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ABSTRACT

A collection of ten papers selected from those presented at the Special Conference on Instructional Technology (San Antonio, Texas, December 1-4, 1970) consider the use and evaluation of instructional technology in the classroom. Papers examine such areas as stimulation of the learning process through technology, the use of the paraprofessional as an interface through programed tutoring in the teaching of reading, the modular instructional system as an interface, man-machine interfaces in training optacon readers, a computer assisted instruction course in the early identification of handicapped children, evaluation of instructional materials and prediction of student performance, validation of learning modules, and instructional resources and their application to a child centered learning process. Other collections of papers from the conference have been compiled and are available as EC 031 520 (Adoption of Technology and Program Development), EC 031 521 (Instructional Technology for Personnel Training), EC 031 522 (The Improvement of Special Education through Instructional Technology), and EC 031 523 (Communication, Production, and Dissemination of Instructional Technology). (CD)

Exceptional Children Conference Papers: The Use and Evaluation of Instructional Technology in the Classroom

Papers Presented at the

Special Conference on Instructional Technology

The Council for Exceptional Children

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December 1-4, 1970

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PREFACE

The Use and Evaluation of Instructional Technology in the Classroom is a collection of 10 papers selected from those presented at the Special Conference on Instructional Technology, San Antonio, Texas, December 1 - 5, 1970. These papers were collected and compiled by The Council for Exceptional Children, Arlington, Virginia. Other collections of papers from the Conference have been compiled and are available from the ERIC Document Reproduction Service. Other collections announced in this issue of Research in Education may be found by consulting the Institution Index under Council for Exceptional Children or the Subject Index under Exceptional Child Education. Titles of these other collections are:

The Improvement of Special Education through Instructional Technology
Instructional Technology for Personnel Training
Communication, Production, and Dissemination of Instructional Technology
Adoption of Technology and Program Development

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Turning Kids On -- An Impossible Dream?

Henry W. Ray
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Technology has provided educators with machines and devices to implement learning strategies and experiences. A technology of utilization -- the designing of materials which are uniquely related to the machinery is slowly evolving. The technology includes the design of new environments needed for maximum quality of technology/media utilization.

In spite of advances in projection screen design: for example the Kodak Ektalite -- multi-media learning experiences require much more flexibility than such inventions provide. Small size and narrowly restricted viewing angles are not conducive to implementing learning experiences which seek the involvement of the student in the learning process.

An interesting mental exercise is to look at a classroom and consider what the classroom design, furnishings and resources discourage or prevent happening as a learning experience. For many years we have been concerned about light control -- the ability to darken rooms so projected materials can be effectively used. Only recently has consideration been evidenced for the utilization of body movement in the classroom as well as in the gymnasium.

Not many years ago it was common practice for individual schools to raise money to buy audiovisual equipment. Bake sales, paper collections, candy sales and other small business ventures provided the money to buy equipment. Many, if not most, school boards did not consider providing any such equipment as the responsibility of the community. If teachers (and students) wanted to use new-fangled contraptions let them get them through their own efforts. Today, of course, a considerable amount of educational resources, including equipment, are provided as a matter of course.

The new "blackboard" -- the overhead projector was probably the most sensational piece of equipment to arrive on the scene. No longer did the teacher have to risk his safety by turning his back on the pupils to use the blackboard. Golden opportunities for the students to fire paper wads and for note passing quickly became part of the passing scene. It is hard to imagine a school today lacking the availability of at least one overhead projector. Many districts provide one for every classroom -- and certainly the quality of education, the quality of teaching, is affected by the availability or lack of such equipment.

It is a pity that the availability of media transmitters such as the projector, has not resulted in a greater burst of creativity in education. A substitute for the blackboard is still the status quo for many overhead projectors. Yet the objectives or goals of education have changed drastically in the past decade -- and to achieve these objectives we must use media -- there is no other way. It is easy to use the machine to project a map, diagram or set of figures, The market is loaded with such materials to be fed into the machine. But what about humanizing education? How can media help overcome the perceptual disabilities of the learning disabled. How can an overhead projector be programmed to improve self image? How can turned-off students become turned-on learners? How can any child -- gifted, normal, retarded or handicapped have his human horizons revealed and developed.

Teacher training in many instances seems to ignore media in the potential role of media in education. Few new teachers come into the classroom with adequate skills and media-related insights to perform well except with the textbook and other printed resources. And the media "specialists" who can turn off, turn on, and repair the machinery seem to exceed by far the number of media specialists who can help teachers make media a deeply meaningful dimension of the curriculum.

One of the most intriguing aspects of media and technology today is the opportunity for student-involvement. For example, an upper grade elementary school class created a unit contrasting poverty and affluence. They searched through hundreds of magazines finding and clipping pictures illustrating or symbolizing the concepts. From hundreds of pictures they edited two groups of eighty each -- to accommodate the capacity of the Kodak Carousel tray -- they taped a narration to accompany the program including a dubbed in folk song recording -- and using two projectors presented contrasting images -- poverty and affluence. Several weeks of work went into the production and the entire class was involved. There are literally endless opportunities in elementary and secondary education to utilize media in a multiple design, idea-research-organization-presentation pattern.

Important as student involvement may be -- teachers too should be concerned with utilizing image, sound, and other sensory stimuli to open up ideas and to stimulate the interest of our young people in learning. This requires a few skills in technology which any teacher can acquire. The teacher should be able to use a simple still and super 8 movie camera, do taping and dubbing, print mounting, and know overhead projection techniques.

Perhaps as teachers become more knowledgable about simple technology, educational television will reap a few needed benefits. Most programs seem to be filtered from the outside into the learning environments. Insight and ability to work with ideas seems to have a relationship to knowledge about the "tools" of communication.

It was suggested at the beginning of this paper that there are two technologies involved -- the invention of the machine, the "hardware" -- and the technology of utilization which is the principal content of this paper and the demonstration conducted at the conference. More of idea generation must emerge from within the ranks of the classroom teacher. The person more broadly skilled in the machine and process technologies can help make the ideas become living realities. Thus we can move away from a saturation of print-centered teaching design toward a balanced learning experience which includes print plus a variety of important sensory components.

New resources are appearing which have the potential of enhancing and stimulating learning. The next giant step may well be through the utilization of computer science. While many schools are using the computer as an information retrieval device business is using it creatively in advertising on television. The Computer Image Corporation for example achieves very unique typographical imagery by the use of the computer. It is going to be up to us -- the educators -- to make the connection between the computer image technique and learning. Can it help us provide essential patterning models for the child learning to write? Does it provide another resource toward visual-motor control? Can it provide help for the child who has a problem with embedded figures? Educators are often prone to let others do the thinking -- and to accept what business finally offers after their marketing research. We should take the initiative -- we should not have to wait until the decisions are made by others outside or on the periphery of the profession of teaching.

Frequently one hears a criticism of Marshall McLuhan that he uses many, many words to tell his audience that this is an electric age -- that print is almost dead. This writer will try through demonstration with media and technology to communicate learning experiences which seem to have considerable power for turning kids on -- and making "The Impossible Dream" a reality.

DEMONSTRATIONS--

A humanities experience -- The Sea.

A student prepared experience -- Poverty and Plenty.

Exploration -- The Computer Image.

Developing a sense of Imagery -- Hide and Seek.

Increasing perceptual power -- Embedded figures.

A self and society concept -- "Images of Man".

A concept of self -- "Me and My Shadow"

Media in the Instructional Process

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Southwest Regional Media Center for the Deaf

I have been asked, as a member of this panel, to address myself to the general topic, "Media in the Instructional Process" with some further specification that I am to deal with the use of media in the classroom. This charge is fortunately broad enough to permit me to emphasize several matters on which I have a particular point of view. I appreciate this opportunity to speak to you on this topic, and I do so with the recognition that in many ways my panel co-members are better able to deal with this subject.

I have set out three purposes for this presentation. First, I wish to suggest some applications of media techniques which are derived from an intuitive analysis of communication flow in the classroom and from a recognition of the need for active student participation. Second, I would like to establish a context in which media can be related, rationally and empirically, to the process of instruction. Third, I would like to point out some areas of mismatch between what should be and what is, with respect to providing conditions under which media can be used rationally in the instructional process.

At the basis of the instructional process is interaction; the interaction of the learner with his environment. The term interaction implies that two or more elements of a system relate in such a manner that one or more of the elements is changed. It is reasonable to view the teacher's role as one of participating in the management of the learning environment to promote interactions.

I specifically use the word "participate" to suggest that the student also has a role in managing his own learning environment. Much of the interaction that occurs in a learning environment is of a social nature, involving interaction among peers and both ways between the teacher and student. This interaction consists of communication including both verbal and non-verbal symbols and representations. While the teacher of the deaf has a considerable array of audiovisual devices available, my guess is that the typical teacher will use these as communication resources only in terms of transmission from teacher to pupil.

If we stop to think of directions of communication flow among several elements of the human component of the classroom, we can begin to see new ways of using the available resources. The usual pattern of communication in the classroom is flow from teacher to student, but since communication can be a two-way street, it makes student to teacher flow a possible relation for communication.

We give lip service to social goals in education, but how many teachers make use of, for example, the overhead projector to facilitate student to student communication?

A simple idea for use of the overhead projector in facilitating student to student communication is to provide each student with his own transparency material. On this transparency material, the student may write his own questions, his responses to questions of others, his own comments, or responses to comments made by other students. These individual transparencies may be placed on the projector at the appropriate time.

Dr. Wyman's Multiple Interaction Visual Response System (MIVR) goes several steps farther by providing each student with his own overhead projector. I see this system as an important step forward in facilitating student to student interaction. In fact, the MIVR system facilitates communication flow in all of the directions referred to above.

Another interesting idea which can be related to social goals in instruction has been developed at Indiana University by Sivasailam Thiagarajan, and others, which is called the grouprogram process. The basic idea here is to structure a group problem-solving situation. A tape-driven slide projector poses a problem for discussion. A chairman function and recorder function are delegated. Time limits are imposed, with the slide projector prompting the students to keep in line with the schedule for discussion. Each participant contribution is recorded on the overhead projector as it is made. Ultimately a group decision is reached and recorded.

I have had one or two opportunities to observe groups of adults use the grouprogram approach and have been impressed by the interaction and efficient progress toward closure. My impression of the weakness deaf children have in group decision-making and in fact in purposeful discussion, suggest to me that this technique should be explored.

In the Southwest School for the Deaf at Lawndale, California, a program has been instituted called "camera of the week." In this program a class is given one Polaroid camera per student plus film. The group of cameras is rotated among classes on a weekly basis. Each class decides what to do with the opportunity. In a unit on personal care, cameras were taken home so that parents could take a series of pictures of their child brushing his teeth, washing his face, and so forth. The pictures were later used as stimulus items in a series of programs on present progressive verb forms involving verbs such as brush, wash, and comb. Students were highly involved in the preparation of the materials and, as you might expect, motivation was high.

At the Wyoming School for the Deaf, a series of films were planned to follow up work on a favorite series of readers. The teacher prepared the story and script for each film. She identified extensive sets of objectives for the language unit to be correlated with the film. Student interest was so high that a second film was suggested. The second story had a western theme, and the girls in the class protested being left out of the cast. They wrote their own story and script which added feminine roles to the series. A third film was produced in which the filming job was turned over to the students. The student involvement in such a production can obviously demand expressive communication skills for writing, directing, and acting.

There are a myriad of examples of how we might creatively use available resources to help us do a more effective job in facilitating communicative interaction in the classroom.

The above discussion is limited in an important way. It focuses on group-classroom interaction and not on individualized instruction. Various commonly available media resources can be readily adapted to an individualized approach.

Each summer the Southwest Regional Media Center for the Deaf conducts institutes in programmed instruction and instructional systems for teachers of the deaf. Because we are interested in communicating the basic processes and techniques, we may over-emphasize, at times, paper and pencil techniques. But we do try to present a wider view.

Some of our participants have developed, during and after the institutes, self-instructional units of instruction incorporating a variety of media.

I have visited classrooms where one or more students were working individually viewing commercially available filmstrip material and were responding to correlated teacher-prepared material designed to facilitate the students' learning from the filmstrip. While this type of approach may not be programmed in a technical sense, it does facilitate independent learning.

Now let us turn to a consideration of the context wherein the classroom teacher must attempt to integrate the available resources and techniques. At some point each teacher must face the problem of determining objectives for her students. Teachers vary considerably in their ability to do so.

If at one point the teacher's objective is to "cover the material" and she feels compelled to use an assigned text, probably her best measure of whether or not she has reached her objective is to count the number of pages that have been assigned. Of course, this would suggest little about what the students themselves have accomplished. Let us assume, however, that the teacher's level of commitment and aspiration is somewhat higher.

Let us assume that an hypothetical teacher reviews her knowledge of the students' needs and her knowledge of the curriculum structure. Upon doing this, she may ask herself what her goals for the students, in a particular lesson, might be. Let us further assume that the teacher translates her student-oriented goals into specific objectives stated in terms of observable student behaviors; that is, statements which contain the following elements:

1. A specific observable behavior,
2. A statement of the degree of this behavior, and
3. A statement of the conditions under which this behavior is to be exhibited.

Now, let us imagine that the teacher's stated objectives adequately reflect her purpose and goals such that if a student meets most of the objectives she will be satisfied with the student's learning. If this teacher were to look at one of tomorrow's lesson plans, which might be "read pages 49 through 54 and fill in the blanks on a hand-out sheet"; make an assignment and conduct her instructional activities as usual; compare student performance against the previously established standards of her measurable objectives; what is the probability that the teacher would be satisfied with the results? Not very high, I suspect.

Because this hypothetical teacher now has a standard against which to measure student performance, two things are easier for her to perceive; (1) that the discrepancy between the standard and the performance might well be the result of somethirg that the teacher failed to do, and (2) that the teacher can modify her instructional approach, measure using the same standards, observe changes in performance level and, in principle, continue to modify her instruction until acceptable performance levels are achieved.

To use an oversimplification, what this hypothetical teacher will eventually be doing is represented at a general level in the following flowchart diagram.

(insert figure 1)

If we think of the above flowchart, the process indicates an approach quite similar to that employed by some teachers. There are, however, several implications whereby we might discriminate between even uncommon practice and my interpretation of the process. They are as follows.

For a number of years we have have heard a lot about an information explosion. We have heard of societal changes and technological changes. Moreover, we have been involved in a firsthand way in these phenomena. I think every teacher of the deaf will agree with me that these phenomema present particular problems to deaf children. I think most teachers of deaf children have experienced that even the small portion of total information which is introduced to the curriculum of the school for the deaf, via standard textbooks, represents more information than can be processed by deaf students at current levels of instructional effectiveness. This suggests that there must be some restriction of input. If this restriction of input is to result in more than a "watering down", then some kind of structure must be imposed on the contents. But, is it feasible in the long run for the individual classroom teacher to assume the responsibility for identifying the content and its structure?

