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ABSTRACT

The instructional needs of culturally disadvantaged students must be differentiated from the needs of slow learners and from the needs of mentally retarded children. The characteristics of a disadvantaged student's family structure, home environment, and neighborhood all affect his learning potential. The special needs of disadvantaged students suggest that, particularly in the field of mathematics instruction, modern electronic technology will be helpful. Computers may be especially useful in that they allow the program of instruction to be individualized to suit the student's needs. Experience with computer-assisted instruction (CAI) drill-and-practice programs such as those developed by the Institute for Mathematical Studies in Social Science, by the IBM Watson Research Center, and by RCA indicates that improvements in performance and student and teacher attitudes may be expected when CAI is used with disadvantaged students. CAI can be useful in overcoming negative teacher attitudes toward disadvantaged students, in teaching students to follow instructions, and in stimulating student interest. CAI would seem to be an important tool to be used to overcome learning problems created by a deprived environment. A table listing CAI programs for the disadvantaged is provided. (JY)

USE OF COMPUTER ASSISTED INSTRUCTION FOR TEACHING MATHEMATICS TO THE DISADVANTAGED

by

Joella Gipson

INTRODUCTION

An examination of sociological and psychological literature which appeared during the past twenty years shows that socio-cultural factors can depress or raise the level of academic achievement and linguistic facility in American Indian, Mexican, Negro, minority, and lower socio-economic groups. A large fraction of the deficit in educational performance and social development can frequently be explained by things other than intelligence The intellectual development of an individual is affected greatly by environmental factors. The environment helps to determine the experiences, skills, and social values a child enters school with. Research studies indicate that children from extreme social groups within society are exposed from an early age to separate and distinct patterns of learning before their formal education.

From the early part of the twentieth century through World War II, two assumptions about intelligence as related to the efficiency of learning have prevailed. One assumption is that intelligence is fixed and unchangeable; the other is that the individual's potential for all types of activity is determined by heredity. The second assumption implies that the individual has inherited the potentiality for all his behavior and that the environment merely provides the stimulation for the potentialities to be released. J. M. Hunt (1961) discusses Piaget's developmental theories which support the need for variety of stimuli in the environment. The greater the variety of situations to which the child must accomodate his behavioral structure, the more differentiated and mobile he becomes. The more new things a child has seen and the more he has heard, the more things he is interested in seeing and hearing (7, pp. 258-259). Hunt further supports the idea of the need for an enriched environment by stating that "it might be feasible to discover ways to govern environments, especially during the early years of a child's development, to achieve a substantially faster rate of intellectual development and a substantially higher adult level of intellectual capacity." (7, p. 363)

Benjamin Bloom in his book Stability and Change in Human Characteristics further substantiates the importance of early environment. Bloom indicates that an "impoverished environment in childhood might retard development of the individual which he could not subsequently make up and an enriched environment might accelerate his development." (2, p. 72)

The information in Table I below is based on the assumption that 100 per cent of mature intelligence is achieved by age 17. Based on this assumption, Bloom estimates that 50 percent of mature intelligence is achieved by age 4, and that a deprived and an abundant environment can result in differences in intelligence scores of at least 10 points until age 4. Similarly, with 80 percent of mature intelligence being achieved at age 8, the difference resulting from the extreme environments can be at least 16 points and at age 17 the difference can amount to 20 points.

TABLE I

Hypothetical Effects of Different Environments on the Development of Intelligence in Three Selected Age Periods

Variation From Normal Growth in I.Q. Units

Age Period	Percent of Mature Intelligence	Deprived	Normal	Abundant	Abundant Deprived
Birth - 4	50	-5	0	+5	10
4 - 8	30	-3	0	+3	6
8 - 17	20	-2	0	+2	4
Total	100	-10	0	+10	20

Source: B. S. Bloom. *Stability and Change in Human Characteristics.* New York: Wiley, 1964, p. 72.

If the research work of experts in psychology is to be taken seriously, the early years are most critical. The external stimuli from parents and peers, as well as from visual objects and focused listening, can detract from or can help to augment factors which are basic to later academic learning. Is there sufficient concern for children who are labeled disadvantaged or culturally deprived within our society? Do all of these children come from environments which are equally void of visual stimuli in terms of home decor and surroundings? How is the difference between the types and quality of language in the lower and middle classes related to differences in learning style ? How can administrators, supervisors, resources coordinators, and teachers update, re-evaluate, and revise their curricula, techniques, and methods of instruction?

