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ABSTRACT

These 34 conference papers presented by more than 40 authors and coauthors represent a documentation of the growth of systematized education and the increasing emphasis on self-learning and self-regulation of the instructional process. The book is divided into the following seven subject areas: (1) Context of Individualized Instruction, (2) Research Studies on Learning Programs in Medicine, (3) Technology: Concept, Application, and Strategy, (4) Instructional Systems for Individualized Learning, (5) Outcomes of Self-Instruction for User and Developer, (6) Programing Specifics and Variables, and (7) Programer Training and Development. A bibliography is appended. (BC)

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INDIVIDUALIZED INSTRUCTION IN MEDICAL EDUCATION

Proceedings of the ~~Third~~ Rochester Conference on Self-Instruction in Medical Education
September 14-16, 1967

Jerome P. Lysaught
Editor

Sydney A. Sutherland   Pauline A. Mullen
Associate Editors

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The activities in self instruction at The University of Rochester which have led to the research and development of programs for medical education—and to our interest in this Conference—have been supported by an institutional grant from the National Fund for Medical Education.

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Preface

This publication marks the Third Rochester Conference on Self-Instruction in Medical Education. In a real sense, it is preamble as well as epitaph. While it contains a valuable record of research and development in the period from 1965 to 1967, it is also a preparatory piece to the call for the Fourth Rochester Conference to be held under the auspices of our Clearinghouse in June of 1968.

The present text, *Individualized Instruction in Medical Education*, represents a continuing documentation of the growth of one of the most exciting developments in all systematized education—the increasing emphasis on self-learning and self-regulation of the instructional process. In this regard, as illustrated in the two prior volumes, *Programmed Instruction in Medical Education* and *Self-Instruction in Medical Education*, and in this one, medical education in the United States has played a major part.

To this observer, there are strange paradoxes at work. If ever an activity truly suffered from the criticism of its opponents and the faint praise of its adherents, it must be medical education. Laymen, bureaucrats, and socially conscious citizens demand better medical care, increased facilities, and larger numbers of practitioners—and ascribe any shortcoming to the health professions and, in particular, to their educational structures. Within the profession of medicine itself, there is mixed emotion. Leading medical figures frequently cite the reluctance of medical schools to change and the resultant lock-step production of medical students.

Now, these volumes on individualized learning in the medical school are not a defense of medical education, *per se*. That academic effort should properly be defended—if, indeed, defense is needed—by the profession and by the faculties of the several medical schools. These books, however, bear eloquent testimony to the contribution that has been made in a most important area of learning research by medical educators, and they emphasize one salient fact: medical and health educators generally have done more to develop self-instructional learning for their curricula than has any comparable segment of American society. Their contributions have in no small way provided a beacon and a model for the public schools, the colleges, and the adult educators of this country.

These volumes, and the papers they contain, speak most forcefully for the values of the discoveries made. When students learn better, and faster, and with more appreciation, then valuable changes have taken place. *In toto* one must derive these generalizations from the research and conclusions reported in the three Proceedings to date. To have been involved in their formation is to have gained a professional education in applied learning theory.

The papers from this Third Conference have necessarily been rearranged in order to provide th[illegible] most logical development of concepts and examples. The manuscripts themselves represent thirty-four papers by more than forty authors and co-authors, and we wish to express our deep gratitude for the cooperation of these individuals. Hopefully, the reader will find a convergence in style that has been brought about by editing, but in no case will he find slanting or alteration to produce an editorial effect. For all that is valuable in these papers, credit properly goes to the authors. The editor accepts full responsibility for all errors of omission or commission—and he invites your bringing any discovered problems to his attention so that proper *errata* may be prepared. While we know of nothing problematic at this point, age and experience have taught us our human frailties, and we suspect that we are somewhat less than infallible.

In the section on acknowledgements, we have paid proper credit to the several funds and organizations that have so long supported our efforts to encourage the growth of self-instruction in medical education. Our thanks also go to several individuals: Robert G. Pierleoni who served as Assistant Director of the Conference; Gilda

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Orioli and Judy Dorman who functioned as secretaries, hostesses, and Girl Fridays through the meeting and the long process of publication; James DeNio who aided in the arrangements and the audio-visual aid preparation for the Conference; Donald Parry and his excellent staff from the conference center of the University who handled most of the detail and auxiliary arrangements. May we also add a personal tribute to Mr. Henry Brayer of the Christopher Press who has worked with us in the preparation and printing of this volume. He is what every editor hopes his printer's representative will be, and this work could not have been done half so quickly without him.

With our work already facing us in the planning and conduct of the Fourth Rochester Conference, we trust that the work of the Rochester Clearinghouse on Self-Instructional Materials for Health Care Facilities will continue to serve those medical schools and other institutions that have become involved in the re-structuring of education, and we look forward to the time when this will have ceased to bear the halo—or the onus—of pioneering [illegible] represent the on-going approach to curricular improvement and student achievement.

JEROME P. LYSAUGHT
Coordinator,
Rochester Clearinghouse

Rochester, New York
April 9, 1968

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Part I

The Context of Individual Instruction

In the introductory paper, Fenninger portrays the challenges of the times and suggests the need and the urgency—and the opportunity—for change in health education. Markee and Lysaught separately survey the events that are taking place within the educational institution, its curricula, its teachers, and its students. Husted points particularly to the potential impact of a new force in the health education field, that of the regional medical program. And Fullagar places the problems of educating the professional against the background of change and ferment in all professional education.

Problems and Perspectives In Education for the Health Professions

LEONARD D. FENNINGER, M.D.*

EDUCATION, the foundation of our society, today faces perhaps the most formidable task of any of our institutions. Education is the means for providing organized bodies of knowledge; for developing judgment, wisdom, and skill; for providing means of change while preserving individual and community stability; for enhancing social consciousness and personal satisfactions. It is at one and the same time the channel for preserving individual dignity and for satisfying the demands of a complex society. Education must meet changing situations and new needs without sacrificing the knowledge, culture, and beauty of the past.

And, just as education is the foundation of society, medical education—or to put it more broadly, health education—is fundamental to the provision of health services.

This morning, as we begin this Third Rochester Conference on Self-Instruction, I should like to consider with you changes that are taking place in educational philosophy and method, the problems in education for the health professions, and how these changes serve toward meeting these problems. Such a view of problems and perspectives may provide a framework for more specific discussions of effective learning not only for medical students, but for all others who must be educated in health services and goals.

This Conference is concerned with exploration of the ways in

*Director, Bureau of Health Manpower, United States Public Health Service.

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which different methods of learning can be used to improve the transmission of information and skill in medical education. It reflects some of the concern with the broader aspects of education and poses some of the questions being raised in every educational community.

I should like to address myself more generally to the problems of education in the health professions and occupations and to their significance in the teaching of people who are involved in the delivery of health services.

The Changing Face of Education

The significance of education for society as a whole is unquestioned. The significance of education in achieving and preserving the dignity of each individual man and woman has been more recently recognized. A system based on exclusion is yielding to a new philosophy and new concepts of social expectation. For many hundreds of years society selected, largely on the basis of birth, economics, and social level, those few among the young in each generation who should progress in the acquisition of information and knowledge, returning those not so selected to a predominantly manual labor force.

This type of exclusive education is no longer suitable to the needs of a society which is urban and technical, where manual labor has a decreasing role. A mechanized society demands a wealth of highly technical skills. Beyond our economic needs, however, this exclusiveness in education is also repugnant to our concepts of democracy.

In every field of endeavor today, we hear of limitations of manpower: not enough trained people to undertake the tasks which must be accomplished if people are to achieve the satisfactions and the happiness which should be possible for them.

As the social pattern has changed, similar developments have taken place in the goals and expectations of individuals. Unrest is characteristic of our time. Aspirations—in fact, demands—far exceed the capacities of our institutions and organizations to meet them. It is hardly necessary to document the current impatience with the educational institutions which were created to encourage "orderly" relationships and "formal" training. Self-fulfillment and career expectations have a different face today.

Changes in concepts of *who* should be educated are necessarily accompanied by changes in concepts of *how* they should be educated. Advances in the understanding of the learning process and knowledge of how different kinds of information, skills, and behavior are

acquired can be and should be put to use. We have been offered an unprecedented opportunity to experiment with ways of developing, selecting, storing, and making available all kinds of information.

The ferment in the educational world is nowhere more pertinent than in the field of medicine and health. Man has always been concerned with health but the *resigned acceptance* of disease, disability, and early death, inevitable until very recent times is largely abolished today. Present-day society expects and demands that health care be adequate in scope, promptly available, and effectively rendered. One has only to pick up any publication or view any television program to be aware of the preoccupation of the public with health problems.

Factors which have led to this concern about the adequacy of health care and services are not particularly mysterious. The population has increased in size; thus, more people need care. There are more people in the oldest and youngest age groups, and these segments of the population need relatively more health care. The population is increasingly concentrated in cities, creating problems in environmental hazards, disease control, and mental health, which earlier generations did not need to contend with. Homes, families, and medical institutions have changed. Means of communication have become more widespread so that the awareness of medical progress is no longer restricted to a chosen few. In our vastly more productive society, a better educated and more affluent public has an increasing expectation of health services. A changed economic picture and a different social philosophy have combined to lower old barriers to health care.

Health care has been changed profoundly by new knowledge and technology which can be applied to the prevention or cure of much illness, to the amelioration of suffering, and to lengthening and improving life. This new knowledge, and the resources to use it, have made most traditional thought patterns on health and disease irrelevant. People confidently expect that effective health care will be available to them whenever they need it under all circumstances.

The implications of this change in attitude for medical education are clear: an urgent, pressing, uncompromising demand for an increasing number of health professionals, well-prepared, well-equipped, devoted to serving people in need, and widely and continuously available. More people must be recruited into the health professions; more education must be afforded them; more means must be given them to keep abreast of their fields and to develop new knowledge.

Yet medical education has been slow to change. Its traditional divisions of roles and duties and its traditional methods of imparting information have remained basically the same for long periods of time. In a world of social and educational ferment, this educational enclave cannot remain untouched. The medical school must be not just the point of education for physicians, but the educational focus for other health occupations and for the general public. What, therefore, can we consider the problems and the perspectives which face medical education?

The Problems in Health Education

It is all too easy to list the problems: the new needs—how are we to meet them? The new people—how can we find and train them? The new institutions—how can we develop them?