Developmental programs involving subject matter specialist expertise such as the SMSG program in mathematics and the AAAS and SCIS programs in elementary science have done this type of thing far beyond the level that can be achieved by the classroom teacher. However, reality suggests that teachers of the deaf often must determine content and structure--because no one else is doing it for them. And, they must do this in terms of their own view of the ultimate need of the student.

Implied in the flowchart is the thought that at some point a great deal more effort and talent needs to be devoted to identifying educational needs and goals.

The second implication is in line with the above comments. The conscientious teacher either arbitrarily accepts or develops instructional goals. If not, she is likely to be buffeted about like a rudderless ship on her course toward providing instruction. Only by drawing on an explicit recognition of purposes and goals can the teacher develop specific measurable instructional objectives. The lack of measurable objectives and related evaluation is, I believe, a basic weakness of the typical instructional program of today. Such objectives can be determined rationally only if needs, purposes, and goals are something more than broad generalized statements.

A powerful advantage of explicit measurable performance-based objectives defining enroute and terminal student behaviors is that implications for instructional techniques and materials can be efficiently brought into focus. With performance-based objectives, there can be a basis for a tentative selection from among competing available materials. The question of which material contributes best to the development of the target behavior becomes answerable, in a subjective way, at least on a tentative basis. But more importantly, the question becomes answerable on an objective, empirical basis. Does the material, or technique, as applied and measured in the particular instance of instruction, produce the desired student behavior to the desired extent? This points to a practical advantage of media in instruction--a larger part of the process can be held constant for purposes of evaluation.

In my opinion, the above statements present in a rather superficial way a fundamental principle of which we often lose sight. Instructional media, of whatever form, is logically subservient to the process of instruction.

Robert Heinich has pointed out that there are at least three phases in an instructional technology approach to instruction, those of curriculum determination, curriculum planning, and curriculum implementation, and that traditional audiovisual considerations have been made at the implementation level--the classroom. He points out that in an instructional technology approach such considerations must be made at the curriculum planning level. His comments have a specific reference to the distinction between the teacher in media as opposed to the teacher with media.

Heinich's distinction regarding the level at which media considerations are involved suggests some major problems in implementing the kind of systematic approach to instruction to which I have referred earlier in this presentation. Implicit in my discussion has been the fact that the classroom teacher is involved in some form of the process described as curriculum planning.

Some may argue that curriculum planning is not the role of the teacher. Others would point out that the teacher should have a role in the process of curriculum planning, but does not have the time to participate effectively.

My response is threefold. First, I have revealed my assumption that some form of systematic instruction, providing for empirically-based revision to permit increased effectiveness is necessary if we are to provide deaf children, and in fact all children, with educational opportunities they deserve. Second, I would point to the obvious fact that schools are not organized and staffed to provide for an appropriate division of labor between the curriculum planning and the curriculum implementation function. Third, I would point to the historical fact that the teacher of deaf students is involved on a daily basis in almost the only meaningful curriculum planning that is happening for deaf children, notwithstanding the fact that she is ill prepared and poorly supported to accomplish this task. Until the teacher of the deaf is better prepared and better supported, the use of media does offer considerable opportunity for improving classroom instruction.

But media alone is not the answer. Unless teachers can be influenced and trained to implement resources within a context that will permit objective evaluation and subsequent improvement of instruction, media will not realize its potential.

If your interest and time permit, during the discussion period, I will be happy to describe in more detail some of the activities of the Southwest Regional Media Center for the Deaf which are designed to influence and train teachers along the lines described. For the moment I will briefly summarize some of these.

In our summer institutes, attended each year by approximately 45 teachers and/or supervising teachers of the deaf, we have undoubtedly our best opportunity to influence and train teachers in a systematic approach to instruction. In these institutes, participants work through the process of identifying an instructional need; specifying purposes, goals, and objectives; conducting analyses of learning tasks involved to accomplish the objectives; designing instructional strategies; developing instructional material of a self-instructional nature; and designing a method of evaluating the materials in terms of the stated objectives. In these institutes we make a special attempt to see that the participant is capable of generalizing the principles to broader context.

One thing that was learned early in the development of the Center is that although an individual teacher may be highly motivated to become involved in an innovative procedure, lack of administrative or supervisory support can quickly extinguish the enthusiasm. As a result, we have designed workshops for supervisors and administrators which are intended to communicate similar principles at a more superficial level. We have taken special care to see that each teacher participant in our summer institute programs is accompanied by a supervisory level person from his or her school, or at least that such a person from his or her school has attended an institute in the past.

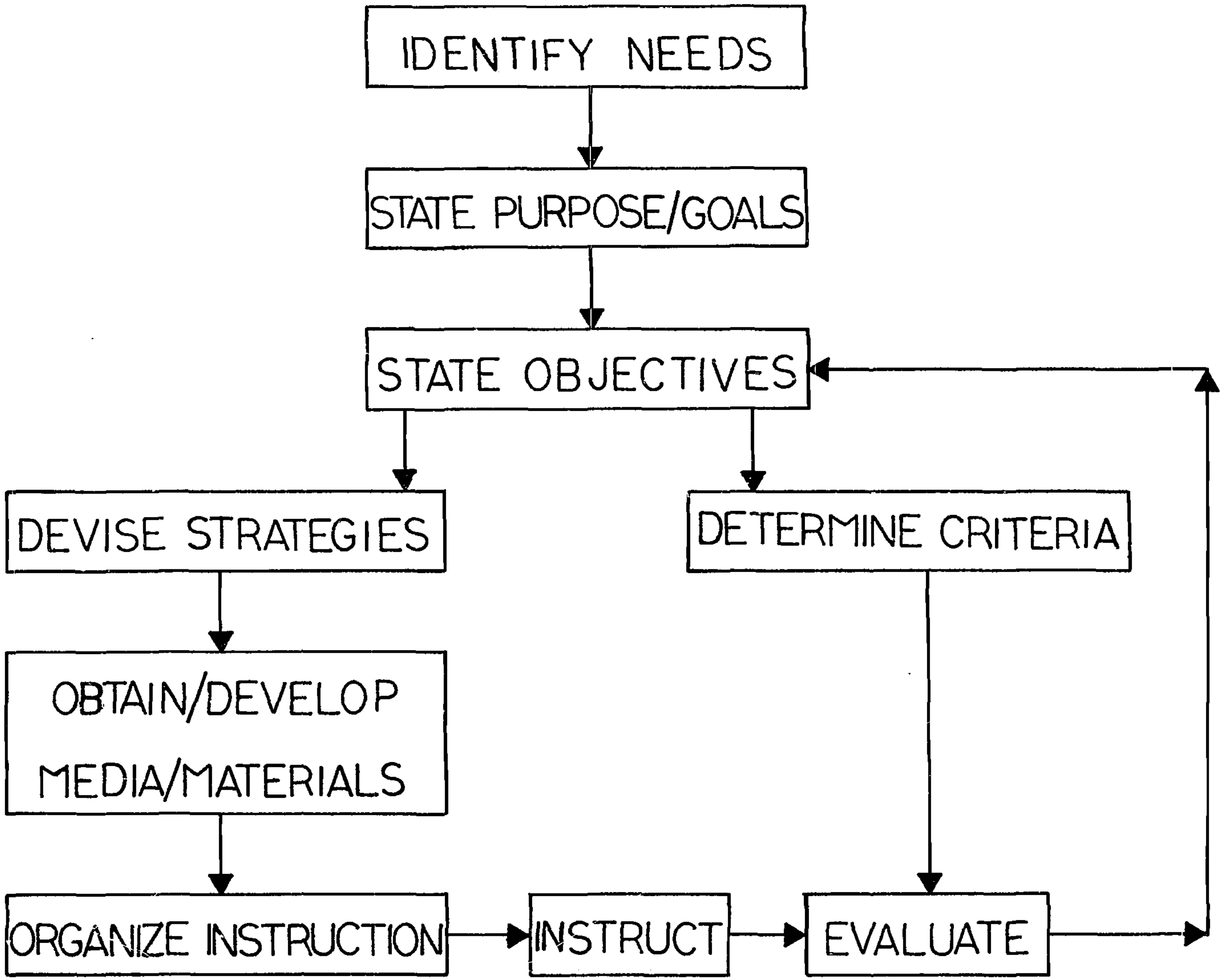
We have developed a four-day workshop for administrators and supervisors on techniques and procedures of systematic design of instruction. In the course of this workshop participants are involved in actually doing some of the processes that would be required in a systematic approach to design of instruction. We anticipate that with minimal further training and with material and consultant support, some of these supervisory level personnel will be able to extend the training to others in their own schools.

Within the context of our short-term media workshops for teachers, we emphasize the use of behavioral objectives as a basis for design of mediated lessons and for evaluation of those same lessons. A similar approach is used within the context of our Project Hurdle. Project Hurdle is a program wherein a media specialist from our staff is placed for a limited period of time, perhaps several weeks, in a school to provide in-service training in media production and utilization. Our Project Hurdle personnel have as a major objective the encouragement and guidance of teachers in application of these kinds of procedures.

This year we expect to establish a cooperative activity among several schools in which the output will be the design of a course of instruction in a particular subject matter area at a particular level, of at least a semester's duration. In this activity, purposes, goals, objectives, strategies, and materials will be identified as well as a structure for evaluation. In-service training will be an integral part of this activity.

We are establishing a clearinghouse concerned with available teacher-prepared programmed instructional material. Stated objectives and a description of target population will be an essential part of the information made available to interested consumers. Related to this clearinghouse activity we expect, in response to expressed interest, to promote cooperation among schools now involved in the development of programmed instructional material so that a coordinated division of labor might be achieved whereby significant sequences of self-instructional material, at least in prototypical form, might be made available.

While I am sure that the sum total of our efforts multiplied many times over will not bring about "that new day" in education of deaf children, I am sure that we are slowly expanding the number of teachers and others who are looking forward to the time when conditions will be created under which the teacher of the deaf will be using all available appropriate resources in a systematic approach to improving the deaf child's opportunity to develop his potential.


IDENTIFY NEEDS
STATE PURPOSE/GOALS
STATE OBJECTIVES
DEVISE STRATEGIES
DETERMINE CRITERIA
OBTAIN/DEVELOP MEDIA/MATERIALS
ORGANIZE INSTRUCTION
INSTRUCT
EVALUATE

The Use of the Paraprofessional as an Interface Through Programmed Tutoring in the Teaching of Reading to the Exceptional Child

Larry W. Barber
Louisville Board of Education

Introduction --

The technique of Programmed Tutoring is based upon a combination of learning theory and programmed instruction practice. It involves an individualized approach to teaching reading where the "tutor" is a paid or volunteer paraprofessional who serves as a vehicle for the transmission of a set of reading content and procedures.

The important difference between the concept of tutoring and the traditional one is that the tutor requires only about 30 hours of instruction to begin his or her task. The reason for this is that the tutor is programmed. Every teaching act that the programmed tutor has to perform is defined by operational and content programs which specify what to teach and how to teach. Every word the tutor says and every action she performs is specified in advance.

Programmed tutoring is a technique of individualized teaching that contains many of the advantages of the traditional tutorial approach, yet is not hampered by its disadvantages. For example, it entails a one-to-one teaching situation. The tutored children are obviously motivated and retain their interest throughout the program. A very close examination of the content and operational programs clearly reveals the student is taught the subtleties of the subject matter being tutored.

It is a system that is designed to be used with the lower 20% of beginning readers. It is not a time-consuming nor a costly system--the cost of this system is approximately $1 per child for the content programs. It is designed to be used with the child for only one 15 minute session per day in addition to his regular classroom instruction in reading.

The programmed tutoring technique provides for a very clear and distinct organizational plan following a graded sequence of presentation of content to be learned. It provides a very high initial ratio of reinforcement for correct responses with a total absence of punishment. It provides for a utilization of a paired associate recall process with the aforementioned reinforcement system for correct responses with a provision of correction for incorrect responses.

Due to the results of this system with a very large sample of over 12,000 children during the last three years of research in this program, it incorporates a very high expectancy rate of success--approximately 98 for children with an IQ of 60 and above.

Film --

This section will be the presentation of a film showing the process of programmed tutoring with an adult tutor and a child performing one of the many content programs of this system.

Summary --

Due to the shortness of the time limit for this presentation, it is not possible to provide this audience with all of the research to date on programmed tutoring.

However, in a brief summary of that research, I would like to point out that there have been approximately 12,000 children tutored with programmed tutoring on a national scale during the last three years.

In general, the results of the tutoring are something like this: given that a child has an intelligence quotient of 60 or above, that he does not have severe clinical pathology nor massive brain damage, and that he has not been in a teaching situation where he, as an individual, has sincerely attempted to learn to read and has failed too often, the probability that any one child will learn to read with this system is approximately .9.

The data available from the results of numerous studies with this system have produced the astounding statistic that the programmed tutoring system has been successful in the teaching of reading to beginning first graders at the rate of 98.6% success predominantly with children whose expectancy of success is almost zero. This, of course, does not say the child is reading to grade level. It simply says that the system is able to take the child over that massive mountain from being a non-reader to a beginning reader.

The accomplishment is not quite so spectacular as it sounds in that it takes additional work with a very well qualified teacher to get the child to read at the level commensurate with his ability. However, it does put to route the notion that the child is unable to learn to read.

The system is one that attempts to point out whether or not any individual child has the ability to learn to read, and, given that ability, he can learn to read to a level that will allow him to communicate with the rest of the society in which he resides--given that he has additional qualified instructors from that point on.

The Modular Instructional System
as an Interface: Kentucky TIME Program

John L. Tringo
University of Kentucky

The point has often been made that educational technology is not hardware alone but it bears repeating. As dramatic and full of potential as hardware is, its ultimate usefulness is dependent on the associated software or instructional techniques. Gagné has stated that "the most important elements of educational improvement are to be found in the technology represented by procedures of instruction, techniques of instruction, and the systematic knowledge associated with them."[1] The program I will describe is basically a software approach. The program could be adapted for computer assisted instruction - and would probably be more effective. This, however, is just a possible added benefit. The program can be disseminated, used, and can achieve its goals with minimum cost for equipment or training. Our primary goal is to teach children to tell time - our secondary goal is to train teachers to be systematic in instruction and reinforcement.

The word "interface" implies a two way relationship between the learner and the instructional material. This is an essential factor in instructional technology. The instructional material should be no more of a static entity than the learner. It should be flexible and always subject to change depending on the needs of the learner. Instructional material must provide a feedback system for these changes to take place. It is sometimes stated as an advantage of programmed instruction that a completed and tested program is permanent. This is rarely true. Times and learners change, and instructional programs must be prepared to change with them.

There are two ways an instructional program can change to meet the needs of the learner. The first is actual revision of the program based on accumulated experience with a variety of individuals and exceptionalities. This must always be provided for - an instructional program should not be validated once and then abandoned to indiscriminate use without controls and continued validation.

