendler (1967) summarizes the significance of the equilibration factor as follows:

> For Piaget, intelligence is not something that is qualitatively or quantitatively fixed at birth, but rather, is a form of adaptation characterized by equilibrium. Part of man's biological inheritance is a striving for equilibrium in mental processes as well as in other physiological processes. Twin processes are involved: assimilation and accomodation. The child assimilates information from the environment which may upset existing equilibrium, and then accomodates present structures to the new so that equilibrium is restored. (p. 336)

Obviously, the more the child is advanced in his maturation, the more meaningful experiences he has, and the more receptive be is to social transmission, the greater the likelihood that the equilibrium factor can be activated to develop his intelligence.

Thus, equilibrium is an active process with change in one direction (assimilation) being compensated for by a change in the opposite direction (accommodation). That this equilibrium process can be activated at any time is not, however, in accord with the research findings. In response to the question of accelerating the development of logical thinking, Piaget notes that numerous attempts have failed because the equilibrium theory has not been heeded. 'Knowing' the addition facts, for example, does not mean that children are convinced of their authenticity. In a study reported by Van Engen (1971) it was found that of one hundred first-grade children who were near mastery in a pencil and paper test of addition facts, only about 50 per cent of them were able to conserve the equivalence relationship through a physical transformation. This is in accord with Piaget's observation that learning a fact by reinforcement does not in and of itself result in mental adaptation.

Concept Development

As evidenced in the thirty-seventh yearbook of the National Council of Teachers of Mathematics (1975), the mathematics curriculum for the young is viewed as an integration of concepts, skills and applications with concepts being of fundamental importance. This being so, let us delve somewhat into the concept formation process, particularly as it relates to Piagetian theory.

Rather than restrict ourselves to treating concepts in a limited way, let us adapt to the usage in current mathematics literature and deal with concepts in their more encompassing sense. Besides, it is in terms of the learner that we get the greater insight into the nature of concepts. Viewed from that perspective we can disseminate the following characteristics of concepts:

(a) An individual dimension--a concept represents an individual's own way of acquiring meaning from his experience.

(b) A formative dimension--a concept continually changes as a person's experiences accumulate.

(c) An eclectic dimension--a concept is a synthesis of a number of events an individual has experienced and conclusions he has drawn from them.

The way we form mathematical concepts is well delineated by Richard R. Skemp (1962, 1971). Skemp distinguishes two kinds of concepts. Those which are derived from our sensory and motor experiences of the outside world he calls primary concepts; and those which are abstracted from other concepts he calls secondary concepts. In order to form primary concepts, it is essential that the learner have a number of experiences which have something in common. For the learning of secondary concepts, it is essential that the learner possess the concepts from which they are derived.

For our purposes, the learning of primary concepts will be given priority. As Skemp (1971) notes, ". . . if a particular level is imperfectly understood, everything from then on is in peril. This dependency is probably greater in mathematics than in any other subject" (pp. 34-35).

Skemp's theory of concept formation closely parallels the stages of cognitive growth of Jean Piaget. That such a parallel can be drawn is also supported by Kagan (1966) and Lovell (1966). Both view the process of concept formation differently from the learning of isolated facts and suggest that many mathematical concepts grow in direct proportion to the cognitive development of the learner.

The slow learner entering school is in the process of building many primary mathematical concepts. This he does from his perceptual experiences. Initially, objects and their properties are abstracted on the basis of their physical and behavioral characteristics. While this allows the child to sort and to classify objects, the abstraction of number is beyond his conceptualization. In essence, he is bound by perceptual constraints.

By the age of seven or eight, however, the child is beginning to abstract himself from his perceptions. The basic concepts of mathematics, or at least arithmetic, are now attainable. The limitation on the concept formation of the learner at this stage is his reliance on the concrete world.

Thus, perceptual orientation and concrete referents are the mainstay of concept formation for our young learners. In such formation it is important that we adhere to the distinction offered by Piaget who notes that the "signified" (what the symbol or word stands for) is not the real object, but rather the child's understanding or intellectual construction of the real object. For Piaget (1964),

> To know an object, to know an event, is not simply to look at it and make a mental copy or image of it. To know an object is to act on it. To know is to modify, to transform the object, and to understand the process of this transformation, and as a consequence to understand the way the object is constructed. (p. 177)

Thus the formation of concepts like the evolution of intelligence in the child involves the continuous organization and reorganization of one's perception of, and reaction to, the world around him. Once again we note the complementary processes of assimilation and accommodation at work. For Skemp (1971), the equilibrium theory embodied therein should permeate the whole teaching process. He observes:

> The responsibility of the teacher in the early stages of learning is therefore great. He has to make sure that schematic learning, not just memorizing the manipulations of symbols, is taking place. He has to know which stages require only straightforward assimilation, and when accommodation is needed, since at the latter stages the pace must be slower, and progress more carefully checked. (p. 53)

The equilibrium theory suggests that concept formation, at the primary level in particular, begin with physical experiences and proceed in a sequence which facilitates internalization. As Flavell (1963) discerns it,

> In trying to teach a child some general principle or rule, one should so far as is feasible parallel the developmental process of internalization of actions. That is, the child should first work with the principle in the most concrete and action-oriented context possible; he should be allowed to manipulate objects himself and "see" the principle operate in his own actions. Then, it should become progressively more internalized and schematic by reducing perceptual and motor supports, e.g., moving from objects to symbols of objects, from motor action to speech, etc. (p. 84)

The success of Fortson (1970) in teaching beginning mathematics to five-year-olds through multiple-stimuli techniques using concrete materials, bodily movement, and sound lends support to Flavell's observation.

Callahan and Glennon (1975), in tackling the question of "What kind of mathematics program for the kindergarten?" conclude that "cognitive elements (concepts and understandings) . . . are best learned by actively manipulating the materials, then by working with pictures which represent things, and finally with the written symbols" (p. 36). In addition, Farnham-Diggory (1968) emphasizes the importance of visual and action-based mathematical experiences on a neurological basis. Thus, particularly for slow learners, it is important that we provide many experiences in which they are allowed to "see" for themselves what is going on by the actions they perform on objects. As Schulz (1972) observes, "tactile experience with objects and events are indispensable to the learner who has no other effective input channel" (p. 5).

Lovell (1966), in noting that the concepts of arithmetic such as number and length arise out of the child's first-hand experience of reality, supports the need for many varied physical experiences for the young. He observes that

> . . . a particular concept is more likely to develop if the child receives many different perceptual impressions of the concept-visual, tactile, kinesthetic-all embodied in a number of different materials and in situations which the child can construct for himself, but in situations which, nevertheless, all exemplify the same underlying structure. (p. 211)

Dienes (1969), besides lending experimental verification of this thesis, proffers a complete teaching strategy based on children having direct interaction with the environment through game-like situations.

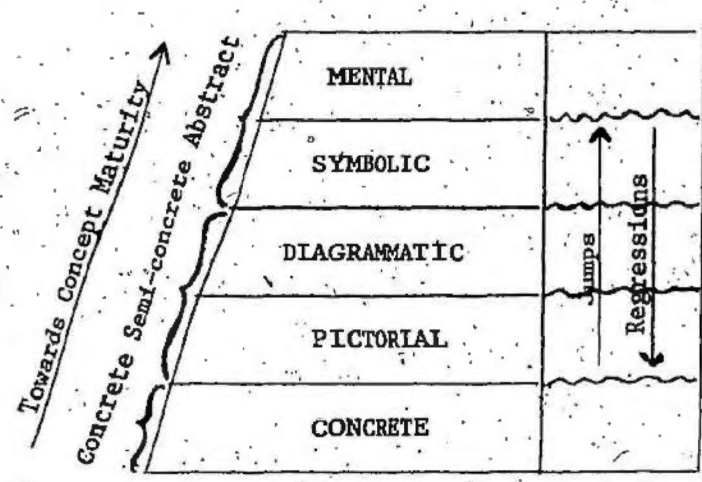
From the above, then, we can deduce that the concrete, physical world which the child understands should always be the starting point for the learning of new concepts. The manner in which we proceed on a concrete to abstract continuum has been well delineated by Underhill (1972) and by Welch and Harvin (1976). Since the work of Welch and Harvin is better suited for our purposes, let us investigate it further.

The Concept Continuum

Welch and Harvin (1976) have taken from the work of Piaget, Gagné, Olsen and Bruner and constructed a concrete to abstract continuum which they believe should be employed in concept development with young children.

This concept continuum consists of five stages: concrete, pictorial, diagrammatic, symbolic and mental and highlights the fact that a successful mathematics program is not only sequential but also provides stimulating experiences of an increasingly mature nature.

The following diagram depicts the framework of the continuum:



Let us now look briefly at the five levels which the concept continuum highlights.

(a) Concrete. At this level children work with real objects such as toys, counters, etc. By manipulating these, quantitative and spatial relationships are discovered. It is important that we capitalize on the fact that concepts at the concrete stage have concrete referents as means for thinking and communicating. Welch and Harvin (1976) sensitize us to the power of this stage as follows:

> If we lose sight of the need for an anchor in concreteness, learning can become over-verbalized. This leads to inadequate referents in actual situations. Teachers must recognize that concepts in mathematics are very often applied to the real world and therefore must be based upon experiences that are equally concrete. (p. 17)

(b) Pictorial. The pictorial stage gives a picture of the objects utilized in stage one and thereby helps to bridge the gap to the more abstract symbolic stage. Within the stage exists four levels of abstraction which can be employed. There are:

(i) Photographic -- the picture looks exactly like the object that children have been manipulating during the concrete stage.

(ii) Artistic representation -- some of the details of the photographed object are omitted.

(iii) Sketched representation -- an outline depiction of the real thing.

(iv) Symbolic -- a mark or geometric shape in place of the object.

The research findings of Campbell (1979) and Posge and Posge (1977) caution us about some of the pitfalls children may experience in interpreting adult-made pictures. Obviously, we need to be sensitive to such interference in children's concept formation. In addition, we must utilize the mode of verbal interaction to clear up ambiguities and thereby allow effective conceptualization to occur.

(c) Diagrammatic. The bridge between the concrete and pictorial stages with the symbolic stage is provided by the diagrammatic. Here quantitative and spatial relationships are represented by some type of drawing, e.g., instead of four pictures of two birds each, a diagram depicting a multiplication array will provide good representation together with the motivation to search for a pattern.

The ability to diagram mathematical ideas and relationships is not innate by any means. As such, it must be taught. Thus, the teacher should have children experiment in drawing many diagrams and in discussing the strengths and weaknesses of their models. In so doing, children will be led toward more systematic generalizations of mathematical ideas.

(d) Symbolic. This stage represents the "shorthand" of communicating quantitative and spatial ideas and as such is highly dependent upon children having facility with primary concepts obtained at the concrete and pictorial levels.

