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An Investigation into the Affect of the Borg-Warner System 80 Machine on the Reading Program of Selected Primary Students

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AN INVESTIGATION INTO THE AFFECT OF THE BORG-WARNER SYSTEM 80 MACHINE ON THE READING PROGRAM OF SELECTED PRIMARY STUDENTS

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Abstract

Bibliography — An Investigation into the Affect of the Borg-Warner System 80 Machine on the Reading Program of Selected Primary Students

Purpose — Measured the effect of individualized phonics instruction presented by teaching machine upon a group of low achieving kindergarten children.

Methods — Four kindergarten classes in a suburban elementary school were screened thru the use of a phonics inventory. The lowest achieving children were assigned to a daily tutorial lesson on Borg-Warner's System 80 Audio-Visual Unit. The other children in the kindergarten classes proceeded with their normal classroom activities. At the end of nine weeks, the phonics inventory was readministered and the achievement of the System 80 users was compared to the performance of the non-users.

Results and Conclusions — Eighteen Ss in the E group completed at least one level of Phonics during the nine week period. Eight Ss completed two levels. In comparing the performance of the E group who had completed one level against the performance of the C group (85 Ss) it was found that both made gains that were statistically significant (.01 level). However, the experimental group rate of gain was higher than the control group rate. When comparing the E groups performance to the lowest quartile of the control group the following results were obtained:

1. On the pretest the C group's scores were significantly higher (at .01 level)

2. On the post-test the E group "closed the gap" in that difference in performances was <u>not</u> significant.

In analyzing the performance of the E group which completed two levels of the machine presented Phonics, the following was found: Comparing E group performance against total C group performance.

1. E group scored significantly higher in pretest (.01 level).
2. Post-test differences were not significant.

In comparing E group performance against the lowest quartile of the Control Group, the E group actually "crossed over" i.e. the E group's post-test scores were higher than the C groups. Although in the pretest, the E group had performed significantly lower (.01 level).

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

With the beginning of the twentieth century, American educators have attempted to bring modifications in education reflecting the challenges posed by rapid growth of industry and technology. Accordingly, significant curriculum problems have arisen as a result of stemming profound and undirected changes. Information about science and technology has accumulated more rapidly than ever before. At the same time, national, international, and political developments have put unprecedented pressures on the American system of education, thus emphasizing the need for curriculum revisions and more efficient methods of instruction to keep pace with these rapid advances.

Educators have proposed and experimented with impressive and interesting methods and media designed to improve the curriculum. The most recent of these innovations is programmed learning. Pressy (1927), Skinner (1958), Porter (1959), Markle (1970), and others, have proclaimed the effectiveness of programmed learning as an instructional tool. Their experiments and laboratory studies were designed to expand knowledge about programmed instruction as a practical means of instruction.

One purpose of this investigation is to review the literature on this subject, and, secondly, describe an experiment designed to test the effectiveness of a reading program using a teaching machine in the primary grades.

Statement of the problem

The primary purpose of this study, using the Borg-Warner System 80 machine with its programs on Reading Words in Context, and Learning Letter Sounds kits as a supplement to the regular reading program in kindergarten, was to compare the reading performance of an experimental group of first graders with a control group at a comparable level. The hypothesis postulated was that the experimental group using the Borg-Warner program and machine will make greater gains in reading than will the control group using other media.

Hypotheses of proposed study

Four hypotheses are postulated. These are: (1) Gains in reading of the experimental group using the System 80 will be greater than gains made by the no treatment control group; (2) Gains in reading achievement of high achievers in the experimental group will be greater than gains made by high achievers in the control group; (3) Gains in reading achievement of low achievers in the experimental group will be greater than gains made by low achievers in the control group; (4) In each case it was hypothesized that comparisons of average gain scores from pre- to post-tests between the experimental and control groups would reveal significantly greater gains made by the System 80 experimental group. In testing these hypotheses a .05 level of significance was used.

Limitations of proposed study

The limitations of the study are as follows: (1) A small number of students comprising the experimental group; (2) timefactor: the study was conducted late in the school year; (3) finally, no attempt made to control for the "Hawthorne Effect."

Purpose of the study

The study was designed to determine the effectiveness of the Borg-Warner System 80 electronic device as a tool for reading instruction, thereby freeing the teacher to do other classroom activities such as diagnosis, prescription, and evaluation of students.

In view of the vast amount of research in the area of programmed learning, there is a need to examine the literature and reach some conclusions regarding the value of this type of instructional media. Another aspect of this study was to determine the effectiveness of programmed media per se at various grade levels using varying subject matter content and involving students with different learning characteristics. One objective for the review of the professional literature was to determine the effectiveness of the media on various subjects enrolled in elementary, and junior high schools. Within this framework, the attempt was made to determine the answers to the following questions:

1. Which subject matter areas can be taught effectively through use of programmed material?
2. How effective is programmed material with students of low, average, and high intellectual abilities?
3. How effective is programmed media with low, as well as high achievers?

4. At which grade levels can programmed media be used most effectively?

Programmed media is apparently exerting some influence on the curriculum in American schools. Programmed teaching materials and machines are becoming increasingly available, and there is no reason to conclude that this thrust will not continue in the future. Therefore, in the interest of progress in education, the field of programmed investigation will provide some evidence in support of the effectiveness or its absence of programmed instruction.

Definitions of terms used

Some terms used in the study have meanings other than those commonly associated with them; hence they are explained. The basic terminology to be defined include the following: conventional teaching, feedback, frame, learning characteristics, programmed instruction, scrambled book, and teaching machine.

Conventional teaching

The teaching act whereby the pupil is trained, and stimulated to acquire knowledge and expand mental powers, and develops proper attitudes toward learning through use of books, periodicals and visual aids under the direction of a classroom teacher.

Feedback

Communicating to the subject pursuing a sequence of programmed materials the kind of information needed to modify responses so that failures or errors can be eliminated, and correct responses reinforced and maintained.

Frame

A single item or statement exposed independently and singly.

Learning characteristics

Pupils differ in various ways; sex, intelligence, mechanical performance, and socio-economic background. These characteristics in some way effect rate and degree of learning.

Programmed instruction

Programmed instruction is defined as being a type of learning experience in which a "program" takes the place of a tutor, leading the student through a set of specified behaviors designed and sequenced to make it more probable that he will behave in a predetermined manner if provided with a certain stimulus. An essential of a program is an ordered sequence of stimulus items, to each of which a student responds in some specified way. His responses need to be reinforced by immediate knowledge of results so that he moves through small increments thereby making few errors and reinforcing the correct responses. In addition, he proceeds from what he knows, by a process of successively closer approximation, toward what he is supposed to learn.

Scrambled book

A special book containing material to be learned in programmed form, but in which the student is directed to different pages, although not necessarily in consecutive order. By means of alternate choice responses at each step, branching to new or review material is made possible.

Teaching machine

A mechanical or electronic device designed for presenting programmed educational material to a subject who controls his rate of mastery.

Overview of chapters

The following chapters will deal more fully with other aspects of this study. Chapter II examines related literature on the historic background of programmed instruction.

Chapter III presents the design of the study. This includes methods of gathering data, population sampled, and materials and apparatus used.

Data collected from the study is presented in Chapter IV. This chapter includes procedure, results and interpretation of the study.

The summary and conclusions of the study are to be found in Chapter V.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter is devoted to an examination of: (1) historic backgrounds for programmed instruction; (2) research on the benefits of programmed instruction; (3) characteristics of programmed instruction; and (4) research on the use of teaching machines and programmed instruction in the schools.

Today's educator must be knowledgeable in the areas of educational psychology and technology. It would not be presumptuous to assume that educational objectives can be realized only through application of this knowledge.

HISTORIC BACKGROUNDS FOR PROGRAMMED INSTRUCTION

Programmed learning appears to have emerged as a result of the interaction between the corpus of knowledge developed by experimental psychologists and the requirements of practitioners for an explicit technology of instruction. Programmed instruction is predicated upon certain defensible laws of learning made applicable to instructional methods through educational psychologists.[1] Nevertheless, to date, the effectiveness of programmed instruction still seems to be in question. However, the dubiousness is not a consequence of negative research findings. In the studies examined none of the investigations concluded that programmed media proved ineffective. The problem appears to be merely one of unacceptance of the findings.

Basic to the design of current programming is reinforcement theory, and the assumption that all students are intrinsically motivated. Such hypothesizing would appear to make negligible any concern for externally motivating the student to learn via the program.

Current programmed instruction, whether designed to be presented as a programmed machine or a programmed text, possesses three essential characteristics. The program (1) presents a sequence of problem materials to the student; (2) provides some means by which the student may record his solutions to these problems; and (3) makes immediately available verification of response.[2] Interest in programmed instruction or machine teaching, since a programmed series of questions and answers often is presented through a machine, can be considered a renaissance of Socratic or tutorial teaching. In both instances, instruction is primarily individual in that one copy of a program serves an individual and only his mastery of its content allows him to progress from idea to idea within the program.

Pressy reportedly conceived the idea of automated or machine teaching approximately one-half century ago when he designed a box-like machine for presenting and scoring multiple choice test questions after which the learner was rewarded with a coupon or a piece of candy for having mastered his task.[3] Of his own device built to function in accordance with then existing knowledge about the learning process, Pressy wrote:

> The "law of recency" operates to establish the correct answer in the mind of the learner, since always the last answer chosen is the right answer. The correct response must almost inevitably be the most frequent, since the correct response is the only response by which the learner can go on to the next question, and since whenever a wrong

> response is made, it must be compensated for by a further correct reaction. The "law of exercise" is thus automatically made to function to establish the right response. Since the learner can progress only by making the right response, he is penalized every time he makes a wrong answer by being required to answer the question one more time, and is rewarded for two consecutive right responses by the elimination of that question, the "law of effect" is constantly operating to further the learning. Finally, certain fundamental requirements of efficiency in learning are met. The learner is instantly informed as to the correctness of each response he makes (does not have to wait until his paper is corrected by the teacher). His progress is made evident to him by the progressive elimination of items. And most important of all, there is an individual and exact adjustment to difficulty, by which wasteful overlearning is avoided and each item returned to until the learner has mastered it.[4]

Dr. Pressy's concept of so-called errorless programming lay dormant until B. F. Skinner, postulated a somewhat similar idea. However, Skinner's design required the student to compose his own answers rather than select them from among a listing of alternate responses. Proceeding through a carefully designed sequence of very small steps on which he could not falter, the student manifests operant behavior.[5] Skinner describes the device as follows:

> ...The machine itself, of course, does not teach. It simply brings the student into contact with the person who composed the material it presents. It is a labor-saving device because it can bring one programmer into contact with an indefinite number of students. This may suggest mass production, but the effect upon each student is surprisingly like that of a private tutor. The comparison holds in several respects: (a) There is a constant interchange between program and student. Unlike lectures, textbooks, and the usual audio-visual aids, the machine induces sustained activity. The student is always alert and busy. (b) Like a good tutor, the machine insists that a given point be thoroughly understood, either frame by frame or set by set, before the student moves on. Lectures, textbooks, and their mechanized equivalents, on the other hand, proceed without making sure that the student understands and easily leave him behind. (c) Like a good tutor, the machine presents just that material for

> which the student is ready. It asks him to take only that step which he is at the moment best equipped and most likely to take. (d) Like a skillful tutor, the machine helps the student to come up with the right answer. It does this in part with techniques of hinting, prompting, suggesting, and so on, derived from an analysis of verbal behavior (Skinner, 1957). (e) Lastly, of course, the machine, like the private tutor, reinforces the student for every correct response, using this immediate feedback not only to shape his behavior most efficiently, but to maintain it in strength in a manner which the layman would describe as "holding the student's interest."[6]

B. F. Skinner, employing the newly designed machine, conducted laboratory experiments in an effort to find improved methods of teaching and new instrumental media. He taught pigeons to perform a variety of tasks utilizing operant conditioning.[7]

This pioneering research permitted him to later design a program in which tasks were divided into many sequenced components with correct responses receiving immediate rewards.

Satisfied with results of these investigations, Skinner later devised a verbal program that was used successfully to teach humans.[8] Word of this research reached the public, and immediate interest was sparked. Educators and psychologists examined programmed learning to see if it had practical value in the classroom. Consequently, many experiments were undertaken to validate the utility of programmed learning.

The sections to follow were reported in order to illustrate many of these experiments in the United States schools.

A unique approach to programmed instruction had been developed by Crowder of Western Design Company, Santa Barbara, California. It is described by its designer as the "scrambled" textbook. Instructional material to be learned is presented in small logical units, usually a paragraph or less in length, with each unit immediately followed by an examination. Every response is concluded with a reference page number. In effect, the text outcome determines the direction to be undertaken, either advancement or remediation. If a student selects a correct response, immediate direction is given for further skills growth. Conversely, selection of an incorrect response results in a forced review of the preceding unit. Additionally, the nature of the error is explicated after which the pupil is retested. This process is known as the "branching" technique, and is predicated on the thesis that human learning takes place in a variety of ways. The variability is a consequence of: (1) intellectual differences; (2) the nature of subject matter; (3) the interactions between these sources of variation; and (4) other undetected sources of variability. To achieve a desired learning behavior, Crowder builds into his program not only the means for determining whether a prescribed goal has been achieved, but also designates the next appropriate action.[9]

The varying models in programmed instruction conceived by Pressy, Skinner, and Crowder, have an obvious commonality even though basic differences appear to predominate. Thus, although Pressy and Skinner chart the same structural course for every learner, allowing for flexibility only in terms of speed and rate of learning, Crowder's programming recognizes that students may respond differently to the same stimulus, therefore, the objective is to provide infinite combinations of questions, answers, and explanations. Nevertheless, predetermination of what is to be learned characterizes all programmed instruction.