The group of children in society who are labeled socially disadvantaged or culturally deprived* are of continuing concern to educators. The concern stems from the past and present knowledge that this group of children produces a disproportionately large share of school failures, school dropouts, reading and learning disabilities, and life adjustment problems. This means not only that this group of children more frequently grow up poorly equipped academically, but also that the effectiveness of the school as a major institute for socialization is diminished. Achievement test scores of children from impoverished background reflect a decline in terms of academic achievement and intelligence the longer the children remain in school. In a study by

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*The terms 'culturally deprived,' 'educationally deprived,' 'disadvantaged,' 'socially disadvantaged,' are used interchangeably through the paper.

Leonard Moriber done in 1961 in the New York City Schools using Puerto Rican, Negro, and other minority children, the mean I.Q. scores dropped significantly from grade three to grade six. The mean I.Q. scores for In-Migrant Puerto Ricans in grade 3 was 85.0 and for the same group of children in grade 6, 79.0. The mean I.Q. for Indigenous (born in New York City) Puerto Ricans in grade 3 was 87.9 and for the same group of children in grade 6, 84.5. Test results indicated that the same kind of back sliding occurred among Negro children, both In-Migrants and Indigenous. As described by Leonard Moriber in School Functioning of Pupils Born in Other Areas and in New York City.

In general the reading and arithmetic scores for the Puerto Rican and Negro children differed significantly between grades 3 and 6. Some groups of children in grade 3 were .7 below grade level and in grade 6, 1.9 below grade level. The following table will give a more comprehensive picture of the children's lack of progress. Similar studies have been made for like populations in Philadelphia, Detroit, Washington, D.C., and Los Angeles.

Scope of the Investigation

Though there are psychological, sociological, educational aspects of the problem of the disadvantaged, the main concern of this report is an investigation of the present use of computer assisted instruction as one of the modern instructional technological aids for teaching mathematics to disadvantaged pupils. The major tasks are: (1) to examine the learning needs of the disadvantaged and (2) to examine the relevance of computer assisted instruction in teaching mathematics to the disadvantaged.

This second task will be accomplished by a review of the mathematics education literature and the reports of public school districts in California and Mississippi, and research centers at Florida State University, University of Illinois, Stanford University, University of Texas, IBM Watson's Research Center, and Dartmouth College.

Definition of Terms

Frequently slow learners and disadvantaged (culturally deprived) children are considered to be identical and to be handicapped in the same way. Is this identification justifiable? The slow learning child is capable of achieving a moderate degree of academic success even though at a slower rate than the average child. Slow learning children have scholastic aptitudes ranging from the third to fifteenth percentile. They have lower achievements in reading, arithmetic, vocabulary, and history than the average child. Some children with I.Q.'s as low as 70 learn reasonably well and are properly classified as slow learners.

Reissman devotes considerable space to the definition and meaning of the slow learner in The Culturally Deprived Child. He state, "In a pragmatic culture such as ours, oriented toward quantity, speed, and measurement it is terribly easy to believe that the child who learns the lesson quickly is a better learner than one who takes a long period of time...Teachers rarely see slowness as simply another style of learning with potential strengths of its own...Slowness can reflect many things. It can indicate caution, a desire to be very thorough, great interest that may constrain against rushing through a problem, or a meticulous style...Extreme slowness probably does connote inadequacy in the absence of counter-indications." (13, p. 63)

In contrast, Kirk defines the educable mentally retarded child "as one who, because of slow mental development is unable to profit to any great degree from the programs of the regular schools, but who has these potentialities for development: (1) minimum educability in reading, writing, spelling, arithmetic; (2) capacity for social adjustment to a point where he can get along independently in the community, and (3) minimum occupational adequacy such that he can later support himself partially or at a marginal level." (9, p. 86) By definition then, the slower learner should not be identified with the educable mentally retarded learner because their levels of potential vary greatly.

Some Learning Needs of the Disadvantaged

The characteristics of the family structure of the disadvantaged has implication for teaching and learning. Among the characteristics of disadvantaged families are: large number of siblings; large number of half-siblings; scarcity of books, toys, puzzles, paper and crayons; confinement to overcrowded and delapidated housing facilities; low adult aspirational levels; frequent unemployment of parents; lack of stable authority system in terms of rewards and punishment; lack of long-range goals and expectations; high mobility within a small area; and poor educational background of parents.