It is important to realize that there are different levels of abstraction within this stage, e.g., the addition of two-digit numbers can be symbolically represented as:

(i)

4 tens	3 ones
+ 2 tens	4 ones
6 tens	7 ones

Successively, this would lead to:

(ii)

$$\begin{array}{r} 40 + 3 \\ +\ 20 + 4 \\ \hline 60 + 7 = 67 \end{array}$$

and finally to:

(iii)

$$\begin{array}{r} 43 \\ +\ 24 \\ \hline 67 \end{array}$$

At the symbolic level, in particular, there is a tendency on the part of some children to revert back to a previous stage, e.g., using fingers or making marks in a tally fashion. To ensure that concept development does not get stifled at this stage it is essential that various instructional techniques be used to bridge any gap which may have occurred in the continuum. In the case of making marks in a tally fashion, an effective technique might be to have the child label the marks he makes to add two quantities and subsequently replace the first group with its label and count on. Thus for 4 + 3 we might have the following:

(i)	////	///	(drawing marks)
(ii)	//// 4	/// 3	(labeling marks)
(iii)	4	/// 3	(counting on)

(e) <u>Mental Stage</u>. At this level we are given a verbal or symbolic stimulus and have to handle the quantitative relationships in our mind, i.e., no objects, papers or pencils are allowed. While this is probably the most neglected of the stages on the continuum, it can be argued that since the mathematics of everyday life is mostly mental that we should strive for maximum capability in this realm. At any rate, complete concept development would suggest our providing opportunities for students to solve real-life problems without the aid of pencil and paper.

It is important to note that the stages on the concept continuum are not separate and discrete entities. Children will often jump to stages or regress to previous levels. However, it is essential that our mathematics program be sequenced so that each child is given the opportunity to move along the continuum in the light of his cognitive structure, needs, interests and success so that effective conceptualization will be assured. As Poage and Poage (1977) note:

> It is difficult to classify every lesson into a specific category and this is not necessary for establishing good learning sequences. What is important is that students receive the types of lessons that fit their stages of growth and development, and that they are given adequate experiences with each of these types. (p. 412)

In summary, the use of the concept continuum suggested by Welch and Harvin alerts us to organize and sequence instructional material for slow learners in a manner which is consonant with their conceptual development. It is particularly important that in our attempts to cover prescribed material we are not deluded by superficial verbalizations which would tempt us to skip foundational stages. At all times it is important, as Schulz (1972) puts it, that we ". . . step into the pupil's frame of reference and look matters over from there" (p. 17).

Affective Functioning

To view learning solely from a cognitive developmental viewpoint is to be overly simplistic. As primary teachers in particular can verify, children bring more to the learning task than their cognition. The child's self-concept and his attitude towards the learning of mathematics can be over-powering determinants in the learning situation.

Both how the child views himself as an individual and a learner and how he views the teacher's acceptance of him have been subjected to research. Firestone and Brody (1975), in a longitudinal study during which 79 kindergarten children were followed into the first grade, found that negative interaction with teachers had an adverse effect on academic achievement. Similarly, Feighery (1975) found that kindergarten children chose to work less time in the subject area in which wrong answers were criticized.

On the other hand, Dil and Gotts (1971) found an improvement in arithmetic self-concept among seven to nine year olds through combined positive reinforcement, peer interaction, and sequential curriculum. O'Brien (1975), in turn, found that the more positively the teacher perceived the pupil, the greater was his achievement in mathematics.

For young children, in particular, praise has been found to be a highly effective way to motivate. Masek (1970), in studying the behaviour of children when teachers provided such positive reinforcement as verbal praise, physical contact, and facial expressions indicating approval, concluded that significant increases in mathematical performance and in task orientation occurred when such reinforcement was frequent. When reinforcement was stopped, lower performance was noted. However, performance increased again when reinforcement was reactivated.

Obviously, how children feel about themselves as individuals and learners plays an important role in how they function in the school setting. Admittedly, the school has little control over the affective development which has taken place prior to schooling. However, if we are to foster positive development in the affective domain, it is important that we learn as much as possible about our young children so that we may tune in to how they view themselves in the school environment.

The relationship between self-concept and achievement or success is one of which many educators are sensitive. Tabs and Elkins (1966), for example, note that if a child is to be an efficient learner he must first and foremost "feel good about himself." They contend that social and emotional stability are a must for the child in the class setting. And such security comes, at the primary level in particular, from mutual trust and respect between the teacher and the child.

This interdependence of child and adult, be it parent or teacher, is highlighted by Jerome Kagan (1966) who suggests that children strive for recognition from parents and teachers and are motivated to adopt behaviours and learn skills which will make them more like their models. In Kagan's terms,

> If these models display an interest in the mastery of the intellectual skills, the child will attempt to mimic such mastery in order to maximize similarity with the model. . . . The absence of this dynamic in many lower-class families is partially responsible for the fact that lower-class children are less highly motivated to master intellectual skills. (p. 99)

In view of this, it is small wonder that children of lower-class families frequently suffer a traumatic loss of self-esteem in the primary school. Their experiences at modeling parents have not fostered those skills prized by teachers. Now, in their attempts to model the teacher, they find themselves at an unfair disadvantage since many of the skills teachers feel 'average' children should possess when they begin school are lacking.

The 'solution' to this awkward situation is often sought through ability grouping. However, Redmond (1969) cautions against such a practice since the self-concept and level of aspiration of the slow learner may be adversely affected. In addition, teachers' and parents' expectations may be lowered as well. The significance of such expectations has been dramatically demonstrated by Rosenthal and Jacobson (1968). As it pertains to the slow learner in school, we find that both the teacher and the principal expects less from these 'retarded' children who in turn reward such expectations with low academic performance.

Unfortunately, this initial loss of self-worth as an effective learner becomes self-perpetuating for our disadvantaged learner. Schulz (1972) pricks at the conscience of us all with his poignant remark that "Ironically, schools may be the only treatment centers that blame the patient rather than the treatment when things go wrong" (p. 2).

What we can conclude from the literature on affective functioning is that if we are to make the slow learner feel good about himself in the learning of mathematics, it is fundamental that we be continually oriented to the positives and the successes. Once a success cycle has been activated the journey along the concept continuum can be a rewarding one for both teacher and learner. As Ginsberg (1977) so well observes:

> Children's self-concept is usually bound up with their intellectual achievements. In some cases, helping children to improve their schoolwork may do more for their emotional health than well-meaning attempts to analyze and treat their emotional disturbances directly. (p. 148)

Summary

If we are to pay more than lip service to the difficulties experienced by many children in their cognitive and affective development, it is mandatory that we suggest concrete strategies for remediation and growth.

While our cursory look at the cognitive and affective domains gives us a perspective from which to view the slow learner, it is important that we attend to many of the specifics which face these children on a day-to-day basis. In order that we may do this in a logical fashion, a guide suggesting appropriate mathematical experiences for slow learners in the first three years of school follows.

CHAPTER III

A GUIDE FOR HELPING THE SLOW LEARNER

This chapter consists of the nucleus of a proposed handbook for teachers based on the research findings delineated in the previous chapter. Such an aid is designed primarily for use with the slow learning student. Nevertheless, its attention to the manner in which all children learn mathematics may enable it to be used as a resource by all teachers using the Investigating School Mathematics program.

Introduction

The pressures upon the Kindergarten, Grade I and Grade II teacher today are many and varied. Teachers of subsequent grade levels expect children entering their classes to show evidence of having mastered the content material of earlier levels. Parents expect to see tangible signs of progress in the form of tests and worksheets and curriculum specialists often compete with each other in encouraging teachers to spend more time at their area of expertise.

Given these demands, the primary teacher often finds it difficult to cater to the needs of the individual child. In the case of the slow learner, moreover, a real danger exists that his development will be victimized because of pressure to cover designated content.

It is the purpose of this guide to suggest means by which the slow learner will be allowed to progress through a mathematics curriculum which adapts itself to the learner rather than the learner to the curriculum. To do this, no radical departure from the present program is seen to be necessary or desirable. Indeed, the Investigating School Mathematics program is admirably suited for working with children who are at various levels in their mathematical concept development.

The guide spans the first three years of school and as such must be somewhat skeletal in its format. However, it is hoped that the suggestions offered will stimulate interaction among teachers, principals, and supervisors to build a curriculum suited to the developmental needs of all children.

SECTION A

FUNDAMENTAL QUESTIONS

1. Why bother teaching mathematics in primary school?

If we are in accord with the observations of the Task Force on Education that ". . . the first aim of education should be to allow the person to reach the highest level of intellectual achievement of which he is capable," we must of necessity place mathematics in a prominent position in our primary school curriculum. Indeed, a close relationship exists between the intellectual development of the child and the informal mathematics he develops to systematize and order the world about him. Because of this, we readily discern that all children come to school possessing at least the rudiments of the subject which will become more formalized into the principles of mathematics, e.g., all kindergarteners know when something is 'all gone' and can make gross comparisons about who has 'more' or 'less'. In essence, the subject matter of mathematics is so tied into everyday experiences that the motivation it derives from these experiences makes it a natural vehicle through which we can extend children's preschool experiences and simultaneously assist in their intellectual development.

2. Why focus on intellectual development so early in the child's schooling?

Our focus on intellectual development is especially important at the primary level since this development is integrally bound up with the child's social and emotional growth. Of special concern for us is the development of the child's self-concept which grows gradually as the result of the feedback he receives from other people and from his own activities and achievements. Our primary school child is constantly evaluating himself as a doer--as an individual who can or cannot do well academically, socially or athletically. As such, if we are to make the primary school pupil feel good about himself we must give him many success experiences.

3. What do we know about the development of intelligence?

The work of Jean Piaget gives us some insight into the manner in which children develop intellectually. For Piaget, intellectual development is an active process through which the child becomes more and more adept at making sense out of his environment. In addition, Piaget delineates a number of developmental stages along this continuum in which the child perceives and interprets the world in a unique way. These stages, which are outlined in Chapter II, Review of the Literature, alert us to the fact that children are not miniature adults but individuals who interact with their environment in a manner appropriate to their development.

4. Do the stages of intellectual development hold true for all individuals?

Research documents the existence of these stages for all except the severely mentally retarded. While the age referents vary from culture to culture and with the advantaged and disadvantaged, the sequence of development through the stages remains the same. Thus, in dealing with primary school children we can feel confident that the development will be in accord with that theorized by Piaget.

5. Who are the 'slow learners'?

The research data suggests the following eclectic definition to identify the core group:

> A slow learner is one whose ability to learn is adversely affected by low intellectual capacity and/or slow intellectual development and/or a poor self-image.

At a purely pragmatic, classroom level we shall admit anyone who has difficulty coping with the average course suggested in the teaching guides for Investigating School Mathematics. As such, then, 'slow learner' is a label which may apply to various children at different times depending on the mathematics topic.

6. Why focus on the slow learner?

The pressures upon primary teachers to cover specific content places them in a difficult position relative to the slow learner. All too often prerequisite skills have to be hurried through in order to do the work suggested at the grade level. For the slow learner lacking these prerequisites, and often other prerequisites, the result is often frustration and a lowering of his self-concept.

While the Investigating School Mathematics teaching guides are adaptable to the slow learner, there exists a need to pinpoint specific strategies by which the slow learner can actively participate with his peers in the mathematics topic under consideration. In addition, by offering practical suggestions to help the slow learner it is hoped that we will be able to attune ourselves to these slow learners and thereby help them develop intellectually in a cognitively healthy manner.

7. Is heterogeneous grouping more effective than homogeneous grouping?

Research tells us that the teacher rather than the grouping technique makes the difference. Thus, if teachers believe that heterogeneous grouping is more effective for her class, it will be. However, viewed from the child's point of view, homogeneous grouping may be quite devastating. Cognitive conceit or cognitive defeat can result depending where the child finds himself. For the slow learner, being in a class where less is expected of him by teacher, principal, and parent can only serve to lower his self-concept as a doer in the academic setting.