There is a panorama of new skills, new technologies, new methods, and new procedures. There is need for a plexus of health professionals, whose responsibilities to prevent illness and to serve the sick stem from those of the physician and are divided among several groups of people. There is need for a range of institutions, both medical and educational, manned by competent and dedicated people whose functions did not exist a generation ago. We are seeing and will see people working together in new ways, with equipment newly developed, using techniques newly devised, in institutions newly constructed or adapted, funded by new processes.

(1) The first problem is obviously that of *recruiting capable people* into the many opportunities which are now available and which will be increasingly available in health fields. All those involved in education must be concerned in this recruitment effort, but particular responsibility falls on the schools of the health sciences. Students in secondary schools and children in early grades must be made aware of opportunities and the ways in which they can prepare themselves for such careers.

(2) The second problem is the *diversity of responsibilities and disciplines* which must be taught. The complexities of health care require many people, possessing many different kinds of skills, working in concert to provide the best in health care to the people who make up the community. Each individual must be prepared not only to do his particular task, but also to understand how his tasks relate to the responsibilities of others.

(3) A third problem is the changing—the very rapidly changing—

body of knowledge required in all fields of health and by their practitioners. Functions of individuals in the field of health develop constantly. New instruments and procedures mean that people must be trained in their use. Work carried on by one type of health practitioner may need to be transferred to another. Tasks may be divided among several interrelated occupational groups. A long familiar procedure may be completely changed by the discovery or invention of a new method or technique. The need for education in a health occupation is therefore continuous throughout life. These people can never regard their education as completed.

(4) A fourth problem is the *institutions* in which health care is given. They must, of necessity, be not only clinical centers, but educational centers as well. The general hospital represents the most complex and expensive portion of the systems which provide health care today. Hundreds of people practicing many professional and technical occupations are represented in its services. Each one must function in his own right and also in relation to all the others. The introduction of any new technique or new service results in a change, great or small, in every aspect of the hospital. The change requires that everyone learn something, because everyone must function differently with the introduction of the new element.

For example, if a new technique is introduced into the laboratory for clinical chemistry (and such techniques are being developed with great frequency), the laboratory personnel are immediately involved, but many others must learn new things also. Consider the changes to be made by those who procure supplies; those who distribute supplies; those who obtain samples; those who schedule procedures; those who record data; those who determine costs; those who make up accounts; those who use the results in evaluating the patient's progress and determining future treatment.

The change inside the institution represents an educational problem and the change in the nature of the institution represents a further one. We are seeing today the development of an entire range of medical institutions—hospitals, clinics, rehabilitation centers, nursing homes, specialty care units, intensive care units—sometimes independent, sometimes united in a medical complex. Whenever a new specialty unit is devised—whether for open heart surgery, renal dialysis, training of the mentally retarded, or treatment of a special disorder like Parkinson's disease or cerebral palsy—new skills and procedures must be taught. And, when a medical advance makes the

old purpose obsolete, the facility and its staff may undergo complete change.

Consider the retraining of an emergency team transferring from an old structure to a newly constructed one. Consider a laboratory where automated equipment has been installed. Consider the change in an orthopedic hospital where crippling from polio is no longer a problem. Consider new patient units for the aged—or a shutdown of some obstetrical beds. These rather simple illustrations indicate some of the gaps in the preparation of people for health occupations and the responsibilities of education in an institutional framework for their initial preparation, for their training, retraining, and professional maintenance.

All of these changes also require education of patients, their families and the public—a field largely untouched in any systematic way.

(5) The greatest problem of all is the sheer matter of *quantity*—how to deliver as much health care as we are capable of to all the people who need it. Research in methods of health care distribution requires types of education and approaches which we are only now beginning to think about.

Perspectives for Health Education

What prospects are there for meeting these problems and solving them? We could, of course, throw up our hands and say there will be too many needs, too few people to meet them, too little training, increasing health demands, as well as limited resources.

But we can also turn these discouraging aspects around and see a completely different picture. The fact that more people are demanding more and better health care means that we shall have a healthier, more able, and more long-lived population. The fact that we have too few people trained for health occupations now means that we have a world of worthwhile job opportunities available. The fact that more training is needed means that we can offer educational challenges and career satisfactions to many who in years previous would have been relegated to uncomfortable, dull, and unrewarding assignments.

To retain our perspective, let us recognize that the institutions which provide education and training in the health field must be part of the mainstream of education. Their students are products of general education. However, we must amplify and extend the educational experience of those who choose to enter the health field, so that students will not only profit from general education, but also will be given a variety of opportunities to continue to educate themselves. This will mean major changes in our ways of organizing, storing, and transmitting information.

I hope that experiments in the transmittal of information by effective technics will show us a variety of means of reaching people of different capabilities, different interests, and different responsibilities. The means of conveying certain bodies of information which do not require the immediate presence of teachers are important to education. This is not to say that Socrates is obsolete. The wise and experienced teacher is an essential in the development of judgment and wisdom on the part of the student. And the development of judgment and wisdom is the ultimate aim of education.

Similarly the wise and experienced teacher can enable the student to see the logical sequels to factual information. He can encourage a student to use his faculties; to observe; to experience; to select; to reject; to grow in maturity, understanding, and knowledge. The energies of both student and teacher are conserved, however, by methods which transmit facts and rehearse procedure. Such methods should be carefully developed, critically tested, and artfully used.

Although changes in education, like all social change, are usually evolutionary rather than revolutionary, these are times when a significant change in direction makes good sense. A new model in education is timely, and I think we are seeing it on the drawing boards. Medical schools are not just changing the curriculum here and there, but are adopting whole new approaches to community health, interdisciplinary programs, human behavior, and the significance of the environment in health. There is intense interest in the principles of education itself.

Our best possible efforts must extend beyond the formal full-time programs associated with the schools. For every person in the health occupations, not just for the physician, there is need to provide ways for improvement and renewal of knowledge and technics. Traditional means are inadequate, and will prove even more inadequate as knowledge expands and technics diversify. Most education has to be self-education.

The range of subject matter for medical education is limitless. Physicians, dentists, nurses, technicians, administrators, and all the new health specialists will work in a new world where subject matter is drawn from other worlds: those of the computer programmer, the radiation scientist, the atomic physicist, the sociologist, the city planner, the systems analyst, and dozens more.

While we increase and develop our resources for teaching and learning, we must simultaneously create an educational setting in which people learn to work together. Unless the educational experience continues to increase the ability of individuals to join together in using their knowledge for the benefit of the members of the community, neither information nor technic will serve any purpose.

We must also provide opportunities for people to improve their range of skills and to progress within their chosen fields. If this means a change in the formal programs of education, we must be prepared to make it. It should be possible to increase one's competency, to have experience recognized, and to undertake further formal education without being considered a novice.

Educational methods, particularly in self-instruction, may play a vital part in preparing people to expand their careers so that no individual need become trapped at any point which does not let him use his full ability.

I should also like to emphasize that the perspective of medical education should be outward as well as inward. Education cannot only serve to improve the training and skills of the people in health occupations, but can also serve to bring to the general public knowledge on the maintenance of health, the prevention of illness, the provision of a safe environment, the recognition of illness when it comes, the safeguarding of home and family, and the understanding of the capabilities of modern therapy.

There is increasing applicability of methods for self-education to augment the efforts of physicians, dentists, nurses and others in the care of patients. The young couple who wish to learn about obstetrical and infant care, the child who learns about immunization, the traveler who is briefed on health hazards in areas to be visited, the serviceman who learns how to care for himself in difficult environments, the parents who learn about orthodontics—these are all candidates for self-education. The quality of our national life and our personal health depend ultimately on education. Since methods for self-instruction can amplify the work of the teacher and expand the scope of the student, they are important to the broad field of education.

Those who gladly learn and gladly teach are our great resource.

Changing Teaching Practices in Individualized Curricula

JOSEPH E. MARKEE, M.D.*

THE FIRST REACTION to this title may be that it is an absurd and complete contradiction; and perhaps it would have been exactly that just a few years ago. But changes have occurred in medical curricula and the teaching practices are changing. As Willard (1) recently wrote, "This is clearly a time of ferment and change, and a time of setting new goals for medical education in general but especially for graduate education. The Millis Commission Report (2) is probably the most indicative document in this regard." As Ham (3) recently stated, "Increases in student participation can certainly be accomplished by the process of change in instruction." And he continued, "Possibly we can shorten the distance between the cup and the lip and actually begin change-over of our methods. The time is right."

Educators in many schools agree with Ham and changes are occurring. As Woodburne (4) recently stated, "Curricular change is rife throughout the country. The writer knows of almost no schools not in the midst of it, planning it, or in the first years of a new program." The apparent central theme in the curricular changes already made, or in the process of completion, is the breaking of the "lock step" M.D. program or the abandonment of the concept that there is any one fixed sequence of courses that will best prepare the many graduates for all the many ways in which they will care for the sick. In short, curricula are becoming more individualized and it is difficult

*James B. Duke Professor, Department of Anatomy, Duke University School of Medicine.

to determine whether changing teaching practices are merely keeping pace with or are, instead, the instigating factors in the new individualized curricula.

Some of the many factors contributing to rapid changes in medical education are: population and knowledge explosions, the technological breakthrough, unprecedented increases in funding of medical education and patient care, and constantly louder and more insistent demands for more and better medical care. They have all recently been described elsewhere (5). Therefore, this paper deals not with the causes of change, but only with the changes occurring in medical curricula and in teaching practices.

Trends in Individualized Teaching

One trend involving changing teaching practices is gradual replacement of the conventional lecture by what is now called large-group teaching. The differences between the two are great and include the use of: 1) multimedia audiovisual materials, and 2) student response systems similar to the Edex or Classroom Communicator installations. As new teaching procedures become more sophisticated, the role of the teacher changes and he modifies his procedures so that he may interact with the increasing participation of his students. As this interaction increases, there is a correspondingly increased similarity between large-group teaching and individualized learning.

Another trend seen in the 75 medical schools visited is increasing opportunity for self-education. Carstairs (6), in his report on *Observations of Some North American Medical Schools*, stated that, "Yale, Stanford, UCLA and Duke University are, in my opinion, blazing a trail which the rest of us are likely to follow sooner or later. They have had the courage to realize that medical education in the future must be *less comprehensive* and *more diversified*." That is, more individualized. Carstairs also points out that elective study familiarizes the students with the valuable techniques of self-education and also enables them to select the areas in which they acquire maximum competence.

Tables I and II supply a visual impression of the extent of the trend towards increased opportunity for self-learning. The percentages are rounded and are based on a sample which includes about 50 American schools and 25 European schools.