The child entering school is handicapped because of little opportunity for previous individual attention. In the large family, answers to questions are given in short, simple sentences and more frequently unfinished sentences or brief phrases. It is common, too, to find that children from these families have few visits away from the home environment. The urban children are highly mobile within a small area though they lack general environmental orientation. A lack of concern with time is a factor of the environment. One day is relatively unimportant as the next day. Shyness is common when children meet strangers because of a basic distrust of new people who are generally thought to be bill collectors, welfare workers, or landlords. It is not uncommon for achieving culturally deprived pupils to be disappointed by the absence of their parents at school activities. The parents are interested and want to share the success of their children. Yet the parents fear an atmosphere which is not totally familiar to them. Too, the parents want their children to achieve academically but the parents are unaware of the motivational and supportive steps needed to attain academic goals. Study in the disadvantaged home is considered to be the easy thing to do because one is sitting down and not spending long hours performing menial tasks and doing back-breaking work.

Deutsch states that "the urban slum and disadvantaged neighborhoods offer the child a minimum amount of visual stimuli. Few manipulative objects are available. Children come to school from homes void of verbal orientation, causing difficulties in form discrimination. Too, the lack of visual stimuli (exception, television) creates difficulties in form, visual, and spatial organization. In addition, there are some deficiencies in memory training, a lack of expectation or reward for performance, and an inability to use adults as sources of information, correction, and reality testing." (4, p. 170)

Attempts have been and are being made to bridge the gap between the environment and the school. The Higher Horizons Project of New York City, the Great Cities Project, the Head Start, the Follow Through Programs, other programs resulting from titles I-VIII of the Elementary Secondary Education Act, 1965, and programs through the Office of Economic Opportunity have tried to offer and to find solutions to meet the needs of these pupils. The changing urban community and family, the current social revolution, and scientific and technological advances have changed the role of the school. Researchers in science, technology, education, psychology, and sociology are beginning to work hand in hand to affect a needed change in education. The results of interdisciplinary interaction and sharing are a continual re-evaluation of pre-service and in-service education for teachers, and a sensitive study of the learning styles of disadvantaged is based upon environment, economic opportunity, family structure and housing.

Teachers are learning to provide more varied environments to stimulate creativity in these pupils. Teachers are beginning to use an integrated learning program to reach these pupils utilizing the many strengths of the pupils. How and when to use discovery methods to teach problem-solving instead of the memorization method is a topic of many mathematics in-service sessions. Answers are being sought to such questions as how modern electronic technology can be used to help train and retrain the mathematics teacher and how modern electronic technology be used to individualize the mathematics classroom instruction for pupils.

Computer Assisted Instruction

Why is there a reasonably widespread interest in using computers to assist in the instructional process? Robert Bundy in his article "Computer-Assisted Instruction -- Where We Are" believes that computer assisted instruction is really the result of a number of converging technologists, including programmed learning, audiovisual communications, the data processing field, and data communications. (3) Atkinson and Wilson from the Stanford CAI center attribute the rapid rate of growth of computer assisted instruction to "the rich and intriguing potential of computer-assisted instruction for answering today's most pressing need in education -- the individualization of instruction." (1, p. 73) Other factors cited by them are the development of programmed instruction, the mushrooming of electronic data processing in general but in particular the advent of time-sharing systems, and the increasing aid to education by the federal government. Sarnoff, President of RCA, observes that the technology revolution in education is being hastened by the staggering growth in the volume of knowledge and the enormous increase in the number of students. He claims that by 1971 every third college graduate will have to become a teacher if the present pupil-teacher ratio is maintained.