8. What are the advantages of using the Investigating School Mathematics series with the slow learners in the regular classroom?

Being in the same book, even if he is doing something different, has tremendous motivational power for the slow learner. He feels he belongs and will readily accept assistance from his teacher and classmates to remain there.

In addition to giving him a sense of belonging, the Investigating School Mathematics series offers many opportunities for help via the five-point teaching/learning strategy that it suggests. Let us look at each phase of this strategy and see the relevance it has for our slow learners.

(a) Preparation. Here the teacher prepares for the lesson by ensuring that manipulatives are ready and that prerequisite skills are assured. While attention is drawn to the slow learner when we consider entering behaviour, the preparation of manipulatives provides an excellent avenue through which the slow learner can become involved even before the formal part of the lesson begins. By helping to distribute and at times to make manipulatives, he can be made feel good about his part in the lesson. In addition, the preparation phase allows the teacher to structure the lesson for the child by acquainting him with the situation at hand and the objective(s) to be accomplished. Such structuring is particularly important for the slow learner who needs the security of knowing what is expected of him.

(b) Investigation. The investigation phase is the core of the designated learning experience. Here the children are encouraged to become actively involved, individually or in small groups, with the germ of the idea which is central to the lesson. Since this activity is child-centred, the teacher is freed to help the slow learners with extra instruction which may be needed to undertake their investigation successfully.

(c) Discussion. This stage, too, is well suited to the slow learner. During this phase the teacher and children interact verbally about what the investigation revealed. Peer interaction and the opportunity for the teacher to clarify and extend concepts are integral parts of the discussion phase. For the slow learner, in particular, the linking of the experience of the investigation with its interpretation is mandatory if we expect him to convert objects and actions into verbal symbols.

(d) Utilization. Here the child works on his own to use the ideas developed in the investigation and discussion phases. The exercises are graduated in difficulty and permit the slow learners to work at a level below that suggested for average achievers.

(e) Extension. This phase allows for the use of remedial activity as well as maintenance and enrichment opportunities. Thus, the slow learner can avoid the frustration of having to proceed to new ideas before the previously presented ideas are understood. In some cases, more physical embodiments of the concept may be given so that the slow learner is given the reinforcement he needs to make the concept his own. Such horizontal elaboration can prove invaluable in cementing a concept which might not have been properly assimilated. In addition, children who have the concept can be employed to see how well they can help a friend. Such peer teaching not only helps the slow learner but often helps the young 'teacher' further consolidate his conceptualization. In fact, many teachers have found that employing a 'buddy system' helps child-centre the mathematics activity of the classroom and thus allows for more effective employment of the Investigating School Mathematics teaching/learning strategy.

9. Why place such strong emphasis upon the investigation stage for the slow learner?

The knowledge we have gained from Jean Piaget and others about the way children make sense out of their world leads us to appreciate the need for the existence of many concrete experiences. The young learner, and the slow learner in particular, needs the freedom to know an object in a manner which is appropriate for him. In many cases, this means allowing children to act on objects as they did in their sensori-motor stage in order that they may get some 'feel' for the situation and thus be freed to abstract the desired concept.

By structuring a particular time for such physical exploration and manipulation, the authors of the Investigating School Mathematics series allow us to simulate the manner in which children first come to know concepts in their natural setting. In addition, by encouraging children to take the initial responsibility for figuring things out, the child is placed in a situation which is simultaneously motivational and creative.

To suggest that such a procedure should only be used with the average and above is not in accord with the facts. Indeed, our so-called 'slow learners' are well able to initiate conceptualization if the required prerequisite skills have been mastered and the necessary direction has been given. As we find in so many situations, the difference between the slow learner and the average is one of degree rather than of kind.

SECTION B

GETTING STARTED

Children may come to school in Newfoundland anywhere from 4 years 8 months to 5 years 8 months; they may come from a home which prizes intellectual endeavours and schooling or from one in which school is shunned by parents and siblings alike; they may come from a home which provides a multitude of experiences for them to know about the world around them or from one where the television screen dominates their waking hours; they may come from a home where parents are interested in helping them order their world or from a home where adult mediation is virtually nonexistent. Whatever the circumstances, they are nonetheless all designated to come to the same classroom on that Tuesday after Labour Day--namely the kindergarten classroom.

A Strategy for Kindergarten Initiation

Given this wide discrepancy in age and background, it is obvious that many children will not be ready to cope successfully with the prescribed kindergarten program. This being so, it is important that we strive to adjust our instruction so that the development of these 'slower learners' is nurtured and not frustrated.

Knowledge of the children we teach is an obvious prerequisite to any decision we take regarding programming. This knowledge can be obtained best from one-to-one and small group interaction. The opportunity for such interaction can be obtained if we start our kindergarten classes in September in a more child-oriented manner. This we can do by dividing our kindergarten classes into small groups for admission purposes as suggested in that helpful guide to primary teachers, A Starting Point. In addition, by simultaneously shortening the amount of class time for beginners, we are helping them make the adjustment to their new environment. Given the smaller group, children feel less threatened and the teacher is able to get acquainted with them on a more individual basis.*

Following this procedure for the first few days and then combining our groups allows children who have no playschool experience to assimilate their new environment more readily and get to make friends of their classmates and the teacher. Such security is particularly important for the child from a disadvantaged environment who may ordinarily find his first school experiences very frustrating.

These first few days of schooling are especially important for the teacher to set the atmosphere for the school year. Obviously, the teacher will be undertaking much informal diagnosis of her young learners to determine their abilities and interests. However, her prime concern must be in getting her kindergarteners to feel that they

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*Our Lady of Mercy Primary School in St. George's has refined this strategy by initiating kindergarten registrants in May and June. Following registration, during which children are introduced to the kindergarten environment, 'classes' of approximately six children are set up. Each class takes turns coming to kindergarten for an afternoon session. After each group has had at least one day in the kindergarten environment, the groups are combined until they attain the class size designated for September. This initiation takes about two weeks to complete. The diagnosis of each child's development, skills, and interests helps the teacher plan strategies for September. In addition, the physical and social experiences of the children in small groups provides a readiness which, because of school opening administrivia and parental expectations, are often unattainable with a September beginning.

belong and are wanted in the classroom. For those children who exhibit few school skills and appear developmentally impoverished the challenge is great indeed.

Importance of the Child's Self-Concept

Research studies substantiate the importance of having the child feel good about himself. His self-concept is part and parcel of his cognitive development and must be helped along through the understanding teacher who adapts kindergarten experiences to ensure success.

This success will be nurtured most abundantly by the teacher who treats children as unique in their own right. If we want children to feel important and possess healthy self-concepts, it is mandatory that our interpersonal relations reflect this concern. Thus, we must be aware not to talk down to children but to be as original as we are with adults. It is essential, moreover, that we show interest in what they say. Such interaction is very critical since the individual conference will prove a most useful evaluative technique in assisting us to ascertain the child's mathematical conceptualization.

At the kindergarten level, especially, it is important that we refrain from commenting on the correctness of what children say. After all, a child's observation or language may not be right from our point of view but totally logical from his. Verbal 'correction' is often interpreted by the child as an attack upon him as a person. Rather, we should accept his point of view, make a mental note of his discrepancies, and try to arrange experiences which will align the child's thinking with ours when he is far enough along in his development to do so. By utilizing this strategy we let the slow learner know that we appreciate him as a person and respect his unique way of interpreting his environment.

The Need for a Physical Education Base

The school, however, is in many ways unrelenting on the slow learner as it becomes more and more oriented to the early interpretation of perceptual data in both the visual and auditory mode. Such processing the slow learner is often not able to do because of his slower development and/or lack of experiences.

Since at this stage mental and physical activities are closely related, it is in keeping with good developmental theory that we promote meaningful motor activities. As Kephart (1971) notes: "Since we cannot separate the perceptual and the motor in the processes of the child, we should not attempt to separate them in teaching him" (p. 115).

Indeed, since from a developmental point of view motor learning forms the foundation for our perceptual and conceptual development, it is especially important that early school experiences capitalize upon the physical domain of the learner. It is reasonable to expect that strengthening this domain will help support the development of the other two. As such, it is essential that physical education be an integral part of the kindergarten program for it is through the physical mode that we can best reach out to children at a level which they can all experience.

Fortunately, the Newfoundland Department of Education presently prescribes a curriculum for physical education at the primary level which is strongly supportive of this point of view. Through it children can develop gross motor coordination and social skills as well as conceptualize structures of space, direction and movement. The gross motor activities, in particular, will do much to ensure that children make perceptual-motor matchups in the right direction. Unless a sound motor base is in place, there is a real danger that children will assign primary importance to perceptual data. Such an occurrence is evidenced in the child who makes tight and inflexible movements with his pencil in attempting to copy numerals or geometric figures.*

In addition, by utilizing his body, concepts such as 'up', 'down', 'over', 'above', 'under', etc. can be internalized for the child. This in turn facilitates the extension of these concepts to the concrete and pictorial representational stages. Ensuring the proper sequential development of these positional concepts will serve children well as they move into the more symbolic aspects of the kindergarten program not only in mathematics but in other subject areas as well.

Diagnosing the Child's Learning Modes

Utilizing the physical domain seems to be the most naturel avenue to ensure proper readiness in the school setting. However, as with experiential readiness, children display a wide variety of skill in their ability to process stimuli utilizing the various physical senses.

If we are to attune ourselves realistically to individual differences, we must be sensitive to the learning style each child favours and to those abilities prerequisite for success in the academic

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*Perceptual-motor training techniques are well delineated in The Slow Learner in the Classroom by Newell Kephart.

setting of the classroom. As such, evaluation which is formative, i.e., ongoing, must be the order of the day as we attempt to guage each child's strengths and weaknesses in the various sense modes. All such evaluation should, of course, take place in a setting with which the child is both familiar and comfortable. In this way, we can ascertain more correctly each child's ability to process in the visual, auditory, tactile, and other sense modes.

Having gained some insight into the learning strategies employed by our young pupils, we must set out to teach the various processing skills. Here stories, rhymes, mime, creative experiences, visual and auditory selection and discrimination experiences can be utilized to help focus on those processing skills which will be needed as the child enters the more abstract world of symbolism.

Building an Appropriate Experiential Background

In keeping with the teaching of these processing skills, we must provide opportunities for our slow learners to know objects in a free play setting. All children need the opportunity of free exploration. However, all too many slow learners have been deprived of needed experiences, particularly with the objects which will be utilized in the mathematics program.

To remedy this, the following materials could be introduced systematically to enrich the child's experiential background as well as serve to build up his mathematics conceptualization:

> Toothpaste tube covers, buttons, clothes pins, plastic tags from bread packages, popsicle sticks, checkers and poker chips to be used primarily for counting; toy cars and trucks, dolls and doll houses, plastic spoons, forks and knives, drinking straws and glasses, keys, shells, bottle caps

> and bottles, nuts and bolts for classification and one-to-one correspondence; coloured cubes, unifex, pipe cleaners, wooden blocks of various sizes, cuisinaire rods, plastic attribute blocks, poleidoblocs for constructing, classifying and comparing; cans and boxes of various sizes, spools, balls, marbles, cone-shaped party hats, funnels, geoblocs for experiencing the three dimensional geometric world.