PROGRAMMED INSTRUCTION BENEFITS

It is not the function of this investigation to evaluate the basic types of programming, however, it does seem necessary to elicit from research some information about the relationship between the program and the learner:

> ...available research on the relationship between the learner's ability and his gains in learning do not justify the assumption that different programs have to be written for high and low ability groups. Also, the data suggests that the clearest cases of a relationship between ability and age occur with (a) memory, both immediate and delayed, and (b) differences in motivation, in past experience, and in degree of familiarity or in the meaning of the symbols used. Even for complex tasks then, separate programming does not seem to be indicated.[10]

It is possible to hypothesize that research data indicates that programmed instruction is not only appropriate for a wide spectrum of intellectual endowments ranging from the seriously retarded to the superior, but furthermore, it tends to reduce individual differences since lower-ability individuals appear to achieve more with the program than do the high-ability learners.[11] In specific aspects of subject matter areas the lower-ability achiever, working at his own pace, has the opportunity to narrow the gap between his achievement and that of the higher-ability learner. Simultaneously the higher-ability learner, relieved of the compulsion to over learn, is afforded opportunity to pursue other studies. Consequently, for these variegates types of learners, various materials and methods of programmed instruction, as opposed to traditional instruction, have made performance freer from error as well as reducing the amount of instructional time required for achievement.[12]

Data further suggests, that the simple workbook of the programmed text or "scrambled book" may be more effective in maintaining proficiency than would more expensive mechanical devices.[13]

Another investigator encouragingly opinionates retention of subject matter learned programmatically as compared to retention of the same subject matter studied traditionally. He found that performance on retention tests appear to favor programmed instruction for all ability levels.[14]

With possibilities seemingly unlimited, programmed instruction is proclaimed enthusiastically by an increasing number of investigations. It seems to offer a solution to some of the problems current in American education. Because this approach permits for individualizing instructions, and reduction of learning time, while liberating the teacher from mechanical tasks, its proponents aver that programmed instruction has proven to be a useful learning tool, worthy of much wider application in classrooms at all levels of learning.

CHARACTERISTICS OF PROGRAMMING

Although learners of all ability groups tend to experience long term gains as a result of being exposed to programmed instructions, its effectiveness is still predicated on the quality of its content. Most important for all programming, are the basic principles or processes involved. The subject matter of a curriculum is broken into small, digestible and sequential learning units or frames which, as they are presented, require active rather than passive participation on the part of the student. Allowed to proceed at his own rate, but not allowed to proceed to a next frame without "mastering" a present step, the student is frequently rewarded with knowledge of his correctness in responding to a question testing his understanding.[15]

One approach to programming, analyzes materials to be used in teaching expressed in terms of learning tasks required to produce a desired behavior. This examination provides a basis for the construction of a sequential unit of frames, each of which contains a cue (stimulus) and a response producer.[16] Whether the learner is to be led inductively to the identification of a principle or whether he is to exercise the application of an identified principle, the problem for the programmer is one of knowing what the learner needs in order to confront him with a sequence of cue-stimuli which indirectly increase the probability of his making correct responses.[17]

Regardless of the stimulus-response relationship chosen for the items, there must be a continuity among items or an interlacing of associations into a pattern consistent with that required when the information concept or skill is put to use. Moreover, the programming process is cumulative. The program is predicated on the assumption that the learner possesses minimum information, or minimum skills as a prelude. He should be led through a series of many small steps, the objective of which is to build a larger response unit of concept. Using induction or deduction, the student is guided in a manner that will permit him to experience all salient points. Meaningful associations and gradually vanishing stimuli should be characteristic of the progression of items in order to help the learner exercise independent thinking.[18]

To date, there have been developed two basic types of programming: (1) "linear" and (2) adaptive or "branching". A linear program is one in which a sequence of information presented to the student is fixed, that is, all students are given the same stimuli in the same sequence. In adaptive programming or "branching", the presentation is continually adjusted on the basis of what the student does.[19]

PROGRAMMED INSTRUCTION IN SCHOOLS

Dr. William LaPlante, of Borg-Warner, opinionates that there is sufficient evidence to permit postulating that if we do not provide opportunities for children to learn in different ways, large numbers will fail to achieve anywhere near their capacity. When we take aptitude differences into account, results can be dramatic. David S. Bushness, in a recent edition of Battelle Research Outlook, claims that when instruction is properly individualized, ninety per cent of our students can master most subjects.[20]

LaPlante further states, that if those in administration and curriculum planning do not individualize instruction, students will subtly do it, first, by "tuning out", then as soon as the law allows, "drop out".[21]

As a result of an experiment designed to compare programmed learning with conventional learning procedures, one school district became a laboratory for various programs of instruction, designed to meet the learning needs of the "gifted", the average learner, and the educationally disadvantaged child.

After a five year study, Harrisburg found only three formats that came close to fulfilling the need for true individualization in the areas of reading and math. Two of the three were audio-visual devices known as the "Talking Typewriter" and the "Talking Worksheet". The third was a program called "Individually Prescribed Instruction" (IPI).[22]

The "Talking Typewriter" was prohibitively expensive, hence could not be seriously considered for general use. Consequently, the system known as the "Talking Worksheet" was selected. The director of the program, felt the system provided overall flexibility, ease in sequencing, high motivation, low cost, conservation of teacher time, and high effectiveness in student achievement.[23]

Fear that "machines will replace the teacher" have diminished, and new technological devices have been recognized as extensions of the teacher, rather than replacements. However, a new spectre has emerged. It seems that the notion of dehumanization of education is a current fear.

Isabel Dible, contends that at the level of empirical observation alone, some aspects of behavior by various media may be more "humanistic" than that preferred by human beings. "Media are tireless and capable of repeating endlessly without fatigue or exasperation." Media are non-judgmental, they do not pass or fail, threaten or punish, and can perform in this way only when programmed by humans. The role of the teacher, therefore, lies not in rejection of media as impersonal, but controlling media to do what it does best, and reserving the unique talents of the teacher for diagnosis, evaluation, prescription, decision making, and direct individual interaction with the learner.[24]

Ferry perceives education as being in danger of being "electronicuted." He feels educators are analogizing the educational system to a factory producing "goods". He claims we are dehumanizing in that the indefinable relationship between teacher and the student is being lost and that the ends of education are being destroyed by the means.[25]

Ferry continues:

> ...Education is today's real growth industry. The four billion dollars we spent on it at the end of World War II has grown to fifty billion plus--an annual rate of increase of more than twelve percent. New corporate marriages have been hastily arranged. Large hardware companies wed large software companies. The object is profits, not education, although the public relations experts have called on their most dulcet prosody to convey the notion that these new matrimonial arrangements aim basically at the welfare of the educational enterprise, from the grades to the graduate schools.[26]

Alvin Toffler, author of Future Shock, states that even prestigious institutions such as Syracuse University, Stanford Research Institute, and the Organization for Economic Cooperation and Development, are constantly scanning the horizon with these ideas in mind. Unfortunately, relatively few educators have directed attention to the future of education. Perforce, what is needed is a movement of educators and public in recognition of the impact of technology (and industry) on education.

The present-day educational system is undergoing rapid change, but much of this is no more than an attempt to refine the existent machinery, making it more efficient in pursuit of obsolete goals. However, what has been lacking is a consistent direction and a logical starting point.[27]

Although severely criticized for its shortcomings, technology continues its advance into the classroom. Impetus is provided by various organizations, such as the research center for programmed instruction in Albuquerque funded by Teaching Materials, Inc.: in Pittsburgh, the American Institute; in Palo Alto, Encyclopedia Britannica Films; in New York, the Center for Programmed Instruction; in Santa Monica the United States Industries and Systems Development Corporation; in London, Systems Research Ltd., under the sponsorship of the European office of the U. S. Air Force Research and Development Command; and not least, Borg-Warner Educational Systems in Niles, Illinois.[28]

Less publicized, but exerting leadership are leading universities of the nation which have been conducting experiments in programmed learning. Among these are Harvard, (investigations of Douglas Porter); Stanford, (work of Wilbur Schramm), and the University of Illinois (studies of Susan M. Markle). Additionally, but no less dramatically, institutions of higher learning such as Hamilton, Dartmouth, Oberlin and Ohio State are equally pushing forward with comprehensive investigation. Questions such as, "what subjects can be taught, how much time should be spent on machines, what is the role of the teacher, and what makes programmed learning effective?" are being studiously examined.

Today there are a number of teaching machines on the market. Markle states educators must be aware of certain implications when implementing them into their program. She states that a student's performance should be central concern of educators when purchasing such instructional materials. There should be some person in the system capable of evaluating company claims, and checking on valid research studies. Schools should also have clear conceptions of what objectives they wish to attain for their student population. Without determining these objectives, it would be difficult to choose among competing programs. Moreover, statement must be made about the role of the instructor in administering the program if it is to be truly effective. In some of the systems, special materials or considerable training of teachers may be a prerequisite for successful use of the program.[29]

Most educators feel that instruction should be as individualized as possible. However, this does not mean it should be completely random so that each student does what he wants and when he wishes. Some objectives are common to all students. Many educators are becoming restless with the current system in which all students of a certain age go through identical activities for a fixed period of time. Most, if not all programmers opinionate that machines will not replace the teacher. However, it must now be the teacher's task to become a prescriber of instruction based on his knowledge of each child in his class. The materials he assigns will program his students in a moment-by-moment sense. In effect, he will perforce now become a generalized type of programmer. The teacher will be compelled to know much more about different types of learning; strategies of teaching; and methods of measuring learning, because he must assume, in the final analysis, responsibility for student achievement.[30]

Morris, has stated that the results of future research should aid in making possible more reliable evaluation of the effectiveness of programmed instruction and teaching machines. He says present research is too inconclusive and incomplete to support either complete acceptance or indicate total rejection of programmed instruction. Although, we have a tendency to generalize conclusions from limited evidence; nevertheless, experience has shown that teaching machines can teach facts and learning skills well. If properly used, teachers may have more time to devote to more complex educational outcomes.[31]

Some educational critics suggest that as programmed instruction and teaching machines become fixed automated components of the instructional practices of a school, they will occupy about thirty per cent of a student's educational program time. Pupils may be with large groups receiving instruction via television, films, or lectures for thirty per cent of the time. Small groups and individual conferences may then account for another twenty per cent of the time, while independent study may account for the remaining twenty per cent.[32]

Smith and Smith say, "Future computer systems very likely will incorporate visual sensing operations far superior to the verbal and numerical representations now in use." They go on to suggest that visual displays might be sensed and reproduced from thousands of cells in mosaic form, or by integrating computer and television signals.[33]

To interpret these, teachers will have to be trained in programming techniques.

Since elementary schools are taught by teachers who are "human" with all of the diversities, strengths and weaknesses inherent in any activity involving people, there is a need for continuous training of professionals in the wise use of programmed instruction.

TEACHING MACHINES FOR THE CLASSROOM

The recorded patents for educational devices which possess the characteristics of teaching machines, date back to the late nineteenth century. Many educators agree that Sydney L. Pressy should be credited with the pioneer work. It was Pressy who, in 1926, published a paper with reference to a teaching machine designed for drill and testing. He concluded that the time simply was not ripe for public acceptance of automation in the classroom and announced abandonment of his work on teaching machines in 1932.[34]

In 1954, B. F. Skinner, noted for his investigations in operant conditioning and for efficiency of operation, decided to apply his findings about behavior to education. Soon after Skinner published his 1954 monograph entitled, "The Science of Learning and the Art of Teaching" which was later reprinted in the Harvard Review, the most recent teaching machine movement was launched. The accumulated evidence of laboratory studies was convincing and the basic principles as well as the underlying philosophy made sense. In anticipation of the tremendous market for this innovation in instructional materials, companies were created to meet the demand. Almost everyone designed some kind of box with a window in it, influenced by Skinner's experimental device. This permitted a student to see only one or two sentences of a program and a blank suggesting a response. Even programmed texts provided a masking device to permit sight of the given item under consideration, but excluded viewing of the answer. Design variations included innovations such as a flashing light, candy dispensers, correct response counters, and others.[35]

Problems with early machines. Educators soon discovered that many of these devices did not stand up under classroom conditions. In many instances, programs for the machine were not available. Many of the early devices, whether constructed of cardboard, plastic, or metal, were not disigned for ease of operation and suffered from frequent malfunctions.[36]

Gradually, the art of programming became better, more programs became available, and the hardware became more sophisticated. Also at the same time, results from research studies became available. Among these were studies in the merits of both machines and programmed text-books as instructional modes. The studies showed that in situations where either mode seemed appropriate, learners using machines took more time to complete the units, and showed the same degree of mastery as those using a programmed book format. It was therefore suggested that if there are no differences in the mastery, then machines and texts are interchangeable. Since books have become an accepted part of classroom materials, the same program in textbook format is perceived as less threatening and dehumanizing.[37]

Successful uses of machines. The major characteristics of a teaching machine are as follows: the sequential presentation of material, provision for an overt response by the learner, and immediate feedback to the learner informing him of the adequacy of the response. Machines are considered important, because they afford better control in presenting a sequence of material. They can minimize the "teacher effect" in many types of educational investigations, but then, the "Hawthorne Effect" may have some short range implications. In using machines, one can better control the variation in the use of a different manner.[38]

As we look away from the "average" classroom, teaching machines are increasingly valued for qualities not possessed by books. In addition to the control feature which can become important for helping learners who find it difficult to follow directions, appropriate use of extraordinary capabilities of machines provide adaptability to the unique needs of disabled or handicapped students. Examples can be seen in the literature of successful use of specially devised machines such as: teaching reading to young children by way of a "talking typewriter"; teaching speech reading to deaf children via programmed 8mm motion picture films; and assisting the rehabilitation of aphasic patients via a specially designed device.[39]

The advantages of machines become self-evident where they can do things humans cannot do such as; experience perfect recall, engage in endless repetition, show endless patience, and be available when the child is ready to learn.