There is considerable variation in the achievement of the different schools utilizing self-instructional methods, devices and materials.

Table I. Percentage of Schools Employing Various Types* of Self-Education.

	Mastery of Information	Supplementary Education	Remedial Education	Continuation Education
American Schools	55%	45%	15%	35%
European Schools	20%			10%

* For a definition of types see John Blyth (7). Proceedings of the First Rochester Conference on Programmed Instruction in Medical Education.

Table II. Percentage of Schools Employing Various "Self-Help" Methods, Procedures or Devices.

	U.S.	Europe
Television Recordings	50%	0
8 mm Film	35%	5%
Written Programs	35%	5%
35 mm Film and Sound	30%	0
35 mm Film and Description	25%	25%
16 mm Film	15%	5%
Computerized Learning	15%	0
Audiotapes and Dial Access	15%	3%
Museums	5%	10%
Learning Machines	5%	5%

For instance, about 55% of the American schools are utilizing self-instructional methods designed to give a mastery of information and about two-thirds are using them very intensively. On the other hand, only about one-third of the 45% of the schools utilizing supplementary self-learning methods are using them so intensively.

Table II deals with the percentage of schools that, in their self-education programs, are utilizing various kinds of procedures, methods or audiovisual equipment.

The percentages stated refer to self-help uses. They do not include any of the usage in large group instruction. If these two tables are studied simultaneously, it becomes obvious that there are many interrelationships between most of the entries in the two tables. A large number of medical schools are already using some or most of the four types of self-education depicted in Table I, and are employing one or most of the 10 procedures, methods and audiovisual devices listed in Table II.

One of the media that is used extensively in individualized learning is standard 35 mm film. As Rehman and Bell (8) state, when a strip of such film is used in sequence, "It is designed to illustrate step-by-step development in areas where change of scene is as important as motion." Such film strips have many advantages and are used extensively in conjunction with a written text or with a recorded narration. Film strips do have some advantage over separate 35 mm slides.[1] A rapid increase is occurring in the use of both, but primarily of the latter. The preference for slides is probably due to the recent technical advances in the design of slide projectors.

One of the major shortages is the kind of software suitable for use in the audiovisual machines. As Mr. Gerald Zornow (9) recently stated, "The teaching machine, which was the biggest thing on the communications landscape a few years ago, came a cropper not necessarily because it was a bad idea, but because of lack of content. 'Thousand-Dollar-Page Turners' is the way certain teaching machines are described in some official quarters now." Maybe that is why so few teaching machines are used in the 75 medical schools visited. An alternate explanation may be that so many schools anticipate great contributions from computerized self-education.

Computerized self-learning is beginning to have some impact on medical education, but it would appear to be foolhardy to even guess how great this impact may be. Although only about 15% of the medical schools are utilizing computerized self-learning, most of the schools are already using computer technology in their research, teaching, patient care or library activities. Currently, computerized self-learning is largely financed through research funds rather than through educational budgets. The dial access retrieval of videotape material being investigated at the Medical College of Virginia, and planned at La Jolla and Davis, would make segments of tape recordings equally available in the classroom or teaching laboratory or at the multi-resources learning carrel in the library. As the educational networks described in EDUCOM (10) become effective, these same segments of tape may become equally available throughout the nation.

In most of the existing schools that are making self-learning opportunities available to the students, the self-learning facilities are merely placed in a laboratory, or in some part of a secretary's office, or in a portion of the library. In some schools, an entire room is set aside for either the entire year or certain parts of the year. Self-learning resource centers are being planned in all, or nearly all, of the existing schools planning new teaching areas, and in the new schools still in the planning or construction stages. These new centers are to be intimately related to the library, computer facilities, and teaching areas. (At Duke, for example, our learning carrels are located right in the library stacks.)

Opportunities for self-learning in medicine have been greatly enhanced by what might be called "Improved Planning of Instructional Presentations." One of these enhancements is most advanced in that area of medical education commonly called "continuing education." Intramural and continuing education were once as far apart as the proverbial East and the West. Now the impact of each on the other is so great that it is folly to consider either separately. Significant improvements in scripting, directing, and producing have become evident in the medical continuation educational programs. These programs are universally pre-recorded on videotape and transfers (copies) of these tapes are viewed by groups of students and by individual students. Four examples are: 1) The Bingham and Boston Associates programs (11, 12); 2) The Los Angeles Broadcast Network (13); 3) The University of California at San Francisco program; and 4) The Albany two-way radio network (14). The planning and direction of the first two programs is now controlled by "ex-commercial TV producer-directors." The programs of the first and fourth achieve their excellence by following a precise and detailed format.

An improved distributional system has increased the availability of material for self-learning and so instructional materials produced in an individual medical school or center are used more widely. Four examples may be cited: 1) The Network for Continuing Medical Education (15) now supplies medical videotapes for use in 450 hospitals and nearly 50 medical schools; 2) The Association of American Medical Broadcasters now lists more than 150 medical tapes and distributes them to the members of the association, and to other eligible medical schools and centers; 3) The Los Angeles Medical Television Network which is described below has a large and growing distribution; and 4) the VIS which is a collaborative project of the American Nursing Association and the National League of Nursing seems to be initiating a new trend in paramedical education. Their distribution of nursing videotapes involves realistically small rental payments and, at the discretion of the producer, small royalty payments. These four examples may illustrate the beginning of a breakthrough in the resistance of many schools to the use of self-learning materials produced outside that school, and we may be nearing the solution of the problem of financial feasibility of the production of excellent self-learning materials.

Four of the techniques employed in continuation education are enhancing self-learning and require special comment. The Bingham Associates combined with the Boston Associates have developed a so-called "medical workbook." The physician listeners receive loose-leaf binders with extensive outlines and summaries of the open circuit TV programs. These productions are planned to assure coverage of the subject matter areas currently significant to superior practice.

A different self-learning procedure is employed at the UCLA (U. C. extension).[2] Their 38 weekly programs are received at 71 hospitals in scrambled image form (3). These 38 programs are videotaped at the receiving hospitals and played back *ad libitum*. The Medical Television Network duplicates are compatible with most videotape recorders. These videotapes are available beyond the broadcast range and 38 weekly videotapes are offered for playback on remote recorders at the same tuition required of hospitals within the broadcast range. Thus, distant hospitals are benefiting from these programs. The playback by or for the physician or student at the time of his selection constitutes a self-learning experience. Smart (16) found that physicians view more playbacks than live programs involving conference teaching.

A third kind of self-learning is achieved at 20 hospitals through the

Utah Clinical Pathological Radio Conferences. In advance, Castle prepares charts, records, graphs, and appropriate art work and distributes about 350 copies so that the listening student or physician may have his own work material. Special mention should be made of the two-way radio continuation education programs conducted by Frank Woolsey at Albany (17). Last year Woolsey distributed over 27,000 35 mm slides for use in the hospitals participating in his two-way radio conferences.

The telephone dial access medical tape recording library in Madison, Wisconsin is a fourth kind of self-learning. During the 12 months ending April 1, 1967, 1,859 telephone calls were dialed by physicians who listened to individual medical audiotapes pertinent to the care of their patients. These tapes deal with the nine major medical specialties. This kind of self-learning is unique in that the physician requests the information because he wants to use it in patient care and to use it immediately. The timing of the calls coincides with the actual times of patient care, as is evidenced by the hourly distribution of the calls; namely, 1%+ from midnight to 6:00 a.m., 24%+ from 6:00 a.m. to noon, 38%+ from noon until 6:00 p.m. and 27%+ from 6:00 until midnight. A special kind of motivation activates these telephone dialings. The ultimate reward of such learning is obviously of direct importance for patient care.

Examples of Use

Space permits only a brief mention of a few of the uses of self-learning procedures in medical education. The use by West and Stickley (18, 19, 20) of cinematic self-instruction (CSI) in the teaching of a part of the pharmacology course deserves special mention. For one part of the instruction, 8 mm films were prepared and used in automatic projectors. To accompany each film, self-instruction programs were written in linear form. They utilized large steps or frames and allowed opportunities for problem solving. Analyses showed that students utilizing the cinematic self-instruction earned higher test scores than did the students who covered the same subject areas in the routinely operated laboratories. West (21, 22) recently reported that this kind of self-learning is an effective substitute for at least a part of the laboratory instruction in pharmacology, but that the cost of the production of the specially prepared films and specially written programs seems to be prohibitively expensive. For this reason, his approach does not seem to be a financially feasible substitute for large segments of laboratory instruction in medical education. However, if West's films were used in a reasonable number of other medical schools, this project could doubtless become a "financially feasible substitute." After all, those textbooks that are used at a reasonable number of schools do survive. As do the schools employing them.

Doctors John and Valarie Graves (23) through their Medical Recording Service and Sound Library carry out another kind of self-learning. Each year they produce some 30 sound tapes on important medical subjects, and prepare packets containing tape on a low-cost reel and numbered 35 mm color film frames in pasteboard mounts. Last year they mailed out 10,000 recordings. This operation is conducted on the first floor of the Graves' home and all costs to the viewers are minimized. The impact on self-learning is terrific. The following is a quotation from one of the Graves' Newsletters: "You never know where you're going to meet one of our tapes nowadays — All the best sister tutors use them and quite a lot of hospitals, and the more up-and-coming academic centres. Doctors are meeting to listen under the midnight sun in Iceland, and in Christmas Island (where the postman only calls, says the Post Office Guide, 'from time to time') and one or two tapes have recently ventured across the Iron Curtain."

An interesting use of programmed instruction for remedial self-learning was conducted by Christensen (24) who identified a group of entering medical students with science grades and MCAT scores indicating a deficit in preparation for the study of biochemistry. During the pre-matriculation summer, this group studied copies of the two programs entitled *pH and Dissociation* (25) and *Body Fluids and the Acid Base Balance* (26). After the first fall quiz the achievement of this group compared most favorably with that of a similar group with matched science grades and MCAT scores, but without the self-instructional experience. Christensen raises the question, "Can we exploit to educational advantage some free time in the students' pre-matriculation summer?"

At Oregon, Pearson (27) is supervising an equally interesting use of remedial programmed learning. With permission from the producers of a number of embryological films, he has prepared reduction prints for use in 8 mm automatic projectors, and has also prepared an accompanying straight-line program from the movie script and drawings used in the story boards. The students who enter with a deficient background in embryology are encouraged to use this kind of auto-instruction. Studies indicate that these students do as well on the embryology questions as do the students who had taken formal courses in embryology as pre-meds.

