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Reported is a demonstration project which involved 20 disadvantaged eighth grade students in a series of specially designed physical sciences experiments. It was hypothesized that these students, classified as nonliterate, would respond favorably to an approach which tended to break up their patterns of failure. Moreover, successful science experiences might stimulate in these students a desire to read in order to continue their progress. The science activities involved concepts essential to an understanding of electricity and magnetism, and mechanics and light. The experiments were stimulated by such phrases as "to see the light," "that rings a bell," and "to blow your own horn." The group responded favorably and showed capacity for abstract reasoning. The self-motivated desire for better reading skills was tied in with reading instruction by the classroom teacher. (NH)

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**Scientific Literacy and the Socially Disadvantaged Youth
A Laboratory-Demonstration Project**

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Creative Science Approaches with Socially Disadvantaged Children

Introduction

Studies relating to the psychosociological phenomena of poverty and their effect on the developmental levels of disadvantaged children by such prominent sociologists, linguists and psychologists as Basil Bernstein, Martin Deutsch, D. P. and Pearl Ausubel and Frank Riessman, can lead to the formulation of certain general characteristics attributed to the disadvantaged youth. These attributes contribute to the way in which they view the educational process as well as their own self image in relation to the effectiveness of the school in providing them with the opportunity to evolve into social human beings with marketable skills which will enable them to take their rightful place in a democratic society. A number of such studies have been documented in the Appendix.

The socially disadvantaged child in the upper grades of the elementary school, who is reading at the third grade level or lower, may be classified as a non-reader, and constitutes the most neglected segment of the school population. By the time he has reached the seventh grade he has received a great deal of attention from his teachers and guidance counselors and has generally been characterized by them as an emotionally disturbed child because of his inability to participate in the normal classroom behaviors which require reading and writing skills. Such children, in general, are found to have a limited store of information and only a meager ability to conceptualize.

Problem

In view of the above considerations, one can discern certain personality traits which are characteristic of the disadvantaged child, namely an impulsive, hyperactive individual, lacking both purpose and organization in his behavior, exhibiting difficulty in delaying his immediate satisfactions for long range goals, in conflict with authority both in and out of school and rebellious. It is therefore not surprising to find that disadvantaged children in the eighth grade of the elementary school, who are non readers, are severely retarded in all academic areas. Furthermore, their inability to cope with a curriculum which appears to have very little meaning for them, has led to their segregation into special guidance classes or into special schools.

Although many services are provided for them very few of these children can be reached either through the special services or remedial methods. Remediation, even on a one-to-one basis, using a traditional approach with its accompanying frustration in lack of comprehension and failure, and the boredom of classroom detail, although being regulated by it, creates a basis for further development of negative self-image and low evaluation of individual competencies. Thus, the disadvantaged eighth grader is found to be three to six years retarded in reading and shows a similar lack of achievement in the other academic areas, i.e., mathematics, science and social studies, as measured by standardized examinations. The unique problem of these children make them unable to respond to the traditional methods of teaching. Frustration, therefore, arises on the part of both pupil and teacher, frequently resulting in

hostility, which in turn breaks down the learning situation completely. This situation gives rise to the following question:

Is it possible by specially planned techniques to offset the progress of retardation in cognitive development and school achievement? Assuming that disadvantaged children lack motivation for formal learning, it is possible that many varied and stimulating devices may catch and hold their attention; and further, that the base of all learning is sensory experience, and that science activities therefore are best suited to provide a high motivational atmosphere for arousing curiosity and interest, a demonstration - laboratory project was undertaken to test several hypotheses.

Hypotheses

It was hypothesized that these children, in spite of the fact that they demonstrated low achievement academically, as measured by standardized tests, did possess a large store of sub-verbal knowledge and ability that could be tapped. It was assumed that this knowledge had been accumulated through the sum of past experiences in the surrounding world, seldom displayed, but capable of contributing to attitudes, conceptions and reasoning processes. This knowledge is not neatly catalogued, nor readily available for recall, yet it does form an important basis for progress in new situations; it can be used to guide, outline and either limit or extend the amount of insight each pupil is capable to exhibit to new and challenging situations.

It was further hypothesized that these pupils would be highly motivated to participate in science experiences which would challenge them, and thereby amalgamate their currently acquired information with previous knowledge. Thus it was hypothesized that with these children, their subverbal knowledge, comprised of feelings and attitudes, would be as valuable as consciously stored information when they are placed into a process of formulating discovery.

Procedure

Previous experiences with disadvantaged children have led us to adopt two teaching strategies as basic to the project. First, the awareness on the part of all "teachers" involved that if they approached the children as though they were capable of learning, they would effect a learning situation. Second, that although it is generally recognized that children learn best when material is drawn from their own life experience, in science, since we are often dealing with phenomena which are not directly part of a child's everyday experience, it is essential to bring these experiences into the classroom in the most dramatic way so as to capture the child's attention, arouse his curiosity, and challenge his imagination.