By providing such a rich environment for the child to explore we can motivate him to make extensive perceptual differentiations. Such active motor exploration will pay dividends when we get to the more intricate perceptual differentiation demanded by the symbolic world of the mathematics textbook.

From the conceptualization standpoint, it is important that children be given ample time to play with these materials in order that they may get to know them in the physical sense. As Baratta-Lortan (1976) states:

> Only when children have had time to play and explore new materials in their own way will they be able to see the materials as learning materials and be able to focus on mathematical concepts rather than on the materials themselves. Without free exploration children's play interests are unsatisfied, and until this need is fulfilled, the children will pursue this priority relentlessly. (p. 2)

In addition, it is important that children be introduced to these materials in a systematic fashion. Thus, before they begin to play with the materials we introduce on a particular day, it is important that the children be made aware of where they come from. In this way, children are able to see that the materials we use are not abstract but come from the real world. It can prove very beneficial, too, for children to bring objects from home to add to any of the collections in the classroom. In fact, there is much merit in having children make the classroom their own by the materials they bring along and the creations they make in the school setting. In addition, the teacher can help children structure these different materials by placing sets in boxes which are properly marked and accessible to the child. (Closed boxes can be appropriately marked for young children by simply taping an article of the set on the outside of the box. This object can in turn be replaced by a picture and later by a word as the child progresses from the concrete to the symbolic.) Having a child find the set of attribute blocks or return his cars to the garage box can help build his perceptual skills while simultaneously exposing him to an orderly, structured environment.

Utilizing the Thematic Approach--Subject Integration

During the first few months, in particular, and indeed for much of the primary years, children should be exposed to themes rather than subject disciplines. The integrated day is very popular these days in kindergarten methodology and should be pursued if we are to capitalize on the learning styles which our young children favour. Moreover, the thematic approach is well suited to provide us the scope in which we can work with the slow learner on related academic skills.

An example of a theme which kindergarteners might explore is transportation. Buses, cars, trucks, trains, planes, boats, rockets, etc., are very motivational for children and can touch on so many academic skills.

Since we are aiming to have children reconstruct meaning for themselves, an enquiry approach should predominate our teaching. Thus, we might want children to investigate why we have vehicles, the purpose they serve, the support facilities they require, etc. The school bus could be a natural place to begin.

A tour of the bus and a talk to the driver concerning his job and the safety rules the children must observe could initiate interest. The children can then record the bus experience through a drawing. Such drawings can be very valuable both in showing us what our slow learners have really observed and in stimulating them to further insights as they witness the drawings of others. In addition, the teacher can chart interesting things which the children volunteer about the bus: its colour, number of tires, pertinent words marked on the bus, etc. The teacher can leave the chart open since children might add to it later as they perceive other things on the bus such as exit doors, fire extinguishers, number of seats, number of children who can sit in a seat, and the like.

The natural classification of the children into bused and non-bused can be capitalized on. In addition to allowing us to group children into two classes, it permits us to initiate graphing in a very concrete manner. By having them form two lines, the bused line and the nonbused line, the children can easily compare which group has the greater number by one-to-one matching. This method of comparison can then be extended outside the children by having them line up again, this time carrying an object which indicates whether or not they travel by bus. For the bused children, this could be their bus drawing; for the nonbused children, it could also be their bus drawing but with a black ribbon stretched diagonally across it, thereby indicating that they don't travel by bus. These pictures can then be matched one-to-one on two lines strung across the room. Appropriate discussion about the 'graph' can then be undertaken to consolidate notions of 'more than', 'fewer than', etc., with the flexibility being afforded for more advanced children to enrich the topic by finding out 'how many more'. For the slow learner, the fact that his drawing 'counts' as 'one', no matter what the quality of his drawing, should provide motivation for him to participate in this experience.

Such early experiences with one-to-one matching and graphing can be extended upon as children classify various objects. By utilizing an appropriate grid system, children will get used to one-to-one correspondence and know that only when objects or pictures of objects are properly placed in the grid will the longer 'line' indicate the greater number of objects. By such attention to one-to-one correspondence, valuable prerequisite number experiences are being fostered.

The transportation theme can be extended with a bus visit to an airport, if accessible. Even if this is not possible, children's sense of flight can be activated by the making of model airplanes. Paper planes can be made easily by children. Folding a sheet lengthways in half and then making triangles will initiate construction while surreptitiously getting in a bit on fractions and geometry. Models can be coloured and named, if thought appropriate. A trial run can then be arranged to determine the flying range of each plane after the teacher makes sure that all planes are 'air worthy'. Large numerals can be assigned to determine the order of starting. By holding up the numeral, a 'pilot' can be told by the teacher to go first if he has 1, second if he has 2, etc.

After these trial runs, the teacher might ask what could be done to make these planes fly further. By trying various weights in their planes, the children are actively experimenting and structuring their thinking about the situation. In the case where planes are reaching comparable distances, the children might suggest ways to determine which plane made the longest flight.

Obviously, such a unit can go on for a long period of time. However, while other interests have to be explored, it is important that children be given time to complete individual tasks in which they are motivated. Maria Montessori (1972) makes an interesting observation of a little boy of 2½ who was unable to view toys in a basin of water around which bigger boys had gathered. After trying in vain to obtain a vantage point, he looked around and spied a chair. Obviously hit with the idea of carrying the chair behind the group and mounting it, he moved toward the chair. Before he could complete his act, however, the teacher seized him in her arms and lifted him up to see the toys in the basin. As Montessori explains:

> The teacher prevented the child from teaching himself without affording any compensation in return. He had been at the point of experiencing the thrill of victory, and he found himself borne aloft by two arms as if he were powerless. The expression of anxiety, hope, and joy which had interested me so much faded from his face, and was replaced by the stupid expression of a child who knows that others will act for him. (pp. 53-54)

As this example so well illustrates, we must allow children to think independently, to structure their experiences, to think creatively. Obviously, this requires us to be more accepting of their level of thinking and more restrained in the 'help' we all too often foist on children.

Utilizing Art and Music

The use of the thematic approach, illustrated in our transportation example, affords us perhaps the best possible means by which we can focus on the readiness skills of the slow learner. In addition, however, if we are to ready the slow learner for those perceptual experiences which will help develop his intellect, we must utilize the natural domains of art and music in a systematic fashion. Finger-painting, colouring and drawing how objects look to him will give us much evidence about the intellectual functioning of the slow learner. To the extent that we have him make pictures and colourings which others can interpret and appreciate, we bring him that much closer to the symbolic world of the school.

Similarly, the domain of music offers a natural means of expression and a ready avenue for learning. Rhymes such as:

> One, two, three, four, five;
> I caught a hare alive.
> Six, seven, eight, nine, ten;
> I let him go again,

can do much to build the rote counting skill which might have been absent from the slow learner's preschool experiences. By putting such rhymes and other nonsense lyrics to music, we build up those skills which the school so often expects beginners to have. Significantly, this learning can be promoted in a manner which is nonthreatening to the child and which does not admit of peer comparisons.

Perhaps we can best take our cue from Hodges et al. (1971) who point out that:

> . . . compensatory education probably cannot afford the luxury of nonacademic activities as ends in and of themselves. It is all right for middle class nursery and

kindergarten children to learn to appreciate (and, within their capacities, produce) art and music for personal enjoyment. But for disadvantaged children, these activities should be both enjoyable and generally acculturating and should carry an extra burden of instruction in such areas as language and motor skills. This double agenda should not be accidental, but well planned, clearly formulated, and consistently carried out. (p. 114)

SECTION C

THE KINDERGARTEN MATHEMATICS PROGRAM

1. Prebook Experiences

> The true cause of failures in formal education is . . . essentially the fact that one begins with language (accompanied by drawings, fictional or narrated actions, etc.) instead of beginning with real and material actions. (Piaget, 1973, p. 114)

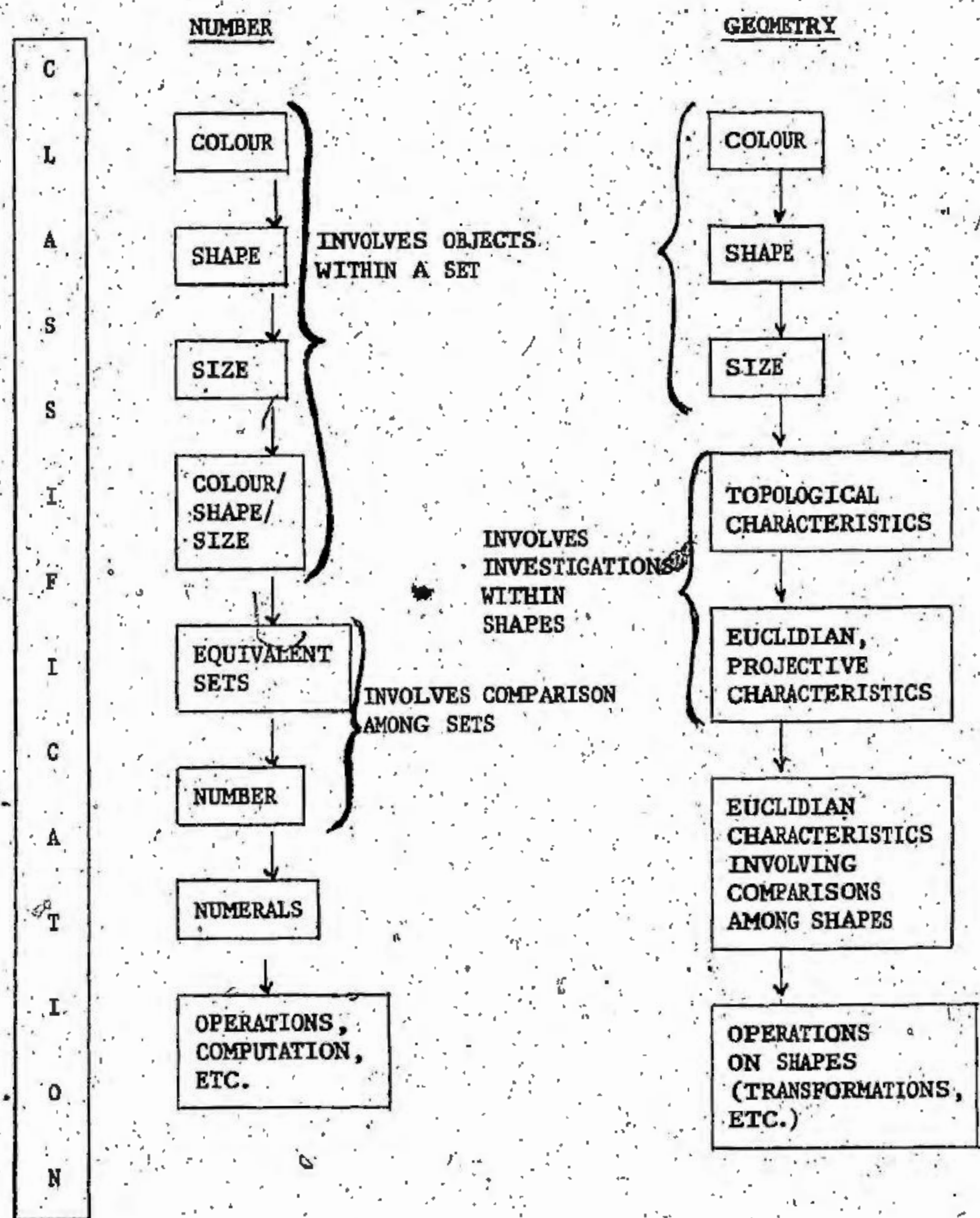
Fortunately, 'real and material action' is central to the Investigating School Mathematics series. As noted in Chapter I, the investigation phase of the five-point teaching strategy advocated by the authors is the core of each lesson and should be closely adhered to if we are to realize the objectives of their program.