To achieve more effective use of instructional time in neuroanatomy, de Groot[3] is using a self-learning device, the 8 mm automatic projector. He has prepared nine neuroanatomy films dealing with segments of subject matter previously requiring lengthy explanations. If the students raise questions about these segments during the laboratory sessions, they are asked to view the appropriate film before asking for further help from the instructor who, consequently, can spend more time in instructional activities that are felt to be more productive.

An Imaginative Departure

Many changes mentioned above were stepping stones that led to imaginative departure which may foretell the future relationship of individualized learning to a changing curriculum. One of the exciting innovations involving changed curricula and individualized learning is the quadruple-pronged La Jolla Project in Neurology. Subject-matter experts in nine neurological disciplines are coalescing this exploding knowledge into an integrated whole. A second prong involves workers who begin the arrangement of this information into blocks which, when mastered sequentially, most rapidly lead to an understanding of all of the information pertinent to modern neurology. (This might be called a certain kind of straight-line programming of learning.)

The third prong involves the simultaneous conversion of the informational content of these blocks into the verbal, or visual, or audio-visual media that is most appropriate. These media can be used for large group instruction, but are planned primarily for use in individualized learning in the multimedia resources learning center.

The fourth prong involves multi-objective learning. By selecting a reduced number of the blocks and arranging them in various sequences, a variety of individualized curricula are constructed. Thus, each doctor learns the kind and amount of neurological information essential to his own career choice.

Summary:

These generalizations apply only to changes currently occurring in medical curricula and in teaching practices.

1. Curricular changes are occurring in nearly all of the medical schools in the USA and in many medical schools in Europe.
2. The central theme of these changes seems to be an increased individualization of the teaching or learning process.
3. Concomitantly, teaching practices are involving greater student participation and a greater opportunity for self-education.
4. The increase in self-learning is occurring simultaneously in both intramural medical education and in continuation medical education. In the former, dramatic curricular changes also are involved.
5. At least ten different kinds of self-learning opportunities are being used either individually or in a variety of combinations and the tendency seems to be to further combine these multimedia into a learning resources center located in close proximity to the teaching area, library, and/or computer facilities.
6. Apparently, the new responsibility of the teacher is to create a better self-learning environment and to help the student acquire the self-educational habits he will need throughout his career in a rapidly changing medical world.
7. The experimental evidence of achievement in self-learning is intriguing even though it is meager. The interest is high and the rate of progress is gratifying.

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Footnotes

[1] The newly developed 16 mm film strips, along with a coupled ¼ inch sound tape, are enclosed in a sealed cartridge. This equipment has many advantages over the 35 mm film strip, and may be the film strip equipment of the future.

[2] The U.C. extension at UCLA is the administrative and fiscally responsible member of the Medical Television Network. The other members of this group of medical television producers are UCLA School of Medicine, U.S.C. School of Medicine, Loma Linda University School of Medicine, City of Hope Medical Center, and U.C. California College of Medicine.

[3] de Groot is Professor of Anatomy at the University of California at San Francisco.

Research on Self-Instruction: Summary and Generalizations

JEROME P. LYSAUGHT, Ed.D.*

IT OCCURRED TO ME that I might begin by mentioning an abstract that appeared in the *Journal of Medical Education* in February of this year, from an article by David Hawkridge and David Mitchell on "The Use of a Programmed Text During a Course in Genetics for Medical Students." The abstract reads, "This is a study on the use of a programmed text in genetics at the University of Rhodesia with first year medical students having varied amounts of previous knowledge of genetics. The students were given lectures, laboratories, and programmed instruction with satisfactory results."

Accompanying the article, there are none of those descriptive and inferential statistics that are so enjoyed by my friends, the psychometricians. There is simple evidence that a group of medical students were able to learn, and to learn effectively, the material on genetics. No proof, of course, that they had learned to a degree significantly better than they might have done by using another method; or that they had learned much more efficiently than they might had they been taught by some other means.

Yet I think in this simple research study, and some of the complications that lay behind it, we have all the reason that we need to pay very close attention to the suggestion of Ham (1) concerning the tyranny of statistics. For these first year students at the University of Rhodesia were not the first year students that you and I know, have

*Associate Professor of Education and Research Associate in Medical Education, The University of Rochester.

met, and have worked with in American medical schools. Many of them had been provided variable, and sometimes almost ineffectual, secondary education. But they were individuals striving with an intense motivation and ambition; and they were working with other individuals similarly committed to the aim of developing these men to their fullest potential.

One commentary on this little article in medical programming is that David Hawkridge is now *persona non grata* in Africa because he demonstrated in this, and in other instances, that black men could learn quite effectively both by programmed instruction and by other forms of teaching. This happens to be a rather unpopular opinion in certain parts of his world.

Problems in Education Research

I chose to mention this study, however, because at times the most significant effects of learning, even learning in medical education, are not those which can demonstrate some absolute form of statistical difference on a test between the means of two groups at a .05 or .01 level of significance. There is moreover a logical corollary involved here and that is this: there are times when we read in the literature of statistically significant differences that pale into insignificance when exposed to the "real world" of a teacher's critical eye.

For example, if you have enough thousands of students in a sample population across the United States, you will find that there is a statistically significant difference, almost one standard deviation, between the scores of 100 and 109 on a certain standardized IQ test. From the standpoint of the classroom teacher, however, that significance is of a very low order of magnitude because both of those scores would place students generally into what we call simply the normal population.

If I seem to stress this over-much in terms of research on programmed instruction in medical education, it is because we're faced with some peculiarities, unique to this profession, that impinge seriously on our efforts ever to find what a psychometrician would accept as "absolute evidence" of superiority for any form of teaching.

To begin with, the student population of the medical schools of the United States is a very select group. They are select because they have survived some sixteen years of a competitive educational system to be where they are. They represent a small and unique percentage of the population, and they are still further selected upon graduation from a four-year college. Despite the fact that there are glaring duplications in the number of applications made for entrance to medical school, I would submit that many medical schools receive thousands of applications from which they can select only forty, sixty, ninety, or a hundred students. Now one thing we do know from the study of educational research is that every time we have a highly select grouping from a population, the variability within that sub-sample begins to increase markedly.

The most homely example I could find of this would be: if you looked at the entire population of United States males, somewhere close to 66 percent of them would probably vary no more than a few inches in height, that is, somewhere between 5'7" and 5'11", we could expect to find roughly two-thirds of the adult male population. On the other hand, if we were to start choosing men on the basis of this specific attribute, all previous predictions are off. If you were to go to Convention Hall sometime this winter and watch the Philadelphia 76er's playing a basketball game, you would find approximately 14 men, having been selected largely on the basis of height, displaying far greater variability between the smallest man on the squad, perhaps a mere 6'2" and Wilt (the Stilt) Chamberlain towering at 7'2".

So selectivity increases variability! And as variability increases, our ability to generalize from one student, or one basketball player, to another begins to fall off appreciably. For these reasons, then, we should recognize that researchers in medical education are faced with a most difficult task when challenged to prove that any instructional method is absolutely better than any other method at any given time. Nevertheless, there is already accumulated evidence of such an order that it would take, I think, almost a degree of naivete, or else the studied resolution of ignorance, to dismiss casually the evidence that has been compiled to date regarding the relative effectiveness of self-instruction.

Research on Medical Programs

Beginning historically with the first programmed course in medical education, we saw evidence as early as 1962 (admittedly on a small sample of students, and admittedly fraught with these same problems of student variability) to indicate that the students learned at least as effectively by means of self-instruction, and, in particular cases, more efficiently. In 1964, at the First Rochester Conference, (2) we heard seven research reports that attested to the fact that students using

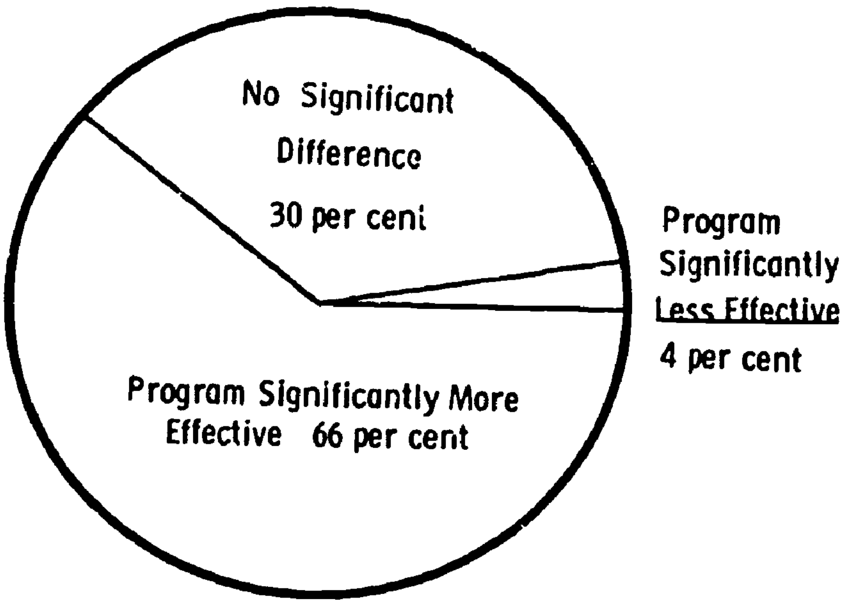

Figure 1. Summary of research reports dealing with the comparison of medical programs to conventional instruction, 1962-1967. Source: The Clearinghouse on Self-Instructional Materials for Health Care Facilities, Rochester, New York.

self-instruction did one of three things: (a) they learned appreciably more than did their colleagues in terms of achievement and/or testing; (b) they learned comparable amounts in significantly less time more efficiently; (c) they tended to become more motivated or more responsible for their own learning.

This last point is most open to dispute since our affective measures are least reliable, but Ham (3) reported in the study on hematology, which came within six months of the study of parasitology, that medical students had accepted significantly more responsibility for their own learning using self-instructional materials. Ham's report credited this as being even more important than possible gains in effectiveness or in efficiency.