The second way is the one used by proponents of branching programs - the routing of the learner to specific parts of the program dependent upon his performance on the current portion of the program. This method of individualization remains controversial - objectionable to some on theoretical grounds and to others on findings that it is often not superior to linear programs. This program dichotomy (linear versus branching) overlooks the more central issue

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[1]Robert M. Gagné, "Educational Technology as Technique," Educational Technology, 1968.

of the needs of the learner and the nature of the material. By "needs of the learner" I do not mean some internal state but the measurable, individual characteristics that every learner brings to the task. Although branching programs do provide for some individualization of instruction, particularly in CAI use where many characteristics of the learner are taken into consideration, they still usually assume a hierarchical continuum of learning. The modular instructional system is an attempt to break out of the hierarchical mode and still retain the advantage of programmed instruction.

The modular instructional system is an attempt to provide for individualization by structuring the instructional program and materials into self-contained units that may be presented in any order or combination. This may or may not be in opposition to Gagné's hierarchy of skills - only experience can tell. It is quite possible that our data will tell us that the program is most effective when it is used in a sequential, hierarchical fashion. We won't have lost anything if this is true, in fact the modular nature of the program makes it easier to identify and change the units that are out of sequence. Although the instructional units can be presented in any order, the steps within each unit are sequenced and this sequence must be followed. Of course, this sequence may be modified by experience. Each step in the sequence has a specified criterion and a record is kept of the number of trials to criterion. These data are then used to modify the sequence within the unit. Records of success with different types of learners and the order of unit presentation will also be kept. Thus we can check both unit sequence and sequence within units to pinpoint problem areas and change specific items rather than the total program. We can also make recommendations on the order of presentation of the units with specific exceptionalities, age groups, or other learner characteristics.

We have tried to build our program in a logical, orderly way - even if what we are teaching is not logical or orderly. The program is constructed as if there is a hierarchy of skills because it appears to be the most efficient way to proceed. I don't see any alternative but we can be orderly without being rigid. We never know the "best" sequence for a program or a learner until alternative sequences have been tried. The best sequence for an EMR child may not be the best for a N.I. child; or even for the same child at different times. This does not mean we must be less systematic. On the contrary, we must be more systematic in program construction and data recording in order to provide flexibility.

The Kentucky Time Instruction by Modular Elements (TIME) program is a self-contained kit designed to teach exceptional children to tell time. The kit consists of a clock with removable numbers and hands, worksheets, transparencies, games and a teacher's manual. The manual includes ten units from Learning the Numbers to Telling Time Without Numbers. The entering behavior is determined by a pre-test. Each unit is divided into lessons with specific objectives, procedures, and criteria. A reinforcement schedule is suggested for use throughout the program.

The program is modular in two respects. The instructional program is modular in that each instructional unit is self-contained and may be used alone or with some or all of the other instructional units. Secondly, the material is modular and may be arranged in a variety of ways. We believe that these components are most efficiently used together but they may be used independently of the total program to reach a desired goal.

The program was developed from a task analysis framework. We determined that we usually tell time from hand position alone and set this goal as our terminal behavior. This is easily illustrated by covering your wrist watch with your hand and trying to remember which numbers are on your watch. Few watches have all numbers and fewer people remember which numbers are present although they have looked at their watches thousands of times. We tried to deal with as few concepts as possible. We do not attempt to teach days, weeks, or months; hours in a day; A.M. or P.M.; or even common terms like half-past the hour. We even eliminate before the hour terms - it is always 11:55, never 5 minutes till 12. This is a rather restricted view of time-telling but our analysis led us to consider such extra concepts as luxuries at best and detrimental to the attainment of our objectives at worst. This is not to say these other concepts are unimportant or can not be added later. However, every program must set its own limits.

The ordering of the ten major units (Table 1) is not arbitrary but it is only one of many possible sequences. The order may be varied, units may be taught in parallel instead of sequence, or units may be temporarily bypassed if progress is slow.

Table 1

Kentucky TIME Program Units

I. Learning the Numbers

II. Positioning Numbers on Clock

III. Long and Short Hand Discrimination

IV. Directionality

V. Telling Time by the Hour

VI. Five Minute Equivalents of Numbers

VII. Reading Minutes by Position

VIII. Approximating Time

IX. Telling Time

X. Telling Time Without Numbers

It took us a year to reach this stage of development. Six months of that time was spent trying out the lessons and materials on children sequentially and recording our mistakes. The manual is now being revised and we hope to have enough copies made for extensive field testing. We know the kit works but we do not know yet if this modular approach is fruitful. We would like to use this format and methodology to produce more instructional material. Anything we learn from the development of the TIME program should be applicable to programs in other subject areas.

I'd like to show a few slides of the TIME Kit.

Slide	Explanation
1.	Title slide - Kentucky TIME Program
2.	The kit consists of a pre-test, manual, transparencies, a clock with removable hands and numbers, worksheets, games, and recording forms.
3.	The numbers 1-12 are first taught alone
4.	and then on the clock for the hour positions.
5.	Hands are added after the long hand - short hand discrimination is learned.
6.	The same procedure is followed for minutes using color-coded numbers and hands.

Slide	Explanation
7.	The final lesson is time telling without numbers - by hand position alone.
8.	Transparencies are used for group teaching,
9.	a number of worksheets are used for drill,
10.	as well as a variety of games - Dominoes, Bingo, Card games and Dice.
11.	A pre-test is given to determine the starting level for each child.
12.	The manual is divided into ten self-contained units - or modules.
13.-15.	Each lesson is highly specific and is divided into Materials, Preparation, Teacher Information, Objective, Procedure, and Criteria. Criteria must be reached for each step before proceeding. Many steps are cross-referenced to games or worksheets that may be used if the learner is having trouble meeting criteria.
16.-19.	The following slides show the kit being used with children.
20.	Tokens are used for reinforcement.
21.	Inflation affects even token economies.
22.-23.	Reward Time.

In conclusion, modular instruction differs from conventional programmed instruction in two respects:

1. The major units of the program are independent and may be used alone or in conjunction with other portions of the program. The units are an integral component of the total program yet are useful out of this context.

2. The program modules are learner-ordered. They can be rearranged to meet the needs of the individual learner or type of learner.

MAN-MACHINE INTERFACES IN TRAINING OPTACON READERS*

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I. The Optacon and the Instructional Challenge

An electronic device, called the OPTACON, has recently been developed which enables a trained blind person to read ordinary ink print, immediately and independently in real life situations. The Optacon thus offers an important, practical supplement to braille and disc and tape recordings by providing immediate access to printed documents not available in these other media.

As shown in Figure 1, the Optacon consists of two parts: a small electronic camera and a larger box that contains a finger-sized array of 144 vibratory reeds. The Optacon camera generates TV-like electrical signals that represent a 144 point black-white image of an area about the size of a letterspace. These signals are then converted into a vibrating replica of this image. For example, the letter "O" is converted into a tactile form much like a crater with a vibrating rim. Other letters are similarly converted into vibrating replicas. Since the Optacon simply copies the patterns on the page into enlarged but identical vibratory patterns, it can be used with any type style and a great variety of materials, even non-alphabetic materials.

As the blind person moves the camera over the print with one hand, he senses vibratory images of the letters with a fingertip of the other hand. The tactile stimulator unit consists of a plate with an indented groove for the fingertip. A matrix of holes is cut in the plate, with a small rod protruding through each hole. Each rod is individually driven into contact with the finger by a reed, evoking a well-localized tickling sensation.

The Optacon design is the result of an intensive research and development effort comprising both engineering and psychophysical studies, coupled with field testing by blind subjects. The entire Optacon is packaged as a unit in a carrying case about the size of a desk-top dictionary. The Optacon is powered by rechargable batteries. Weight has been minimized, and a shoulder strap is included to make the instrument easily portable.

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To date sixteen blind people have been trained in various ways to read with the Optacon. All have been able to read with the Optacon, though their levels of proficiency and amounts of experience have varied. Reading speeds at this time range from 10 to 80 words per minute.

Our training methods have progressed from informal and ad hoc procedures to more organized lesson plans. The first several persons we taught to read received highly sporadic training over a period of several years with various rudimentary early models of the Optacon. These first readers have since played a key role in teaching others to read and in developing lesson plans and teaching equipment.

Since we now have a well-engineered and practical reading aid that is clearly useful to some blind people, the challenge now is to make the device, together with proper training, generally available. Both the Optacon and training are essential, neither is useful without the other. Good training will enable a blind person to use the Optacon to the maximum limits of its and his capabilities. If we are successful in making the Optacon generally available, this training challenge will fall on current teachers of the blind and workers for the blind.

Very little is presently known about the best way to teach Optacon reading. We hope to design our initial field trials with the Optacon so that they not only evaluate the Optacon but also increase our knowledge of the learning process. Training blind people to read with the Optacon in these initial times will be a period of discovery and innovation.

II. Instructional Technology for Teaching Optacon Reading

We are presently using the equipment shown in Figure 2 in the training situation. First there is a tracking aid, which is a simple clipboard-like device fitted with perpendicular sliding rods into which the Optacon camera can be plugged. This tracking aid helps the beginning reader to keep the Optacon camera properly aligned to the print, to stay on the line of print, and to change from one line to another. Secondly, we use an auxiliary display to allow the teacher to see exactly what the Optacon reader is feeling on the tactile stimulator. This auxiliary display can be either visual or tactile, depending on whether the teacher is sighted or not. In the case of the visual display there are 144 lights corresponding to the 144 vibrating pins in the Optacon. The signals in the Optacon which activate the vibrating pins at the same time activate the corresponding lights in the visual display and/or the pins in the auxiliary tactile display. This enables the teacher to help the blind reader to position the letter correctly by manipulation of the camera and to identify the letter.

In addition to this basic training setup, we have been experimenting with the system shown in Figure 3 which we call the Optacon Training Aid. This is an electronic system which can substitute pre-recorded signals from a magnetic tape recorder for the Optacon camera signals of any Optacon. The components of this Training Aid are a variable speed tape recorder, the conversion electronics package, and a normal Optacon minus the camera. With this arrangement, the student does not have the task of controlling the probe. As the text in tactile form passes beneath the reader's finger at a fixed rate of speed, he can give his full attention to the task of sensing and interpreting the letters and words. This system has proved to be useful for building up speed by pacing the student.

Our newest training accessory, called the Typing Aid, is shown in Figure 4. This accessory makes it possible for a student to sense an image of the letter that has just been typed. It consists of a normal Optacon with its camera mounted on the typewriter so that it views the area on the page that the key strikes. We are experimenting with this accessory for both teaching Optacon reading and for teaching typing.

We are in the process of developing lessons for the early stages of learning to read with an Optacon. Our approach is to divide the alphabet into six groups of five or fewer letters each, the first group being the easiest letters to recognize with an Optacon and the last group being the hardest. After some practice with the first two groups of letters the student practices with words and sentences using these ten letters. After each new group of letters is introduced he then receives words and sentences using all the letters he has had thus far. This appears to be a promising technique for rapidly getting to the stage of text reading. Once a student has reached the stage of being able to read ordinary text material, we try to find material for him to practice that he is intensely interested in. Practice with this material directly, alternated with practice with the Optacon Training Aid, seems to be especially effective.

III. Instructional Case Histories

A. The Monroe School Experiment

When we learned that a nearby grade school had six totally blind children in the resource program, we arranged to meet the resource teacher and the students as a prelude to possibly setting up a pilot field trial for the Optacon within the school. Approximately two weeks after this meeting, and coincident with the beginning of school after Easter vacation, the program began. We assumed responsibility for providing the personnel and equipment needed, and Monroe School supplied the facilities, a part of the resource room, and a tremendous amount of cooperation in assisting us.

The childrens' ages were 8, 10, 11, 12, 14, and 15; one second grader, one fourth grader, one fifth grader, one seventh grader, and two eighth graders, with grade levels corresponding to the ages. School records indicated that all the children were of at least average intelligence. These children offered no unusual problems which we would have been totally unprepared to handle, considering that we had no previous experience with the kind of training and that we had almost no time for preparation of curriculum materials to be used.

Because of the experimental and research nature of this program we presented it to the children as something we were doing for our own edification and we asked the children to help us with this project. We were receptive to all forms of input from the children and through flexibility and sensitivity we tried to find workable techniques.

Miss Carolyn Weihl(1) of our staff saw each child, one at a time, for 15 to 30 minutes every day for about ten weeks to the end of school. We began by teaching single letter recognition. The shapes of the letters were taught by verbally describing the tactile sensation pattern which the student felt on the Optacon. To maintain the student's interest in the goal of actual reading, we moved to words as quickly as possible, even if the entire alphabet had not been mastered. Emphasis was placed upon getting the child to recognize common letter groups (i.e., <u>and</u>, <u>ing</u>, etc.) as soon as possible.

The six students appeared to separate into three categories of accomplishment in Optacon reading. Two students obviously had mastered the task of learning to read with the Optacon. One of these had 20.5 hours and the other 21.5 hours of training. The next set of three children did master the task of letter recognition and proceeded on to text reading, but the initial stage took longer and frequent reviews were necessary. The facility with which these three students dealt with text was not so proficient, and they tended to have much greater day-to-day variability in quality of performance. However, only one of these three had 18.5 hours of training; the other two had about 10 hours of help. The remaining child, the youngest of the group, reached levels of letter and even word recognition, and it was the actual reading of text which separated him from the others.

Given our unprepared state and the short duration of the Monroe School program, we were pleasantly surprised at how successful the program was. It convinced us that the Optacon is a useful instrument to younger students than we had previously thought. In fact, the Optacon was designed with adult dimensions in mind, and the ability of elementary school children to use it is an amazing side benefit. However, this result has stimulated us to attempt to reduce the size and weight of the Optacon to make it more manageable by these children.

B. The San Diego High School Living Skills Institute

A blind Stanford student whom we taught to read with the Optacon had a summer job at a seven-week live-in program for blind high school students. She worked with the Optacon briefly with each of the 16 students and then more thoroughly with six students. The teaching conditions were hectic due to the very nature of a program designed to teach academic subjects, living skills, recreational activities, and written communications, just to mention the major projects. The seven week program was not long enough to train anyone thoroughly, but several students were reading simple text by the end of the program. Everyone thought it was worthwhile and a good introduction to Optacon reading.

C. Teaching A Blind-Deaf Person

During last summer another of the blind Stanford students we had taught to read with the Optacon worked with a 29 year old totally blind and totally deaf person. They worked together for approximately 11 days over a three week period for from two to four hours per day. Because the deaf-blind student's speech was not always intelligible and because his ability to perceive the teacher's speech by the vibration method was not perfect, the training sessions posed unique circumstances to the trainer and student. This has been the only time we have worked with a blind-deaf person.

The daily log of the training sessions indicates that this student did exceptionally well in learning the letters of the alphabet and recognizing them in words and sentences. The usual next step in Optacon reading is to go from excercises to reading meaningful text for practice toward the skills necessary for fluent reading. It appeared that the student's own language deficit, resulting from the handicaps, was a hindrance to his achievement at this point. This experience clearly illustrates the importance of access to written information in language development. However, the student felt the Optacon was useful to him and he continues to use it.