Innovative methods which lead to a desire to read on the part of these children implied the use of a combination of extrinsic and, intrinsic systems of motivational activities. Constructions in manipulative and search-type activities led to the organization of facts in a conceptual structure and to present them in a logical sequence of increasing difficulty. This type of organization provided the proper context into which the process of discovery could be

imbedded and enabled the child to process new information that he obtained.

In this demonstration project, 20 students, classified as non literate, since they were in the eighth grade in a special service school and in a special guidance class, in large urban community, with reading scores below the fourth grade level, were involved for two hours a day in a series of specially designed experiences in the physical sciences. These experiences were developed in a dramatic and challenging manner by three graduate students who participated in this project and assisted the author, each one meeting the group separately on consecutive days. The lack of continuity of the "teachers" was offset by the variety of approaches, and the attitude of at least four individuals who demonstrated to these students their belief that they expected the children to succeed, and challenged them accordingly. Thus, an attempt was made to modify the classroom situation and develop an approach which tended to break up the pattern of failure, built up over the years, and made these children explicitly aware that they can learn. Within such a frame of reference, this experiment, whose major objective was to motivate these children with a desire to read, exposed the children to experiences with which they could deal successfully and in a non competitive atmosphere. It was anticipated that successful experiences in science would lead to a development of a desire to read, if gradually the students were to realize that further continued success required it.

The physical science activities dealt with concepts essential for understanding the behavior of electricity and magnetism, mechanics and light, and terminated in a series of construction projects involving the "Heathkit Electronic Workshop." The problems were challenging and required a level of skill and understanding of children with normal achievement at the eighth grade. Each child recorded the experiences in an individually constructed activity book, using drawings and illustrations to communicate his discoveries as well as writing brief statements about their learnings.

To develop the extended meanings and multivariied uses of such phrases as "to see the light", "that rings a bell" and its fun to "blow your own horn" a series of experiments in electricity and magnetism were designed. These involved:

1. the construction of a flash-light, ("see the light", when the conditions to light the bulb were understood and carried out)
2. the construction of an electrically operated bell, ("that rings a bell", when it was realized that the conditions necessary to light the bulb and close the electromagnet were similar),
3. the construction and assembly of an electrically driven horn, ("blow your own horn", when success in understanding and skill in carrying out the assembly correctly was realized).

The difficulty that these children experience in using words is exemplified very strongly when such a play on words is the desired objective of these experiences. It can be quickly appreciated how such elegance in language usage is lost when one seldom experiences the many-faceted uses of words. Realization of such

multiple uses of words did not become apparent to these children until the meaning of "blow your own horn" was appreciated. A real joy in using the other phrases in a new context was exhibited. A sequence of experiences in light resulted from an examination of a box which came to be known as the "how come box?", a cardboard box 4" x 4" x 6", with a 1/16" hole on two opposite sides and one on top. The flash-light, which had been built was directed into one of the holes on a side and the light was observed viewed from the hole on the opposite side but not when viewed from hole on the top side. A variety of reasonable alternatives were explored and rejected and finally, when the conditions necessary to bend the light so that it could be seen from the top were understood, the concept that light travels in straight lines was appreciated. The pupils themselves then initiated a series of experiments in reflection of light to make the light visible from the top hole. One pupil recalled that a spoon which is half submerged in a glass of water looks broken, and the sequence in light culminated in the nature of refraction from which these children concluded that "light breaks in going from air into water". Their interest in "things are not what they seemed to be", led into an exploration and examination of many other illusions in perception. This activity exploring a world in which "things are not what they seem to be," was as dramatic and exciting to the children as the science experiences. The activity culminated in a discussion of the following problems, which showed a great awareness and concern, by these students for, "things are not what they seem to be in this classroom," "things are not what they seem to be in my neighborhood," and "things are not what they seem to be at home."

Questions of values, desires, attitudes, and aspirations were discussed in a realistic manner indicating a real desire on the part of these children for such activity and the view that the classroom could be an institution for a socialization experience.

Summary of Preliminary Results

The children responded very favorably to the science experiences. They demonstrated their ability to work with concrete science materials in a meaningful way. They showed that they were capable of abstract reasoning in applying the science concepts which they discovered experimentally to new situations. They were motivated with a desire to read. These experiences were then coordinated with a reading experience conducted by the regular classroom teacher to which they responded favorably, especially when this experience involved diagnosis, individualized remediation using self-directing and self-correcting techniques, peer to peer teaching, and materials based on the science experiences. By this means, motivation for effective remediation in reading was effected by means of the success achieved by these children in the task oriented situations which were provided by the science experiences. As these children proceeded from the simple tasks to the more complex science activities, they became aware that continued success required the need to learn new vocabulary associated with the science concepts they were concerned, of the need to gain higher reading skills in order to make the most effective use of the instructions which were provided with each of the new science tasks. Thus, the desire to reach

definite successful goals in the science tasks was found to be the motivating device toward learning in the reading experiences. Personal records of the science projects undertaken and the science concepts learned provided the writing experiences for these children. Success in the writing experience, however, was soon found to be its own motivation and the children were observed to enjoy these experiences as much as the science activities.