One year later, in 1965, at the Second Rochester Conference (4) an additional twelve studies were reported with comparable results. Still later, in preparation for this meeting, the Clearinghouse on Self-Instructional Materials which operates out of our University of Rochester Medical School (5) analyzed those nineteen research studies that had been previously recorded at these conferences, and added to them an additional eleven studies which met all our criteria for controlled research including: experimental and comparison groups; adequate instrumentation; well-constructed, definitive achievement tests that could be examined and, of course, be validated; and finally an acceptable degree and manner of execution. We can report that of the thirty studies—which met these rigorous requirements for control—two out of three, sixty-six percent, showed that programs were significantly more effective in the instruction of the student. (Effectiveness in this case is defined as a combination of achievement testing at the conclusion of instruction and efficiency in recorded learning time.) In thirty percent of the cases, almost one out of three, there was no significant difference. In one particular case the program was significantly less effective than traditional instruction.

I think there is a reason for this general excellence, a reason for these kind of results, and for just a moment I would like to compare it with some of the results we found in general education which are not nearly so promising. John Hartley (6) in England and James Gilbert (7) of Northeastern University did very similar, almost identical, studies of the first 112 programmed courses that were used in general education in the United States. These, of course, included perhaps a few of the medical studies, but, for the most part, were studies which involved secondary and college level courses in the United States, plus a smaller number of elementary level courses. The studies revealed that approximately forty-five percent of the self-instructional units were significantly more effective than conventional instruction, but that almost fourteen percent were significantly less effective. When we analyze this contrasting picture, an interesting pattern begins to emerge, high school programs tend to be more effective than elementary programs; college programs more effective than secondary, and graduate and adult programs more effective still.

I think there are two reasons, at least, for this phenomenon. The first is that in medical education, and in some of the college and graduate school programs, the subject matter experts themselves were more uniquely and closely involved in the development of the instructional material. When we glance over the authors' list of medical programs, we find them identified as professors at Dartmouth, at Harvard, at Michigan, at Rochester, and at many other schools. Most of those programs developed for public education in the United States were done by anonymous research groups and/or commercial developers. The point, in fact, is not that there is anything wrong with the commercial development of a program, but that many of these programs were detached from the two most important assets a good program can have—a good teacher, and direct experience with the student body.

The second general observation on this contrasting trend involving programs at varying levels is that there has been a significant difference in the field testing procedures, and in the experiences with student utilization, between the programs designed for different levels of learners. Many of the programs that failed to meet the success level we might desire or expect simply lacked adequate field testing.

P. Kenneth Komoski (8) reported, for example, in one of the last issues of the Bulletin of the Center for Programmed Instruction, on some 300 commercial programs. (These would certainly include most of the ones from the Hartley and Gilbert studies.) First of all, Komoski couldn't get *any* information from the publishers on field testing or validation, indeed couldn't even get a reply from the publisher in some cases, with regard to 93 programs. Another 100 programs met merely the most minimal standards of field testing and validation. This left only one-third of the programs to meet the process criteria that we insist upon in our own work in Rochester.

In direct contrast, the programs developed for medical and health education seem to have been constructed with the same reserve, the same caution, and the same demand for quality that go into medical textbooks generally.

It is frequently not the fault of the public schools that their materials have not been better developed, but it is to the credit of the medical profession that high standards have long obtained.

Because medical teachers have developed their self-instructional material personally, and because they have pursued legitimate field testing, revision, evaluation, and rewriting, their programs have succeeded even better than might have been predicted.

Generalizations From Research

There are several generalizations that emerge from the survey of available research. One is that there are still too few programs available. At the same time, there has been a significant growth, certainly a "growth rate" that is almost unparalleled in any other form of education. In Figure 2, the solid line represents medical programs that are actually in print and available. Notice in 1960 there were only two activities—the Dartmouth project and the Western Reserve study, both of them just getting under way. It was 1963 before he first program was actually available to the medical communi y at large. Since then, we have seen a geometric growth such that in mid-1967 there were approximately 45 programs available. Each one of these programs, I think, satisfies all of the requirements that we might demand of a good self-instructional sequence developed according to a recommended process (9). As a comparison, we have included the growth curve in paramedical programs. This is steeper, but only because we have lumped together programs for nursing, medical technology, and medical technician training. Incidentally, the apparent fall-off is simply an artifact of the reporting system; the Clearinghouse normally receives very prompt information from medical publishers, but we simply have not developed as rapid a means for learning what is happening in the paramedical fields.

A second trend that emerges, related as it is to some of the concerns expressed in earlier papers, is that medical programs are designed to cover a multitude of curricular needs. Frequently, we hear the comment made that programs are useful for teaching *facts*, or teaching *information*. I think the general expectation was that the first and greatest impact of programmed instruction in the medical

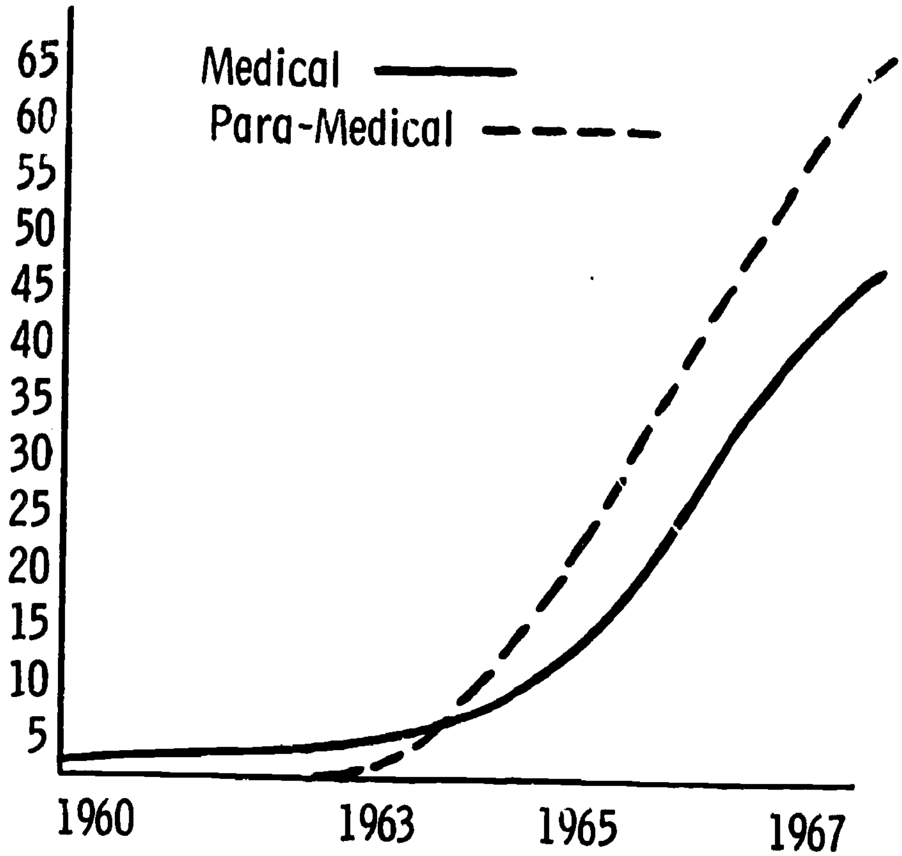

Figure 2. Growth in self-instructional learning programs for the health professions, 1960-1967. Source: The Clearinghouse on Self-Instructional Materials for Health Care Facilities, Rochester, New York.

field curriculum would be in the preclinical years. And, as we examine the studies on those first lengthy programs in anatomy and neurology, there is ample documentary evidence that you can teach a great deal of *information* and do so effectively and efficiently.

By the conclusion of 1963, however, there were a total five programs available. Interestingly enough, two of them were rather short programs in clinical areas. (See Figure 3) This same proportional distribution of programs obtained in 1965. By 1967, however, a very definite shift had taken place. The geometric growth rate continues constant—that is, moving steadily in its upward trend. But internally, a significant change has taken place. More and more programs have been developed in those clinical areas which some persons had considered as being "beyond" the capability of self-instruction. Programs, in short, are now being used to teach much more than rote materials. They are being used to teach current controversies regarding diagnosis and treatment. For that matter, they are used to teach theoretical controversies. And often we find, as clinical programs become more and more available, that these are the ones that seem to have the most widespread benefit for practitioners, interns, and residents—far beyond our initial expectation that programs would most likely be of help to medical students.

In terms of a general analysis, then, of what research has shown concerning programs in medical education, we have good evidence in 30 studies that programs are significantly more effective, or more efficient, or both, when compared to traditional methods. If we accept the simple, descriptive reports such as that by Hawkridge and Mitchell (10), that do not meet the control requirements of the psychometrician, but might very well meet the practical requirements of the medical educator, we can add at least 25 additional studies.

There are also the reported "definite increases" in the motivational level of many students using these kinds of self-instructional materials. There are without doubt some boring programs, and there are some rather tedious programs in medical education, but learners still generally find them interesting and useful enough to ask for more. Perhaps, the boredom and tedium are not so excruciating in comparison to other current methods of medical instruction.

The most exciting research finding, however, comes from another factor which is intimately bound up in our whole concern about significant differences. It is this: if all the research since 1962 on programs for medical education had produced not one single significant