IV. Optacon Dissemination Program

Our experience to date with the Optacon has given us tremendous encouragement to make the Optacon widely available. We have recently formulated a plan toward this goal. The first step in this plan is a proposal to the U.S. government for a field trial to teach fifty blind elementary and secondary school students to read with the Optacon. The blind students in each of these school districts would be taught to read with the Optacon and test data would be collected regarding their progress and the utility of the Optacon for them. If the test data from this field trial is sufficiently encouraging, then proposals for more extensive deployment of the Optacon would be submitted to governmental and private agencies.

Making the Optacon generally available is contingent upon obtaining funds to establish this field trial. Our goal is to make an Optacon available within 5 years to every blind person who needs and desires one. We will need help and cooperation from everyone involved in the "blindness system" to achieve this goal.

References

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A COMPUTER-ASSISTED INSTRUCTION COURSE IN THE EARLY IDENTIFICATION OF HANDICAPPED CHILDREN*

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Introduction

Under grant support from the Bureau of Education for the Handicapped, and the Bureau of Educational Personnel Development, U.S.O.E., personnel at The Pennsylvania State University have developed a computer-assisted instruction course in special education for inservice teachers. The course, called CARE (Computer Assisted Remedial Education), is a completely self-contained 3 credit college-level computer-assisted instruction (CAI) course which deals with the identification of handicapping conditions in children. The purpose of CARE is to give inservice pre-school and primary teachers of seemingly typical children the knowledges and skills necessary to identify children who otherwise might be educationally retarded by the age of nine or ten. The course is designed to promote clinical sensitivity on the part of regular classroom teachers and develop in them a diagnostic awareness and understanding of the strengths and weaknesses of handicapped and normal children. It is expected that teachers who complete the 35 hour course will be able to evaluate systematically children's learning potential and to formulate appropriate educational plans for the children.

The special education course is given a wide audience of teachers by an entirely new concept in continuing education. Instruction is individualized for participants by means of a mobile computer-assisted instruction system. An expandable mobile van houses a complete 16 terminal CAI installation which permits 16 teachers to interact simultaneously with the computer. The mobile operation is placed in various remote locations in the Appalachian region for periods of six to eight weeks. Approximately 150 teachers can complete the course during each six to eight week period

Need

This project seeks to improve the quality of experienced teacher preparation in the area of special education. Intensive training in special education concepts is directed primarily toward regular classroom teachers of elementary grades in rural schools in Pennsylvania's sparsely populated counties. A high proportion of the children in these counties come from low-income families who must depend heavily upon their local schools for long-term support and escape from poverty. The situation in Pennsylvania's Appalachian region reflects a pressing national need for special educational provisions. It has been estimated that 3-3/4 million of the nation's six million handicapped children are not receiving the special services they need. The absolute level of this lack of service is relatively more severe in schools serving the rural population than in the urban and suburban centers. The present rates of preparation of special education personnel are not sufficient to diminish the gap between needs and delivered services. It should be obvious that an alternative, or at least an augmented approach to the provision of special services to atypical children must be undertaken. An alternative is illustrated in this project: preparation of inservice teachers of elementary and preschool children to identify and deal effectively with conditions in children which may adversely affect their school performance.

Specialists in early childhood education and special education continually stress the need for early diagnosis of educational or behavioral deviancy, followed by early intervention with programs designed to promote cognitive and social development, in order to help handicapped and disadvantaged children get off to a good start in life. It is the contention of these specialists that the early years of a child's life are extremely important in terms of personality development and intellectual development. Unfortunately, most pre-school and primary level teachers have not been trained specifically to identify children who are handicapped or who exhibit behavior which may be symptomatic of future educational difficulties

Purpose of CARE

The purpose of the course called Computer Assisted Remedial Education (CARE) is to give educational personnel the knowledge and skills necessary to deal effectively with children who have educational problems.

The course is appropriate for teachers of all grade levels, but especially for preschool and elementary school teachers. The course is designed also to be of interest to other educational personnel such as principals and other administrators and supervisors; special class supervisors; school nurses; psychologists; aides; music, art, shop, and physical education specialists; special services personnel; and other school related personnel including day care workers.

The CARE course is designed to prepare inservice preschool and primary level elementary teachers and other interested persons to know the characteristics of, and be able to identify, handicapped children. Handicapped children are defined, for purposes of this project, to be those children who have atypical conditions or characteristics which have relevance for educational programing. Handicapped children include children who display deviations from normal behavior in any of the following domains: a) cognitive; b) affective; and c) psycho-motor.

The philosophy of the course is such that teachers are encouraged to look at children as individuals. The use of traditional categories or labels is minimal. However, certain terms and concepts related to handicapping conditions are taught so that persons who take this course are better able to communicate with other professionals in the field.

Objectives. Upon completion of the CAI course, participants will have achieved the following objectives, which are directly correlated with the decision process flowchart. Participants will:

A. know the characteristics of handicapped children and be aware of symptoms which are indicative of potential learning problems;

B. be able to screen all children in regular classroom programs for deviations and determine the extent of the inter-individual differences;

C. be able to select and use for those children with deviations, appropriate commercial and teacher-constructed appraisal and diagnostic procedures in order to obtain more precise information as to the nature of the deviation;

D. be able to synthesize information by preparing individual profiles of each child's strengths and weaknesses on educationally relevant variables;

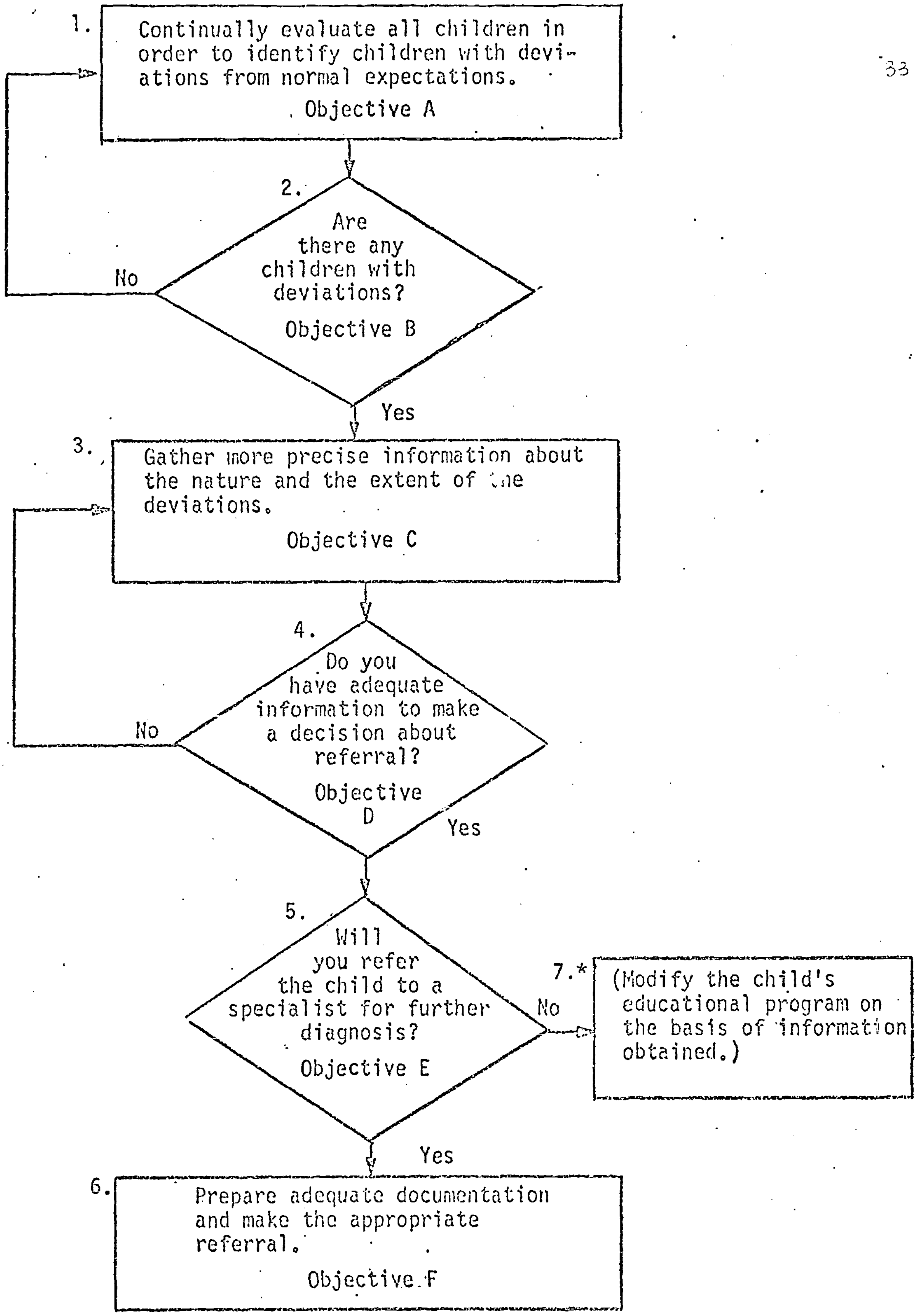
E. be able to evaluate the adequacy of the information available in order to make appropriate decisions about referral to specialists;

F. be able to prepare adequate documentation for the case if the decision to refer is affirmative.

It is expected that teachers who exhibit the competencies listed above will systematically evaluate children's learning potential and formulate appropriate educational plans according to the decision process outlined in the following section.

Relationship between objectives and the decision process. The six objectives are directly associated with the first six steps (boxes) in the decision process. The first two steps in the decision process dictate that the teacher evaluate all the children in the classroom in order to identify those children who exhibit deviations from normal behavior. Objectives A and B are related to the first and second steps in the decision process.

Evaluation should be thought of as a continuous process which is an integral part of the total educational process. The evaluation process includes two major tasks: a) obtaining both quantitative (numerical) and qualitative (categorical) data about children's abilities in the cognitive, affective, and psycho-motor domains; and b) making value judgments about these data. To identify children who exhibit deviations from normal expectations is



*This step is the subject of a CAI course to be developed.

Fig. 1. Decision Process.

to make a value judgment that a particular behavior is considerably different from that which is displayed by a majority of the child's chronological age peers and is, therefore, different from the behavior usually expected of children in that age group.

In order to make appropriate educational judgments (i.e., judgments which result in educational planning aimed at intervention for the purpose of preventing potential learning problems, correcting existing learning problems, or enhancing learning assets), teachers need information about the atypical conditions and characteristics which are likely to be present, to some degree, in groups of school age children. Information concerning both normal behavior and possible abnormal behavior in each of the domains (cognitive, affective, and psycho-motor) is the prerequisite for the task of screening children in terms of deviations. It is assumed that inservice teachers possess adequate knowledge concerning normal behavior and operate, in general, with expectations of normal behavior for the children in their classrooms. The investigators maintain that the majority of inservice teachers have not had an opportunity to acquire extensive information about possible deviations, or abnormalities, in behavior which influence learning. Therefore, course content used in association with objective A provides the basic information which is the prerequisite for the screening task (steps one and two) and for subsequent tasks in the decision process.

The following items are examples of the course content for objective A: a) definitions of atypical children; b) descriptions of various groups of atypical children such as mentally retarded, and emotionally disturbed children; c) descriptions of children with speech, motor, auditory, and visual problems; and d) justification for the use of certain variables in describing atypical children. Since the course is intended for teachers working with preschool and primary level children who may not yet manifest clear-cut signs of atypical behavior, teachers are given information relative to the more subtle clues to incipient problems.

Acquisition of the prerequisite information allows the teacher to identify, or screen out, those children who exhibit deviations from normal behavior. Achievement of objective B enables the teacher to make correct use of data which are usually readily available to classroom teachers. Course content directed toward objective B focuses on the following: a) the relative nature of normality in terms of socio-cultural factors, and societal and educational expectations; b) inter- and intra-individual differences; c) interpretation of information which is generally available for all children in the group such as results of group intelligence, readiness, and achievement tests, questionnaire responses concerning home and family, and so forth; and d) the continuous and circular nature of the screening process.

During the first phase of the decision process, the teacher surveys the entire group of children for performance on certain relevant variables in order to select those individual children who exhibit deviations of a sufficient degree to warrant more intensive diagnosis. With the completion of the screening at any one time, the teacher will have formulated "suspicions" or hypotheses about some of the children in the group and will proceed to the third step in the decision process for these children. It should be noted that the teacher would continue to use the screening process as new group data become available.

During the third step in the decision process, the teacher gathers precise information concerning the nature and the extent of each individual child's deviation. Objective C is associated with this step. At this point, the teacher adds information about each child's intra-individual differences to that previously obtained (in the first step) about the inter-individual differences. The teacher needs to obtain data concerning discrepancies within the individual's growth pattern (the child's specific abilities and disabilities) for each of the children selected during the screening process.

Achievement of objective C enables the teacher to perform at the third stage of decision making. Course content for objective C includes: a) rationale for use of a variety of appraisal procedures; b) use of commercially prepared tests and non-testing materials; c) techniques of constructing and using teacher-made tests and non-testing procedures, both formal and informal; d) criteria for selection of appraisal procedures with emphasis on validity and reliability relative to a variety of purposes; e) sources of information about the child from other individuals, such as peers and parents; g) use of day-to-day informal situations, devised by the teacher, to yield information about attainment of specific behaviors of interest. The emphasis at step three of the decision process, and for objective C, is on individualizing appraisal for each child in terms of the deviations noted during screening. The teacher seeks information in addition to that which is usually available for all children, and this information will be unique to the deviation for which the child was screened out of the total group.

Tentative completion of the third stage in the decision process, together with achievement of objectives D and E, enables the teacher to evaluate the comprehensiveness of the obtained data and, therefore, make the decisions required in steps four and five. Course content associated with objective D includes: a) description of profile charts and related diagrams; b) procedures for selecting certain variables for inclusion in an individual's profile; c) interpretation of normative data; d) rationale for the use of various kinds of information, from a variety of sources, in combination; and e) techniques of constructing and using profile charts and related diagrams. Course content for objective E consists of: a) criteria for determining the comprehensiveness of the obtained data; b) information concerning the specialists who can be expected to provide various types of intensive diagnostic services for children; and c) descriptions of the classroom teacher's role in relation to the roles of various specialists.

If the teacher makes a negative decision at step four, he needs to return to step three and collect the information required to complete the child's profile chart before proceeding through to step five. However, if the teacher is able to make an affirmative decision at step four, he will proceed immediately to the next decision block, which is step five in the process.

In formulating an answer to the question posed at step five, the teacher asks himself: Have I exhausted all sources of information available to me in my role as a classroom teacher? Can I make educational plans for this child on the basis of information currently available? Do I need more information before making educational plans for this child?

If the decision at step five is for referral, the teacher will proceed to step six. Objective F is related to step six. Course content associated with step six includes: a) criteria for selecting the appropriate specialist for various types of referrals; b) procedures to be used in documenting the request for referral; c) descriptions of general procedures to be followed in making referrals; d) activities which might be required of the teacher subsequent to requesting a referral; e) feedback to be expected by the teacher relative to disposition of the referral.