In the main, the materials that were used were improvised from readily available commercial equipment, assembled and adapted to develop the desired activities. This provided no handicap, since the important aspect of the program was not so much the materials but the way in which the materials were used. The methods that evolved and which were found to be effective in terms of learning experiences with these disturbed children may be characterized as structured discovery approaches which relied on inductive procedures and the use of the process of inquiry. The novelty of the situation, the challenging way in which the material was presented, the unexpected and non conventional behavior of the materials used, all tended to motivate a desire on the part of these children to find out why they observed the apparent inconsistencies with their previous experiences. To do so, strategies had to be developed to explore alternatives, and inferences made which were dependent upon real meaningful understandings of the concepts involved.

Thus these children, in response to a challenge, learned meaningful science concepts which they were able to apply to new situations. Their attitudes and approach to these learnings in science, when they were given the indication that they could learn, were found to be similar to the advantaged child at the same grade level.

The project is currently continuing with the main emphasis on the development of a science and mathematics educational skills center supplementing a reading skills center to reinforce the learnings, and provide these children with the opportunity to see what they can do, if they so desire, and to allow them time to pursue that desire. The teaching is oriented so that curiosity and enthusiasm is allowed to grow, and the children develop new interests and broaden their backgrounds with the awareness and appreciation that the school is a place where a child learns.

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Appendix

Studies relating to the psychosociological phenomena of poverty and their effect on the developmental levels of disadvantaged children by such prominent sociologists, linguists and psychologists as Basil Bernstein, Martin Deutsch, D. P. and Pearl Ausubel and Frank Riessman, can lead to the formulation of certain general characteristics attributed to the disadvantaged youth. These attributes contribute to the way in which they view the educational process as well as their own self image in relation to the effectiveness of the school in providing them with the opportunity to evolve into social human beings with marketable skills which will enable them to take their rightful place in a democratic society.

The disparity between the performance of the ghetto children and those of middle-class and upper working class children becomes evident in the younger years, and increases in age and in grade level so that from the fourth grade on there is a difference of one grade or more in school achievement. Deutsch (1) finds that as early as the first grade..."psychological aspects of social deprivation contribute to perceptual, language, and cognitive patterns which reflect a restricted range of experiences." Thus, Deutsch finds that among children who come from lower class socially impoverished circumstances, there is a very high proportion of school failure, truancy, reading and learning disability, as well as life adjustment problems. These children not only..."grow up poorly equipped academically but also the effectiveness of the school as a major institution for socialization is diminished."

Bernstein (2), the English sociologist, finds that... "lower-class children tend to use informal language mainly to convey concrete needs and immediate consequences, in contrast with the middle-class children, who use language more formally to emphasize the relationship of concepts, especially in areas where precise and abstract language is required for problem solution. Thus, Bernstein finds that disadvantaged children use a restricted language code in comparison with the more complex elaborate language codes available to the advantaged children in school learning situations. Deutsch (1) observes that in order for children to handle multiple attributes of words and to associate words with their proper referents a great deal of exposure to language is presupposed. This confirms Bernstein's claims that language structures and conditions when the child learns and how he learns, setting limits within which future learning may take place. In identifying the two forms of communication, codes or styles, restricted and elaborate, Bernstein reveals that the restricted styles are stereotyped, limited, condensed, lacking in specificity and exactness needed for precise conceptualization and differentiation. Sentences are short, simple, often unfinished, with little use of subordinate clauses for elaborating the content of a sentence, it is a language of implicit meaning and represents a mode whose basic quality is to limit the range and detail of concept and information involved. Bernstein sees language as a social behavior... "used by participants of a social network to elaborate and express social and other interpersonal relations and in turn is shaped and determined by these relations".

Hess (3), influenced by Bernstein, finds that the nature of the control system in the deprived family context means that the nature of the control system restricts the number and kind of alternatives for action and thought that are opened to the child, such constriction..."precludes a tendency for the child to reflect, to consider, to choose among alternatives from speech and action,"... developing modes for dealing with the immediate rather than the future and which are disconnected rather than sequential."

Furthermore, contemporary theorists of psycholinguistic thought, as Vygotsky (4), Luria (5), and Brown (6), have made language the essential ingredient in concept formation, problem solving, and in relating to an interpretation of the environment. Fowler (7) finds that..."language is probably the central vehicle that enables the child and the adult to represent conceptually and regulate his behavior in relation to the world. Without language it is almost impossible to constrict the elaborate explanatory systems and conceptual models that are the heart of scientific activity."

Disadvantaged children have been found by Fowler to be less effective than the advantaged children, in classifying, and conceptualizing activities and because..."general mental ability, logical reasoning, and the ability to use language systems and classificatory approaches to problem solving are the central ingredients of productive scientific inquiry, the socially deprived child is especially disadvantaged in cognitive processes required for scientific activity."