Stolurow, who has a long history of involvement with CAI, having been in a pioneer center at the University of Illinois and being director of the center at Harvard, sees in computer assisted instruction three key capabilities: "(1) individualizing instruction, (2) doing research on teaching under controlled conditions with the ability to collect detailed records of student performance, and (3) developing ways of assisting authors in the development of instructional materials. Other applications, aside from instruction, include the development of teaching models, curriculum planning, man-machine relations, and evaluation of student performance." (15, p. 180)

Professor R. Gerard, Dean of Graduate Studies, University of California at Irvine, lists these benefits CAI will bring to the student: "(1) better and faster learning since the student can time his learning at his convenience, go at his own pace, and catch up missed time; (2) better teaching at many levels and in many areas; (3) personalized tutoring; (4) automatic measurement of progress; (5) and the opportunity to work with vastly richer materials and more sophisticated problems. For the teacher the system (1) takes away a great deal of the drudgery and repetition; (2) allows him to be updated effectively; (3) encourages frequent changes in the actual material used; and (4) makes more time available for teacher-student contact." (5)

Computer assisted instruction is a technological innovation which has one of its varied capabilities the use of a computer system to assist the teacher in presenting educational mathematics materials to the pupils. In addition to presenting the mathematics material as the regular textbook does the computer goes several steps beyond the traditional approach. The computer assisted instructional system can (1) provide highly individualized mathematics instruction to a large number of pupils daily; (2) perform an immediate analysis of the accuracy of the pupils' mathematical responses making possible individualized instruction; (3) keep each pupil and his teacher informed of the individual pupil's progress; and (4) provide reports to the teacher on class performance and item reliability for use in daily planning. Unlike most mathematics textbooks, the material presented to the pupils can be on many levels of difficulty allowing pupils to progress at their own level and pace.

Basically a computer assisted instructional system consists of three parts. These parts are the hardware, the operating system software, and the curriculum materials. The hardware includes the computer and its peripheral equipment installed at a central location; the teletype or other instructional stations for pupil use installed in schools; and a communications network connecting the central computer system and the pupil stations. The operating software provides the necessary commands and instructions for on-line processing. On-line processing is necessary during the time pupils receive their instruction at student terminals. Off-line updating and processing prepare the material prior to on-line communication and maintain files on pupil performance as well as summary reports on all pupil's progress. The mathematics curriculum materials are written by teachers.

The sources used to obtain data on computer assisted instruction programs for the investigation included (1) Molnar and Sherman's, USOE Source Book - Support of Computer Activities for the Fiscal Year 1966-69; (2) Educational Resources Information Center (ERIC) Research in Education Journal; (3) visits to sites and observation of pupils at Washington School, Champaign, Illinois; Brentwood School, East Palo Alto, California; Los Angeles City Schools, Los Angeles, California; and, University of California, Irvine, California; and (4) the Watson IBM and RCA Research Centers. From the one hundred-thirty computer projects listed by Molnar and Sherman, thirty-five projects were funded by USOE in computer assisted instruction and computer management instruction for the period 1966-69. The kinds of computer assisted instructional programs in operation which are related to elementary and secondary schools mathematics are: (1) in-service training programs in mathematics for elementary school teachers; teaching of spelling to sixth graders; humanities program on non-Western cultures; (2) improvement of student achievement and faculty instruction in secondary school mathematics and science; Dovack method of learning of reading; (3) individualized instruction in mathematics and language arts for primary students; teaching of secondary school physics; teaching English to bilingual migrant children; and (4) computer controlled simulation games. The programs which were used for the disadvantaged are given in Table II. Three of the programs for disadvantaged youth are summarized in detail in addition to their appearance in the table on pages 14 and 15.

Computer Assisted Instruction and the Disadvantaged

What are the ways in which computer assisted instruction is being used for teaching mathematics to the disadvantaged? The drill and practice programs, the tutorial programs and problem solving programs are beginning to offer the creative teacher some varied ways of preparing materials to aid the disadvantaged learner. The Institute for Mathematical Studies in Social Science at Stanford University has pioneered computer assisted instruction over the past four years with disadvantaged areas of Brentwood, California and for the past three years in the schools of McComb and Franklin County, Mississippi. Drill and practice lessons written at the University of Illinois for use on PLATO III are in operation daily. Similar programs have been in operation for disadvantaged pupils at Florida State University and East Orange, New Jersey (Cooperation with I.B.M. Watson Research Center). The table on the following pages lists the programs which have been in operation at some time during the past four years for disadvantaged pupils in mathematics.

Gayden Stovall (1969) states that the drill and practice program in McComb, Mississippi, is serving elementary children in McComb, South Pike, and Franklin School districts using 60 teletypes in grades 2 - 6. A PDP-10 digital computer located at Stanford is used. During the year 1967-68, 700 children were served in an experimental program. The experimental groups scored significantly higher in computational skills than did the control groups.