Current teaching machines. As stated earlier, Professor Sidney L. Pressy of Ohio State University designed the first mechanical teaching machine in 1926. It was about the size of a portable typewriter, and had a window display unit with a question and four multiple choices; four keys to indicate the response, and types sequences of questions (programs) to use in the machine. There was no change in the window when a wrong response key was pressed. Machines have followed this same basic idea to present day developments, however, rather than using mechanical devices, manufacturers are using faster, more quiet, electrical inventions.[40]

The Grolier T. M. I. Min-Max I uses a program sheet that a student pushes up with the end of a pencil eraser. The written answers are covered by a clear plastic mask as the correct answer is shown. Students complained that the paper jammed in the Min-Max I, and that has now been corrected in the Min-Max II with a knob and roller so the student does not have to push up the paper.[41]

The Atronic Tutor has its own texts and gives the right answer only when the correct key is pushed. It is only linear in its programmed operation.[42]

The A.V.T.A. machine uses a magnetic-tape playback and headphones to provide an audio track. This has been a good approach to the teaching of foreign languages and music. This offers a fine program with linear instruction. This audio-visual machine has no branching programs.[43]

The Wyckoff Film-Tutor uses filmstrips operated with a button keyboard.[44]

Professor Harlan L. Lane of the University of Michigan Psychology Department, designed a machine that asks a student a question, records his answer, checks it, grades it, and chooses an appropriate next question. It is called the Speech Auto-Instructional Device (S.A.I.D.), and is primarily useful in teaching certain features of speech.[45]

The University of Illinois has an electronic teacher called the P.L.A.T.O., and can be used to teach any subject from algebra to zoology. (P.L.A.T.O. stands for Programmed Logic for Automatic Teaching Operations.) Its central unit is an electronic computer. Its size and speed of its memory determine how many students it can teach at one time.[46]

Illinois has developed another machine under a grant from the U. S. Office of Education, for use with young mentally-retarded children. The machine contains five programmed cards on each of two parallel drums; a cue drum and a response-term drum. The drums are then rotated by circuit-control discs, which provide the programmed sequence wanted by the instructor. The respondent makes his selection by pushing one of two switches alongside the display window, on the side next to the response term.[47]

The Memo Tutor is a teaching machine that is often used in industry to help in memorizing names of machine parts. It has now been introduced to schools for the purpose of teaching languages. The Memo Tutor is an audio-visual device with a rear screen projection and audio device. The machine pronounces words as they are flashed on a screen. The student then says the words himself. His speech is then recorded on tape, which he re-plays to hear how closely his accent matches the correct one. This provides a major aid to learning according to Dr. B. F. Skinner; immediate reinforcement. This combination of visual images, sounds and the reinforcement, teaches efficiently and pleasantly.[48]

There are over one hundred different teaching machines on the market, ranging in price from five dollars to fifty thousand dollars. The Astra Auto Score is in the lower middle range. Its program is printed on 8½" X 11" sheets, works by multiple-choice. The student reads the question, then selects an answer, and inserts his stylus in a corresponding hole on the right side of the machine. If his answer is correct, the stylus completes an electric circuit and a row of bulbs on the left side of the machine lights up.[49]

The Talking Typewriter was introduced in 1964, and today, hundreds of them are being used in schools throughout the nation. Considered to be on the expensive side, ($40,000), the Talking Typewriter has met with a good deal of success.

Thought by many to be one of the most exciting innovations in modern education, the electronic teaching device is officially known as E.R.E. (Edison Responsive Environment). It grew out of the work by Dr. Omar Khayyam Moore, a Yale psychologist, who discovered that when young children are left to themselves in a proper "responsive environment", they can perform amazing feats of inductive reasoning.[50]

Dr. Moore tried out various situations that would respond to a child's actions and show him what happens. When using the talking typewriter, the child controls the situation and it "responds" to him. The multicolored keyboard offers a clear discrimination of letters. The machine has a lighted screen on which slides are projected, with a window showing letters or words to be copied or which have been typed by the child. There is also a microphone for reading back what has been written. In the operation, many variations are possible.[51]

The E.R.E. has also proved very effective for the handicapped child for a variety of reasons, perhaps the main one being that it guides the child toward success so he cannot fail. By using touch (keys), sight (screen), and sound (voice), a triple sensory impact is made on his mind, that helps him to retain knowledge. Instruction is individualized. This computerized typewriter, with infinite patience, waits for him to master each lesson at his own rate.[52]

A less expensive teaching machine, selling for under fifteen hundred dollars without the softwear, is the Welch Autotutor. Though having no audio, the Autotutor with its tutorial branching system is considered one of the more sophisticated teaching machines. The student sets his own pace with a minimum of supervision. It is selfpacing and has an immediate response-to-success pattern. There is complete control over the learner. Behavioral objectives have been clearly outlined with course contents uniform. The programs pre-establishes a common background of knowledge, and the desired terminal behavior.

The branching technique of programming is a special feature of the Autotutor. It presents the student with instructional material by way of a "program", which is an organized series of logical study units (frames). These are re-projected from within the machine onto a 7" X 9" viewing area. The study units are composed of small portions of explanatory texts together with multiple choice questions to evaluate student achievement. The student selects one of the response buttons to answer the question and this response determines the sequence of frames to follow. If he answers the question correctly, he is presented with a new frame containing the next study unit, followed in turn by its probing question. If he answers correctly, as with typical branching programs, he is presented automatically with a frame containing a more elementary explanation of the original study unit. Only when the student has given evidence of proper understanding, does the Autotutor submit a new study unit.

The "electronic" age of the 1970's promises to be much more sophisticated than the original "boxes with windows." As we can see with some recent developments, they are becoming more flexible, more adaptable to the needs of the individual learner. Research points out the emphasis is on computer-based instruction, complex machines, and sophisticated simulators.

Instructional programs of the future will be emphasizing a "systems approach" broadly applied to the whole variety of materials, media, and learning environments. It will then be up to the teachers or special consultants of the staff, to analyze the learner's needs, and then to prescribe an appropriate instructional environment.[53]

SCHOOL EXPERIMENTS WITH PROGRAMMED INSTRUCTION

Today, many of the teaching machines have disappeared; those remaining are used on an experimental basis until their worth can be better ascertained. Programmed instruction per se however, is still around; an estimated five million students used programmed materials during 1968. Although a few top men in the education field still feel that programmed instruction is a passing fad, other education officials as well as large corporations and well-known foundations continue to study and invest heavily in this form of instruction.[54]

The Carnegie Corporation and Ford Foundation are among those offering grants for the research and possible expansion of programmed instruction. The American Management Association and the National Society for Professional Engineers offer programmed courses to their membership. Professors at twenty-three universities have prepared programs that are "remarkably effective". The Air Training Command, part of the Air Force, is using a total of 339 programmed instruction packages. Due to their effectiveness, the Air Force has directed its technical training centers to use them in airman training programs.[55]

Correspondence schools employ programmed instruction techniques, as seen in the RCA Institute course, "Introduction to Electronics", using a linear programming style called "Auto-Text". The director, Mr. Jack Friedman, says: "Students learn more quickly with programmed material, and they greatly prefer programmed lessons to the conventional type." [56]

In many cases, educators are learning from businessmen how to make maximum use of staff and in some cases how to increase learning through new techniques used in the business world. Mr. Allen Calvin, President of Behavioral Research Laboratories, provides the leadership of one agency helping schools increase achievement results through programmed learning and teaching machines.

Mr. Calvin's company recently published the results of a one year study in a public school. The firm has brought major improvements in some of Gary, Indiana's inner city pupils reading and mathematics skills. It is also doing so, according to Mr. Calvin, for less money than the school system ordinarily spends.

Mr. Gordon McAndrew, Gary school Superintendent, said tests scores for the first year show that 75 per cent of Banneker Elementary School children, under the controversial performance contract, will graduate at or above grade level. Before the program, 75 per cent of the students were below grade level. The gains were cited at all grade levels, with ninety per cent of the school's kindergarten pupils scoring at or above national averages in "readiness" by school work. The first grade students in one year were achieving an average of a year and seven months in both reading and mathematics. The second through sixth grades recorded 72.5 per cent had made average or better than average gains, and 32 per cent gained a year and a half or more.[57]

Mr. McAndrew, in a press conference, disclosed that the program cost about $830.00 per pupil and the city-wide average is $924.00. Thus, representing a savings of $94.00 per pupil.[58]

The school district released the results of a survey which showed that 87 per cent of the parents believe the program should continue, 79 per cent thought their children made greater improvement in reading than last year, and 71 per cent reported that their children read more at home now.[59]

The notion of performance contracting has been a controversial subject, opposed by teacher organizations on grounds that it dehumanizes education and presents a temptation to teach to the test.

Other performance contracting using programmed instruction now in operation, have strict rules of operation with clear cut objectives and independent testing services.

Duval County, Florida is involved in project IMPACT, (Instruction and Management Practices to Aid Classroom Teaching); funded by the county school board and Title I. The contractor is Learning Research Associates and the testing auditor is Educational Testing Service. Their contract objectives are to raise I.Q.'s of elementary pupils and increase content achievement.[60]

Mesa, Arizona is trying to determine if the use of student and teacher incentives can accelerate mastery of basic skills by disadvantaged students. The contractor is the Mesa school district and the Mesa Education Association. The evaluator is the Battelle Memorial Institute. Here, students are given rewards such as candy, small toys or extra time to play games in an attempt to reward scholastic achievement and modify behavior.[61]

In an attempt to identify potential dropouts at an early stage of development, Dallas, Texas, under the Quality Education Development Corporation and Education Turnkey Systems, Inc. with Battelle Institute as an evaluation, are embarking on an ambitious project. The program ability.[66]

Dr. Robert G. Scanlon also studied reading achievement with the use of Individually Prescribed Instruction (IPI), in Philadelphia, Pennsylvania. He found this method to be significantly superior to the usual reading programs, however, there were a number of problems in organization and administration that had to be worked out.[67]

Also in Pennsylvania was a study by Dr. Marilyn Suydam, Professor of Math Education at Pennsylvania State University. In a project which involved a 15-week unit in individual spelling instruction, using programmed instruction, the better spellers were able to cover the ground quickly, in many cases only four weeks. The slow learners, took the entire learning period. Dr. Suydam contends that the advantage of machines and programmed instruction is that the student can know immediately whether he is correct, and if he is wrong, he is able to retrace his steps and discover where the error occurred.[68]

Educators of today realize that teaching at any level is no longer a one man job. Today's pupils are quite sophisticated, and used to modern communications media. The vast array of available media makes the classroom teacher ask, "How can I make a choice between these programs? Which is the best for my particular pupils at their age level? What may I expect from each type of program or device in terms of potential to meet learning needs?"

The following experiments may help provide answers to the foregoing questions.

An experiment designed to compare programmed learning with conventional procedures and materials was studied by Banghart, McLaulin, Wesson and Pikkart.[69] Fourth graders were studied and compared. The experimental group used programmed learning, and the control group used conventional methods to study arithmetic. The authors concluded there was no difference in achievement between the control and experimental group. However, programmed learning was reported to be an efficient tool of learning. The experimental group finished the materials in less time than the control group.

Robert Kalin conducted research on material designed to teach advanced mathematics to elementary school students who were intellectually superior fifth and sixth grade pupils in a Florida school. His research involved the use of his program, constructed to teach equations and inequalities in mathematics. The experimental group studied the programmed textbook, and the control group worked with the regular text. The results of the experiment showed that there was no significant difference in the means of the scores when compared. Mr. Kalin stated: "Results indicated that intellectually superior fifth and sixth grade pupils can learn a particular advanced topic from a programmed text in less time than the conventionally taught group."[70] There was relatively equal achievement between groups of subjects.

Evan Keislar examined subjects who studied the concepts of squares, rectangles, length and width in a multiple-choice program.[71] The material was prepared on film and projected on a viewing plate. The fourteen experimental subjects who worked with programmed learning and the fourteen control subjects who worked in the conventional instruction, had been matched on the basis of intelligence, sex, reading ability, and pre-test scores. They were fifth and low sixth grade students. The consequences of the experiment indicated that all but one subject in the experimental group showed a greater variance in the score on the post-test score that the control subjects. Thus, it was reported that programmed learning was more effective than conventional instruction.