In keeping with the findings of Jean Piaget, the Investigating School Mathematics authors suggest a natural introduction to the world of mathematics. Thus, for the first five or six months of schooling, concrete experiences should be the order of the day. To promote this goal, a number of prebook activities are contained in the teacher's primer edition. These are designed to develop children's mathematical awareness and, as the program authors note, ". . . will help the children become adjusted to the school environment and to the degree of formality conducive to participation in group activities" (pp. 6-7).

Six prebook activity areas are delineated for the teacher: recognition of shapes; developing visual memory; following directions; ordering, classifying and comparing sets; and discovering patterns.

Teachers are well advised to use these activities since for many potentially slow learners the precise sensory judgments they involve have never been called into play before. In addition, these activities help children develop vocabulary in a natural setting while simultaneously fostering an intuitive understanding of basic mathematical concepts.

The following classification adopted from Dr. F.T. Riggs (1974) substantiates the necessity of our delaying the symbolic presentation until appropriate prerequisites are met.


CLASSIFICATION
NUMBER
COLOUR
SHAPE
SIZE
COLOUR/ SHAPE/ SIZE
INVOLVES OBJECTS WITHIN A SET
EQUIVALENT SETS
NUMBER
INVOLVES COMPARISON AMONG SETS
NUMERALS
OPERATIONS, COMPUTATION, ETC.
GEOMETRY
COLOUR
SHAPE
SIZE
TOPOLOGICAL CHARACTERISTICS
EUCLIDIAN, PROJECTIVE CHARACTERISTICS
INVOLVES INVESTIGATIONS WITHIN SHAPES
EUCLIDIAN CHARACTERISTICS INVOLVING COMPARISONS AMONG SHAPES
OPERATIONS ON SHAPES (TRANSFORMATIONS, ETC.)

Attention to this hierarchy within the physical resources of the kindergartener's world can make for very enjoyable and cognitively comfortable conceptualization in the realm of mathematics. As Dr. Riggs points out, classifying according to shape and size can be very pronounced as with triangles and squares or very minute as with different shaped utensils, toys, leaves, books, etc. Thus, even as a hierarchy exists from colour to numerals, there exists a range within each category which progressively leads the learner to finer and finer discrimination, an ability which will in turn pay dividends once the symbolic world of mathematics is introduced.

Such experiences are particularly necessary for our disadvantaged children who often have not had sufficient experiences with the materials which make up the world of the kindergarten program. If such children are to conceptualize number in its true sense, they must have a wealth of experience in classification so that the distractions of configuration can be overcome. By giving such attention to the learner in this hierarchy, we can appreciate the necessity of delaying the symbolism of mathematics which, if imposed too early for the disadvantaged in particular, will not only be conceptually futile but cognitively and emotionally frustrating.

Of course, many of the social experiences of the kindergarten program are 'naturals' for developing such concepts as one-to-one correspondence, comparisons and the like, and should be capitalized upon. Indeed, almost every 'subject' area of the kindergarten program provides opportunities to group and count objects. The well-ordered classroom where all objects are assigned appropriate places is a conducive to promoting the orderliness which is mathematics. The matching of straws to drinks, of cups to saucers, of 'drivers' to toy trucks, of colouring sheets to children in a row are all valuable prenumber experiences. However, it is important that these experiences be in keeping with the child's intellectual development and consistent with the concept development concerned.

A common activity adaptable to a range of intellectual growth is block building. At the first level of play, children build towers until they topple. At a later stage of development they begin to let their blocks represent objects such as garages and roads. This stage is thus conducive to the spatial organization of several objects or the organization of a sequence of activities.

During these activities children compare blocks to select those suited to their purposes. Creativity is natural in this setting, with divergent thinking being fostered as children represent many different things with the same blocks. Moreover, block building provides a comfortable setting in which social development can be fostered with peers. Even clean-up time can promote classification skills if long blocks are placed on one shelf, cylindrical ones on another, etc.

In geometry, too, we can more appropriately attune ourselves to the intellectual development of our kindergarteners if such topics as closure, proximity, separation and simple ordering of objects are investigated first. Such experiences are within the capacity of all kindergarten children and as such allow for many meaningful success experiences.

While these concepts can be developed in a physical setting, the use of familiar materials, however, can help dramatize the situation and allow for many fun activities. By using a piece of broken balloon for example, children can experience how it is impossible to stretch the balloon to release the tiger (X) from inside its cage (simple closed curve), i.e., put him on the outside. To extend this, children can experiment with trying to open the cage on a rubber surface through stretching (no tearing allowed).

The use of elastic thread with coloured spots painted on it can highlight vividly the order relation along a path, i.e., if a red car, a yellow car and a blue car are in line, the yellow car will always be between the red car and the blue car although their relative distances might change through stretching or contracting. Intersections, too, can be shown to remain intact no matter how the roads are 'reconstructed' through pulling and pushing.

Special care should be taken to develop the language of mathematics throughout these experiences. This language must be learned early if children are to function successfully in our prescribed mathematics program. This is particularly true of such words as 'over', 'on', 'in front of', 'between', 'around', etc. which have to do with following directions. By having various sets of children stand inside, outside, or on hula hoops on the playground, gym or classroom floor in accordance with hair colour, type of footwear, etc., we initiate the conceptualization process through the child's using his own body to experience the concept. Following this, objects such as toy cars or dolls can be used by the child to extend his conceptualization to objects. Thus, toy cars can be placed in or out of a garage or on the road. A doll can be placed in or out of its cradle or on the floor. To further assist children, the teacher verbalizes what they do as they do it and subsequently gets the children to verbalize as well. This can be done during the lesson but, more importantly, should be reiterated after the physical experience so that conceptualization is assisted.

In summary, then, the prebook activities of the kindergarten program offer ample opportunities for many success experiences for all learners. Such experiences are important not only in being prerequisite for success in the subsequent book activities but also in the confidence they build up in the child as an effective learner. As Piaget (1973) notes, the cognitive and emotional are inseparable. Indeed, the 'blocks' many adults have towards mathematics are often the result of the failures they experienced in having indistinguishable ready-made knowledge forced upon them.

2. The Primer Text

The mathematics of the primer text is divided into two units, P and R. Unit P, concerned with prenumber activities, is divided into three modules which deal mainly with comparisons, classification and one-to-one correspondence. Such a sequence of presentation is very much in keeping with the manner in which children structure their world and as a consequence should be given careful attention. Unit R begins work on number.

It is very important that work in the text not be begun until the children have had many readiness experiences. As listed by the authors (p. 17), children should be able to (1) sit and listen to a story and then participate in a discussion of the story in an orderly fashion, (2) carry out simple one and two-step direction, and (3) do simple colouring and drawing.

The transition from physical experiences to work on the printed page must be carefully planned for the slow learner in particular. It can well be argued that the stronger the child's base in physical experiences the greater facility he will have in making this transition. As such, then, to postpone work in the primer text until the latter part of the kindergarten year is highly advisable and well in keeping with good intellectual developmental theory.*

The preparation phase of the five-point teaching strategy advocated in the Investigating School Mathematics program is of paramount importance at this level. The concrete to semi-concrete (pictorial) transition should be made as natural as possible. Thus, whenever feasible, objects should be handled before questions about pictures of these objects are considered. In this regard, many pre-book activities are suggested which should be capitalized upon, e.g., the sorting activity suggested on page 30 of the guide will help children structure the concept of 'set' before they begin page 13 of their text. Moreover, the transition to the printed page will be facilitated even more if toys of the text objects are available and if magnetic or flannel board representations exist which can be grouped.

*In this respect texts should not be given to children when they are purchased in September. Rather the texts should be kept by the teacher who gives out perforated pages at the appropriate time. In this manner, the teacher will avoid undue pressure to do "the book" from both children and parents.

In addition, the Big Book which accompanies the primer program should be used to ease the transition from the physical to the pictorial level.

The use of the Big Book can highlight the demonstration art at the beginning of the lesson. Thus, although there are no written instructions at this level, it is important that we encourage children to 'read' this demonstration art. Focusing on these directions will help children structure the activity which is to follow as well as allow the teacher to ascertain whether or not children know what's expected of them in the text page activity. Of special benefit, moreover, is the opportunity it provides us to assess pertinent entry level behaviours of children, e.g., whether or not they know how to circle the picture of an object.

In like manner, experiences with 'provoked correspondence' should be given with real objects before children begin work on one-to-one correspondence in the text. Matching cups to saucers, bottles to bottle covers, toy drivers to toy trucks, buttons to button holes, etc., can help establish the one-to-one correspondence relationship which is developed from page 37 to page 46. Such matching can be fostered through sociodramatic play and by capitalizing on the various correspondence situations which arise naturally throughout the school day at recess and project time. It is most important, however, that we remain sensitive to the learner's experience, e.g., for some children the matching of frog to lily pad suggested on page 37 or frog to insect suggested on page 38 might not be provoked by children who do not have knowledge of frogs.

The discussion phase of the five-point teaching strategy allows us to clear away ambiguities which might have arisen during the investigation part of the lesson as well as structure the concept under consideration. It is important that this discussion not be teacher dominated. Indeed, children should be encouraged to listen to one another so that they can appreciate how their peers interpret a particular investigation and thereby be encouraged to decentre their thinking.

Unit R begins with the introduction of the numbers 1 to 4 in a very natural manner, i.e., not dependent upon the counting process. This is well in keeping with the fact that most children are able to recognize the number of a set containing four or fewer objects. These exercises thus become a bonding of the number words to the sets and as such are easily mastered.

The introduction of '5', however, signals the advent of counting skills. To ensure that all children are able to engage in rote counting, many number songs and stories should be provided. Old standards such as The Three Pigs, Goldilocks and the Three Bears, and Snow White and the Seven Dwarfs should be read and dramatized. In addition, familiar songs such as "Ten Little Indians" and "This Old Man" together with many number rhymes, can make the learning of this rote process more enjoyable.

Once again, the physical should be utilized to build appropriate initial experiences. As such, children should be encouraged to use the kinesthetic feedback from their bodies to make number-word associations. For example, having steps for children to climb while they say the number sequence can help bond the one-to-one correspondence of a distinct action, i.e., climbing one step, to mouthing a number word. Besides, the use of such a vertical 'number line' will capitalize on the natural interests of kindergarten children who seem obsessed with height.

To extend this kinesthetic feedback to the enumeration of concrete objects, children should be instructed to touch each object as they say a word of the number sequence. Since children now know groups of 1, 2, 3, and 4, these groups can be counted and children made to realize that the last number word in the sequence they employ with one-to-one matching will in fact name the number of elements in the set. With this association, counting to 10 objects is quickly mastered.