TABLE II

	Years Funded	Physical Facilities Equipment	Drill and Practice Problem-Solving or Tutorial
Central Ele. Sch., McAllen Texas and Univ. of Texas	1967-68	IBM 1050 typewriter with audio/visual components linked to IBM 1440 at CAI Laboratory at Univ. of Texas	Tutorial
Proj. Compute East Providence, R.I.	1967-68	Not indicated	Tutorial
Univ. of Ill. and Univ. of Ill. Upward Bound Summer Prog.	1967-68	PLATO	Tutorial
Local Jr. and Sr. HS, Fla. St. Univ.	1966-67	IBM 1440	Drill and Practice Tutorial
McComb and Franklin Co., Miss.	1967-70	PDP-10	Drill and Practice
East Orange, N.J. and IBM Watson Research Center	1966-67	IBM 1050	Drill and Practice Tutorial
L. A. City Schools	1968-69	RCA 716	Drill and Practice
N. Y. City Schools	1968-70	RCA Spectra 70/45	Drill and Practice
Ravenswood City Sch. Dist. (Brentwood Sch.) and Stanford Univ.	1967-70	IBM 1500	Drill and Practice Tutorial
Washington Sch. Proj., Univ. of Ill.	1968-70	CDC 1604, PLATO II & III	Drill and Practice
Philadelphia	1968-70	Philco	Unknown

ABLE III

Subject	Grade Level	Prior Inservice for Teachers	Voluntary or Required	Pre-Test	Post-Test	Time	Length of Lesson
Reading for bilingual migrant child; Arithmetic long division and addition	3-6	Yes	Voluntary	None	None	6 weeks	15 minutes
Mathematics	10-12	Not Indicated	Required	Not Indicated	Not Indicated	8 months	15 minutes
Mathematics (Geometry)	11-12	Not Indicated	Voluntary	Yes	Yes	8 weeks	10 minutes
Arithmetic Reading	7-12 2-7	Yes	Voluntary Paid	Yes	Yes	6 months	20 minutes
Arithmetic	1-6	Yes	Required	Yes	Yes	3 years	5 minutes
Arithmetic Reading	5 and 6	Yes	Required	Yes	Yes		20 minutes
Arithmetic	7-8	Yes	Voluntary	Yes	Yes	8 ~~6~~ weeks	10 minutes
Arithmetic	2-6	Yes	Required	Yes	Yes	2 years	10 minutes
Arithmetic Reading	1-6 1-6	Yes	Required	Yes	Yes	3 years	15 minutes
Arithmetic	2-3	Yes	Required	Yes	Yes	2 years	15 minutes
Unknown	Un-known	Unknown	Unknown	Unknown	Unknown	1 year	Unknown

The teachers involved in the program received training at a four-week workshop at Stanford University during the summer of 1967 or at Morehead State University in Kentucky. The teachers of both control groups and experimental groups had comparable academic training and were rated as the best sixth grade teachers in their school districts.

The four-week workshop for the experimental teachers consisted of four phases. The first phase was a mathematics curriculum seminar in which each teacher had to become familiar with the mathematics text which would be used for the first time the following September. Part of the seminar required each teacher to write behavioral definitions of course objectives for his instructional program in mathematics. One of the purposes of the mathematics curriculum seminar was to correlate the drill material presently available over the computer with each teacher's own instructional sequence of concepts for the coming year.

The second phase of the training program was a series of mathematics lectures. The materials used for the lecture were Studies in Mathematics published by School Mathematics Study Group. The third phase of the training program provided teachers with daily experience at the teletype working through as many of the 2,700 lessons as possible. The fourth and final phase of the training program for the teachers at Stanford was observation of children working on terminals at the Stanford Brentwood Computer Assisted Instruction Laboratory. The Morehead University teachers did not observe children working on terminals.

The control group used the textbook Modern Mathematics Through Discovery forty-five minutes per day for 130 school days. The experimental group received the same conventional type of instruction as the control group but the experimental group's instruction was supplemented by an average of five minutes of daily computer assisted instruction. The report did not indicate whether the control group teachers wrote course objectives or special lectures. A comparison of achievement test scores of the experimental and control groups showed the experimental groups able to achieve at a significantly higher level than the control group.