Another experiment with programmed learning was reported by Buzby and Mann.[72] The investigation compared automated teaching of spelling with classroom instruction and flash cards together with the text. The fourth grade subjects were grouped into three classes -- accelerated, average, and slow. The results of the study explained that there was no significant difference in achievement between the experimental and control groups. As the authors indicated "...the use of the T.M.I. Self-tutoring Program in Spelling does not appear to hold any advantages over the ordinary classroom."[73]

In another spelling study, Douglas Porter of Harvard, evaluated programmed learning in spelling by comparing it with conventional instruction.[74] The experiment was two-fold in nature. It also compared subjects according to the relationship of intelligence to achievement. The outcome of Porter's experiment with sixth and second grade students, revealed that the experimental group achieved a significantly higher score, thus favoring programmed learning. It was evident that there was a relationship between intelligence and achievement which favored children of higher intelligence.

Alice Edgerton and Ruth Twombly studied the effectiveness of spelling with programmed learning compared to conventional methods among subjects who were heterogeneously grouped third graders.[75] The groups contained subjects with like intelligence and achievement level. The effects of the experiment on the students indicated that the experimental group did not achieve significantly different results as compared to the control group. Both methods of instruction produced achievement in students studying spelling.

Fincher compared achievement results of heterogeneously grouped fifth grade subjects who used programmed learning in addition and subtraction of fractions with subjects who used conventional classroom instruction.[76] The program used was presented in a programmed text. The gain was in favor of the experimental group. The programmed learning had more desirable results than conventional instruction. Thus, programmed learning proved effective for teaching drill.

In a study to determine the effectiveness of programmed learning compared to conventional instruction, Dessart compared a linear and a branching program with conventional instruction.[77] The programmed learning was designed to teach divergence and convergence of infinite series to superior eighth grade students. The subjects were the intellectually superior students in a Maryland school. The study showed no significant differences between the two programs and conventional instruction. One conclusion reported was that the teacher-taught material required more time to complete.

O'Toole compared programmed learning effectiveness in a study designed to determine spelling achievement of subjects in the fifth and sixth grades.[78] The experiment questioned the attitudes of the students and the faculty. A group using programmed learning was compared with a group studying in the conventional classroom. The author found a significant difference in favor of the experimental group in programmed learning. Student and faculty attitudes showed they favored programmed learning as to effective use of time.

An experiment designed by Wesson tested the effectiveness of four approaches to teaching elementary school arithmetic.[79] The four methods were conventional standard textbook instruction, and three different constructed-response linear programs. The fourth grade subjects, who took part in the experiment, were tested. The results indicated no significant difference in mean final achievement test scores for the four treatments. Wesson explained that programmed learning could be used effectively to teach elementary school arithmetic, but that it had no special advantages over conventional instruction.

Dutton studied the achievements of fourth grade pupils in science - sound, light, and heat.[80] Mr. Dutton wanted to determine the effect of programmed learning to conventional instruction. The subjects were randomly assigned to two groups, heterogeneous in nature. Learning achievement for the experimental group was significant when compared to the control group. The experiment indicated that the utilization of programmed learning can teach science concepts effectively, and more efficiently than conventional practices.

Henry Fillmer studied programmed learning in English.[81] He studied two sets of fourth grade subjects in learning English verb usage. One set had intelligence quotients above 115 and one set with intelligence quotients below 100. The results of the experiment indicated that there was no significant difference between the control and experimental groups at either intelligence level. However, the author indicated that the programmed learning was more effective for pupils with an IQ above 115. In addition, he explained that programmed learning attributed a substantial saving of instructional time.

Smith studied subjects in fifth grade who learned fractions in the classrooms by programmed learning and conventional instruction.[82] Subjects were assigned to groups according to their mental ability. The subjects were tested for their arithmetic achievement, and the results of the gain in achievement determined the conclusions. The information gained in the study showed no significant modification of abilities, and the subjects had nearly the same achievement. Thus, no relationship between mental ability and achievement was evident in the experiment.

Smith and Moore reported a pair of experiments in programmed spelling.[83] In one experiment, a group of sixth grade subjects with intelligence quotients from 67 to 123 were randomly assigned to experimental and control groups. The groups studied spelling for fifteen minutes each day in the school year. The authors noted that cheating was very evident in the performance of the subjects. There was no significant difference between the programmed learning and conventional instruction among subjects of the selected IQ range. In the second experiment reported by Smith and Moore, another group of sixth grade subjects studied spelling. The experiment compared programmed learning with conventional instruction. The pupils were randomly assigned to two heterogeneous groups; they had an IQ range of 81 to 128. The results of the experiment indicated that there was no significant differences between the groups. However, cheating was eliminated by presenting material on a teaching machine.

Keislar and McNeil experimented with primary grade subjects in the field of science and compared programmed learning to conventional instruction.[84] Some 300 subjects in the primary grades studied science for 20 minutes per day. The outcome of the experiment among the heterogeneously grouped students showed that there was no significant difference between experimental and control groups.

In another experiment, Keislar and McNeil studied a group of primary grade subjects who studied mathematics in the classroom, and they used programmed learning. The investigation centered around first grade subjects. The two groups of control and experimental subjects were grouped heterogeneously. There was no significant difference between the groups. Among the four tests given, only one demonstrated a measurable difference in favor of the experimental group and programmed learning.[85]

Goldberg reported a study in programmed spelling with second grade subjects grouped according to reading ability.[86] The median IQ of those studied was 104. All subjects were slow readers, below average in spelling achievement. The author indicated that the students learned by using programmed instruction, but did not reveal how much the other subjects in school contributed to achievement in spelling. The ex-group was not compared to other students in the regular classroom.

In an experiment with fourth and fifth grade subjects, Schutz, Baker, and Gerlach studied subjects with various achievement levels and compared their achievement when they studied capitalization of words.[87] The pupils used a special program that taught them how to use the rules of capitalization. The resultant findings clearly illustrated that subjects with higher ability and achievement levels scored higher on the post-test. Thus they achieved at a higher rate. The high achievers learned to capitalize words, and developed more background from the information presented.

Keislar and McNeil taught subjects to give scientific explanations of physical phenomena by learning the theoretical language for dealing with such events.[88] The subjects were first graders, assigned to an experimental group according to their verbal ability. The findings indicated that programmed learning was more effective in teaching first grade children with high reading readiness and high verbal ability.

The same authors experimented with programs used to teach reading.[89] They used first grade students, paired according to IQ and reading readiness scores. The subjects had a mean IQ of 107, with a range of 72 to 138. The conclusions demonstrated a disadvantage in the use of programmed learning to teach reading to first grade subjects among students of lower IQ. Conventional instruction was a more effective means of instruction. All of the students achieved some degree of reading achievement according to the test results, but the achievement was directly related to intelligence.

A study conducted by Andrews compared intelligence and achievement and their relationship to the study of mathematics at the sixth grade level.[90] The subjects were grouped according to their intelligence, mathematics achievement, sex, and post-test scores. They worked independently and at their own rate with the program. The evaluation indicated that there was a positive relationship between intelligence and mathematics achievement when the subjects used the program. Students with higher intelligence quotients, scored higher on their achievement test in direct proportion to their intelligence, and the girls scored higher than the boys in the experiment.

Belton studied subjects in the intermediate grades in the Milwaukee, Wisconsin, schools.[91] The students learned mathematics through programmed learning. They were grouped according to intelligence, arithmetic achievement, anxiety level, motivation level, and dependency level. Unfortunately, a reading test was not administered. Belton did not report a significant difference in achievement for subjects in the experiment. None of the variables was found to affect the achievement results because all of the subjects learned mathematics with programmed learning.

Blank designed a study to measure achievement in ability to ask questions about science, arithmetic, and social problems. The sixth grade subjects were grouped according to intelligence and achievement -- high, average and low. The subjects studied programmed learning and general principles of questioning. The results of the experimental groups who studied programmed learning were positive. However, intelligence and ability levels did not directly relate to achievement.[92]

An experiment by Cassel and Ullom measured the achievement of corresponding typical and average students in grades nine through twelve.[93] The subjects learned computer arithmetic. The experimental group studied programmed learning, and the control group studied in the traditional setting. Comparisons of groups showed significantly greater learning by those in the experimental group. Both groups attained a high degree of achievement, but the programmed learning was more effective.

Kreklow reported a six month increase in reading performance of a subject labeled "slow learner" after devoting one summer session to instruction in reading using the Borg-Warner Systems 80 reading program.[94]

Ellson found a 43 to 70 percent reduction in failure of disadvantaged first graders after using programmed material and paraprofessional tutors in Indianapolis, Indiana. In this study, two thousand students tested during the 1971-1972 school year showed significant gains in achievement over the non-treatment group, with only one percent failing to respond. The subjects represented those who ranked in the bottom third of first and second grades in inner-city schools that qualified for Title I funds under the Elementary and Secondary Education Act.[95]

In August of 1971, Bauer and Hallfy reported a study of variables affecting the performance of retarded junior high school students who used the Borg-Warner System 80 machine.[96]

The subjects were three retarded girls enrolled in the Special Education summer campus laboratory school at San Diego State College. The two subjects, chosen to work under the experimental condition as a heterogeneous pair, were selected on the basis of reading ability levels and IQ scores. The higher ability pair member (S_1), had a Stanford Binet (LM) IQ of 86, and a Gray Reading Test Score of 1.3. The lower ability pair member (S_2), had an IQ of 64 and a reading score of 1.4.[97]

The third subject (S_3), was selected to work on a contingency basis under the experimental condition. She had an IQ of 56, and a reading test score of 2.9, and a reported impairment of visual motor function.[98]

Three conditions were used in the experiment. Condition "A", represented working alone, condition "B", working with another student, and condition "C", returned to working alone. S_3 substituted condition "B", with reinforcers of plastic markers and candy.[99]

The results favored the low ability pair member while under condition "B". The high ability pair member did not profit significantly. The question of the effect of tangible reinforcers as a supplement to the intangible reinforcement built into System 80 was unresolved by this experiment.[100]

It was the opinion of the researchers that retarded junior high students can use Reading Words in Context with a few possible adaptations.

Hardware

1. The System 80 headset did not eliminate much of the normal noise found in a classroom.

2. The System 80 console and controls provided stimuli that proved too distracting.

Software

1. The lesson content of Reading Words in Context was geared to the primary student. Many retarded students who read at the first or second grade levels are socially mature and are more highly motivated by frames depicting parties and beach scenes, rather than frames depicting storybook characters and familial relationships.

2. Discrimination and perceptual disorders may have caused some of the subjects to fail to notice the differences between certain words (confusion of he and we or home and some). Although seeing the general configuration of the picture frames, subjects still missed the details.

A non-parametric statistic was used to determine if there was a significant relationship between outcomes. This was indicated at the .02 level, and suggests that further research into the ability of some retarded students to decode pictures fully may prove fruitful.[101]

Bauer and Hallfy concluded that in the cases sampled, there were immediate and positive reinforcement that apparently aided learning. Therefore, there is some evidence that with the modifications mentioned earlier, junior high school students may be able to benefit academically through the use of teaching tools exemplified by the Borg-Warner teaching machine.

Summary

The purpose of this literature review was to describe some existing practices and developments in programmed media.

Although programmed learning is based upon certain defensible laws of learning as postulated by Pressy, Skinner, Porter, Mackle, and others, the effectiveness of programmed instruction is still questioned.

Current studies provide some documentation of the effectiveness of programmed media which lends some support to the notion that some students will do as well or better than other students working with conventional teaching tools.

Reinforcement theory is fundamental to an understanding of programmed media. Whether structured into a media machine or a programmed text, each manifests three essential characteristics: (1) presents a sequence of problem materials to the student; (2) provides some means by which the student may record his solutions to these problems; and (3) makes immediately available verification of the response. Apparently, programmed instruction enables the individual to master its content through completion and progression.

In the studies reviewed, there is some evidence that programmed media was able to contribute to learning by improving achievement, by reducing learning time, or in some cases do both. In addition, student attitude appeared to be positive. Achievement, reduced learning time, and positive student attitudes are of critical importance in assessing instructional media or methodology. Consequently, any teaching procedure offering these advantages warrants careful consideration.

The most consistent findings in the review of the literature was that students using programmed media learned equally as well as students using conventional media with commonplace techniques. However, they frequently learned in less time than those students employing conventional media. These studies have introduced an important concept into education which may be expected to influence the future thinking of educators and teachers. Efficiency and effectiveness were combined to bring about learning achievement, and although there were several studies which illustrated that programmed media was not more effective than conventional instruction, the basic premise remained; students learned when they use programmed media. The conclusion could be made that from the studies selected, programmed media was effective as a teaching process, but there was no indication that it surpassed other means of instruction in its effectiveness. The only exception was with pupils of higher ability who had better scores and higher gains in achievement when they used programmed media. Coupled with increased efficiency, it was possible to endorse programmed learning as a teaching process for the gifted student.