If the decision for referral at step five is negative, the teacher will be responsible for modification of the child's educational program within the regular classroom setting (step seven in the decision process). It is not possible in this one course to deal with extensive modification of programs. A second course is planned to cover this problem. Modification of programs for atypical children would include the following topics: a) techniques of effective classroom management; b) specialized teaching strategies which might be used for amelioration of difficulties, or for enrichment, in various subject-matter areas; c) special materials to be used in association with specific strategies; d) sources of information regarding specialized strategies and materials; and e) resource persons usually available to assist classroom teachers.

Computer-Assisted Instruction

Instruction is individualized for the teachers by means of computer-assisted instruction (CAI). CAI presents instruction in an environment where the material presented to the learner is selected and sequenced, with the aid of a computer, to be responsive to the individual learner's needs. The computer selects sequences of instruction which are appropriate to an individual's background knowledge of the course content, his rate of progress through the material, and the types of errors (or non-errors!) the student makes as he interacts with the system.

Because each student can communicate with the system independently, and since the computer can arrive at logical decisions based on its analysis of incoming student performance data, the capability exists for the intelligent adaption of instruction for each student. The logical decision-making ability of the computer, along with its extremely rapid access to large volumes of stored information, combined with the knowledge and skill of the author-programer, can provide for a wide variety of individual differences among learners. Recent experience with CAI for several hundred teachers shows that they are highly motivated by the responsive environment provided at the CAI terminal.

They appreciate the opportunity to learn without exposing their lack of knowledge to their peers. They appreciate the flexibility of scheduling individual sessions which enables them to continue with community projects and to meet family responsibilities.

To accomplish the course objectives outlined above, a 16 terminal IBM 1500 Instructional System has been installed in a custom-built expandable van. The van measures 20 by 40 feet expanded and contains 16 student stations or consoles at which inservice elementary teachers and supervisors take the special education course.

The IBM 1500 Instructional System consists of 16 instructional stations each with cathode-ray tube display, light pen, typewriter keyboard, audio device and image projector. The computer equipment is comprised of an 1131 central processing unit, 1442 card reader and punch, 1133 multiplexer control unit, one 2310 disk storage drive, 1502 station control, two 1518 typewriters, and two 2415 tape drives.

The central processor is an IBM 1130 computer with 32,768 sixteen bit words of core storage. In addition to the usual peripheral equipment, the central processor depends upon three IBM 2310 disk drives (1,436,000 words) for the storage of usable course information and operating instructions. Twin magnetic tape drives record the interaction between the program and the student for later analysis and course revision. Core storage cycle time is 3.6 microseconds and read/write time for disk storage is 27.8 microseconds per word.

Each IBM 1500 student station consists of four optional display/response devices which may be used individually or in combination. The central instrument connected to the computer consists of a cathode-ray tube screen with sixteen horizontal rows and forty vertical columns for a total of 640 display positions. Information sufficient to fill the screen is available in micro seconds from an internal random access disk. A light-pen device enables the learner to respond to displayed letters, figures, and graphics by touching the appropriate place on the screen. A part of the CRT device is a typewriter-like keyboard which makes it possible for the learner to construct responses, have them displayed at any author-desired point on the CRT screen, and receive rapid feedback in the form of an evaluative message. Four dictionaries of 128 characters each of the course author's own design can be used simultaneously. An image-projector loaded with a 16mm microfilm is capable of holding 1000 images on a single roll and of accessing forty images per second under program control. An audio play/record device based on four channels on a 1/4-inch tape is an integral part of the system. An electric typewriter on the system is a separate device which enables the proctor to receive a paper copy of information about students and course progress.

Modes of Instruction by CAI

The CARE course uses a wide variety of instructional strategies to assist students in reaching the course objectives. All the strategies are interactive and all require active involvement on the part of the learner. The most prevalent strategy used in the course is the tutorial approach. This approach simulates the master tutor engaging in an interactive dialogue with an individual student. The tutor presents information, asks penetrating questions, and carefully analyzes the student's responses to the questions. On the basis of the student's demonstrated understanding or lack of understanding of a given concept, the tutor provides alternative courses of instruction, remedial sequences of instruction, or even enrichment material. The tutor can move a capable or well-informed student through a course of instruction very rapidly. Similarly, the tutor can tailor a sequence of instruction to meet the needs of a student who is not as capable or does not have a good background of experiences or preparation. The sophisticated CAI system can perform the chores of dozens of tutors rapidly and efficiently. The net effect is that hundreds of teachers in the CARE project have been individually tutored in certain special education skills.

The second major mode of instruction used in the CARE course is the inquiry approach. This type of activity is used in the latter stages of the course to draw together all the concepts acquired by the teachers throughout the course. This strategy includes simulation of regular classroom problems, as well. In essence, the inquiry and simulation approaches as used in the CARE course are directed problem solving strategies. Teachers are told that they have access to information about a class of first grade children. One or more of the children in the class may be handicapped or have an educational problem of one kind or another. It is the teacher's task, in effect, to screen the class for children with educational problems, identify those children with potential or existing problems, and deal with the problem by modifying the child's educational program or making an appropriate referral. The teacher begins the screening by looking over the complete cumulative records of the children in the class. The student may ask the computer for additional information. Not all the information the student receives is accurate; in fact, many false leads are given to lure the unwary teacher into making the wrong decision. The computer system will lead a teacher down the wrong path for awhile and then explain why that particular line of reasoning is not appropriate for that specific child. Eventually, as a result of skillful questioning on the part of the CAI system coupled with the appropriate line of questioning by the teacher, a decision is reached by the teacher to refer a child or to modify the child's program. The teacher's decision is evaluated by the system and then the teacher's plan for referral or program modification is evaluated by the CAI system.

When a teacher completes the course he has actually constructed several case histories of children with problems and has made educational decisions related to the best plans for dealing with these problems.

Off-Line Materials Used in CARE

When a student is interacting with the CAI system he is said to be working "on-line." On-line instruction in the CARE course is dependent upon additional materials which are not controlled by, nor accessible to the computer system. These materials are called "off-line" materials; they play a large and very important role in the course.

CARE Handbook. The CARE Handbook was written especially for the CARE course. The book is 400 pages in length and contains a 350-item glossary of terms used in the course. It has two functions. First, the handbook is a detailed summary of the course material. It may be used as a reference or refresher after a student has completed the course of instruction. Second, the handbook contains reference material to which the student must refer when he is working on-line. The reference material consists of charts, tables, student cumulative records, examples of evaluation devices, definitions, and many other kinds of information. The handbook also serves as a readily available notebook in which students make notes of important points.

Specimen tests. The appropriate usage of three screening tests is taught. The three tests are the Denver Developmental Screening Test, the Metropolitan Readiness Tests, and the First Grade Screening Test. These tests were designed to be used by teachers and others who have not received extensive training in testing. Each participant in the project receives sets of all three instruments. Actual test administration is simulated and problem areas pointed out. Teachers are asked to score and interpret results of the simulated administrations.

Textbook. The textbook used as a supplement to the course is:

> Smith, R. M. (Ed.) Teacher diagnosis of educational difficulties. Columbus, Ohio: Charles E. Merrill, 1969.

Mobile Computer-Assisted Instruction

Mobile CAI is a new and innovative concept in inservice teacher education. The impact of the CARE course is maximized by the fact that mobile CAI permits the course to be disseminated to large numbers of teachers who reside in different parts of the state.

The Penn State Mobile CAI Laboratory is a complete CAI system installed in a specially designed, custom built expandable van. The van with the CAI system can be hauled by diesel tractor to remote parts of Appalachia and set up for instruction in a short period of time. To prepare the van for instruction, it is necessary merely to expand the sides of the van. When expanded, the van contains a CAI classroom which is 20 by 40 feet. Power for the computer, and for heat or air conditioning is supplied by local power sources with little difficulty.

The mobile CAI system is located for approximately six to eight week periods in a planned sequence adjacent to centrally located school buildings in rural Pennsylvania. Teachers and other interested persons drive to the central location in the afternoons or evenings at their convenience to take the course on an individual basis. The Mobile CAI Laboratory can serve up to 150 persons during each six to eight week stop.

Graduate credit in the amount of three units is given to the student by Penn State upon successful completion of the course requirements.

Systems Analysis: Evaluation of Instructional Materials and Prediction of Student Performance

Mark L. Berman
University of Washington

Introduction

Education, by definition, is greatly concerned with improvement of practices and procedures. Pressure is increasing from parents and others for accountability. It appears that the time is not too far away when standards for performance will be set by the states, and actual performance of teachers and students measured against these standards. If such is the case, goals will have to be defined in very precise terms, and detailed systems analyses carried out in order to determine how well the educational system is functioning on its various levels.

Systems analysis is not relevant to education and the individual teacher simply because of the possibility that its use may enable us to deal with future events, such as performance standards set by the state. Systems analysis is very important right now, to enable more effective instruction.

The classroom may be viewed as a "system for learning." This system is composed of a number of sub-systems or components; for example, the teacher, the students, the instructional materials and methods used, and the techniques for measuring pupil performance. Diagram A depicts the classroom as a "system."

(Insert Diagram A here)

Programmed Instruction

For purposes of simplicity, we will deal mainly with a single sub-system, that of instructional materials and methods. The components of this sub-system (in other words, the sub-sub-system) are workbooks, films, slides, and so on. Another and fairly recent variety of instructional materials is programmed instruction. Programmed learning has been an effective technique in education. Though the precise form that programmed instruction takes may vary, in general the term refers to information which has been organized so that students progress only after demonstrating mastery of current materials. Consequently, an initial step in the development of programmed materials involves a thorough analysis of subject matter.

A determination is made of the behaviors to be acquired by the student as a result of his completing the materials. This analysis, when properly done, contributes to more effective learning, since redundancies, gaps, and inconsistencies are discovered and corrected. Immediate knowledge of quality of performance may be provided to both student and teacher by way of feedback built into the materials. In addition, students working with programmed materials are generally able to proceed at their own pace, and are not constrained by other students, whose pace may be slower or faster.

Programmed instruction is particularly well suited for use with students whose educational experiences have been incomplete or negative. When working with these students, instructional procedures are needed which demonstrate that education can and does pay off, that learning has positive, and not only negative, aspects. It is necessary, but not always sufficient, to promise delayed rewards for participation in educational programs. Many students want to see evidence of immediate payoff, rather than wait for intangibles such as a future job or prestige. Academic performance must be sustained until delayed rewards become available. For these and other reasons, programmed instruction, in which students are usually correct a high percentage of the time, produces higher level motivation in many students of poor academic background.

Specifying Objectives

A critical aspect of systems analysis relates to the goals of the system. What form might such goals take, when translated into the classroom as a "system for learning?" In general, teachers are interested in improved academic and social behavior. But this is too gross and amorphous a goal to be of much use in any systems analysis. More precise specification is needed. Robert Mager, in his book, *Preparing Objectives for Programmed Instruction*, asks: "How often are educational units... prepared in response to the questions: 1) What is it that we must teach?; 2) How will we know when we have taught it?; 3) What materials or procedures will work best to teach what we wish to teach?"

Precise statement of performance objectives is an integral part of programmed instruction. Three basic steps are involved in this process:

1) Identification of the behavior by name, i.e., specification of the kind of behavior which will be accepted as evidence that the learner has achieved the objective; 2) further definition of the desired behavior by describing the important conditions under which the behavior will be expected to occur; 3) specification of the criteria of acceptable performance, which involves describing how well the learner must perform to be considered acceptable.

Assume that we are all teaching mathematics. One of our objectives may be as follows: "The student, following completion of programmed materials, will be able to solve quadratic equations." This is an objective stated in behavioral terms, since the objective tells us what the learner will be <u>doing</u> when he is demonstrating that he has reached the goal. He will be solving quadratic equations. Contrast this with the non-behavioral objective of, for example, "to develop an appreciation for music." This does not tell us what the person is actually <u>doing</u> when he is "appreciating music." More specificity is called for. As an example, we might change the objective to read, "the person will correctly match the names of famous composers with the title of one of their prominent musical compositions." This, now, is an objective stated in behavioral terms, i.e., it states a behavior whose occurrence is readily observable by anyone.

the objective to read, "the person will correctly match the names of famous composers with the title of one of their prominent musical compositions." This, now, is an objective stated in behavioral terms, i.e., it states a behavior whose occurrence is readily observable by anyone.

A discussion of which are the "best" criteria to measure performance is beyond the scope of this paper. However, it can be said that, regardless of whatever criterion or criteria are finally selected, we must have feedback or communication in our system. The nature of feedback, to both teacher and student, varies from information concerning scores on standardized tests, which are received very infrequently, to daily and even minute-by-minute information resulting from student responses to programmed materials.

Given this information and tools for analysis, the teacher is better able to make decisions concerning which materials and management techniques to use with particular students. The more frequent and detailed the feedback, the more effective will be these decisions. The Experimental Education Unit of the Child Development and Mental Retardation Center, University of Washington, has been working on the development of a Pupil Performance Profile and a predictive model, both of which relate systems analysis to programmed instruction or instructional materials in general. The project is designed to make several important steps toward the full-blown development of a methodology for the evaluation and specification of instructional materials and behavior management procedures, as well as the prediction of student performance on instructional materials under various environmental conditions.

Numerous approaches exist for the evaluation and specification of instructional materials. However, their success has been limited by insufficient emphasis on systematic analyses of data generated by students working on instructional materials. In regard to prediction of performance, little has been done to enable a teacher to deal with individual students.

The Pupil Performance Profile (PPP) utilizes the following information: a) the "type" of student involved, i.e., his characteristics such as scores on standardized tests; b) the instructional materials involved; c) the behavior management procedures used, if any; d) student performance in terms of correct and error rate, percentage correct, speed, plus additional dependent variables where relevant. Figure 1 presents the information which forms the Profile. Figure 2 presents a part of the Profile, depicting one student "type", two sets of instructional materials, and one behavior management procedure.

(Insert Figure 1 here)

(Insert Figure 2 here)

The predictive model utilizes data provided by the Pupil Performance Profile. That is, the Profile will tell us how students of particular "type" performed on particular materials under various conditions. Given the added information of the history of the individual students whose future performance we are attempting to predict, we have a broad, but precise, data base for our predictions. Figure 3 represents the relationships between the performance of an individual student and the performance of other students.

(Insert Figure 3 here)

Figure 4 illustrates the application of the predictive model:

(Insert Figure 4 here)

Given the above information, how might we structure both the type of materials presented to the individual student and the nature of the management procedures in order to improve his performance? The preceding chart supplies several basic pieces of data from which to make such decisions. First, the individual student's correct rate on frames 1-100 was lower than the other students' mean correct rate on those frames. The individual student's error rate on those frames was higher than the other students' mean error rate. Second, the mean correct rate of the other students, regardless of whether or not a contingency system was in effect, was lower for frames 101-200 than it was for frames 1-100. This was accompanied by a higher mean error rate for frames 101-200 as compared to frames 1-100. Third, the students operating under a contingency system did better, in terms of higher correct rate and lower error rate, on frames 1-100 and 101-200 than did students not operating under a contingency system.