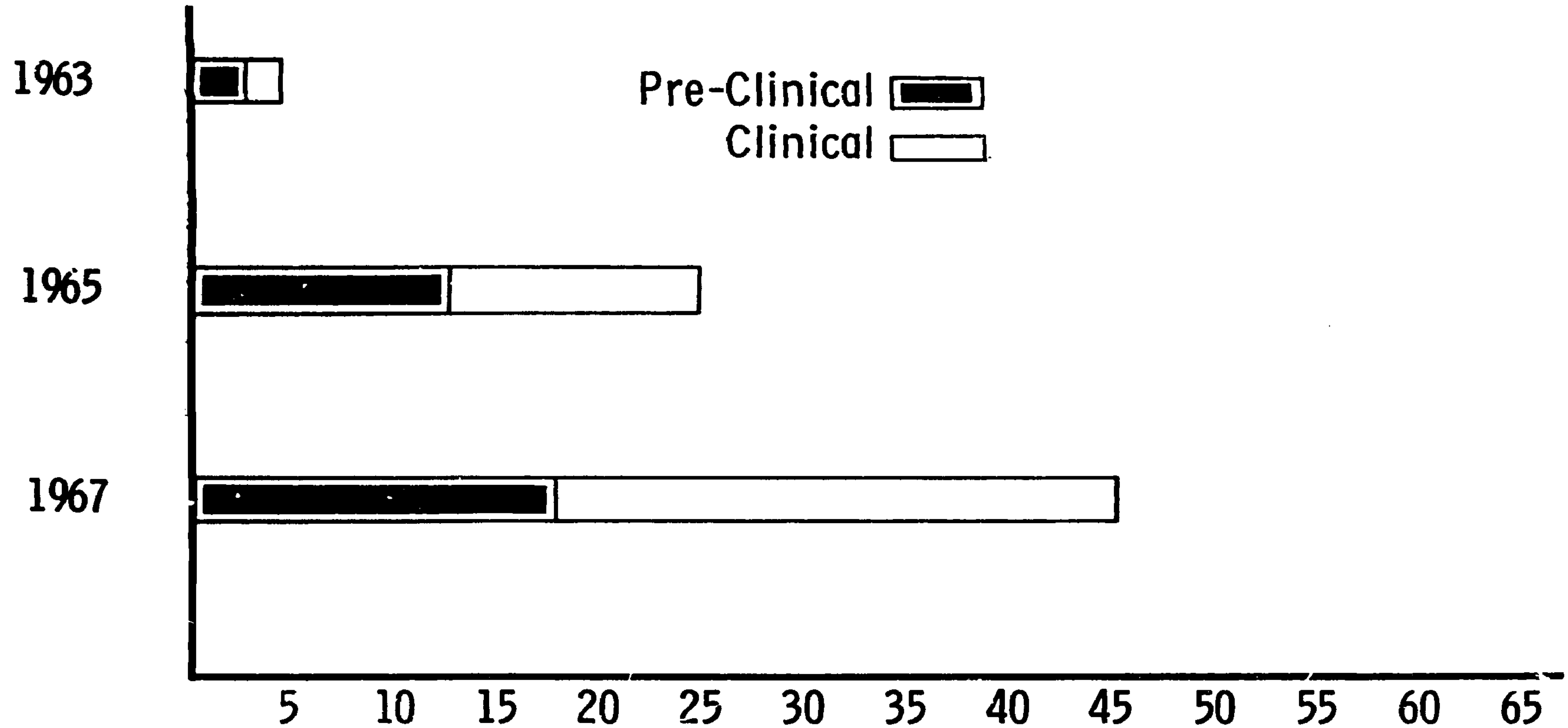

Figure 3. Distribution of medical education programs, 1963-1967.
Source: The Clearinghouse on Self-Instructional Materials for Health Care Facilities, Rochester, New York.

difference between these methods, then medical education would still possess today a valuable new tool.

Earlier in these papers it was emphasized that the medical teacher faces problems in expanding information. He faces problems in obtaining needed faculty. He faces problems in additional numbers of students, and finally, he faces the problem of teaching students who have a variable and more diverse background than ever before.

There was a time perhaps when most students entering the medical schools of the United States came from a fairly consistent pre-medical undergraduate career. We find in our own institution, and this is surely representative of many others, that more frequently students are coming out of the sciences, the social sciences, and, indeed, from the humanities. The medical student has changed!

All this signifies that many of the generalizations we have formerly utilized about the background of students, their prerequisites, and the boundaries of the subject matter to be learned are all changing. We need new tools simply to retain the quality education we have today without expanding or improving upon it. Since this is the case, any instructional method which offers comparable results, accompanied by alternatives in terms of scheduling, teacher time, and student grouping, is well worth study by the profession. When we can further add such bonuses as more rapid and/or more thorough learning, then, indeed, we have reached a point of real promise.

The Real Value of Self-Instruction

Having considered the record of research, however, the fact remains that self-instruction at best is a process. It is a process of examining what it is that we want the students to learn, how they are going to demonstrate they have learned it, determining where the starting point is for a student so that he doesn't repeat material that has been learned previously, then fashioning an efficient logical sequence. When this process occurs, the most significant finding from all our research on programmed instruction in medical education might be simply this: EACH OF THESE PROGRAMS NECESSARILY EXAMINED SOME SEGMENT OF THE MEDICAL CURRICULUM MORE CLOSELY THAN IT HAD EVER BEEN STUDIED BEFORE.

I can give you one brief example of this phenomenon from an experience in developing programmed materials on cancer for our third and fourth year medical students. When we first went to faculty members and asked the question, "What is it your students should know about cancer of the breast?", the answer that we received from some highly intelligent people was that "the learners should have an adequate knowledge." Now that's an indisputable statement, I submit. When we asked them to specify what that ADEQUATE knowledge was, however, there was immediate disagreement. Not only then, but every time we later achieved what I hoped might be an adequate compromise, someone would insist that we speak to another pathologist, or radiologist, and the compromise soon broke down.

The upshot was, however, that after some nine months of soul searching, of argument, of downright recrimination and name-calling there is now closer agreement and closer understanding of what those students are to learn than there had ever been before. And the self-teaching program that we now possess, requiring less than two hours of student time to complete, does result in significant learning on the part of the student. This student achievement is only the outer manifestation of far greater learning and understanding that developed within the faculty.

The entire process of self-instruction makes these explicit decisions necessary. Not only do we have to know what it is we want to teach, it becomes necessary to sequence it, break it into sub-sections and items, and then produce it in visible form. Each of these steps is subject to review, analysis, and revision. Finally, we must decide whether learning has taken place, how it is to be measured, and what the acceptable level of accomplishment must be. And these decisions, in turn, are reflected in products also: student responses, test items, achievement scores. In short, there is nothing in the process of self-instruction that cannot be checked, up-dated, improved, or altered. It is not so surprising, then, that instruction developed in such a way works. If it doesn't work, we can pinpoint our problems and correct them. In this way, the process of self-instruction might be seen as the application of the scientific method of teaching, in place of a sometimes artistic, but frequently unmeasurable idiosyncratic approach.

In the last analysis, self-instruction is good instruction because it deliberately includes each factor that we now know contributes to good learning. While devices, formats, and features may change, the heart of individualized learning, the real value of self-instruction, lies in the process by which it is developed, and this, many years from now, will continue to represent a signal contribution to medical education.

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The Role of Continuing Education and Programmed Instruction in the Regional Medical Program Setting

FRANK L. HUSTED, Ed.D.*

MAY I BRIEFLY REVIEW our history and our present status by indicating that the Regional Medical Program is a product of the President's 1964 Special Health Message to Congress; that this message spoke of the three health specters of heart disease, cancer, and stroke as requiring the special attention of the legislature. The commission then appointed by the President to study the problems posed in combatting these diseases, came) with over thirty-five recommendations out of which Public Law 89-239 was forged.

This act established the Regional Medical Programs, a mandate which contains several salient features making it unique in the history of health legislation. These unique features include: regional programs must be conceived *in* the region, *by* the region and *for* the region; regional boundaries are set by consent of the several health forces indigenous to a region; funds will be made available (through competitive grants) for a planning phase which may well result in the development of an operational regional medical program designed to combat the diseases of heart, cancer, stroke and certain related diseases.

Continuing this brief review, it is necessary to emphasize that these activities must take place through cooperative arrangements which

*Head, Educational Evaluation and Research Section, Continuing Education and Training Branch, Division of Regional Medical Programs, National Institutes of Health, Bethesda, Maryland.

include all the health forces within a region. And now, for the purpose of this meeting, we come to the "piéce de resistance" and I quote this from Section 900 article (a) of Public Law 89-239 . . . ". . . .to encourage and assist in the establishment of regional cooperative arrangements among medical schools, research institutions, and hospitals for research and training (including continuing education) . . ." I would be quick to suggest that the main purpose, the raison d'etre, of the regional medical program is patient care: to provide better patient care in heart disease, cancer, stroke and related diseases. This is a patient care program!

However, it is necessary to note that one of the vehicles singled out for aiding in this process is that of continuing education and training. This aspect is of such supreme importance as to encourage the early establishment of a specific branch in the Division of Regional Medical Programs office to give attention to the educational institutions. Continuing education programs for all the health professions have been a most important component of the proposals received and approved to date. As of September 1, 1967, 49 planning grants in the amount of twenty-million dollars and five operational grants totalling more than seven-million dollars have been awarded. Many others are on the verge of approval. The regional medical program is a national phenomenon and *it is on the move!* Each of you, as a health educator, has a responsibility to see where your new techniques of programmed instruction and your old educational tools, tried and true, can contribute to this swelling need for the continued education of health professionals.

A Closer Look at Continuing Education

Can we take a look for a moment specifically at continuing education? With all of its inadequacies recognized, I wonder if we can accept for the moment the premise that continuing education includes all those educational ventures engaged in by professional persons for the express purpose of gaining the knowledge, skills, attitudes, and understandings necessary to maintaining and improving basic professional capabilities acquired in an earlier set of educational experiences.

Viewed in this light, continuing education becomes a personal, individual activity. We can present a continuing education "course" only when we can find and bring together a group of professionals whose needs are identical or, at best, quite similar. However, the personal nature of needs, the exigencies of time, the cost of absence from the patient-contact scene in reduced delivery of health care, in *locum tenens* arrangements, in time, dollars and other factors suggest that the *optimum* continuing educational effort in the health professions is one which is individualized . . . one selected by the learner as a personal choice based on *needs* and with reasonable expectations of the fulfillment of these needs. Further, the venture should be one over which the learner has some measure of control in terms of objectives, timing, rate of progress, recourse to referral, and continuance or non-continuance as his schedules and priorities will permit. This is a most difficult order and one which the familiar "mass production" educational systems simply cannot satisfy.

Is programmed instruction, with all of its ramifications, a panacea for continuing education? The first, and lasting, and yet over-simplified answer must be, "No, it is not!!" But let's pause just a moment and look at available continuing education processes in light of the assumption which suggests that continuing education is as personal as the daily bath.

The traditional continuing education course would seem to be a good "jumping off" place. It conventionally takes the form of bringing the student to the academic institution. The major appeal of this time-honored process is vested in the locale, the availability of multiple faculty members, the ability to capitalize on familiar academic patterns and settings, the bringing together of a number of people with similar needs, interests and objectives, and the general availability of services not otherwise obtainable outside the "academic center." One aspect, however, in which almost all these programs "miss the boat" is their inability to meet squarely the personal, continuing education needs of the participants. In a practical, realistic sense, this may not be a wholly valid criticism, but that portion of the criticism which is valid can be greatly reduced, and the program consequently enhanced, if more attention is given to the needs of the intended student and if he can, somehow, be intimately drawn into developing the course objectives and content.

A newer strain in the continuing education effort seeks to bring the academic experience *to* the student(s). Circuit courses, two-way radio, two-way video, films, filmstrips and other techniques keep the student close to his home base with the implicit assumption, or hope, that the problems with which the content deals will be those which he is currently facing. These excellent efforts add one more important dimension to the continuing education package and they do, in many instances, move a step closer to the personalization so vital to continuing education. The opportunity to immediately relate the educational experience to current patient-care problems, to enable the student to scurry to his own familiar personal or institutional library, adds measurably to this elusive component via the very personal mechanism of reinforcement.