Four questions were posed in Chapter I. The purpose of this was to delimit the problems associated with programmed media. The first question asked, "Which subject matter can be taught most effectively using programmed media?" Keislar, Porter, Fincher, O'Toole, Goldberg, Schutz, McNeil, and Nichols reported that programmed media was most effective in teaching material that was highly structured, i.e., those subject matter areas which contained factual information. It was used most effectively when the program was organized to present background information. Programmed media was used to deal with issues that needed clarification or emphasized subject matter which ranged in nature from capitalization of words and question development, to algebra and arithmetic. In these studies, programmed media was used to teach isolated skills, such as: various computational proficiencies in arithmetic; reading of graphs and tables; vocabulary development; structural analysis; comprehension development in English; learning letter sounds in reading, and enrichment in science.

Question two was, "How effective is programmed media with students of low, average, and high intellectual abilities?" Studies reported by Porter, Fillmer, Keislar, and Schutz demonstrated that programmed media was most effective when used by students of high intellectual ability. Consequently, programmed media was not as effective for students with low or average abilities.

Students in all ability levels learned in varying degrees through use of programmed materials. It has value for the intellectually superior student, simply because it permits him to learn faster. Although the experimenters concluded that despite the results, it is very likely that good students will excel with or without programmed media.

The average student also learned through use of programmed media, however, the degree of learning was considerably less than that for the more capable students. Experiments by Buzby and Mann, Edgerton and Twombly, Wesson, Fillmer, Smith, Keislar and McNeil, Belton, Bauer and Haffly, and Kreklow, showed that slow learners could learn when they used programmed media. However, none of the studies demonstrated significant achievement among this group.

Question three asked, "How effective is programmed media with under-achievers, average-achievers, and over-achievers?" The answer was not ascertainable from the literature due to the structure of the studies. However, in studies where subjects were grouped according to achievement level, the pupils did achieve desirable results at all achievement levels.

Question four read, "On which grade levels can programmed media be used effectively?" Programmed media was reported to be effective at all grade levels, from kindergarten through the eighth grade. The subject matter included reading, arithmetic, spelling, science, and geography.

In summary, the results indicated that programmed media is an effective learning tool. There were consistent reportings indicating that subjects using programmed material learned at least equally as well as pupils who learned in the conventional classroom with conventional teaching, and the students often learned in less time when they used programmed media. Moreover, students at all levels of ability used programmed media and achieved desirable results. However, there was no evidence that subjects with below-average, or average ability would not have done equally well using conventional media. Only those subjects with above-average ability showed significantly higher achievement. It was found that subject matter having a more rigid form or arrangement of its elements was taught most effectively in this mechanistic manner. In conclusion it may be said that important variables effecting outcomes were, the availability of the programs, the type of students to be taught, and the subject matter to be presented.

FOOTNOTES--CHAPTER II

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CHAPTER III

METHOD

Population and Experimental Description

For this study, a learning center laboratory approach was used. Seven System 80 audio-visual units were placed in a central location within the test school. On a daily scheduled basis, those children identified as the experimental group left their regular classrooms, came to the learning center and took a lesson on the System 80 audio-visual unit. East session lasted approximately 15 minutes.

The experimental group consisted of children who showed a need for the subject matter taught in System 80 lessons. Group administered achievement and diagnostic tests were used to select the experimental subjects. The control group consisted of the remainder of the children from the classes from which the experimental children were drawn.

The study lasted nine weeks, but because of the individualized nature of the program, the number of lessons taken by each child in the experimental group varied. See Appendix p. for Mean Number of Lessons Taken by Subject - Learning Letter Sounds and Reading Words in Context.

The school for the study was selected by officials of the participating school district. It was located in a suburb northwest of Chicago. The neighborhood served by the school consisted principally of relatively expensive single family homes. According to the 1970 U.S. Census, most of the children's parents were in what are generally considered professional occupations. The average family income was estimated at $20,000.

The programs analyzed in this study were Kits C, CC and D of the Learning Letter Sounds series, an individualized audio-visual phonics program and Kits I, J and K of the Reading Words in Context series, an individualized audio-visual reading program. The phonics program provides instruction in identification of initial consonants, initial blends and digraphs. The reading program stresses the mastery of high-frequency vocabulary items.

In System 80 programming, tasks are presented in simple sequential increments. Each task must be completed successfully before the next is presented. The material is presented in such manner that the child is immediately apprised of the correctness or error of response.

Learning Letter Sounds

The Learning Letter Sounds program is two-tracked: a basic series identified by single letter designation, i.e., Kits C, D, E, etc.; and an applied series, identified by double letter designation Kits CC, DD, EE, etc.; which presents more diversified practice of the skills taught in the basic track.

Selection of Subjects

For the phonics study, four kindergarten classes were screened on the Borg-Warner Learning Letter Sounds Prescription Test and the Borg-Warner Learning Letter Names Prescription Test. It was anticipated that there would be sufficient children who knew the names of the letters (an entry requirement for the program) but not the associated sounds (the content of the tested programs) to make up both control and experimental groups of reasonable sizes.

However, this proved not to be the case. There were only a few children who did not know the letter sounds. Moreover, most of these children who did not know the letter sounds did not know the letter names - an entry requirement for the programs to be tested. Because of this, it was decided to take all kindergarten children who knew neither the letter names nor sounds and identify them as the experimental group. Those who did not know the necessary letter names were instructed until attainment of mastery through Borg-Warner's Learning Letter Names program before being placed in the phonics lessons. The remainder of the kindergarten children in the four classes from which the experimental children came were designated as the control group.

Reading Words in Context

Much the same situation existed regarding the reading portion of the study. The intent of the test was to study the effect of Kits I, J and K. However, prior to performing in those levels it was necessary for the children to have mastered all the words covered in Kits A thru H. Therefore, it was necessary to find children who had mastered the 300 words covered in the lower levels but who still didn't know the words taught in Kits I, J and K. Given a longer time span, this task presents no difficulties. Children were selected who were below the entry standards for Kits I, J, K and then taught the necessary vocabulary until prepared to enter the desired kit. However, in this study the closeness to the end of the school term made this a less than effective solution.

Eleven children who most closely approximated the entry requirements for <u>Reading Words in Context</u> Kits I, J and K were selected for the experimental group. The remainder of the children from their classes were then considered as the control group for comparison purposes.

However, all of the children selected for the experimental group had to take lower level lessons to bring them to a point where they could enter the I, J or K Kits.

As the data will show, because of the relatively short duration of the study, only five children completed Kit I of the <u>Reading Words in Context</u> series.

MATERIALS AND APPARATUS

System 80 Rationale

System 80 consists of an audio-visual unit which utilizes programmed instruction materials. These instructional materials present tasks in a simple step-by-step progression. The lessons move from easy tasks to more complex ones, and each task must be completed successfully before the next problem is presented. The method is based upon evidence that immediate and positive reinforcement aids learning and that systematic repetition and review help the student retain what he has learned. The unit is operated by one student at a time.

System 80 Components

The System 80 audio-visual unit resembles a small table television, 13" high, 18½" wide, and 16" deep, which weighs 36 pounds. It is constructed of welded steel with a die cast aluminum front and a fiberglass cover.

The front of the unit contains five response buttons placed directly below a 4" X 8" rear projection screen. To the right of the screen is an enclosed speaker and below the speaker is a filmslide slot. At the far left on the front base are two earphone jacks. When earphones are plugged in, the speaker is automatically shut off so that only the person or persons using the earphones can hear the audio. The audio is produced by a record which fits into a record slot at the top of the unit.

Three parts on the front of the unit are manipulated:

1. The record door across the top of the unit
2. An on-off switch to the right of the screen
3. A focus adjustment knob at the far left of the base

In addition, there is a volume control knob which is under the base at the rear of the left side of the machine.

The program or software components of this system are a record and a filmslide.

The record contains eighty audio messages which are synchronized with a visual frame in the filmslide. The record is labeled with the lesson letter and number, a circle for side one, and a triangle for side two.

The filmslide consists of a 35mm. filmstrip containing eighty full-color frames laminated and enclosed between plates of clear plastic. A response coded strip of plastic is located on either side of the filmslide and it advances the frames. A tab on the end of the handle indicates the lesson and the circle and triangle side of the filmslide to correspond to the record.

System 80 Programs

Learning Letter Sounds

This series has been designed to provide individualized instruction in those sound-letter relationships that research has shown to be most useful to beginning readers.

The program teaches initial consonants, digraphs, blends, and vowels as they appear within whole words which occur with high frequency in children's speaking vocabularies. Whenever possible, these words are illustrated or used in sentences to give them context.

There are two parallel programs - the Basic Phonics program identified by a single letter (Kits C-H) and the Applied Phonics program identified by a double letter (Kits CC-HH). The Applied Phonics program provides additional practice and enrichment exercises for the phonic skills taught in the Basic Phonics program.

There are six Basic Phonics kits and six Applied Phonics kits. Each kit contains six instructional lessons, two branching review lessons and a test lesson.

Reading Words in Context

This series has been designed as a supplement to any basal reading program; it teaches a vocabulary of approximately four hundred high-frequency beginning reading words in sixty-six instructional lessons and thirty-three review lessons. There are eleven levels in the series (Kits A - K). However, only Kits I, J, K were selected for inclusion in this study. The vocabulary taught in the program was selected because of its importance in primary reading instruction; the words correlate highly with the vocabulary used in most primary basal readers. The words are presented in the lessons in the order of their frequency of use in the speaking vocabulary of primary grade children.

These words are presented in meaningful context situations in the programs, so that in addition to improving sight vocabulary, reading comprehension and listening skills are also increased. Both oral and visual discriminations are required for a correct response.

Each Reading Words in Context kit contains six instructional lessons, two branching reviews, a cumulative review of the entire level and a test lesson.

TESTS AND MEASUREMENTS

The tests listed in this section were administered before and after the experiment to both control and experimental groups.

The following tests and measures were used in conjunction with the Learning Letter Sounds study:

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST:

Kit C Side 1 and 2

Kit D Side 1

The Borg-Warner Learning Letter Sounds group tests are designed to measure the child's ability to recognize initial consonants, blends and digraphs. This skill is measured by asking the child to identify whole words or the first letter or letters of words given to him orally.

The following tests were used in conjunction with the Reading Words in Context study:

Stanford Achievement Test

Word Meaning

Primary II Battery

Form W^2

The Word Meaning subtest of the Stanford Achievement Test "consists of 36 multiple-choice items, graduated in difficulty, which measure the ability of a pupil to read a sentence and to select a correct word to complete the sentence."

BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST (Kits I, J, K Side 1)

The Borg-Warner Reading Words in Context Tests are group-administered tests designed to measure a child's word recognition ability. This is done by asking the child to choose a word, which is read to him orally, from a group of words consisting of the spoken word and three other words similar in configuration.

CHAPTER IV

PROCEDURE

The two System 80 programs, Learning Letter Sounds (Kits C, CC and D) and Reading Words in Context (Kits I, J and K) were tested for a period of approximately nine weeks in the late spring of 1971.

The school in which the programs were tested served an upper middle class suburban community. Generally, the children were high achievers on nationally standardized tests. Group screening tests (see Appendix) were administered to the kindergarten, first and second grades. The most appropriate population for the Learning Letter Sounds program was found in the four kindergarten classes; the Reading Words in Context population was taken from two first grade classes.

Consequently, it was decided to take the lowest achieving children in both the kindergarten and first grades and through administration of lower level Borg-Warner individualized instructional programs, bring them up to the point where they could effectively take the kits that were to be analyzed. For purposes of data analysis only those students who completed at least one kit in the target System 80 program are included in this study. The control group was considered to be the rest of the children from classes from which the experimental children were chosen. For the phonics program, of the twenty-four children who were selected for the experimental group, eighteen reached and completed at least Kit C. In the reading program, four children out of eleven reached and completed at least Kit I.

The procedures used in implementing the System 80 programs followed those recommended in the teaching manuals for the programs with the following exception: results of machine pre- and post-tests were verbally verified by the on-site school testing staff.

Learning Letter Sounds

Both the control and experimental groups were pre-tested and post-tested with the following measures:

1. Side 1 Kit C Learning Letter Sounds Prescription Test
2. Side 2 Kit C Learning Letter Sounds Prescription Test
3. Side 1 Kit D Learning Letter Sounds Prescription Test

These tests were administered in the classroom to experimental and control groups simultaneously by members of the school testing staff.

These tests indicated that twenty-four children showed sufficient lack of letter sound mastery; consequently, it was opinionated that they could profit from Kits C, CC and D of the Borg-Warner Learning Letter Names Prescription Test. On the basis of this data they were prescribed lessons in the alphabet program. After they had mastered these lessons, they were placed into the Learning Letter Sounds program.

Reading Words in Context

Both experimental and control groups were administered the following tests before and after the System 80 treatment. These tests were administered in the classroom to both groups at the same time.

1. Side 1 Kit I Reading Words in Context Prescription Test

2. Side 1 Kit J Reading Words in Context Prescription Test

3. Side 1 Kit K Reading Words in Context Prescription Test

4. Word Meaning subtest, Stanford Achievement Test

Data will be presented for those children who completed at least one level of the I, J or K kits. Of the eleven children identified as experimental group subjects, only five finished at least Kit I. This was because the group required a large number of lessons in the lower level kits.