From the preceding, three conclusions may tentatively be drawn: 1) the individual student we are dealing with had considerably more difficulty with the initial (frames 1-100) portions of the materials than did the average student. In fact, this student's correct rate was very close to the minimum rate for the other students; 2) the second 100 frames of the materials are more difficult than the first 100 frames, as indicated by both lower correct and higher error rates for the other students on the second 100 frames; 3) the contingency system produced better performance than did baseline conditions, for both frames 1-100 and 101-200.

Armed with this information, we can predict several things about the individual student's performance on the immediately upcoming frames (101-200): First, that we can, all things being equal, expect a decrease in correct and an increase in error rate on these frames. Second, we can expect that this student will have a lower correct and a higher error rate on these frames than did the average of the other students who have worked through the same materials. Third, that a contingency system will increase correct and decrease error rate on these frames.

Now we have the means for specifying, in advance, the performance of the individual student, in addition to knowledge of which management procedure will most improve performance. If we also have data regarding the performance of students of similar "type" on other materials dealing with the same subject matter, we can also predict whether or not the individual student's performance will improve or deteriorate if shifted to these other materials.

Summary

In order to improve instruction, it is necessary to know what is going on in the classroom. We must specify what it is that we are attempting to achieve, the steps to be used in achieving these goals,and devise ways to determine whether or not we have succeeded. Provision must be made for changing practices and materials so as to make the system more effective. All this calls for precision; precision in specifying goals, in devising procedures to improve learning, and in measurement, so that we know exactly how much change in student performance has occurred.

Systems analysis is a way of getting at the innerworking of any system, such as a classroom, and finding out "what makes it tick." A thorough systems analysis depends upon the processing of a large amount of data, just as a system itself requires well-designed communication channels in order to function effectively.

By viewing the classroom as a "system for learning" we may investigate relationships between its various constituent parts and discover how each contributes to improvement in student performance. One component, found in an increasing number of classrooms, is programmed instruction. Programmed instruction is highly compatible with and similar to systems analysis in a number of ways. Data, feedback, and specificity of goals and methodology are critical factors of both.

Effective programmed materials have been developed and validated through analysis of a great amount of data generated by students who have worked through the materials. The materials go through a number of drafts as a result of this performance analysis. Furthermore, both program writers and systems analysts are concerned with specification of what it is that the "system", whether it be a programmed text or a classroom or a hospital, is attempting to accomplish. The program writer is involved in the construction of behavioral objectives, which tell student and teacher precisely what it is the student will learn from mastery of the materials. The systems analyst generally is not able to construct objectives, but is more often assigned the task of determining what are the objectives in an ongoing system.

Despite this difference in emphasis, the two share a common methodology built upon gathering and assessment of information, and a determination of what a "system" should do or is doing. Armed with this we have made the attainment of effective education more feasible.

DIAGRAM A

THE CLASSROOM AS A SYSTEM FOR LEARNING,
WITH EMPHASIS ON THE
SUB-SYSTEM OF INSTRUCTIONAL MATERIALS

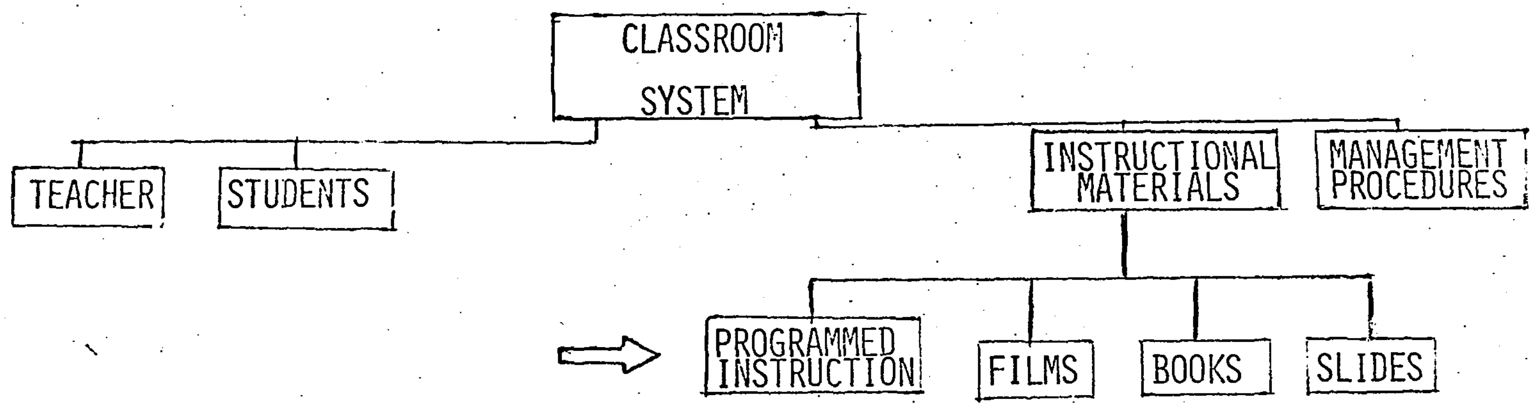


FIGURE 1

PUPIL PERFORMANCE PROFILE

STUDENT "TYPE"

	TYPE A	TYPE B	TYPE N
MANAGEMENT PROCEDURE:	NONE/PROC. 1/PROC 2.	NONE/PROC. 1/PROC. 2.	NONE/PROC. 1/PROC. 2.
INSTRUCTIONAL MATERIAL:			
A			
B			
C			
D			

Figure 2

Portion of the Pupil Performance Profile Restricted to a Single Student "Type" and Single Management Procedure

Type A

Management Procedure: **Procedure 1**

Instructional Material:

A

Correct rate/min. (mean)
Maximum correct rate/min.
Minimum correct rate/min.
Error rate/min. (mean)
Maximum error rate/min.
Minimum error rate/min.

B

Correct rate/min. (mean)
Maximum correct rate/min.
Minimum correct rate/min.
Error rate/min. (mean)
Maximum error rate/min.
Minimum error rate/min.

Figure 3

SOME SOURCES OF INPUT FOR THE PREDICTIVE MODEL

I. Individual Student Measures

A. Performance on preceding portions of the present set of materials, e.g., frames 1-100 of BRL Mathematics.

B. Performance on related materials, e.g., Sets and Numbers.

C. Performance on related activities not classifiable as materials, e.g., classroom discussion.

D. Other relevant data, including, perhaps, student's preference for particular kinds of materials, particular kinds of reinforcers, for working accurately as opposed to rapidly, and so on.

II. A. Performance on preceding portions of the present set of materials, e.g., frames 1-100 of BRL Mathematics.

B. Performance on immediately upcoming (for the individual student) portions of the present material, e.g., frames 101-200 of BRL Mathematics.

C. Performance on related materials, e.g., Sets and Numbers.

D. Other relevant data.

FIGURE 4

APPLICATION OF THE PREDICTIVE MODEL

FRAMES	PERFORMANCE OF INDIVIDUAL STUDENT ON MATERIALS (NO CONTINGENCIES IN EFFECT)	PERFORMANCE OF OTHER STUDENTS ON SAME MATERIALS (W/CONTINGENCIES IN EFFECT)	PERFORMANCE OF OTHER STUDENTS ON SAME MATERIALS (NO CONTINGENCIES IN EFFECT)
1-100:	CORRECT=2.8/MIN.	MEAN CORRECT=3.9/MIN. MINIMUM CORRECT=2.6/MIN. MAXIMUM CORRECT=5.0/MIN.	MEAN CORRECT=3.5/MIN. MINIMUM CORRECT=2.5/MIN. MAXIMUM CORRECT=4.7/MIN.
	ERROR=4.1/MIN.	MEAN ERROR=2.0/MIN. MINIMUM ERROR=0.7/MIN. MAXIMUM ERROR=4.4/MIN.	MEAN ERROR=2.8/MIN. MINIMUM ERROR=1.2/MIN. MAXIMUM ERROR=4.6/MIN.
101-200:	(STUDENT HAS NOT YET BEGUN THESE FRAMES)	MEAN CORRECT=3.0/MIN. MINIMUM CORRECT=2.6/MIN. MAXIMUM CORRECT=3.9/MIN.	MEAN CORRECT=2.9/MIN. MINIMUM CORRECT=2.7/MIN. MAXIMUM CORRECT=4.1/MIN.
		MEAN ERROR=2.8/MIN. MINIMUM ERROR=1.4/MIN. MAXIMUM ERROR=4.6/MIN.	MEAN ERROR=2.9/MIN. MINIMUM ERROR=1.5/MIN. MAXIMUM ERROR=4.8/MIN.

Validation of Learning Modules

Gilbert Louis Delgado
Bureau of Education for the Handicapped

The objective of this panel presentation is to discuss with you the various aspects involved in the validation of learning modules.

In special education we are very familiar with the paucity of special materials for handicapped children. Conversely, we are not entirely overjoyed with the "specially designed" materials being produced. We would like to explore with you some notions on what validation is or should be. We would like to talk about criteria, kinds of validation, constraints and variables.

Represented on the panel are directors of various projects that are involved in what we can call, design and development of learning materials. Each has approached the problem in a discrete manner with respect to content, area of exceptionality and perhaps criteria.

If we use the procedural format for the development and validation of programmed instructional materials we realize that basically materials go through a try-out, evaluation and validation sequence. For the purposes of this discussion let us define try-out as the testing of materials with a few "local" students. This can usually be done with rough sketches, mock-ups, etc. Evaluation we can consider as the next level, i.e., a school district, county or perhaps several similar populations. This stage can include finalized materials but not yet "fixed". That is, flexible enough to allow revision. The last step could include a much wider universe with the final product.

Needless to say, there are numerous steps built into the process for feedback and revision. Unquestionably, one could go through the cycle interminably and still not produce the module.

Popham has illustrated the criteria most frequently used by educators for the selection of materials. He talks about three criteria:

1. The Content Criterion
   Here we ask about the adequacy of the content. Does it reflect the current trends. Its main weakness stems from, perhaps, subjective judgement reflecting the user's preference.

2. The Cosmetic Criterion
   This criterion talks about the manner in which materials are packaged. <u>Anyone</u> is susceptible to the wiles of good sales promotion.
3. The Charisma Criterion
   The stature of the author, the designer, the publisher play a significant role in materials selection.

   The three "C's", content, cosmetic, charisma, unfortunately constitute a rather weak base for selection, hence validation becomes indiscernible.

The criterion suggested by UCLA can be schematically shown as follows:

Designate Objectives → Assess Learners → Use Curriculum Materials → Assess Learners

This schema obviously is based on the selection or construction of operationally stated instructional objectives. It implies pre and post-test measures.

I believe there is one step missing. There should be a needs assessment preceding the first box. Objectives can be stated subjectively and objectively. As we look to "objective" statements we rely on a consensus of experts. What we frequently fail to do is involve the <u>consumer</u>. In special education we need to carefully analyze if the curriculum is directly related to what the <u>adult</u> needs or uses or whether it is only "nice to know". We need to tap a resource not used as often as it should, that is, the successful <u>and</u> when possible, the unsuccessful handicapped <u>person</u>. In brief, I would submit that materials and curricula have focused predominantly on cognitive development at the expense of development in the affective areas. We are all painfully aware of the handicapped individual who in spite of rather severe disabilities "gets along beautifully". Where have we failed in the learning process?

Ideally, measures for good validation can only be determined if they are inherent in the modules during inception.

It appears that there is a definite trend in the design of instructional materials to include the same basic criteria purported for programmed instruction, to a greater or lesser degree.

Vanderschmidt has developed a checklist of eight steps which might be very useful. These checkpoints include:

1. A statement of prerequisite knowledge.

2. A statement of terminal objectives.

3. A pre-test and a post-test with analysis of pre-post test data.

4. A description of the test population.

5. A statement of error rate.

6. Suggestions for program administration.

7. A statement of average time required to complete the program.

8. A measurement of student attitude.

I believe we are sensitive to most of these criteria. However, we often fail to ask ourselves, (with respect to number 1. prerequisite knowledge), what must the learner know <u>before</u> he can use the materials we are developing? Without this knowledge the teacher can misuse the materials and forever ban them as ineffective.

Vanderschmidt feels the first four items are the most important. Under item 3, pre-test and post-test analysis, we run into some problems. That is, the standards we use to determine effectiveness. I will discuss this a bit later.

Item 6, Program Administration is an area that is often treated very lightly and can be the source of inadequate use of materials.

Reichard has concluded that evaluation of special education instructional materials have three separate important implications:

1. Support to student's acquisition of needed skills.

2. Selection policies used by the teacher.

3. Construction of instructional materials.

These items basically refer to the selection process. However, they are worth mentioning, because for a good while yet, we will be at the mercy of the producers and publishers. Reichard makes a strong plea for the need to train teachers in selection process at the pre-service level.

Validation or evaluation, in the context we are to discuss at this point, can be perceived from various dimensions. For a moment let us limit ourselves to non-print or film materials. The teacher who uses media to "supplement or enrich" the instruction can only expect to see some, if any, change in learner behavior. In any case, it will be near impossible to assess. The teacher who truly understands the role and curricular integration of media can expect higher output and by careful planning can make some judgements on overall effectiveness. An individualized instructional program is perhaps the best way to validate materials or modules for their inherent effectiveness because variables can be controlled.

Some of the constraints in the validation of materials include:

1. Teacher variables - enthusiasm, methodology, understanding the materials.
2. Motivation - materials, programmed instruction are often unattractive or fail to elicit child identification. Media can have a passive, conditioning effect, we have often failed to spend the time necessary to show "why?" materials are important <u>to</u> the learner. This is critical to all learning.
3. Time - to design and develop effective materials, select or construct operationally stated objectives, determine measures necessary for validation is generally lacking.
4. Program Administration - failure to describe, train, orient the users of materials on the why and how, leads to questionable validation both up and down the scale. The lack of follow-up is also pertinent.
5. Norm-referenced and criterion-referenced assement - attainment and success in schools is usually acceptable only in terms of standardized tests. Through criterion tests, through behavior change,

can show learning has taken place, it is difficult to correlate with the prescribed normative measures. This is a special dilemma in our field.

What can be done? What are our resources?

1. Popham suggests:
   a. E.P.I.E. Educational Products Information Exchange. Though it has devoted most of its time to hardware, it plans to undertake evaluation of curriculum materials.
   b. Instructional objectives center - U.C.L.A. This center will be able to provide behaviorally oriented objectives by field of study and grade level. From the entire pool, a school can then select the objectives applicable for them.

2. SEIMC/RMC network -
   The network has focused on the development of evaluation criteria for selection and development of materials. Many of the 300 associate centers have conducted validation studies. This is a tremendous resource for solving and coordinating validation efforts.

3. The National Center on Educational Media and Materials for the Handicapped
   With the advent of the National Center a pooling of extant resources and criteria along with the development of new strategies in design, development and validation of modules will ensue. The center should provide a vehicle for storage and retrieval of validation information. It will work with the SEIMC/RMC to disseminate information and diffuse innovative strategies. It will provide the setting for scholars to conduct much needed research in design, development and validation of materials.

4. Commercial Producers
   The above mentioned activities, the broader "market", including special education, disadvantaged, bilingual, foreign born, etc., will be instrumental in doing more than "attracting" the producers.