The skill of counting is one of special interest and value to kindergarten children. Hence, we should take pains to ensure that they can all count meaningfully. Thus, pushing objects to one side as they are counted might prove a valuable technique for some children. For others, the use of finger counting should be encouraged. Indeed, fingers can be very beneficial to the counting process since in effect they are personal 'counters' which can be moved at will. A child's dependency on finger counting most often signals his dependency on the concrete and as such should be encouraged if we are to promote meaningful growth in the intellectual domain.

In essence, the primer program should allow children to develop their mathematical skills in keeping with their intellectual development. As such, concrete representations must be fostered for the slow learner in particular. However, it is important that the materials we use are familiar and natural to the child. In this respect, the primer text's use of coloured strips is very questionable indeed and should be omitted. Besides, the use of the 1.5 cm by 1.5 cm strips conflicts with the strips available from School Supplies for the Grade 1 program.

The train concept being promoted is nonetheless a valuable one in that it dramatizes the association of the counting sequence to the number of the set, i.e., size of the train. However, the use of unifex cubes or the centimetre cubes supplied to schools by the Department of Education to assist in metrication would seem more suited to the manipulation capacities of the young child. In addition, the coupling and uncoupling of the 'cars' gives the kinesthetic feedback we want to encourage as we promote the concepts of addition and subtraction.

However, no matter what experiences we design in keeping with his intellectual growth, our main emphasis must be upon the child and how he feels about himself as a learner. To the extent that we design appropriate mathematical tasks for him to master, promote his counting skills and his knowledge of number, we allow him to compete effectively in the intellectual enterprise of mathematics and as a consequence simultaneously boost his self-concept.

SECTION D

THE GRADE I PROGRAM

The first part of the Grade I year should be closely aligned to the experiences which kindergarteners have had during their first year of schooling. In keeping with this, the Grade I teacher must be very familiar with the kindergarten program and, in particular, with the type of experiences her new pupils have had.

Emphasis is still primarily upon physical experiences with meaningful manipulatives. That this should be the case is not only out of consideration for the slow learner but in keeping with what research tells us about how children learn best in what Piaget terms the pre-operational stage, a stage in which most Grade I children are. Thus, children should classify and discuss that which is familiar to them: balls, bottle caps, kitchen utensils, toy cars, etc.; they should match scissors and children, cups and saucers, shoes and socks, toy cowboys and toy horses, toy drivers and toy cars; they should make visual inspections relative to which of two pupils has more crayons, toys, etc. In addition, they should revisit the wooden blocks and coloured rods which they were introduced to during the kindergarten year. In the main, then, we must continue to dwell upon that physical world with which the child is both familiar and comfortable.

Fortunately, the Investigating School Mathematics program makes provision as well for the linking of the kindergarten and Grade I mathematics program by revisiting the primitive number concepts which were explored in detail during the kindergarten year. In this way many of the children who appeared to be 'slow learners' the previous year get a second chance to experience success in the mathematics world of the kindergarten year. As so often happens, the process of maturation, together with the assimilation and accommodation which took place during the summer months of those types of experiences which children perceived as important to the teacher, result in an increased ability to handle the mathematics symbolism of the printed page. It goes without saying that such improvement should be rewarded appropriately so that a success spiral can be initiated for all learners.

The formation of numerals in the Grade I program, however, signals a new emphasis on symbolism. Prior to this, the formation of numerals was a part of the printing lesson and not dwelt upon in the presentation of the kindergarten book program. However, beginning with the Orange Module, Unit A, the association between the number of a set and the writing of its numeral is highlighted.

Since children often perceive correct numeral formation as success in mathematics, the formation of the numerals 0 to 9 should be given careful attention. Thus, as we do in our printing lessons, we should begin with the gross motor skill of forming the numeral 'in the air'. Large models should be presented for children to copy. Such models should be colour-coded to indicate starting and stopping points. For example, the numeral 5 should be appropriately marked to indicate not only the two independent actions being utilized but also the beginning and end of the formation. Subsequently, children should trace the different sized models of the numerals with their fingers and pencils before forming the numerals on their papers. In this way, children are initiated into writing numerals in an appropriate manner. By so doing, we help ensure that this symbolism will not be a source of continued anxiety for the child whose lack of experience with numeral formation causes him to make reversals all too frequently--action which leaves him vunerable to 'correction' from others.

While it is important that we attend to this symbolism of mathematics from the affective point of view, we must, nonetheless, devote our energies to the cognitive domain. Fortunately, the Investigating School Mathematics program is well suited to our purposes with its emphasis on a five-point teaching strategy.

The central feature of this five-point teaching strategy is the investigation phase. Here the nucleus of a concept is explored. For example, in introducing the idea that various combinations can be used to form sets of the same number (Yellow Module, Unit B), the child is presented with an imaginative activity. Here the child is challenged to find how many ways he can use four brown circles and four yellow triangles to 'hide' five mice pictured on his page. The activity is not only interesting but allows for differing correct responses as well as providing us with a good setting in which to diagnose abilities and learning modes.

It is difficult to overemphasize the importance of the investigation phase of the five-point teaching strategy of the Investigating School Mathematics program. By building in this feature as an integral part of the program, the authors are ensuring that we attend to the essential ingredient of concept formation, mainly experience with the concrete world. Such experience, moreover, is not restricted to the primary level but is promoted throughout all of the K-VIII program. Thus, by paying maximum attention to the investigation phase we are not only promoting meaningful learning but familiarizing our young learners with a strategy which they will be called upon to employ throughout their school years.

It is important, however, that we ensure that our investigations are meaningful. Thus, the objects to be used must be familiar to the child, either from preschool experience or from a free exploration activity provided by the school program. Workjobs and Mathematics Their Way by Mary Baratta-Lortan suggest many excellent investigations with familiar materials designed to 'turn children on' to meaningful mathematics experiences.

This adherence to utilizing the familiar will make it necessary to substitute for some of the activities suggested in the Grade I text. Thus, the use of number strips in an investigation may often be inappropriate with the slower learner who needs to consolidate a particular strategy. If he has been utilizing only discrete objects, the train concept promoted by the strips may often lead to confusion and as such will tend to frustrate rather than facilitate concept formation.

In essence, then, we must make our investigations as motivational and as relevant as possible. By so doing, we initiate discussion upon the investigation. Such discussion will be meaningful and valuable only to the extent that the investigation allows.

Discussion of the investigation, as Jean Piaget points out, is necessary to good concept formation in that it helps us structure the concept being explored. In addition, discussing what children have all had a chance to experience allows for attention not only to the task at hand but on how others perceive it as well. Thus, children are helped to decentre their thinking through their interactions with the teacher and other children regarding an activity which they all have in common.

If children are familiar with the materials being used, they should all experience some degree of success in the investigation phase. Such success can easily be ensured by the teacher's praise and encouragement of each child's action during the activity. In this way, the teacher has an excellent opportunity not only to undertake meaningful diagnosis but to build up each child's confidence in his ability to interpret the world of mathematics.

We should endeavour, too, to make the investigation phase as unitary as possible. Thus, with the example discussed previously on number combinations, the investigation can be followed up with a similar activity involving other combinations (as suggested on page 94 of the Teacher's Edition). In this way children are given a second chance to demonstrate competency and to experience success in the field of mathematics.

While it is necessary that each investigation be completed with a discussion of the activity, there exists as well a discussion section relating to a picture in the child's book. These pictures in the main relate to practical everyday situations which in themselves should be talk-provoking. However, for children who are not familiar with some aspect of the picture it will pay dividends to have related experiences integrated into the Grade I program. For example, the Let's

Talk section of page b-2 will be more motivational for those children who have played marbles and hopscotch and as such won't be distracted unnecessarily from the concept being promoted.

Even when children are familiar with the objects represented, there is no guarantee that they will be able to 'read' the picture of these objects. As a consequence, we should endeavour to provide training in this skill. In this regard, the use of a flannel or magnetic board is well suited to our purpose. Thus, following the combining of boys and girls to make groups of children, models can be used on the flannel or magnetic board. In similar fashion children might play the role of birds or other animals and have them represented in turn by models. For example, the addition of three red and two blue birds can first be demonstrated through children's action. Once magnetic or flannel models of birds are used the children then act upon the objects to form particular sets. In this way, we move naturally from the child to the object. The flannel or magnet board can then be used meaningfully for picture reading and serve as a valuable prerequisite to the picture interpretation of the Let's Talk section.

Our attention to the investigation and discussion phases of the five-point teaching strategy provides the foundation necessary for effective utilization of the concepts involved. However, it is mandatory that we view the phases as a continuum rather than isolated strategies. Thus, following the investigation phase of making groups of five children using different combinations of boys and girls, or making a flock of five birds using two differently coloured birds, we should proceed naturally to using objects representing the children or the birds and then to more symbolic embodiments.

In the case of the birds, say, after the models are handled by the children at their desks or on the appropriate display area, they can be replaced by pictures and subsequently by sketches and markings. Thus, a picture of three and two birds can be represented as:

and then:

/// //

and finally:

3 + 2

Attention to this concept continuum not only provides us with an effective strategy but allows us ample time to diagnose prerequisite skills. In addition, the focus on small steps allows us to attend to aspects of the learning process which we all too frequently overlook. By assessing the skills and the subskills required for the mastery of a particular concept we are more likely to diagnose accurately difficulties which tend to hinder efficient conceptualization.

Our attention to the concept continuum with our slow learners dictates that we concentrate more on a single strategy until it is mastered. Thus, the use of the number line should be sequentially introduced only after children have been provided maximum exposure to real life experiences of the concept through the use of discrete objects.

Before addition can be anyway meaningful to the child on the number line, he should be exposed to a number of physical activities. Thus, the vertical number line of steps would seem a natural starting point for the child. Following this, 'steps' can be taped to the floor to designate distances from a starting position. By having children climb three steps and then go up two more they are being provided with the kinesthetic feedback so essential to the counting process. In turn, being on the fifth step regardless if he takes one step and then four or four steps and then one should alert him to the addition combinations.

Similarly, two jumps from home base and then three jumps in the same direction will help dramatize the action element of addition and number line usage. The child can then replace his body by toy animals which 'jump' from one step to another. Thus, a toy frog can be used to extend the number line concept outside the child. It then becomes a very small step to translate this action on a chalkboard and subsequently to the printed page.

Similarly, if coloured strips are to be used, a definite sequence should be followed. Thus, coloured rods should first be handled in a free play situation. There is much merit, moreover, in having children make their own rods with the centimetre cubes already in our schools from the introduction of metrication. As such, two red cubes can be joined to make a '2' train which is then exchanged for a red rod or strip. In like fashion, other trains can be built to give the rods and/or strips more meaning.

As already mentioned, however, it is essential that the use of the coloured strips not interfere with the conceptualization process. In fact, it is perhaps best that we substitute the coloured rods for the strips since they are not only more durable but more in keeping with the child's ability and interests. Even with the rods, however, we must take care that we do not jump around too much. Thus, a lesson which attempts to use common everyday objects together with the number line and coloured rods is apt to confuse the slow learner rather than aid his conceptualization.

As always, we must attempt to utilize the familiar to help accommodate new information. This being so, it would seem natural that we secure conceptualization with discrete objects with which the child is familiar before branching off prematurely into the world of number lines and coloured rods.