Experimental S's were prescribed lessons individually according to the results of machine-administered pre-tests. When a teaching lesson was assigned, the appropriate review lesson was also assigned. Upon completion of a prescription, a machine administered post-test was given. Children who made no errors on the post-test were then given the pre-test for the next higher level. If the post-test revealed any deficiencies, the child was given the appropriate lessons to develop the necessary skill.

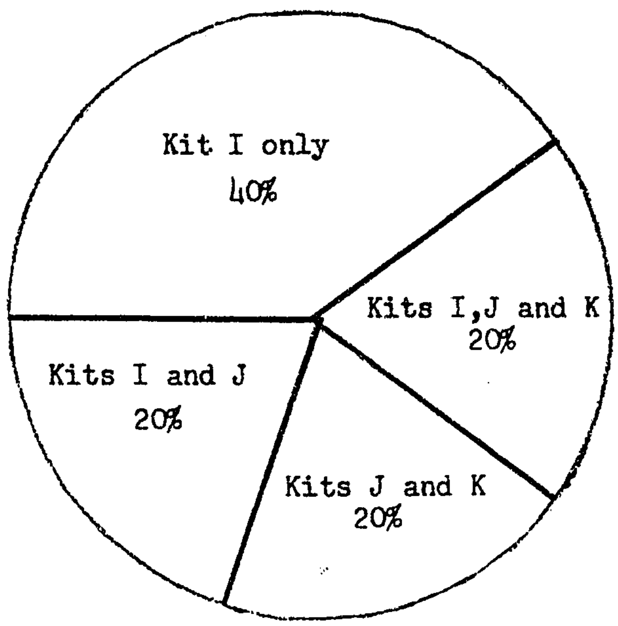
Graph 1 below shows the level achieved by the subjects in the experimental ~~group taking~~ Reading Words in Context at the close of the study.

Graph 1

KITS COMPLETED

READING WORDS IN CONTEXT

N=5



CHAPTER V

RESULTS AND INTERPRETATION

The data presented in Tables 1 to 14 and Graphs 1 to 12 show the analysis for the two programs studied: Learning Letter Sounds and Reading Words in Context.

Analyses of differences and other statistical tabulations were computed on all of the tests used as pre and post measures in the study. A statistical comparison in this study is considered significant only when it exceeds the .01 level.

As has been indicated, and as the data will show, the S's selected for the experimental group were not similar in pre-test performance to the S's used for control purposes.

In fact, the experimental groups' performances on the pre-tests were significantly lower. Therefore, instead of the usual test situation wherein one of two equal groups is given a treatment with the expectation that the treatment effect will cause a difference and make the two groups unequal in some respect, this study begins with two unequal groups with the treatment applied to the lower achieving group. In this case, the anticipation is that the treatment will result in such improvement in performance of the experimental group as to bring about an equality of the two groups, or movement in that direction.

Learning Letter Sounds

Both the experimental and the control group were administered the thirty-six item Borg-Warner C level Prescription Test and the eighteen item Borg-Warner D level Prescription Test.

Of the 24 children originally assigned to the experimental group, eighteen learned all their letter names and completed at least one level of the phonics program.

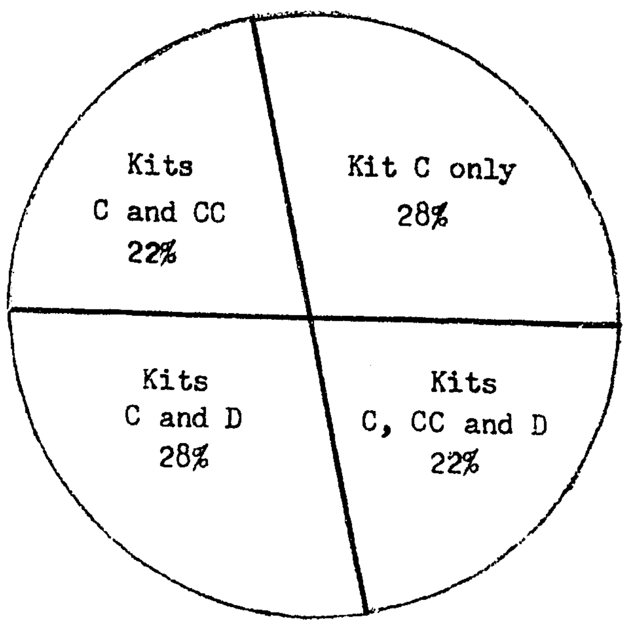
Graph 2 indicates the level achievement of these eighteen children.

Graph 2

KITS COMPLETED

LEARNING LETTER SOUNDS

N=18



All of the children used in this study were selected from the four kindergarten classes in the school.

Table 1 indicates the class and boy/girl distribution of the experimental and control groups. Though there were a total of 109 experimental and control students, information is given below on only those subjects who worked within the levels being evaluated.

TABLE 1

PLACEMENT AND BOY/GIRL DISTRIBUTION

LEARNING LETTER SOUNDS

Class	Sex				
	Experimental		Control		
	Boys (N=14)	Girls (N=4)	Boys (N=42)	Girls (N=43)	Total (N=103)
A	2	0	12	11	25
B	5	1	10	8	24
C	4	0	9	14	27
D	3	3	11	10	27

As Table 2 shows, there was only .4 of a month difference between the mean ages of the control and experimental groups. This difference was not statistically significant.

TABLE 2

ANALYSIS OF DIFFERENCE

AGES IN MONTHS

LEARNING LETTER SOUNDS

Variable	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Age	18	72.5	3.07	85	72.1	3.17	.86

TABLE 3 shows the performance of the two groups on the Kit C Prescription Test.

TABLE 3

ANALYSIS OF DIFFERENCE

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST

KIT C

Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	18	12.33	4.39	85	28.09	6.77	9.4408*
Post-test	18	24.16	7.19	85	31.71	5.71	4.8572*

*p .01

The pre-and post-test means of the two groups show that the experimental group went from a mean pre-test score of 12.33 to a mean post-test score of 24.16. This represents an improvement of almost one hundred percent.

The control group also showed a gain from a mean raw score of 28.09 to 31.71. The percent improvement is not as dramatic simply because the control group pre-test score was already very close to the ceiling limit of the test. (36).

As Table 3 indicates, while the difference between the two groups is less on the post-test ($t = 4.8572$) than on the pre-test ($t = 9.4408$), both differences were found to be statistically significant at a greater than .01 level.

As a further method of analyzing the data, the performance of the experimental group was compared with the performance of the lowest quartile of the control group. This was done in order to obtain a comparison of performance between two groups that resembled each other more closely on pre-test scores. The large size of the control group made this a practical approach.

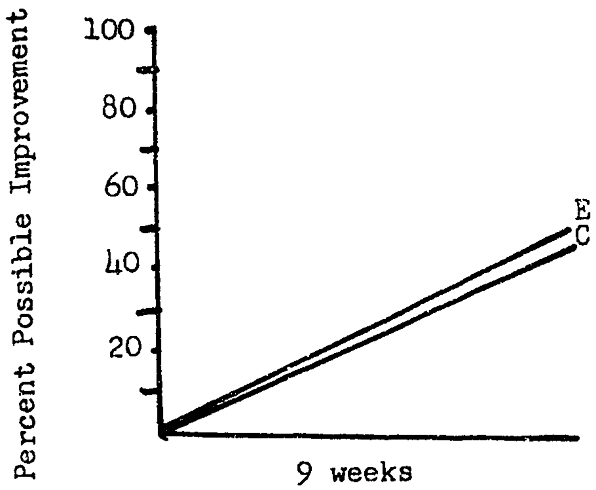
Graph 3 shows the mean percent of improvement of the two groups for the period tested. The percent figure illustrated in the graph is the percent of total possible achievement. This chart depicts the fact that the experimental group learned 50% of what it could have, while the control group learned 46% of its potential possible gain. Since the experimental group had obviously not gained at this rate before - if they had they would not have been significantly lower than the control group on pre-test scores - the data suggests that the treatment has increased the learning rate for the experimental group children. It is not unreasonable to assume that the rate of learning would not have accelerated without the intervention of a new instructional mode.

Graph 3

RATE OF POSSIBLE IMPROVEMENT

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST

KIT C



E = Experimental group gain

C = Control group gain

TABLE 4 indicates that while there is still a large difference between the pre-test means of the two groups, the post-test mean difference is quite small.

TABLE 4

ANALYSIS OF DIFFERENCE

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST

KIT C

EXPERIMENTAL VS. LOWEST CONTROL QUARTILE

Test	Experimental			Control (Lowest Quartile)			t
	N	Mean	SD	N	Mean	SD	
Pre-test	18	12.33	4.39	21	18.61	3.63	4.8883*
Post-test	18	24.16	7.19	21	25.80	7.03	0.7194

*p .01

As the table above shows, the pre-test difference between the two groups was significant (t = 4.883) at the .01 level, while the post-test difference (t = 0.7194) was not significant at this level. This is a case where the treatment group closed the performance gap.

Graph 4 shows the mean percent of improvement of the two groups for the period tested. The experimental group learned 50% of what it could have, while the lowest control quartile learned 41% of its potential possible gain.

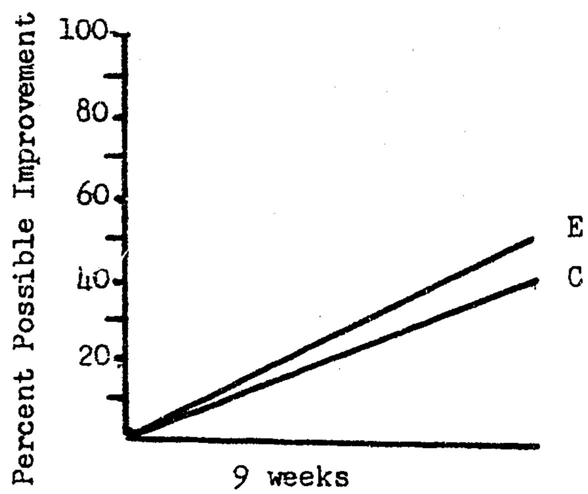
Graph 4

RATE OF POSSIBLE IMPROVEMENT

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST

EXPERIMENTAL VS. LOWEST CONTROL QUARTILE

KIT C



E = Experimental group gain

C = Lowest Control Quartile gain

Eight of the eighteen children who completed the Kit C were randomly selected and given Kit CC of the applied phonics series. Table 5 shows the results of this comparison.

TABLE 5

ANALYSIS OF DIFFERENCE

BORG-WARNER LEARNING LETTER SOUNDS TEST - KIT C

FOR CHILDREN WHO TOOK KITS C AND CC

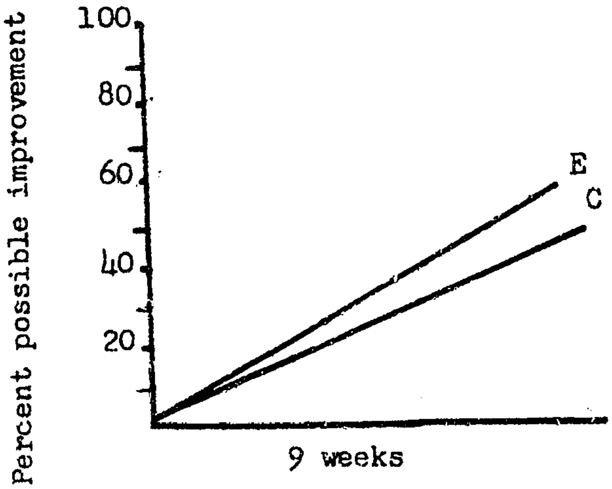
Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	8	12.12	4.35	85	28.09	6.77	6.5243*
Post-test	8	26.37	4.98	85	31.71	5.71	2.5507

*p .01

As is indicated, the pre-test difference (t = 6.5243) was at the .01 level of significance, where the post-test difference (t = 5243) was not. The experimental group closed the gap in their performance with the control group.

Graph 5 indicates the percent of possible improvement made by both groups. As is shown, the control group gained 46% of what it could have learned as opposed to the experimental group's gain of 60%.

Graph 5
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER LEARNING LETTER SOUNDS TEST - KIT C
FOR CHILDREN WHO TOOK KITS C AND CC



E = Experimental group gain

C = Control group gain

When the performance of the eight experimental subjects who took both the basic and applied phonics is compared with the lowest quartile of the control group, there is a significant difference in the pre-test scores (t = 4.0719), but not in the post-test scores (t = 0.-2073). (See TABLE 6)

In addition to this, the mean score of the experimental group is actually higher than the control group on the post-test. Not only has the treatment group closed this gap, but they have "crossed over."