As mentioned, the panel consists of project directors in the "throes" of module development. I am sure they have had problems and insights with respect to their projects that we can share. I'll only introduce the panelist by name and look to the speaker to describe his project.

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Instructional Resources: Their Application to a Child Centered Learning Process

Frank B. Withrow
Bureau of Education for the Handicapped

their was so much handwriting on the wall
that even the wall fell down.......

Christopher Morley

Why does so much of learning remain trapped outside of the school door? So many of the dramatic, disruptive, exceptional events of our times and environment make up the fiber of this generation's knowledge; yet it is so seldom brought to life within a classroom.

Why is there this paradox between the real world and the classroom? Could it be that as a society we are afraid to take a chance...to use the technology that we have created...to explore our feelings and our understanding of one another? Are we more comfortable behind our masks of the traditional establishment? Can we as a society remain insensitive to our tendency to waste our natural resources...to rob future generations of their birthrights...to remain a voracious consumer society? As Americans, we represent 6% of the world's population and we consume 40% of the world's non-reusable resources. Can the rest of the world long live with this misappropriation of the world's resources? Can we as a society continue to consume without respect to the distribution of that consumption? Shall we use up our most valuable non-reusable resource, PEOPLE, by failing to give every child in America an equal chance at the best education the world can offer?

Adlai Stevenson once observed that, "We travel together, passengers on a little spaceship; dependent on its vulnerable reserve of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work and the love we give to our craft." These words by Mr. Stevenson so aptly point out that we are all on a ship that is dependent upon the balance of all activities if that ship is to maintain its viability. What happens to me does effect you and what happens to the little child does contribute to my well being. As our life space becomes more crowded, each of us becomes more dependent upon the other. The solutions of my handicapped child's problem helps me to understand people. We are each enriched by the others accomplishment.

If we fail to use the technology that is available to us, or if we fail to provide for each child the tools that can enrich his learning space, then we will have also contributed to the destruction of the society as well as the individual.

What is the nature of a modern educational program? Such a program will be centered in the learning process and not the teaching process. It will look at the different faces of learning...it will strive to divorce learning from restrictions of time and place. Instructional resources will be made available on an instantaneous basis to serve the learner when he needs them. Learning as a profession will take its place in society as a leading profession. The educator who works with the young child will have the responsibility of the greatest scientist of our times because we will learn that the first teacher of a child may be the most important person in that young child's life. It is through this teacher that he either gains entry into the world or is blocked from that world forever. Our teachers will be chosen with great care for their ability to love, their ability to seek knowledge, and their ability to manage the learning process. If in this world that I dream of there are some of these teachers that show exceptional talent and sensitivity they will be allowed to teach handicapped children or children from the hard cores of our slums. These teachers can be the central fiber of our society. They will work on the frontiers of social revolution and knowlege. Without them we will no longer remain a viable State, Nation, or world.

How can we make this dream come true? Our first effort must be to throw off the chains of ignorance. We must not be the slaves of our new technology. We must not be consumed by fantasies about what our technologies can or can not do. We must use their power to enter into a new world of education that says the child can learn and that failure occurs through errors in the system and not the child. Education has the power through modern technology to provide the world for the child to experience and explore. Through the touch of dials we can recreate and simulate the past experiences from history or explore remote places.

Intelligence is a complete mystery. It is said that most people never develop more than a very small part of their intellectual capacity. Why don't they? Do schools stand in their way? Most of us have our engines running at about 10% of their power. Why not more? How do some people manage to keep revived up to 20% or 30% of their full power--or even more? What turns the power off, or keeps it from ever being turned on?

Are some people just born smarter than others and the schools will never be able to do much about that? We conduct our classes as if this were true and have treated individual pupils as if there was an absolute limit to their ability and that the schools were challenging that ability. But if you really go into a school...if you really look at the action...if you are honest in your analysis of what you see, you can't escape the fact that some people are much smarter part of the time than they are at other times. Why should a boy or girl who is witty, observant, imaginative, analytical, in a word, intelligent, come into the classroom and, as if by magic turn into a complete dolt? Our rationale for failure in such a system is to put the entire burden for learning upon the shoulders of the child. Our basic assumption is that the teacher and the establishment which he represents, the school, is right. Many of our young people are telling us today that this is wrong that it isn't being honest...that we are not looking at education honestly if we come to that conclusion. They say that if you tell it like it is, we really have instructionally disastrous schools. Schools that do not provide the environment that will enable learning to take place. Schools that are manned by instructionally incapacitated teachers that create specific learning disabilities in children.

John Holt in his worthwhile little volume on Why Children Fail describes strategies that children use in making their way through the schools. I would like to share with you one such strategy:

Children are often quite frank about the strategies they use to get answers out of a teacher. I once observed a class in which the teacher was testing her students on parts of speech. On the blackboard she had three columns, headed Noun, Adjective, and Verb. As she gave each word, she called on a child and asked in which column the word belonged. Like most teachers, she hadn't thought enough about what she was doing to realize, first, that many of the words given could fit into more than one column; and secondly, that it is often the way a word is used that determines what part of speech it is.

There was a good deal of the tried-and-true strategy of guess-and-lock, in which you start to say a word, all the while scrutinizing the teacher's face to see whether you are on the right track or not. With most teachers, no further strategies are needed. This one was more poker-faced than most, so guess-and-look wasn't working well. Still, the percentage of hits was remarkably high, especially since it was clear to me from the way the children were talking and acting that they hadn't a notion of what Nouns, Adjectives, and Verbs were. Finally, one child said, "Miss Jones, you shouldn't point to the answer each time. The teacher was surprised and asked what she meant. The child said, "Well you don't exactly point, but you kind of stand next to the answer. This was no clearer, since the teacher had been standing still. But after a while, as the class went on, I thought I saw what the girl meant. Since the teacher wrote the word down in the proper column, she was, in a way, getting ready to write, point herself at the place where she would soon be writing. From the angle of her body to the blackboard the children picked up a subtle clue to the correct answer.

This was not all at the end of every third word her columns came out even.

This example points out very well the activities that go on in the classroom. The old cliche that the pupils learn the teacher and not the subject is probably most true in the lower grades.

These children learn what pleases the teacher and may not learn the objectives that the teacher thinks are being taught.

In our search for better education during the 60's we have frequently used technology to teach children a way of getting the right answers. We have been obsessed with the desire to cram all of the cognitive information possible into our pupils. We have used teaching machines and other technologies to insure that the pupil gets the right answer every or almost every time.

We have organized for our students different kinds of logical learning strategies. Children have frequently adopted these strategies without thinking...without the need to devise their own learning strategies they frequently have become producers of correct answers rather than thinkers.

This does not mean that we should abandon technology but that we should program our technology so that it reaches out to encompass the broader range of needs of education. Technology should become the tool of the learner rather than the learner becoming the slave of the technology. The purpose of education is to expand to the limit the child's capacity and desire for self-education, for seeking and finding meaning, truth, and enjoyment in everything he does. Technology can assist in both cognitive and affective education.

Todays truth for the young child is filled with a marvelous array of electronic communication equipment. He is brought into this world to the tune of technology. He has never known a world without constant technology. He moves through technology. He sees, hears and feels the technological world surrounding him. He is at home in that world. More at home than his parents and his'teachers. Given the proper opportunity he learns to use the technology for his own learning experiences. Knowledge seeps into him from a constant barrage of music, movement, and sensory beats. The school must be at least as well informed as the television set or the child will turn off his educational experience as easy as he changes channels on his home TV set.

INSTRUCTIONAL TECHNOLOGY

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To many technology in education unfortunately has meant new gadgets for doing the same old things. As it is used by most professional workers in the field, however, educational technology is more a way of doing things than it is things for doing. Robert Snider (1970) aptly summarized the conception most of us use when he wrote:

> "Instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out and evaluating the total process of learning and teaching. . . employing a combination of human and non-human resources to bring about more effective instruction."

Those of us interested in changing education constitute a new generation of critics of our school system while we agree in the concepts and approaches of the "old" education, we are not all of us of one voice. People like John Holt ("Why Children Fail"), Jonathan Kozol ("Death at an Early Age") and James Herndon ("The Way It Spozed to Be") are the voices on one side. They have no possible interest in technology in or for education. They describe the ghastly, ugly side of schools, and share our concern with the insidious established practices, the way in which schools have institutionalized the delivery of education to students. However, we differ in means and look upon technology, particularly computers, as a critical tool for dealing with these problems.

If we look at the parts of education, one citadel appears which has seriously tried to maintain a relationship with individual students; it is special education. Its instructional methods and approaches are more congruent with educational technology than are those of general education. However, similarities should not be mistaken for identities. Many rather subtle discriminations are required to distinguish the practices of educational technology from those of special education but the concepts are not as different as the methods.

A substantial variety of ideas and techniques has contributed to the body of knowledge and practice that is instructional technology as we know it today. Contributions come from psychology of learning, psychometrics, human engineering, operations research, media, education and computer science, for example. A division of activities within educational technology is useful for descriptive purposes. One possibility is in terms of: (a) design; (b) deliver; and (c) evaluation.

Design

In designing learning programs using the methods of educational technology, three processes are essential. One is task analysis; the second is the preparation of clearly formulated behavioral objectives; the third is instructional strategy.

Task Analysis

Elements and relationships. Task analysis produces the elements and the relationships among them. The task elements are the behavioral objectives or statements of things that the individual has to be able to do. Relationships are revealed by prerequisites for example.

Domains of objectives. If we look at the elements there are four domains of objectives: (a) the cognitive domain (see Bloom, et al., 1956); (b) the affective domain (see Krathwahl, et al., 1964); (c) the psychomotor domain; and (d) the psychological. Within each domain there are both marco-objectives and micro-objectives.

The macro-objective is the overall, large-scale instructional intention of the author of the program. For example in the cognitive domain, the acquisition of knowledge is a macro-objective, as are comprehension, application, analysis, synthesis and evaluation. Knowledge is characterized mainly by remembering which is the major psychological process involved, and the desired knowledge may be recalled or recognized. In the affective domain some examples are receiving (attending), responding, valuing, organizing and characterization. The psychomotor domain has not been elaborated, and the psychological domain includes hearing, retention and use, or transfer.

The micro-objective is a "do statement"; it states what the individual must do. A critical part of the micro-objective is the "virile verb" (Moger, 1962, Gagne), and, for example, use 26 categories, e.g., identify, distinguish, construct, name, order, describe, apply, perform. Within each of these categories there are differing numbers of synonyms, e.g., for identify there are: choose, determine, match, pick out, point at, and select.

Statements of objectives also contain restrictions and criteria for evaluation purposes. The restrictions limit the virile verbs. They usually begin with prepositions such as "when" and "with." Evaluation includes such criteria as time to complete a task. Typically, the criterion is the correct answer; however, in computeraided instruction, many systems allow the author to process various partially correct answers as well as the correct one.

The psychological domain refers to learning, retention and transfer aspects of objectives. For example, mastery and over-learning are two different levels of learning; short and long-term retention are distinguishable objectives in terms of the relative length of the time interval following learning at which retention is tested. The result of a task analysis is a structure. The structure of a program is a description of the relationships of the objectives to one another in terms of prerequisites or enabling and terminal objectives. For example, subtraction is a prerequisite for long division as it is typically taught in school. It has become a common practice to refer to all analyses of structures as "hierarchies"; however, not all courses turn out to be hierarchies. Some are linear strings or groups. It also is important to distinguish between the analyses of the course into its structure and the pedagogical rule for instructional strategy used to teach the course. The distinction between the structure and the strategy is apparent when, for example, a course is analyzed into a set of elements which make up a linear set. This describes its structure but does not specify the pedagogical strategy. A particular structure might be taught in differents ways, for example inductively and deductively, with or without a mastery requirement.

Insistence on clearly formulate objectives is one of the most distinctive characteristics of the "new" educational materials. Objectives define precisely the content and performance that is to be taught. They also make it possible to measure whether the desired learning has, in fact, taken place. The objectives serve an important function, they determine the nature of the test items used to evaluate student learning. Special education and vocational education objectives are usually rather clear cut making them easier to measure than general education objectives.

In the "new" education, tests are different. They are criterion referenced rather than norm referenced. A criterion referenced test is one in which the items relate to objectives, and for each objective there is one, or more, test items. The purpose of the test is to provide an inventory of the student's learning. In norm reference tests which are used in the "old" education, test items are used only if they distinguish among the learners. There is no mopping requirement in norm referenced testing. In other words the items for an "old" test are not mopped on objectives, in the "new" educational material there is a one-to-one correspondence between the objectives and test items.

Feedback

Feedback is a significant design concept in educational technology and it is used in all systems. One usage is in reference to the learner and in the context of the instructional system. This can be called learner-feedback. Learning situations make use of feedback which is called reinforcement, whereas testing situations do not. Reinforcement is any stimulus event that follows a response and increases the probability of the reoccurrence of the response in the presence of the stimulus. Knowledge of results is that feedback which tells the learner he is right or wrong. Evaluative feedback or social reinforcement is information that evaluates the response e.g., "excellent", "you're doing very well." Learner feedback is generally more effective when delivered immediately than when delivered late. Evaluative feedback seems to both improve learning and attitudes toward the learning experience if used selectively.

Another type of feedback is author feedback. This consists of data revealing the kinds of students responses made to each part of a program. Author feedback is usually quantitative, but also may be qualitative. It is the information that is used in the formative evaluation process. It is the formative evaluation process that results in specific revisions of a program to improve its rhetoric, instructional effectiveness, or acceptability. A variety of controls are an essential part of the methodology of instructional technology as it relates to formative evaluation and developmental testing. For example, when programs are tried out on a sample of the "target population" it is necessary to sample in ways that insure representativeness. In addition, sample size is an important factor (e.g., Stolurow and Frinke, 1966). It has been demonstrated that samples which are too small lead to unnecessary, and therefore undesirable, revisions. The essential question in developmental testing is "Does the program teach what it is supposed to teach?" This is the question of validity. It is qualified in terms of the percentage of students who achieve a specified minimum percentage of objectives. This criterion is variable but is expressed in the following from an 80/80 or 90/90. When we used educational technology and programed learning for technical, vocational instruction, we also used a criterion of 100 percent correct responses on selected critical objectives. The selection of the critical objectives was usually based upon the relationship to the safety of the person or the equipment (see Hobbs, 1947).

A variety of data are collected in formative evaluation in addition to pre- and post-test results. Included are personal interviews, the time taken during learning and student's expressed attitudes. The variety of information, especially the objective data, is seldom available in the "old" education. Probably the most critical data used in the formative evaluation process is a measure of gain or change in performance, e.g., knowledge. High scores on a post-test only are meaningful if the pre-test scores were relatively lower than the post-test scores. Some indication of gain is critical in establishing the value of a program. An essential difference between the "old" and "new" conceptions of instructional programming is instructional accountability. The "new" education makes instructional accountability a fundamental requirement of any developmental effort. While cost effectiveness is an important concern of the "new" education, the first problem is to establish the effectiveness. Then measures can be taken to achieve minimal costs without corresponding losses in effectiveness. Instructional accountability is the measure of the program's effectiveness and it is to be distinguished from the economic accountability of program development or delivery.