The printed page, long the single most important vehicle of individualized education, adds still another dimension to continuing education. Armed with a truck load of journals, a case of cold beer, and a quiet room, a man can get a lot of education at *his* own pace . . . or is he hampered by misleading titles, unnecessary verbiage, or just damn poor writing? Yes, he is so hampered, but it does not alter the fact that he can be more selective. He can scan an entire page, or he can pick meticulously through each sentence. This he can do for his own private, uncluttered reasons. He can check back to previously covered materials or he can pause for as long as he likes to ponder the mysteries of some esoteric thought or some profound theoretical position. This he can do, privately, without fuss or fanfare. Faced with a perplexing problem, he can search through the literature (with indexing aides) to find how some other scholar solved a similar puzzle.

This is *personal, needs-oriented* education . . . for one must be an *active* participant in the reading process. The late Nathaniel Cantor argued that the learner must be an *active* participant in the *learning* process. I would admit that reading the literature is not quite all I am making it out to be. Nevertheless, it *is* one of the media of continuing education in the health professions.

The whole fabric of traditional education shook like a leaf in the wind with the advent of automation and its marriage to audio-visual aids. The innovators are still having a field day with automatic sound-picture projectors, synchronized tape recorders, single concept films, video tape replay units, and a host of other gimcracks too numerous to recite. In truth, the dog who heard the master's voice has given birth to a litter of whelps so numerous and so surefire as to warrant the discarding of book, journal, and lecturer! But the hardware people deserve more than facetious mention. The whole exciting area of electronic transmission of knowledge joins programmed instruction as among the more promising avenues to date for continuing education in the health professions.

The *caveats*, however, are many. One cannot help but be alarmed by the all too frequent concentration on hardware to the neglect of the quality of content; by the ignoring of objectives in favor of indiscriminate utilization; by the "blinders" approach which touts only one medium to the damnation of all others; and by a disregard for the learner in favor of concentration on the "gimmick." Continuing education needs these tools as surely as it needs the academic setting, the lecture, the laboratory, the circuit courses, and the printed page . . . but we must ever bear in mind that continuing education must be *learner* oriented, not process oriented.

Self-Instruction for the Future

This is the Third Conference on Self-Instruction in Medical Education. This conference deals with one of the most exciting innovations in the history of education—a set of principles, practices, and accoutrements dedicated to self learning—one of the most important educational concepts you or I will ever encounter. Out of this concept have come teaching machines which range from simple hardware to multi-million dollar computer systems; programmed texts and pamphlets ranging from a few pages for a single concept program to massive volumes covering an entire discipline. More than any other *medium*, programmed instruction gives primary attention to the learner. Objectives must be clearly delineated; sequencing must be given the most arduous consideration; field testing on live students must be a part of the process. Early in his encounter, and with each subsequent exposure, the learner has an opportunity to match his objectives with those of the educational experience he is about to enter. And yet Programmed Instruction is only one tool or set of tools in the continuing education package. Despite the glowing account just rendered, many problems loom and defy solution . . . maybe, just maybe, some of these problems arise out of our inability to shake off the mass production phenomena wherein we may well sacrifice quality of content to the gods of expediency, and the learner's needs to the idols of commercialization.

One of the important pictures drawn to characterize the need for continuing education in the health professions is that of the "knowledge gap" . . . the telescoping of the distance between the research bench and the patient's bed! Between these two points stands your student—the practicing health professional. The knowledge, skills, attitudes and understanding reached at the research bench must, somehow, more quickly become a part of him! *All c ... tions which ignore this are as nothing!* Media are only vehicles ... ping the vessel to fill itself!

Where does programmed instruction "fit" into continuing education in Regional Medical Programs? This can best be answered by considering the practical, earthly, problems of the "knowledge-hungry" professional. The student in any of the formal undergraduate sequences has, in reality, but one charge . . . to learn! The health practitioner, on the other hand, has quite a different charge . . . to care for patients who desperately need his skills; to care for them in the best possible way using the very latest skills and knowledge in his field. Thus, his charge is twofold: to care for the patient and to keep up with the latest in his field.

The critical nature of this constant task is magnified by the severe manpower shortages in the health fields. The straight line deduction suggests that absence from the field by even a few professionals may well result in reduced patient care . . . the obtaining of needed education in new knowledge and skills may well result ultimately in better patient care, but what happens to the patient now when the practitioner must absent himself for long periods of time to "bone-up" on the latest developments? I submit that one crying need is an educational repertoire which embodies the concept of immediate availability; an educational "supermarket" that's as close to the health professional as a bar of ivory soap! Programmed instruction, television, radio, audio-visual carrels, computer assisted instruction systems, the printed page and the ubiquitous telephone should form a vital part of the armamentarium of continuing education for the health professional.

But I would remind you that the programmed course which ignores student needs will ring up "no-sale" on itself, and many of the more worthy programs which follow it; the television or radio sequence whether it's one-way or two-way is really "no-way" if the objectives of each and every program are not clearly delineated and meticulously constructed; the audio-visual carrel that belches the junk produced by everyone but *you* might as well become the repository for the equally valuable Steri-optican slide a[illegible] ...ctrola; the pri[illegible] ...ge, that ancient of academic media, which is put to th[illegible] f[illegible] ...ying the writer's logomachistic prowess instead of impa[illegible] preciseness and clarity to new and exciting findings might better have been put to the double use of the mailorder catalog; and the ever present telephone, with its exciting dial access and phone-a-vision potential, which fails to serve the needs of those who find it a valuable learning aid might just as well wind up with one end of the wire in hell and the other end in a hot place.

In closing, may I paraphrase a great patriot and suggest that as you prepare for each and every teaching-learning experience your constant, conscious thought should be, "The Learner- and The Learner- and The Learner- and The Learner."

The Professional Educator and the Teaching Professional

WILLIAM A. FULLAGAR, Ed.D.*

I AM INDEBTED TO Professor Lysaught for a number of things, among them the invitation to speak to you, the topic, the title for my remarks, and an admonition—even an order—to be brief. You should be grateful to him, at least for this last.

This month in the United States, more than 57 million students are starting a new year in our schools and colleges, and over 2½ million teachers and other personnel are beginning their work with these students. If you add to these 57 million all those persons who are studying part time in institutions and all those persons who are enrolled in formal training programs in industry, in agencies, and in other organizations, you will have a number of people that approximates the number of employed individuals in the United States. In other words, you've got as many people going to "school" as you have going to work. I mention these figures because I'm always amazed by the size of this enterprise in which all of us here are engaged.

In my observation of various parts of this vast educational system in the United States, I'm struck by the similarity of the problems that face those of us who make up the 2½ million. I have had some opportunity to observe the health and medical education fields, having participated in three or four continuing seminars on medical education in the medical school here at the University of Rochester. Also,

*Dean, College of Education, The University of Rochester.

I've served on a number of different advisory committees in connection with nursing programs, and at one time the division of nursing education at Rochester was part of the College of Education. We do, indeed, share the same educational problems. If we had taken a tape recorder into one of the medical teaching seminar meetings, recorded what was said, then changed a few words by dubbing in new ones, the recording could have been passed off as a meeting of the faculty in an elementary school in a suburb of Rochester or—by changing a few other words—a meeting in the company training division of Eastman Kodak Company, or a meeting of a department committee in the College of Education We all face the same curriculum and instruction problems, and we generally speak about them in the same way.

The problems that we face and the questions that we ask fall into three categories. First, there are the "what" questions—what to teach, what to achieve. Accompanying these are the "why" questions—the rationale behind the "what," the psychological, the philosophical, the sociological reasons for selecting what it is we want to do. Finally, of course, there is the problematic area of the "how" questions.

It seems to me that the "what" and the "why" belong essentially to the sub-groups within the educational establishment. Certainly those of you in the medical health field have the responsibility for defining the "what" and the "why" in your area. That is exclusively and uniquely your province. But the "how" belongs to all of us. It is in this area of the "how" that we can have a productive "coming together" of those Professor Lysaught has here labeled the professional educator and the teaching professional.

In the category of professional educator he is, of course, referring to people like me, and like others in this room—people you will find in colleges of education and similar operations; people who have devoted their career efforts to the study of the processes of learning and the training of educational personnel.

And the teaching professionals he refers to are you in the audience people with a primary commitment to a profession, or a discipline within a profession, and the additional responsibility of inducting persons into the practice of that profession

The distinction between these terms is perhaps not very wide in practice because you are all professional educators for you are all continuously involved in the education of others. The categorization, however, does help to give meaning to the theme of this brief paper.

The "how" questions are importa. fact, you can make a very good case that the great educational problems of today lie here. In this country we are asking "how do you educate children with various physical and psychological handicaps, how do you educate the slum child, how do you teach people who really don't want to learn, how do you teach people so that they will continue to learn and want to learn throughout life?" Or as Dr. Fenninger asked earlier in this meeting, "how do you deal with the vast amount of information, understandings, and techniques in the education of doctors and other health personnel?" We could go on and on in describing and detailing this "how" area.

Needless to say, the "how" questions do not have simple answers. In fact the answers and the methods of finding them are really quite sophisticated. I know that the critics of teaching, and of teachers, and of colleges of education, and of teachers' colleges have always seen the "how" questions as very low priority items. They have frequently said that the only thing those damnable educationists believe in is how to teach—something called methodology—and that the only thing that teachers study is a witches' brew called methods courses. You hear this all the time. Actually, if our critics but knew, they have leveled the wrong charge. If there is any one thing that we are guilty of it is that we have known far too little about the "how."

Despite the fact that we have had formal instruction for centuries and centuries, we have really given very little attention to a deep study of the teaching-learning relationship. In the preparation of teachers, for example, we really haven't focused on this at all in the past. If anything, we have avoided it. We've taught *about* teaching, *about* the learner, *about* the school as a social institution. It has only been in the last few years, and then largely under the stimulation of federal monies, that we have seen real movement toward fundamental study or research into what really goes on in the teaching-learning process.

Of course, the "how" questions include methods of instruction, but they include much more than this. They include the questions of how you go about selecting objectives, how you determine the teaching strategies necessary to achieve those goals, how you test and evaluate to see if you are moving successfully toward those objectives, how you conduct research on comparative methods in different areas of instruction. And, of course, we must not overlook the whole matter of the use and evaluation of media and media systems. You are well aware of what has been going on in the last two years in American business with the formation of those complexes sometimes called knowledge industries—industries that are quite prepared to sell us complete systems of education, and I dare say not only the procedures but also the objectives if we would but let them.