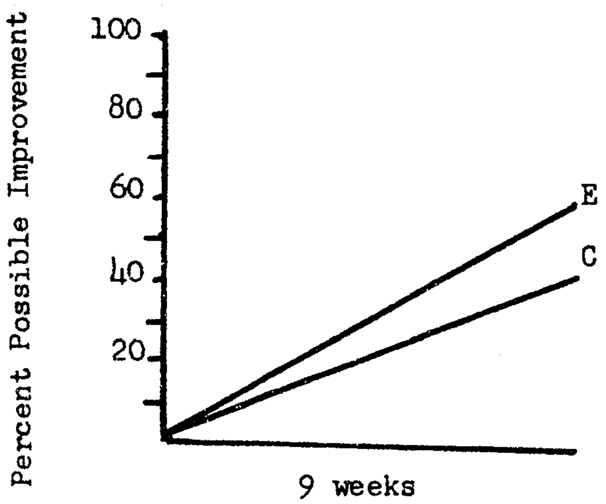
TABLE 6
ANALYSIS OF DIFFERENCE
BORG-WARNER LEARNING LETTER SOUNDS TEST - KIT C
FOR CHILDREN WHO TOOK KITS C AND CC
EXPERIMENTAL VS. LOWEST CONTROL QUARTILE

Test	Experimental			Control (Lowest Quartile)			t
	N	Mean	SD	N	Mean	SD	
Pre-test	8	12.12	4.35	21	18.61	3.63	4.0719*
Post-test	8	26.37	4.98	21	25.80	7.03	0.2073

*p .01

Graph 6 indicates the percent of possible improvement made by both groups. As is shown, the lowest control quartile gained 41% of what it could have learned as opposed to the experimental group's gain of 60%.

Graph 6
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER LEARNING LETTER SOUNDS TEST - KIT C
FOR CHILDREN WHO TOOK KITS C AND CC
EXPERIMENTAL VS. LOWEST CONTROL QUARTILE
KIT CC



E = Experimental group gain

C = Lowest Control Quartile gain

Of the eighteen children who completed the C Kit phonics program, ten also completed their prescription in the D Kit.

TABLE 7 shows the results of their pre- and post-test scores. The control group again has demonstrated considerable mastery of the pre-test, 15.05 out of 18 or 84%, while the experimental group scored only 6.9 or 38%.

As TABLE 7 shows, the differences between the two groups was significant on the pre-test (t = 8.2008) but not on the post-test (t = 2.6277). The children in the experimental group performed with the mastery of the control group after the treatment.

TABLE 7

ANALYSIS OF DIFFERENCE

BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST

KIT D

Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	10	6.90	2.28	85	15.05	3.04	8.2008*
Post-test	10	14.40	2.95	85	16.63	2.49	2.6277

*p .01

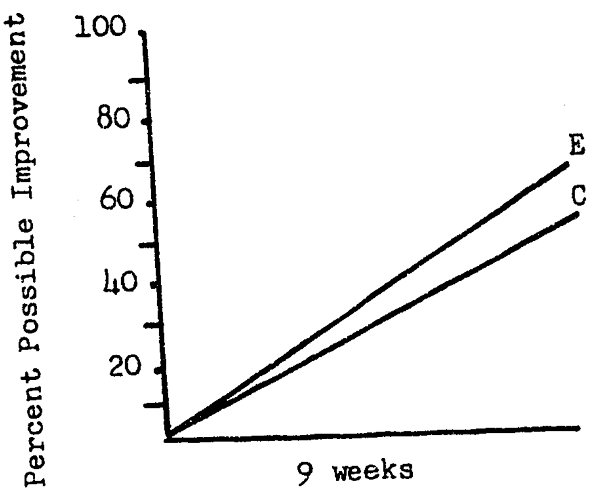
Graph 7 shows the percent of possible gain made by each of the groups on the post-test.

This measure of possible improvement is obtained by use of the following formula:

$$\frac{\text{Post-test Score (\%) - Pre-test Score (\%)}}{\text{100\% - Pre-test Score (\%)}}$$

The experimental group learned 68% of what it could have learned, compared to the 54% achieved by the control children.

Graph 7
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST
KIT D



E = Experimental group gain

C = Control group gain

Comparing the experimental group performance against the performance of the lowest quartile of the control group yielded the results presented in TABLE 8.

TABLE 8
ANALYSIS OF DIFFERENCE
BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST
KIT D
EXPERIMENTAL VS. LOWEST CONTROL QUARTILE

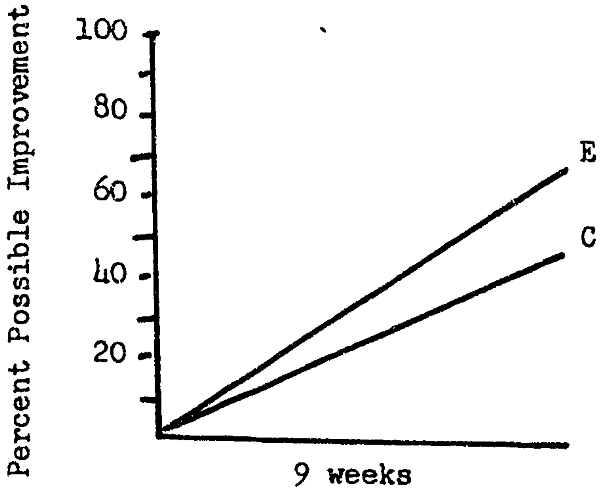
Test	Experimental			Control (Lowest Quartile)			t
	N	Mean	SD	N	Mean	SD	
Pre-test	10	6.90	2.28	21	10.52	1.69	4.9772*
Post-test	10	14.40	2.95	21	14.00	3.72	0.2969

*p .01

The difference between the pre-test scores of the two groups (t = 4.9772) was found to be significant at the .01 level. The post-test scores of the two groups (t = 0.2969) showed no significant difference. And, in considering the post-test means, it is seen that the experimental group actually did better than the control group in the post-test situation.

Graph 8 shows the percent of possible gain made by each of the groups on the post-test. The experimental group learned 68% of what it could have learned, compared to the 47% achieved by the lowest control quartile children.

Graph 8
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER LEARNING LETTER SOUNDS PRESCRIPTION TEST
EXPERIMENTAL VS. LOWEST CONTROL QUARTILE
KIT D



E = Experimental group gain

C = Lowest Control Quartile gain

TABLE 9 indicates the class and boy/girl distribution of the experimental and control groups. Though there was a total of 34 experimental and control students, information is given below on only those subjects who worked within the levels being evaluated.

TABLE 9
PLACEMENT AND BOY/GIRL DISTRIBUTION
READING WORDS IN CONTEXT

Class	Sex				
	Experimental		Control		
	Boys (N=3)	Girls (N=2)	Boys (N=11)	Girls (N=12)	Total (N=28)
A	2	1	2	6	11
B	1	1	9	6	17

As TABLE 10 shows, there was only 3.8 months difference between the mean ages of the control and experimental groups. This difference was not statistically significant.

TABLE 10
ANALYSIS OF DIFFERENCE
AGES IN MONTHS
READING WORDS IN CONTEXT

Variable	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Age	5	84.2	3.8	23	80.4	4.48	1.12

Reading Words in Context

As indicated earlier in the report, the number of students who completed at least one level of Reading Words in Context Kits I, J, K was small - five children. While extreme caution must be used in interpreting such data, it is presented so that at least some discussion of the program might be made.

TABLE 11
ANALYSIS OF DIFFERENCE
BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST
KIT I

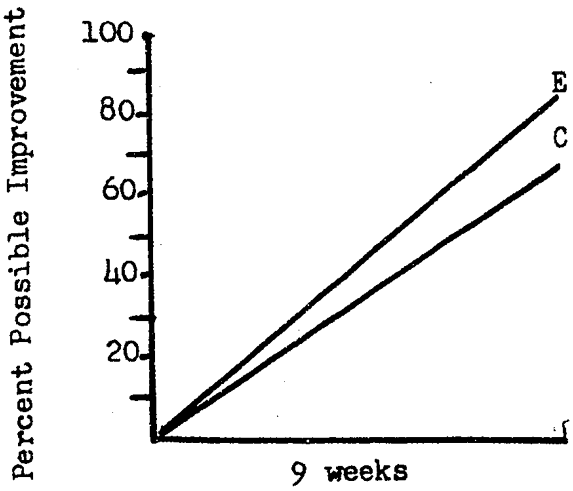
Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	4	13.75	1.50	23	14.52	2.21	0.6656
Post-test	4	17.25	1.50	23	16.91	1.47	0.4209

TABLE 11 shows the results of the pre- and post-test performance of the two groups on Kit I Prescription Test. The experimental group is N=4, since one child placed out of the I Kit.

As TABLE 11 indicates, the performance of both groups was not significantly different on the pre- (t=0.6656) nor on the post-test (t=0.4209).

However, as seen by Graph 9, the experimental group achieved 82% of possible attainment on the Borg-Warner Prescription Test as compared to the 69% achieved by the control group.

Graph 9
RATE OF POSSIBLE IMPROVEMENT
READING LEVEL I



E = Experimental group gain

C = Control group gain

Three students completed the J Kit of the <u>Reading Words in Context</u> program.

TABLE 12 indicates that while the control group's performance was significantly higher on the pre-test, it was not on the post-test. In fact, the experimental group had a higher mean post-test score.

TABLE 12
ANALYSIS OF DIFFERENCE
BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST
KIT J

Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	3	8.00	1.73	23	12.86	2.81	2.8917*
Post-test	3	15.33	0.57	23	15.08	2.74	0.1523

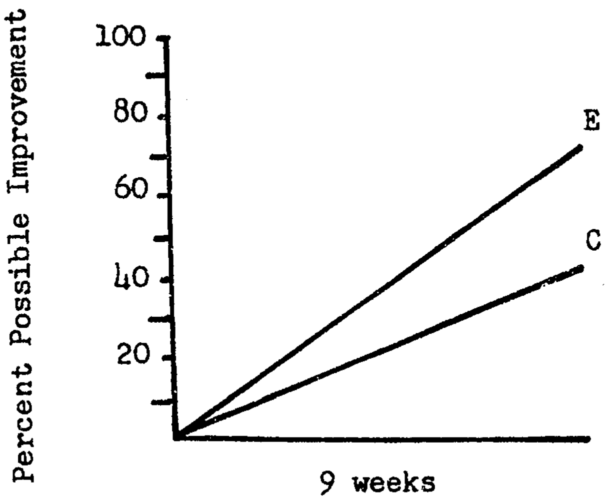
*p .01

Three students completed the J Kit of the <u>Reading Words in Context</u> program.

TABLE 12 indicates that while the control group's performance was significantly higher on the pre-tes., it was not on the post-test. In fact, the experimental group had a higher mean post-test score.

The three children who took the J Kit System 80 programs achieved 73% of possible gain while the control group only averaged a 43% gain as is shown on Graph 10.

Graph 10
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST
KIT J



E = Experimental group gain

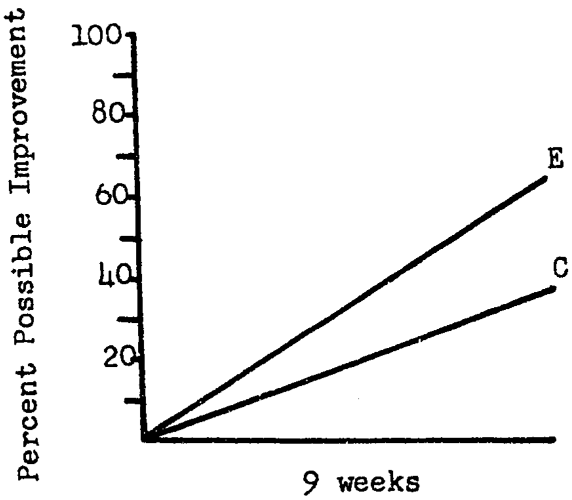
C = Control group gain

Two students reached the K Kit of the reading program. According to the data presented in TABLE 13 and Graph 11, it can be seen that although the experimental group gained 63% of its possible gain as compared to the 36% gained by the control group, the pre-test (t = 1.8699) and post-test (t = 0.000) difference between the two groups was not found to be significant. This lack of significance can probably be ascribed to the extremely small size of the sample.

TABLE 13
ANALYSIS OF DIFFERENCE
BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST
KIT K

Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	2	7.00	0.00	23	11.69	3.48	1.8699
Post-test	2	14.00	0.00	23	14.00	2.62	0.000

Graph 11
RATE OF POSSIBLE IMPROVEMENT
BORG-WARNER READING WORDS IN CONTEXT PRESCRIPTION TEST
KIT K



E = Experimental group gain

C = Control group gain

Both control and experimental groups took the Word Meaning subtest of the Stanford Achievement Battery. As TABLE 14 indicates, the differences between the pre-test scores (t = 1.3520), while large, were not statistically significant, even though the control group had a mean average 4.0 months higher than the experimental group.

The post-test differences (t = 0.7498) were also not significant, although it can be observed that the difference between the two groups was only 1.8 months. In other words, the experimental group had reduced the difference by 2.2 months during the 9 week study.