Related to the commitment to instructional accountability in the "new" education is the commitment to prescription. It is at this point that the dual emphasis of the "new" education becomes apparent for we are now discussing another side of the coin; namely, the evaluation of a program in terms of the learner. As Brunner (1964) has pointed out, a theory of instruction differs from a theory of learning in that the theory of instruction is prescriptive and a theory of learning is descriptive. Consistent with a tradition in special education, the "new" education is concerned with diagnosis and, in fact, with relatively specific diagnosis of educational needs. Diagnosis is the basis for prescription, but, obviously, prescription requires more than an indication of specific needs. It also requires information and materials that are known to be capable of removing a deficiency or remediating.

Personalization of Instruction

Individualization as it relates to the "new" education means prescriptive instruction not isolated learning experience. Possibly personalization is a more descriptive term than individualization. Not only does the learner proceed at his own pace, but he also may be given different learning experiences to achieve the same objectives (see Stolurow and Davis, 1965). In fact, group learning may be a prescription and it may or may not be a programmed instructional experience. Thus, the design of instructional programs takes into account possible requirements for personalization. The instructional designer is faced with problems of individual differences in needs for both information and method of instruction. The design of instructional programs that are personalized is a qualitatively different enterprise than the design of a standard set of materials for a group such as children with dyslexia, or deaf students. A finer analysis of possible needs has to be made; questions of diagnostic procedure and of criteria for decision have to be faced from the start and continuously as the design is modified to take into account the feedback.

Flexibility

Another feature of the design of "new" instructional materials is flexibility. They are frequently designed in modular form and with a view to change as the need is identified. The immediacy with which programs can be modified is a distinctive feature of them. Most computer-based learning systems have an author mode that assists the process of editing by making substitution, deletion or rearrangement of materials easy to accomplish. Also, once made by the author, the system makes all future presentations according to the changes made. There are no delays for the second edition of the manual or book.

Analysis and Rewriting with Technological Aids

Figure 1 is a diagram of a set of activities currently being developed as a man-machine system for processing curricular materials during the design stage on the left and delivery on the right. It is comprehensive in its objective to provide support to curricular and course development whether or not the computer is used as a delivery system to the student.

The left side represents the set of activities of interest at this point. It is the use of computers by and for instructors and authors. TREE is an acronym for Translating English into English. It describes the basic idea which is to rewrite textual materials so the level of reading difficulty fits the individuals for whom the materials are intended. The purpose of the project is to develop and use the resources of the computer to prepare, with diminished human effort, simplified versions of educational materials suited to the specified level of a student and his needs. We are developing a system and procedures which can reduce the human effort and the cost of producing appropriate new text materials for instruction. One large area is the "translation" (editing) of reading materials written in English prose too difficult for an intended reader into English prose which he can read efficiently and without frustration. Normally this process is time consuming and estimates are that it takes a skilled person three (3) to four (4) times as long for this process as for the original writing.

Six considerations used in developing our computer programs for readability are shown in the next slide. They are: (1) common hardware-software; (2) convenient program design; (3) common programming language; (4) sample size options; (5) test options; and (6) optional counts of text characteristics. Figures 2 and 3 illustrate the optional features. In figure 2 the key word in context or KWIC analysis is useful in keeping track of vocabulary and the different meanings of tenses of verbs are used and the spacing of repetitions since each occurrence is numbered to reveal its line location in the text.

Figure 2 also illustrates a syllable and word counting program that can be used in the analysis of text (see Klare, Rowe, St. John and Stolurow, 1969).

Figure 3 illustrates the deletion program used to produce programs requiring completion of blands of "fill-ins". When this program is used without comparing the student's response with the expected one, the system generates tests of literal comprehension. Words are deleted according to the instructor's specification so it can be used to test the student's knowledge of key words.

Flow Charting

The architecture of programs is an important part of the development process of an instructional system. It is gradually becoming defined but it is still not as generative or prescriptively determined as it probably will be soon. Some examples of flow charts for simple mastery or "correction" procedure and non-correction procedure are illustrated in the next slide. An instructional sequence from a program called a culture assimilator is illustrated in the next series of slides. The first slide identifies a module in the program and represents its parts symbolically. The next three provide illustrative text for the module and the fourth shows how a set of modules is organized to produce a programmed series involving a mastery criterion for determiing the number of episodes used in a student's training.

The next three slides are different sections of the same course. The purpose in showing them is to indicate how the architecture of a program can differ from segment to segment. The first is a linear sequence; the other two are branching structures of moderate complexity.

Interactive Instructional Uses

The delivery of instruction by means of an interactive computer-based system is growing steadily. Many systems are being used around the country for this purpose. These are multiple access systems. Sometimes they are called time-shared systems since at any time many uses can share the same central processor or computer. Each user, however, has the experience of having the computer all to himself.

The next slide summarizes some of the motivating reasons for computers. They are grouped into two categories: (a) speed and accuracy, and (b) innovative or more sophisticated aspects. Of the seven things listed, we will deal mostly with instruction. In this connection, the next slide summarizes some of the activities of the student, on the one hand, and the author, on the other hand.

Systems

Systems for interactive instruction differ in many ways. One way that is very apparent to the users is in the console available to give the author and student access to the system.

One of the basic consoles is a typewriter which has both the keyboard for the user's use in communicating to the system and a printer for the system to communicate to the user. The teletype is the most common console because of availability and price. It is illustrated in the next slide. Other similar devices are shown in the next two slides. Additional equipment for display of instructional materials is added to the consoles in the next two slides. Each as a rear view projection screen for displaying slides. The next slide also shows the audio tape recorder in the console that is under computer control to deliver auditory messages as needed. A still more sophisticated console is illustrated by the next slide. With it the student has, in addition to film and audio tapes, a cathode ray tube (CRT) on which computer generated material is displayed. He also has a light pen which he can use in pointing at parts of a CRT display.

A system is much more than its consoles, however, to give you an idea of the various components that make up a "midi-system," the next slide describes the one we use. A maxi-system may have tens of thousands of consoles and a large central memory, or core. The most developed maxi-system is PLATO IV at the University of Illinois which is being designed for 4,000 consoles. Midi-systems can handle hundreds, but not thousands, of consoles; most existing ones handle 100 consoles. The third class is the "mini." A mini-system handles from one to sixteen consoles and has a much smaller control processor. Most mini-systems are not able to do very much computer-aided instruction, but they can do some.

Language

An important part of a computer-based system for interactive instruction is the language it uses to provide the author and students with the access and processing they need. Languages differ greatly. Some have been designed for CAI and others are used for CAI but are general purpose languages. About fifty

CAI languages have been developed, but just a few languages have been used to write very much material. The most used language is IBM's Coursewriter. Like most other CAI languages its main components are its author capability and student capability. Some languages like PLANIT, developed at SDC (System Development Corp.), also have a calculation capability.

Our language is called CAILAN; it has an information retrieval, or IR, capability as well as the author and student capabilities. This IR capability allows the author, or student, to search lists of materials, or abstracts or titles for the things he wants by simply using key words from a thesaurus. We have been adapting computer tapes both from CEC of their abstracts, and from the George Washington University IMC, to create a data base for special education. We can convert the IMC and CEC tapes and read the modified tape into our CAI system to create a data base for retrieval. The system with this data base we call HISAR--handicapped information storage and retreival. A person working at a teletype console, for example, could dial up the system, sign on for HISAR and enter key words from a thesaurus. The system will search all the listings in the data base looking for the key words, and it will tell him how many there are and will type out up to 10. The rest, if there are more, are sent by other means.

Since the information retreival capability is a part of a computer-aided instruction (CAI) language, it is possible for the user to receive instruction if he does not know critical terms in the titles or abstracts he receives. For example, if he is given a title with the word strephosymbolia in it, and didn't know what it meant he could ask for an instructional sequence the system would take him to a program on word blindness and dyslexia, for example.

CAILAN is not a rigid language and, in fact, provides a wide set of options to students and authors. The entire control of the learning can be turned over to the student if the author wants it to be that way. Usually control resides in the system but even when it does there are options for the student's use. For example, if he makes a mistake in typing he can cancel and retype. That is essentially an erasure option. He can ask for help by simply typing "help". He can use a "go to" option if he knows specifically what he wants. He can take notes at any time and the system will not process what he types. He can review slides or tapes by requesting them and the author can allow variations in the conditions. For example, if he wants to review slides the student can have them available as long as he wants, or just briefly by timing the exposure. This could help him develop faster recognition speeds which may be a program objective.

Idiographic Model of Instruction

With the range of possibilities provided by a computer-based system individualized instruction becomes a challenging opportunity. It also introduces completely new sets of conditions not previously available to a teacher for use in relating to a student.

Three-stage decision process. One problem is the development of a useful conception of the interactive relationship so that it is coherent and permits controlled variation and thereby the testing of alternative possibilities. One meta-model for instruction is the idiographic programming conception which treats the processes as a sequential decision problem (Stolurow). Three basic sets of decisions are: (a) pretutorial; (b) tutorial, and (c) management. The first two sets are represented in the next two slides.

Pretutorial decisions. Initially the system utilizes test data to identify useful characteristics of individuals to relate to the objectives of the course he is to take. Once a match is made, either the student takes the course under prescribed conditions or two other possibilities exist. One is to reject him; the other is to either change the program or the student through special training on programs that teach the prerequisite skills or knowledge.

Tutorial decisions. The tutorial process, while basically involving the functions described, can be discussed in terms of modes of interaction: (a) problem solving; (b) drill; (c) practice; (d) inquiry; (e) gaming; (f) simulation; and (g) tutorial dialogue (Stolurow, 1969). Each of these can be looked at from two sides--the faculty and the student--as they each relate to the CAI system.

Problem solving refers to the use of a computer to solve quantitative problems on line by employing a language like BASIC or interactive Fortran. Drill as a mode of CAI is the use of a highly structured sequence and format in which variation occurs only among the elements of a set, e.g., two-digit numbers, vowels, words that have a double consonant, binomials. The CAI system presents these and preferable generates them, and it generates the right answer so that it can automatically process the responses of each student and immediately give him feedback and another problem if he responded correctly. Practice is a mode of CAI that is broader than drill in that several drills (at least two) are involved in a practice exercise. For example, two single digits arranged vertically for addition may constitute a drill; whereas a practice exercise also could include the addition of two-digit problems. Similarly, a drill might involve carrying, whereas a practice exercise also might present similar problems presented verbally.

Inquiry is the mode in which the student asks questions such as when did Charles V rule Spain, or when did the Visigoths cross the Pyreneas and throw the Vandals out of Toledo? For this mode, the CAI system has to be programmed to do information retrieval. It has to accept questions in natural language, process them using an algorithm and then search its files for information that it retrieves.

Gaming is the mode in which the student uses his natural language to interact with the system. The system displays information in natural language and the interaction resembles a real situation off-line in the way it maintains sets of possible relationships among 'before' and 'after' events. An action on the part of the student, for example, may lead to any one of a number of outputs, each of which would be a alistic possibility, but the actual occurrence of any one possibility would be determined by some random number generator. In an economic game, for instance, the student might learn that he either has to add more money to his original partial payment to maintain his margin or sell his stock when the price changes. The rise and fa.. of the stock market for example, would be a chance event in a stock market game, but the amount of money the student has to pay the broker when the stock falls by a particular amount is governed by laws or rules. In playing the game he learns what he has to do and how much he has to pay all of which are valid if he invests in the real stock market. The actual amount of the change in the value of his stock is not critical for the objective of this gaming experience is to teach the student what he is obliged to do when the price of stock changes.

Simulation is a mode of instruction which is very much like a game. However, to the CAI system, and therefore to the author, the two modes are quite different. To present the student with a simulation, the author must have a model of the phenomenon, e.g., stock market, and it has to be stored in the system to relate input to output. The model replaces the random number generator of a game. A model is a formalized symbolic representation of a real world system. It may be a business, a gas law in physics (e.g., Charles or Boyles), a law of electricity (e.g., Ohm's or Kirkoff's law).

Tutorial dialogue can be the most complex mode of instruction but it is not always developed to its fullest. In its more sophisticated forms, artificial intelligence procedures are used to process the student's responses. This mode of computer usage has been accomplished by a language like ELIZA, developed by Weisenbaum (1967) at MIT to provide a Rogerian type of machine generated reply to each student's response. For more structured tutorial dialogues, languages like the following have been used: COURSEWRITER, CAILAN, PLANIT, PILOT, WRITEACOURSE, TUTOR, or FOIL.

In this mode authors can compose complex conditional procedures that are dependent on student performance. In processing responses the author may wish to have the student match a numerical answer for the problem within numerical limits, or as an inverse, multiple or power. In short, the tutorial mode frequently involves the evaluation of an expression (student's response) as equivalent to an expected one, or if different, then it has to recognize the way it differs from the expression anticipated. If it does this, then the program also could branch the student to appropriate new information which extends his learning.

Generative programming is frequently a part of the tutorial mode although it can also be used to produce drills and practice exercises, as well. In generative programming, the computer programs assemble instructional materials from elements of the subject matter and elationships among those elements to produce an entire class of problems. From one general description, an indefinite number of test or instructional items should be generated for presentation to each student according to his needs. (see p. 23-25)

In the tutorial mode of instruction, the system may be programmed to save performance data and accumulate it for a large number of students in a cumulative file. These data could be used on-line as a conditional expression within a program.

Also in this mode, the multi-lingual capabilities of a general purpose time-shared system (GTSS) can be useful particularly if the student has to solve problems by writing a computer program.

A tutorial dialogue may branch a student to problem solving, a drill, practice, inquiry, gaming or simulation. Typically, a tutorial dialogue has built into the programming the ability to diagnose the student's responses, including his past performance, and the ability to prescribe what will happen next.

Management subsystem. Computer managed instruction (CMI) is another subsystem designed to integrate and interrelate information about students and courses. CMI is sometimes described as an alternative to CAI but a complete system is capable of both. With CMI the system keeps a current record of each student's progress and performance on tests and on assignments. With CMI the terminal is used by the teacher not by the students. The purpose of CMI system is to aid the teachers in their management of individualized instruction. Few if any, have faced the problem of scheduling thousands of students in an individualized curriculum. The data on student progress through a single course indicates clearly that the spread between the slowest and fastest student can be very great and may, within a year, exceed two years of instruction. Rate differences of three times have been reported at the elementary level so a CAI system has to accommodate this degree of spread if it is neither to be constrained in its use nor constraining in the rate of student learning.

A CMI subsystem is used to compile data on student performance in classes or projects that do not use CAI. It is to allocate scarce resources such as teachers, television equipment, projectors, laboratories, and CAI terminals. The teacher or administrator should be able to obtain information about each student or any group of students and receive help in making decisions about the student's educational program or the availability of instructional resources, such as television tapes and equipment or audio tapes, which would be appropriate for use by a student at the time of inquiry to continue his instruction.

In addition to the subsystem already described, a CAI system has to have a variety of utility programs to use in data analyses of student responses, system performance, and course effectiveness.