Our attention to the conceptualization process with its foundation in the physical domain necessitates that we omit a sizeable portion of the Grade I book work. Fortunately, this can be done quite easily without depriving children of the necessary core learnings. Thus, in Unit B we can substitute for the Dark Green Module, thereby omitting b-53 to b-64. In Unit C, we can easily omit c-27 to c-35 and c-45 to c-64. And in Unit D we should omit d-25 to d-64. In total, then, we can free our slow learners from 81 text book pages, thereby allowing for greater emphasis on more important and relevant experiences.

Some of the material suggested to be omitted contains work with money, time and fractions. However, it is the considered opinion of many teachers that these concepts be dealt with away from the printed page. Money, for example, lends itself to a sorting and counting activity involving real coins. In addition, it integrates naturally into a canteen activity where children are encouraged to provide the correct amount of change for selected items.

In similar fashion, the concept of clock time is not something which lends itself to coverage on a number of textbook pages. Rather, it is best covered throughout the school year as we sensitize children to specific times: beginning of the school day, recess, lunch, etc. Moreover, it lends itself well to a very practical activity with a circular face, such as a pie plate, around which we can wrap a 1 to 12 number line. In addition, it integrates well with beginning work on fractions in that half our number line or plate designates one-half hour.

Initial work on fractions, like money and time, is best done away from the printed page and perhaps away from the numeration process. For example, the art lesson where children are folding and cutting things out to make models can be an invaluable opportunity to introduce fractions in a natural, meaningful way. The fact that a child can't make his 'halves' fit one another indicates that he didn't make a proper fold or cut. Through such experiences the child begins to handle fractions appropriately with a definite purpose in mind.

Work with ordinal numbers and the calendar are also omitted from the book pages. However, the authors do suggest a strategy similar to that mentioned above, i.e., capitalizing on the natural interests of children as they line up or anticipate various holidays and birthdays throughout the year. As mentioned previously, we must be constantly on guard to capitalize on those teachable moments which are apt to be bountiful when we use a thematic approach which thereby integrates a number of subject areas.

The omission of the measurement section is not meant to downplay the importance of this topic. However, since the STEM program does a better job of introducing this important concept, it would be best covered there. In fact, many of the activities of the STEM program lend themselves to integration with our mathematics course. For example, the world of shapes is introduced very naturally and interestingly through work on solids in Level I, pp. 94 to 111. Following manipulative experiences, the transition is then made to the two-dimensional world of triangles, circles, rectangles, etc., through projecting shadows of 'mystery' objects on a screen. Such an activity is not only interesting but instructive as well.

While integration is the overriding strategy for meaningful coordinated learning, there is much benefit to be gained from promoting mathematics and science in their own right. Thus, we should provide for a mathematics/science corner in which children can play with geometric solids, put together common geometric shapes to copy interesting designs, 'fish' for numerals with magnets, 'make' numerals on a hand-held calculator by pressing the appropriate buttons, measure their heights in relation to a chosen standard, etc. Provision for these activities not only heightens interest in mathematics and science but also provides an opportunity for the consolidation of concepts to which children may need further exposure.

In summary, the Grade I program must be integrated as much as possible with the other subject areas to provide for the exploration of various themes and the completion of pertinent projects. Its foundations must be in the real object world of the child and must build upon the experiences and strengths that he possesses.

To the extent that the slow learner may be experientially impoverished we must provide for compensatory activities—activities which in giving children valuable experiences simultaneously provide us with an excellent evaluation tool to diagnose the child's ability. In so doing, we can build meaningfully on the child's store of mathematical experiences and, through formative evaluation, promote the development of those power skills so essential to later progress in mathematics.

SECTION E

THE GRADE II PROGRAM

The greater symbolism of the Grade II program requires increased vigilance on the slow learner. Even if he has had a meaningful introduction into the symbolic world of mathematics during the Grade I year, it is essential that we keep his experiential foundation broadening and his intellectual development level under constant evaluation.

In attempting to build upon the Grade I program, however, we must be careful that we do not proceed too quickly. For example, the Yellow Module of Unit E should not be glossed over. If anything, we should exceed the time suggestion for this section. After all, we need to initiate our children once again into the five-point teaching strategy of the Investigating School Mathematics program. Besides, this module, which is review in nature, not only allows for many success experiences but also provides us with a convenient opportunity to diagnose the strengths and weaknesses of all our students, and in particular our slower learners.

For many slow learners it will be necessary to revisit the early conceptualization levels of the Grade I year. In the case of place value, for example, we should initiate the concept continuum by having children group into tens. They can subsequently be replaced by squads of toy soldiers and garages holding toy cars, etc. Since our game requires a squad of ten soldiers and a garage of ten cars, we can evolve a marking system of 'tenness' which lends itself to concrete, pictorial and symbolic representation.

The important ingredient in the above evolution from the concrete to the symbolic is the action the children perform. Thus, in our place value example, children should actively group their soldiers into squads. Initially, this grouping can be done with models. However, to expedite the grouping process, our models should subsequently be replaced by popsicle sticks or rods. These, then, can be counted out in squads, or tens, and bound with an elastic band. This counting out and binding process provides excellent sensory feedback which is so essential to proper concept formation. Moreover, the use of sticks allows for easy pictorial representation which can in turn be represented symbolically by tally marks, and then by decimal numeration.

Having journeyed along the concrete-to-abstract continuum, it is essential that we try to provide concrete evidence of how our concept relates to real life. Level 2 of Stem Science suggests such an example on page 16 of the pupil text. This Halloween activity of counting pumpkin seeds is the type of application which is not only motivational in its own right but which also lends itself to integration with a number of related activities encompassing other 'subject' areas. Indeed, the Halloween, Christmas and Easter seasons readily lend themselves to an integrative approach which not only captures the attention of children but also shows the applicability of the symbolic world to the 'real' action world of the child.

Our attention to this 'real' world dictates that we continue to provide meaningful experiences—the type of experiences which are bountiful in the Stem Science program. This being so, we should strive to integrate Investigating School Mathematics and Stem Science whenever possible. At times it might even mean substituting one for the other. For example, the measurement section in Level 2 of Stem Science is more developmental in its approach as well as being more activity oriented. As such, it would seem preferable to replace the Light Green Module of Unit F with this more appropriate section.

The child's dependence on the concrete at the Grade II level should be nurtured fully. Counters and the use of fingers as aids should be admissible in every Grade II classroom if we are to attune ourselves meaningfully to the thought levels of our children. In addition, physical models should be utilized as much as possible. Geoblocs, geoboards, and rubber material for topology should be integrated either into the mathematics program or be utilized as fun activities in themselves. Such experiences can do much to sensitize children to the world of shapes prior to symbolic presentations on the text page. In this way the slow learner in particular can identify with a section of mathematics which, if introduced and presented properly, can be both rewarding and stimulating.

Relative to concept formation, however, it is important that we do not overstimulate the slow learner with too great a variety of embodiments of a concept. Thus, the use of the number line and coloured rods, or strips, together with other physical representations of a concept may overwhelm a child to the point of confusion, particularly if he is not comfortable with the material suggested.

Formative, i.e., on-going, evaluation must as a consequence predominate the assessment of all children at this level, as it did in kindergarten and Grade I. In this way, if a slow learner is still at the exploratory stage with the coloured rods, he should not be exposed to this material as an 'aid' when a new concept is being introduced. Rather, we should look for a physical model with which he is comfortable. In the case of sums to 18, for example, this might be the use of his fingers. Here, then, we promote the 'counting-on' technique to aid his power skill development. The fact that he can arrive at the correct sum just as efficiently with this technique as his fellow students can with their use of strips or number lines gives the slow learner confidence in his own ability and promotes his self-worth.

Of course, it is important that all children have access to the coloured strips, or coloured rods, and the number line at given times. However, there will certainly be a wide range in the manner in which these aids are used. For more advantaged children, the exploration of a concept with strips/rods and number lines can prove very motivational. For slower learning children, however, these strips/rods and number lines are utilized more for building their concrete reference base.

Attention to the intellectual functioning level of the child dictates, in particular, that we individualize our mathematics curriculum. Fortunately, this can be done quite conveniently with the Investigating School Mathematics program. Its five-point teaching strategy admits of a variety of experiences for all children while zeroing in on a particular concept.

As discussed in Section D, the investigation, and the discussion of that investigation, can permit a variety of responses while invariably allowing for some degree of success for all. In this respect, then, it is best that all children, advantaged and disadvantaged alike, be exposed to this initial experience both in manipulation and in discussion. In this way a common bond relative to the concept is established. Thus, the slow learner witnesses that he begins work on three-digit numbers, say, simultaneously with the rest of his class, albeit they will eventually be using different materials and exhibiting varying levels of conceptualization.

It is in the utilization phase, then, that the evidence of individualization is most pronounced. Fortunately, the pages of the Grade II text are perforated, thereby allowing us to present utilization work in varying amounts. For example, since the number line and the coloured strips or rods are commonly employed in the utilization pages, it is easy to omit these pages with slow learners and concentrate on the use of the other manipulatives of the module such as popsicle sticks and counters.

In this manner, then, we can attend to the child's level of conceptualization without forcing him to use materials or deal with symbolism which may hinder him. Simultaneously, moreover, we are allowing him to experience success both in his cognitive development and his affective functioning.

No matter what the method of utilization, it is well in the interest of both the affective and cognitive domains that all children frequently be brought together at the end of a lesson. In this manner the class which began work together on a concept, and discussed their initial findings following the investigation, have the opportunity of further meaningful interaction. This recapitulation stage affords the teacher the opportunity to highlight the concept and provide successful feedback to the class and the slow learner in particular. By eliciting answers from the slow learner, albeit at the very initial stages of the concept, we are allowing him to contribute to the lesson and simultaneously to the class. In like manner, by allowing the slow learner to witness the symbolism of the concept at a higher level than he has experienced during the lesson, we are helping to motivate him and to get him ready for a later stage of the concept continuum.

The last phase of the five-point teaching strategy, the extension or follow-up phase, should also be employed for further individualization. While this phase may be enrichment, it is most often another look at the concept—a review which is often linked with some activity. For example, an abacus is suggested for use following work on three digit place value. By having children move the beads along the wires to represent various numbers, they get reinforcement relative to the place value concept in a new and kinesthetically appealing manner. Often this new embodiment of the concept is just the stimulus required to facilitate the slow learner's conceptualization.

All in all, then, the five-point teaching strategy of the Investigating School Mathematics program is well suited to the creation of a truly individualized program. By attending to the child as an individual in domains in addition to that of the intellectual, we can focus on the learner as a complete being. Such sensitivity is what the slow learner needs if he is to avoid being victimized by the symbolism of the mathematics text.

By adhering to the presentation of a single concept at a given time rather than allowing children to progress from page to page in a helter-skelter fashion, we provide greater opportunity for integration with other subject areas. In addition, by striving for novel embodiments of a current concept, we can enrich the mathematics corner. Such a corner should have manipulatives, models, etc., which are easily accessible for children to interact with at all times. The kinesthetic, tactile, visual and auditory stimulation which can be provided from such a teacher- and student-created centre can yield a variety of benefits. Indeed, the experience of interacting with these materials in a free play situation with other pupils is often the essential ingredient in making a new concept for the slow learner 'his own'.