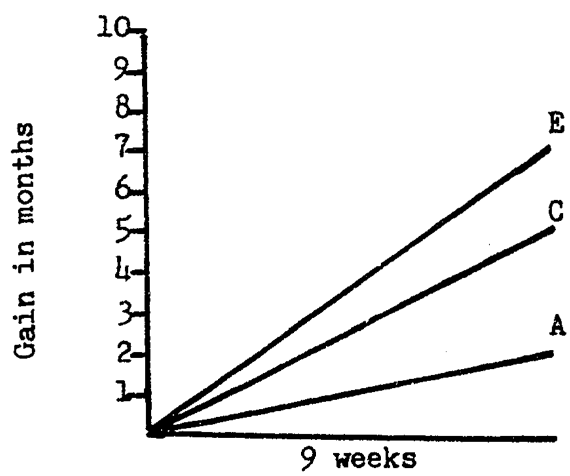
TABLE 14
ANALYSIS OF DIFFERENCE - STANFORD ACHIEVEMENT TEST
WORD MEANING SUBTEST - GRADE EQUIVALENT SCORES

Test	Experimental			Control			t
	N	Mean	SD	N	Mean	SD	
Pre-test	5	1.26	0.71	23	1.66	0.57	1.3520
Post-test	5	1.99	0.43	23	2.17	0.47	0.7498

As Graph 12 illustrates, while both groups made higher than anticipated gain during the two months the treatment lasted, the experimental group gained 2 months more than the control group.

However, because of the small number involved, the data must be viewed with caution.

Graph 12
RATE OF IMPROVEMENT
STANFORD ACHIEVEMENT TEST
WORD MEANING SUBTEST



E = Experimental group gain

C = Control group gain

A = Anticipated average gain

SUMMARY

For the testing of the effectiveness of Borg-Warner's Learning Letter Sounds program, one difficulty became readily apparent: the selection of a test population large enough from which to select both control and experimental groups. This problem was due to two factors: the overall high achievement of the students in the test school, and the lateness in the school year.

In most schools, even at the end of the year there are often many kindergarten children who still have not mastered the initial consonant sound-symbol relationship. However, this was not the situation in the school in which the study took place.

Most of the children in the kindergarten had mastered initial phonics skills. There were only twenty-four out of 109 kindergarten children who had not. Since to have broken this number into two groups would have given a population smaller than desired, it was decided to consider all twenty-four children as the experimental group and the remainder of their classmates as the control group.

What this meant was that the experimental group's performance on the pre-tests would be significantly less than the performance of the control group. So, instead of starting out with two groups with the same skills and seeing how different the treatment would make these groups, the opposite was the case.

A treatment effect was studied to see if System 80 could produce a narrower range of achievement or could "close the gap" between two initially different groups.

It is precisely the initial difference between these two groups that makes the results of the study most interesting. This study suggests that when instruction is individualized, children who have spent most of the school year not achieving, can make significant learning rate improvements. What appears to have happened in this study is that the very bottom of the total group (as measured by achievement tests) was redistributed throughout the total group as a result of the treatment. This performance is of more interest because the past record of these children is such that a change in learning achievement was not to be anticipated.

Since children who had completed two levels of phonics showed even higher gains, it is probably reasonable to hypothesize that if the study had been of longer duration, then the entire experimental group would have made proportionately greater gains.

The same phenomena was discernible with the children involved in the reading portion of the study; however, the small number of children who completed any one level severely limits the interpretation of their achievement.

CONCLUSIONS

A field test of Borg-Warner's System 80 programs Learning Letter Sounds and Reading Words in Context took place during the 1971 school year in a suburban Chicago school. The testing program took place during the last nine weeks of the school term.

The programs were tested in a learning center situation, i.e., seven System 80 units were placed in a central location and the experimental children left their regular class activities once a day to take a lesson on the System 80 unit.

Children were selected for the experimental groups on the basis of their need for the content taught in the System 80 programs. Both the lateness in the term and the general high achievement of the school population contributed to the situation of a relatively small population for whom the lessons would be appropriate.

For this reason, rather than dividing the eligible children into two groups, it was decided to consider all of the eligible children as the experimental group and to compare their performance against the rest of their classmates who would be considered the control group.

Since to be eligible for the experimental treatment meant to not know the materials taught in the System 80 programs, the result of this approach was that the mean score of the experimental children on the pre-test was much less than that of the control group.

Using this procedure also contributed to the unequal cells that occur in this report, i.e., the control group was larger than the experimental group.

Because of this factor and also to compare more similar achieving groups, the performance of the experimental group has also been compared to the performance of the lowest achieving quartile of the control group on all measures. The control group was divided into quartiles on the basis of their pre-test performance.

Learning Letter Sounds

1. In comparing the eighteen children who completed at least one phonics kit against the performance of the entire control group of eighty-five, the following was found:
   a. Although the experimental group improved its score from 12.3 to 24.2 - almost 100% - , the differences between the two groups on both the pre ($t = 9.4408$) and post-test ($t = 4.8572$) was found to be significant at the .01 level.
   b. The experimental group gained 50% of what it could have learned, while the control group attained 46% of its possible gain.
2. When the performance of the eighteen children in the experimental group was compared with the performance of the lowest quartile of the control group (N=21) the following occurred:
   a. The experimental group's percent of possible gain remained at 50%, while the control group's percent was reduced to 41%.
   b. The comparison of the mean pre-test scores of both

groups showed a difference favoring the control group at the .01 level of significance (t = 0.7194) were not significant. The System 80 users had "closed the gap."

3. In comparing the performance of the eight students from the experimental group who took both the basic (Kit C) and the applied (Kit CC) phonics against the performance of the entire control group, the following occurred:

   a. The experimental group scored a 60% increase in possible gains as opposed to the control group's 46% gain.

   b. The difference between the two groups on the pre-test (t = 6.5243) was significant at the .01 level favoring the control group. The difference between the two groups was not significant at that level on the post-test (t = 2.5507).

4. The following was found when comparing the performance of the lower quartile of the control group (N=21):

   a. The experimental group gained 60% of possible gains; the control group gained 41%.

   b. The difference between the two groups on the pre-test (t = 4.0719) favored the control group at the .01 level of confidence. The post-test scores showed no significant difference (t = 0.2073). In fact, the experimental group "crossed over," i.e., had a higher mean post-test score.

5. The following data were compiled in the comparison of the ten children who completed the D Kit of the phonics program against

the entire control group (N=85):

a. The experimental group gained 68% of possible gains as opposed to a 54% gain for the control group.

b. The differences between the two groups on the pre-test (t = 8.2008) was significant at the .01 level favoring the control group. The post-test differences (t = 2.6277) was not significant.

6. When the ten students who completed the D Kit were compared with the lowest quartile of the control group with regard to pre- and post-test performance, the following were the results:

a. The experimental group gained 68% of total possible improvement, while the control group gained 46%.

b. While the difference between the two groups on the pre-test was significant at the .01 level (t = 4.9772) favoring the control group, the experimental group on the post-test had a higher average score.

Reading Words in Context

For the reading portion of the study, the following results were obtained:

1. Four students completed the I Kit of the Reading Words in Context program. Pre-and post-testing of this group showed the following:

a. The control group (N=23) had a higher pre-test mean score than the experimental group, but on the post-test the situation was reversed with the experimental group having the higher mean score. Neither difference was statistically significant.

b. The control group gained 69% of all it could have gained, while the experimental group gained 82%.

2. For the three students who completed the J Kit the following results occurred:

a. They had a significantly lower pre-test score than the control group (N=23); however, on the post-test they had a higher mean score.

b. The experimental group gained 73% of maximum possible gain while the control group gained 43%.

3. Two students completed through the K Kit with the following results:

a. A lower pre-test score although not significant; a post-test score equal to the control.

b. A gain of 63% of maximum compared to the control group's 36% of possible gain.

4. The Word Meaning subtest of the Stanford Achievement Battery was administered to both the experimental group and the control group. Data was presented for the experimental group students who completed at least one kit of the <u>Reading Words in Context</u> series.

a. Both groups made gains greater than expected on this nationally standardized test. The experimental group (N=5) gained 7.3 months as compared to 5.1 months gained by the control group (N=23). Although large, this difference was not found to be statistically significant. This lack of significance is probably due to the small number of the experimental group.

APPENDIX A

SAMPLE TESTS

Name ______________________

Grade ______________ Date ______________

C
Learning Letter Sounds (Basic Phonics)

Prescription Test

No.			
1 Lesson 1	b	r	s
2	p	m	c
3	mop		top
4	g	t	s
5	m	d	p
6	saw		paw
7 Lesson 2	c	f	b
8	m	t	e
9	tent	rent	cent
10	n	b	i
11	r	t	j
12	look	took	book
13 Lesson 3	s	p	r
14	c	m	f
15	wire		fire
16	p	n	k
17	f	c	o
18	pan		ran

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Name

Grade Date

C
Side Two

19 Lesson 5
w t r

20
m d i

21
duck luck suck

22
l t r

23
d w s

24
red wed fed

25 Lesson 6
d n c

26
t n g

27
night light

28
w c t

29
y n p

30
far car

31 Lesson 7
c h v

32
d h l

33
pick sick lick

34
h p i

35
l g n

36
hen men pen

Name

Grade Date

D

Learning Letter Sounds (Basic Phonics)

Prescription Test

Item			
1 Lesson 1	e	m	g
2	h	v	c
3	vest		best
4	t	w	g
5	v	b	a
6	game		name
7 Lesson 2	s	f	k
8	r	j	o
9	jump	dump	lump
10	l	k	m
11	e	j	s
12	lick	pick	kick
13 Lesson 3	d	z	y
14	a	t	w
15	pet		wet
16	z	h	u
17	w	p	i
18	zoo		boo

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Name ______________________________

Grade ______________ Date ______________

Reading Words in Context

Prescription Test

1	Lesson 1	sever	even	seven	server
2		foot	food	feed	fool
3		world	could	wound	would
4		because	became	become	cause
5		veil	well	wall	will
6		one	an	are	or
7	Lesson 2	either	eager	eight	height
8		yesterday	westerly	yeast	today
9		thing	thin	thank	think
10		sight	right	might	night
11		been	teen	born	bean
12		annoys	alleys	always	away
13	Lesson 3	live	love	lone	glove
14		dream	best	press	dress
15		at	sit	its	hits
16		done	bone	tone	dove
17		clock	occur	opal	o'clock
18		up	upon	upper	pour

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Name

Grade Date

Reading Words in Context

Prescription Test

1	Lesson 1	Saturday	Sandy	Sunday	Monday
2		Monterey	Monday	Sunday	Mandy
3		wrap	wrung	wring	wrong
4		fight	fought	light	right
5		hand	hard	heard	harp
6		around	record	secret	second
7	Lesson 2	poison	parson	person	proven
8		face	fact	fear	fame
9		another	anyplace	nothing	anything
10		torn	turn	term	burn
11		along	alone	about	long
12		foot	fit	fat	fact
13	Lesson 3	Turkey	Tuesday	Thursday	today
14		dear	item	ideal	idea
15		Asia	Africa	America	American
16		life	file	live	like
17		toy	yell	yes	yet
18		peak	speak	spoke	spread

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Name

Grade Date

Reading Words in Context

Prescription Test

1	Lesson 1	doll	taller	dollar	roller
2		tent	twenty	thirty	twice
3		port	cart	sport	sort
4		except	expect	extra	exceed
5		fin	fine	fire	phone
6		thank	three	tired	third
7	Lesson 2	humble	housed	husband	hushed
8		town	torn	towel	down
9		over	outer	odor	order
10		vote	note	tone	not
11		already	treaty	almond	always
12		there	whiter	whether	wither
13	Lesson 3	official	office	offer	after
14		choice	chase	change	chance
15		cord	coat	cost	cast
16		though	through	trough	thought
17		myself	self	its	itself
18		paper	appear	appeal	apart

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APPENDIX B

ADDITIONAL TABLES AND GRAPHS

MEAN NUMBER OF LESSONS TAKEN BY SUBJECT

LEARNING LETTER SOUNDS

Kits	N	Mean	SD
C	18	19.7	8.9
CC	8	10.0	4.0
D	10	4.8	1.6

MEAN NUMBER OF LESSONS TAKEN BY SUBJECT

READING WORDS IN CONTEXT

Level	N	Mean	SD
I	4	6.25	1.3
J	3	10.3	0.9
K	2	7	0.0

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VITA

Daniel Thomas Cunniff was born in Chicago, Illinois, in 1939. He was graduated from Proviso High School in Maywood, Illinois in 1957. He attended the University of Miami in Coral Gables, Florida, and graduated from Northern Illinois University with his Bachelor of Science degree in 1962.

His initial teaching experience began in September of 1962 as a sixth grade teacher in Mount Prospect, Illinois, School District #26. He taught seventh and eighth grades until 1966 when he received his Masters in Educational Administration and an All Grade Supervisory Certificate from Northern Illinois University.

He was appointed principal of the newly opened Park View Elementary School, District 26, in August of 1966. Here he helped to integrate a class of deaf students into the regular school program. He served as part-time consultant in a Title III project with the Cooperative Educational Research Laboratory in Northfield, Illinois, and Lawrance University, Appleton, Wisconsin until 1968.

This experience led to an offer of a two year contract with the Government of American Samoa as Advisor to their Educational Television System. Here he trained Samoan teachers in the maximum use of instructional television. He participated in the Southeast Asia Educational Ministers Conference, and became a Charter Member of Pago Pago Rotary International.

He returned to the United States in July of 1970, to assume the principalship of Melzer Elementary School in East Maine School District #63, Niles, Illinois. Here he introduced a teacher aide program (TAP), creativity classes, and multiage teaching in this non-graded, team-taught building.

In May of 1972 he was asked to read an abstract of the foregoing paper to the International Reading Association Convention in Detroit, Michigan.

In July of 1972 he was asked to assume the Directorship of the International School in Munich, Germany.