E. M. Quinn (1967) states that the programs operated by the IBM Watson Research Center in the Intermediate School, East Orange, New Jersey, concentrated on reading and arithmetic for fifth and sixth graders. The type of programs were tutorial for reading and drill and practice for arithmetic. The pre-test and post-test used were different forms of the Iowa Test of Basic Skills. Proctors were used to assist the boys and girls. The equipment used for this field test program was the IBM 1050 computer and the program was conducted for eight weeks. (12)

The report by the Los Angeles City Schools, Division of Measurement and Research indicates that the pilot program operated by RCA in the Edison Junior High School in Los Angeles, California, concentrated on arithmetic for seventh and eighth grade pupils who were underachievers. The type of program used was drill and practice material. The pre-test and post-test used were the Wide Range and Iowa Test of Basic Skills. As these pupils were already a part of a state experimental program in mathematics the California Achievement Test had also been administered to them earlier in the semester. The range of the test scores (grade placements) for the pupils in grades seven and eight on the pre-test ranged from 2.9 to 5.7 and on the post-test from 3.5 to 6.9. The in-service training for the teachers was extensive as there was not a proctor employed to assist the pupils. The equipment used for this program was the RCA 70. The community was involved in this pilot project by attending several demonstration sessions; by having a consultant from the state experimental program visit their homes to inform them of the nature of the program and by encouraging the parents of the pupils to visit the classroom when the terminal was in use.

All of the above programs were essentially drill and practice programs. The administrators and program coordinators studied the pre-test and post-test in addition to observing the pupils at work and in their other classes. Progress in any new program can be a result of the Hawthorne effect sustained interest and continued improvement in mathematics is a true test of the effectiveness of the program. Personnel generally agreed that most pupils showed improvement as a result of their experiences using computer assisted instruction. A positive pupil attitude was indicated by class attendance, punctuality, interest in class work and school as a whole. Likewise, teachers expressed satisfaction in knowing that many pupils had gone beyond the teachers' expectations in achieving and mastering various levels of the drill and practice material.

The success of any program is due in part to the materials used. The following points are mentioned by Max Jerman in his Teacher's Handbook as being most characteristic of a good curriculum program for drill and practice:

"1. A drill must fit the needs of the individual.
2. The pupil must understand where he is going, why he is doing it, and the best method for doing it.
3. Drills should be given frequently and in small amounts.
4. Drills should have a time limit.
5. Drills should be on the entire process and facilitate diagnosis.
6. Drills should include verbal problems.
7. The same element should be presented in a variety of ways.
8. Massed practiced should follow the introduction of a topic, and mixed practice should be given periodically to maintain the skill.
9. Examples should occur in order of difficulty." (8, p. 5)

The use of computer assisted instruction can be useful in overcoming negative teacher attitudes regarding pupil performance and potential. The computer has no preconceived notions of pupil performance. Therefore, computer assisted instruction tends to accept the pupil where he is and works to obtain higher performance from the pupil. Immediate reinforcement is given to the pupils in terms of comments and responses. The student is motivated because he knows where he is and what he is doing. In the drill and practice computer assisted instruction program, block or unit, each step is specified so that weakness can be isolated and new and varied materials provided for these unlearned areas. The use of the cathode ray tube in instruction can produce visual objects in many two dimensional forms to give disadvantaged pupils the needed variety and acquaintance with many different forms which may not have been a part of his previous environment. The use again of the cathode ray tube to display tasks related to pattern formation, position, relationship of direction and size is very significant for the perceptual and spatial development of young children.

The following of directions is essential to the completion of tasks. Many teachers of the disadvantaged have indicated that inability to follow directions is one of the serious weaknesses that they find in their work with disadvantaged children. Lessons can be programmed so that children must follow successive directions in order to obtain new slides on the screen for any given segment.

At this time one of the limitations of the use of computer assisted instruction is the variety of mathematics curriculum materials which are available. Many of the existing programs have been written to focus on basic skills. Yet if the research work of Deutsch, Hunt, Torrance, and others are to be taken seriously there is a need to develop simulation type experiences and lessons which lead the pupil to the release of his creative potential.

In conclusion the use of computer assisted instruction can provide the disadvantaged pupil with flexibility in mathematics which accommodates his ability. Learning situations and lessons can be structured to permit frequent and short leaps. Properly programmed lessons can provide the pupils with significant content.

The teacher who writes creative materials and the teacher who guides the pupils and allows the pupil's creative potential to be released can use computer assisted instruction to its utmost in providing a learning situation which will help to open future doors for disadvantaged learners.

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