No matter how effective we are in promoting good conceptualization, it is a fact that our slow learners will often need extra time with certain sections of the prescribed program. To provide for such time, there is a sizeable portion of Book 2 which should be omitted. For example, g-35 to g-62 and h-39 to h-62 need not be mastered at this level. Thus 52 text book pages can be discarded immediately. In addition, other sections of the text can be replaced by more activity-oriented presentations. For example, the topics of money and time are best done in a social context throughout the year, thereby eliminating e-25 to e-40. Similarly, geometry lends itself to cutouts, geoboards and models and only subsequently to work on a printed page. Fractions, too, are best handled through free time experiences with solids which are shared or cut.

It is essential, however, that these important topics not be neglected. What is being suggested here is simply that the text book presentation is not appropriate at this level for many young learners, and in particular the slow learner. It is important, then, that we substitute suitable experiences with respect to geometry, money, clock time, fractions and calendar time. Since pictures will not suffice and may indeed tend to confuse and frustrate, we must approximate as closely as possible real life situations--those situations which are presented as real life problems, e.g., the problem of sharing an apple equally among four children; of verifying that a pizza has been cut into three equal slices; of providing the correct amount with two coins to buy something costing 35 cents; of determining the solid which cast a particular shadow. These are the situations which not only provide for appropriate experiences but which by their motivational nature allow for true problem solving.

In summary, then, our attention must transcend the text book and focus on the slow learner in a manner which is cognitively and affectively rewarding for him. Our cognitive considerations must provide for a wealth of experiences with a concrete world which the slow learner can both know and appreciate. As well, we must adhere closely to a concept continuum so that we can help our slow learners develop their processing skills. In the affective domain, paradoxically, we need to resort to what so often is the cause of frustrated development, namely the text with its early introduction to symbolism. However, by utilizing the five-point teaching strategy advocated by the authors of the Investigating School Mathematics series, we can bridge the gap between the cognitive and the affective and provide a program which is both rewarding and stimulating.

SECTION F

OTHER RESOURCES

As mentioned in this guide, there will be times when teachers will find the suggested text material inappropriate for particular children. The Investigating School Mathematics authors recognize this fact and suggest an extensive resource list to help teachers meet varying needs.

Such resources, obviously, will have to be obtained over a period of time. In the meantime, however, every primary school should have Mathematics Their Way and Workjobs by Mary Baratta-Lortan. These excellent books are chockful of suggestions to make mathematics learning meaningful for the child with materials from his world.

In addition, every primary school should obtain the thirty-seventh yearbook of the National Council of Teachers of Mathematics. This resource, Mathematics Learning in Early Childhood, gives an excellent overview of the types of mathematical experiences young children should be encountering in our schools.

The National Council of Teachers of Mathematics has many other excellent resources for the primary teacher. Perhaps the most valuable of these is the Arithmetic Teacher. This journal, which is published monthly from September to May, should be accessible to all teachers since it contains many practical, exciting ideas not only from the world of research but also from the classrooms of successful teachers.

Mathematics Their Way and Workjobs can be obtained from Addison-Wesley (Canada) Ltd., 57 Gervais Drive, Don Mills, Ontario. Mathematics Learning in Early Childhood and the Arithmetic Teacher are available from The National Council of Teachers of Mathematics, 1906 Association Drive, Reston, Virginia, 22091.

SECTION G

CONCLUSION

The foregoing has attempted to delineate a strategy for dealing with the slow learner in mathematics. Basic to this strategy is the condition that the slow learner be in the regular class during the first three years of schooling in particular. Such a requirement allows greater opportunity for the slow learner to become normalized into the schooling process.

This process of normalization is an attempt to have the slow learner adapt to the cognitive world of the classroom. To expedite this adaptation process, every consideration must be given to the child as an individual. Thus, we take care to ensure that his first social contact with the school is pleasant. We attempt, in turn, to show that we want him in our class and that he belongs and counts as every other child in the class does.

However, since the school, even during the first three years, is predominantly cognitively oriented, we must take steps to ensure that successes are forthcoming in this area. Children, slow learners included, are very sensitive to the treatment they receive and of the expectations we have of them. As such, the challenge becomes one of integrating the slow learner into the regular subject offerings of the school.

Mathematics, in particular, is a natural for such integration. Its association with the intellectual development process allows us to tailor our instruction to varying ability levels. In this way, different abilities can be catered to, not through a different program but through varying degrees of abstraction.

This attention to the intellectual development process is one of the major attributes of the Investigating School Mathematics program currently in use in our schools. Its emphasis on a five-point teaching strategy centred upon investigation and discussion parallels the way in which learning theorists such as Jean Piaget suggest children make sense out of their environment. By making these two strategies an integral part of their lesson structures the program authors have gone a long way in ensuring that we attend to the needs and capabilities of each child, and in particular to the slow learner.

The use of concrete, meaningful materials, and the subsequent discussion of the investigation with these materials, allows for our attention to the intellectual development of the slow learner. In addition, if we look closely at the concept being considered and delineate a concrete to abstract continuum, we can attend to the processing skills needed by the child in order to experience success.

What we arrive at is a totally individualized program in which the externals of the program are very similar for all learners. Thus, all children are exposed to the same mathematical investigation with appropriate, meaningful materials. They all discuss this investigation. However, at the utilization stage we get a variety of applications depending upon how far along the concept continuum the individual child happens to be. Following this, nevertheless, the group once again combines to interact on the concept.

Thus, the <u>Investigating School Mathematics</u> teaching stragegy is easily adaptable to work with the slow learner. By emphasizing what translates into a thematic approach, we can concentrate on the core learnings of mathematics to ensure a measure of success for all children. And, what is of special importance is the fact that this can all be done in a manner which is not only cognitively successful but which is emotionally satisfying for the slow learner as well.

CHAPTER IV

SUMMARY AND RECOMMENDATIONS

Overview of Project

This project involved the development of a 'guide' to assist the teacher of slow learners in mathematics during their first three years in school. It was motivated primarily to alleviate some of the frustration experienced both by teachers and children alike in their attempts to cover the content of the present prescribed texts at the Kindergarten, Grade I and Grade II levels.

Both cognitive and affective domains were considered in providing a framework for the suggestions offered in the 'guide'. In the cognitive domain, the developmental theory of Jean Piaget and related research were utilized. In the affective domain, the child's self-concept was highlighted.

This focus on the child was featured throughout the 'guide'. Thus, emphasis was placed on the appropriateness of particular experiences to the child's cognitive and affective development. As such, the 'subject' of mathematics was often subordinated to the concept of the integrated day in which the teacher makes school meaningful and practical.

Relative to mathematics content, a core program was suggested for Kindergarten, Grade I and Grade II. Thus, in keeping with the overriding concern about cognitive and affective development for the slow learner, recommendations were made relative to the omission of a number of sections in the Investigating School Mathematics texts. In some cases suggestions were made to cover these concepts by means other than the printed page. In others, the recommendation was to neglect the concepts entirely since they were not core to that particular grade level.

In addition, a strategy was outlined to enable the teacher to individualize her teaching in dealing with a heterogeneous class. This was suggested in a manner which was cognitively and affectively in accord with the slow learner's ability and sensitivity. As before, reference was made to the Investigating School Mathematics program.

Suggestions from the Research Findings

The value of this 'guide' is found primarily in the approach it suggests. However, if we are to ensure successful classroom application, we must provide a more detailed list of specific suggestions.

The nucleus for such a list is found in the research literature and includes the following:

1. Children learn best when the method of presentation is in accord with their level of development.
2. An abundance of experiences with concrete materials will foster the child's early conceptualization of number.
3. Children's conceptualization in mathematics is facilitated when the materials used are interesting and familiar.
4. A multisensory approach will expedite conceptualization.

5. A concrete to abstract continuum is favoured in the presentation of mathematics. At the primary level this means beginning with the manipulation of materials, following with work on pictures which represent these materials, and finally using written symbols.
6. Verbalization will facilitate concept formation when the language used is appropriate for the child.
7. The child's self-concept has an important effect upon his cognition.
8. Ability grouping adversely effects the slow learner's self-concept and level of aspiration.
9. Positive reinforcement by the teacher improves the performance of children in mathematics.

Conclusions and Recommendations

The 'guide' which was developed may prove useful in helping some teachers adapt the Investigating School Mathematics program to their slow learners. This notwithstanding, however, it is hoped that at least a sensitivity to the needs of the slow learner will have been provoked.

It is apparent that the 'guide' attempts to help remedy a very serious problem. However, it is conceivable that the best we can hope for is that the school will not compound the injustices levied at all too many slow learners by their home environments.

If we are to make substantial progress with our slow learners, it is imperative that we give consideration to the following:

1. A type of 'head start' program should be initiated in areas where it can be documented that children come to school ill-equipped for academic work. Such a program should be government funded and concentrate on giving children a multitude of experiences with concrete materials. It is important to ensure, moreover, that such experiences are meaningful in that they are consistent with the child's particular environment. Once the child is secure in his environment and assured of his self-worth, he should be introduced gradually to the type of world which is depicted in our school curriculum.
2. If we are to maintain the present content of the primary school, we should admit children to formal education at a later age. This consideration would be particularly advantageous for boys who all too often are not ready to begin schooling at the legal age presently in existence in this province. We need only witness the information contained in the Statistical Report for the Minister's Committee on Women's Issues in Education (1980) to find support for this statement. Here we find the fact that there are approximately twice as many male special education students in our schools as there are female special education students and that the majority of these are at the elementary level (p. 5).
3. If no change can be implemented relative to school entry, we should promote a revamping of the suggested Kindergarten to Grade XII curriculum. Thus, rather than concentrate on adding

an extra year beyond Grade XI, we should endeavour to lengthen the time spent at the primary level. By so doing, we would give teachers the opportunity to promote appropriate, meaningful conceptualization for all our young children. In this way, a strong cognitive base will be built which will allow for greater assimilation and accommodation of subsequent elementary and high school content material.

4. Teachers should be in-serviced on strategies to be used with slow learners. Such in-service should be a cooperative venture between the mathematics/science coordinator at the district level and mathematics education personnel of Memorial University. By pooling our resources in this manner we shall be allowing the theoretical, research-oriented university community to stimulate innovation while simultaneously enabling the pragmatism of the classroom to temper idealism.

A valuable written resource should result which would guarantee greater exposure to core mathematics concepts for all learners. In addition, it would help obliterate the all too prevelant practice of omitting important developmental topics such as geometry for our slow learners.

The real value of such an undertaking, however, would be in the process itself. The interaction and cooperation promoted by different groups focusing on all learners, and the slow learner in particular, would do much to generate a child-centred program. And once a sensitivity to the child is created, everything else should fall in place quite naturally.

In short, then, we must strive for meaningful change. Whether this change comes from the utilization of resource material such as this 'guide' or from curriculum and administrative reorganization, it is incumbent upon us to promote maximum intellectual development for the slow learner. Our attention to his development of particular concepts both in process and product will allow us to pose appropriate problems for the slow learner to struggle with and to solve. In so doing, we not only promote the main purpose of the school for our slow learners but ensure that they, too, will be benefactors as we gear up to align ourselves with the recommendations of the National Council of Teachers of Mathematics (1980) which predicts that meaningful problem solving will be the focus of school mathematics in the 1980s.

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