The single point I'm trying to make is this. While the teaching professional must function in the "how" area, the very fact of his commitment to his profession, and to his discipline within his profession, means that he can give relatively very little time to his activities in this realm. But there are some other people who have committed themselves to making their professional contribution in this area, and, of course, I am referring to the people you will find in colleges of education and elsewhere, the so-called professional educators. My plea is that you affiliate with your colleagues in professional education, that you seek them out in your own or in a nearby institution. I must caution you that you may not find them readily, but if you do not find them at all in your institution you should ask "why not?" And you ought to use your influence to see that such resources become available to you.

Here at Rochester we have made a small start in this direction. We have had several joint appointments between the Medical School and the College of Education, some medical education studies, programmed learning and clearinghouse activities, a few research projects—but we are just getting started. I think it is significant that at the beginning of this week when I went up to Dr. Lowell Orbison and told him how pleased I was that he has just accepted the deanship of our Medical School, the first thing he said to me was "let's get together very soon for lunch and talk about the medical education project." Well begun may only be half done, but I know we share a mutual commitment.

I sincerely believe that you can derive benefit from a working relationship with your colleagues in professional education. But I'm not entirely altruistic and unselfish because benefits flow both ways. In our College we profit immeasurably from this relationship. One of the great benefits is the stimulation that we get from colleagues who are among the more stimulating on a university faculty. Also, it is helpful to us to broaden our whole view and perspective of the educational field. Further, this cooperation subjects our ideas to much more rigorous criticism than they have usually been exposed to in the past. As you know, historically we have worked more with the public schools where our ideas are oftentimes accepted uncritically and without question. And, of course, we profit from certain shared resources. It is my hope that our beginning here at Rochester will develop into a significant and continuing relationship. And my further hope that the benefits we are beginning to realize will be shared generally throughout the medical schools of this country.

Part II

Research Studies on Learning Programs in Medicine

Individually and collectively, these papers demonstrate the development of self-instructional methods as a force to be reckoned with in the future medical curriculum. Fiel and Garcia report on the use of learning programs in the basic sciences to meet the several problems that seem to be indigenous to that instruction. Azneer, Bush, and Pierce all discuss clinical applications of programmed learning and suggest multiple usage in each case — for medical students, residents, and practitioners, or others — indicating a versatility of programming not often emphasized. Claxton points out the use of programs designed specifically for review and up-dating for para-medical personnel, and shows the utility of such an application. In total, these papers provide tangible evidence of effective, efficient, and retained learning by means of self-instructional materials.

A Preparation Laboratory for Advanced Mammalian Physiology*

NICHOLAS J. FIEL, D.O., Ph.D.**

LEARNING in the modern university science laboratory presents a formidable challenge to the student in terms of the complexity of the equipment and the intricacies of the procedures that must be mastered before an "experiment" can be conducted. Students must often spend large parts of each laboratory period familiarizing themselves with equipment, learning to operate electronic instruments, and assembling mechanical apparatus. In the "Advanced Mammalian Physiology Laboratory," the student must also become proficient with various, complex, surgical procedures. Consequently, "pre-experiment" time may consume up to fifty percent of the laboratory period: students' *entry behaviors* (skills and knowledge brought to the laboratory) are inadequate for the learning situation to be efficiently approached. Students often lack the time to observe, discuss, and learn the basic principles the experiment was designed to teach.

To alleviate this situation the Department of Physiology at Michigan State University initiated the development of an instructional method, based upon a systems approach, designed to provide students with appropriate skills and orientation *before* they began the experimental phases in the advanced Mammalian Physiology Laboratory. This method involved the development of a *Preparation Laboratory*, isolated from the traditional experimental or *Action Laboratory*, and conforming to the following specifications:

*The work described in this paper was supported in part by a grant from the Educational Development Program, Michigan State University.
**Assistant Professor, Department of Medical Education Research & Development, Michigan State University, College of Human Medicine.

1. Be limited to 30 minutes.
2. Be flexible enough to allow the treatment of a great variety of subjects and procedures with clarity and brevity.
3. Be available at times convenient to the student.
4. Not require the presence of a professor.
5. Possess simplicity of operation.

The initial step was the formation of a production team[1] which would determine the basic procedures for the development of the *Preparation Laboratories.*

At this point we had completed phase I of the systems approach — *The Analysis of the Problem* (Figure 1). We had asked and answered the following questions:

What was the problem? Student setup and preparation for experiments in the Action Laboratory required too much time.

Why did the problem exist?—Because the students' entry behavior into the Action Laboratory was inadequate.

How do we solve the problem?—Improve the students' entry behavior by means of a Preparation Laboratory.

The next step in the systems approach was the *Specification of Objectives in Behavioral Terms.* The objectives of the Action Laboratory were the first to be identified. From these objectives, the *Entry Behaviors* required for the Action Laboratory were determined. Once these two elements had been defined (i.e. action laboratory objectives and entry behaviors), the requirements of the Preparation Laboratory could be identified further in the following sequence:

1. Preparation Laboratory objectives.
2. Entry behavior into the Preparation Laboratory.
3. Training procedures.
4. *Exit behavior* from the Preparation Laboratory (knowledge and skills taken from the laboratory).

From this it can be seen that the exit behaviors from the preparation laboratory were meant to correspond to the entry behaviors for the Action Laboratory (Figure 2).

The flow of events illustrated in Figure 2 provided the basic format for the development of detailed objectives, entry, and exit behaviors. Earlier experimental "write-ups" for action laboratories were studied and objectives reidentified: the general procedure is illus-

[1] Dr. Raymond Johnston—Associate Professor of Physiology, who was the originator of the concept of a Preparation Laboratory for Physiology.
Dr. Robert Davis—Director of Learning Services.
Dr. Horace Hartsell—Associate Director of the Instructional Media Center.
The Author.

SYSTEMS APPROACH

I. Analysis

   A. What
   B. Why
   C. How

II. Specification of Objectives in Behavioral Terms

III. Mode of Instruction

   A. Individual
   B. Group

IV. Media Decisions

V. Field Testing

VI. Evaluation

Figure 1

Outline of systems approach employed in the development of the Preparation Laboratory.

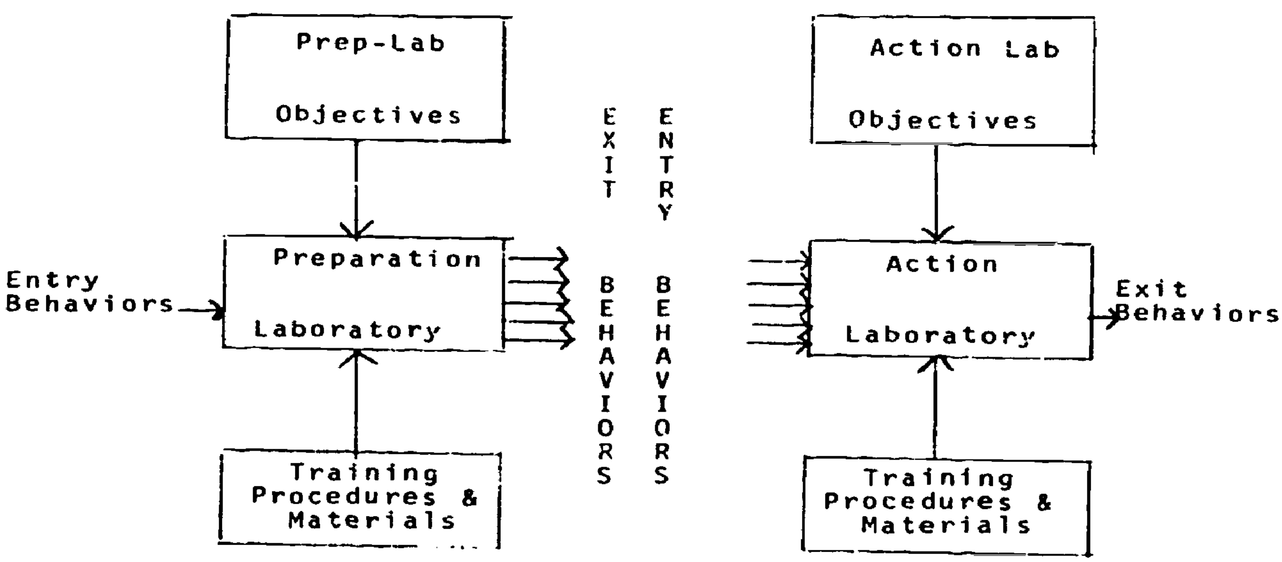


Figure 2

Schematic diagram illustrating the relationship between exit and entry behaviors, objectives, and training procedures for the Preparation and Action Laboratories.

trated in Table 1. This table was developed for the sixth experiment in the series on the *Exposed Dog Heart* and is only one of many pages constructed for this experiment.

The third step in our systems approach was to determine the *Mode of Instruction*.

Based upon the specifications for the preparation laboratory, determined in the analysis phase, we decided the mode of instruction would be individualized and placed in a carrel situation.

The fourth phase involved *Media Decisions*. The persistent question was—what media would best train students for the desired exit behaviors from the Preparation Laboratory? An example of the flow charts used to plan media applications is shown in Table 2. In the left hand column possible media are listed and in the center is a statement of the task to be considered.

The final step, an *Overview Chart* (list of procedures) (Table 3) was compiled from the prepara on laboratory objectives. For each general heading, such as "A cial Respiration," one picture was selected to illustrate the gen pic. Overviews were used to orient members of the production t who were not physiologists, to the various experimental proce s. Describing the proposed pictures also aided in this orientatio

When the above procedu had been completed for the first two Preparation Laboratories, a ntative production schedule was drawn up and production of slides, single concept films, linear programs, etc. was begun.

Field Testing was the fifth step. Linear programs, written for the Preparation Laboratory, were evaluated by Dr. Davis and tested on senior nursing students. When the first complete Preparation Laboratory unit had been assembled it was similarly field tested on senior nursing students.

Facilities

The basic instructional unit was the carrel. Four pieces of equipment were placed in each carrel.

1. Kodak Carousel Model AV 900 with remote control attachment.
2. Viking deck tape unit.
3. Koss headphones.
4. 16" x 16" cardboard projection screens.

Equipment specific to the carrel function was selected: the Model

Table 1

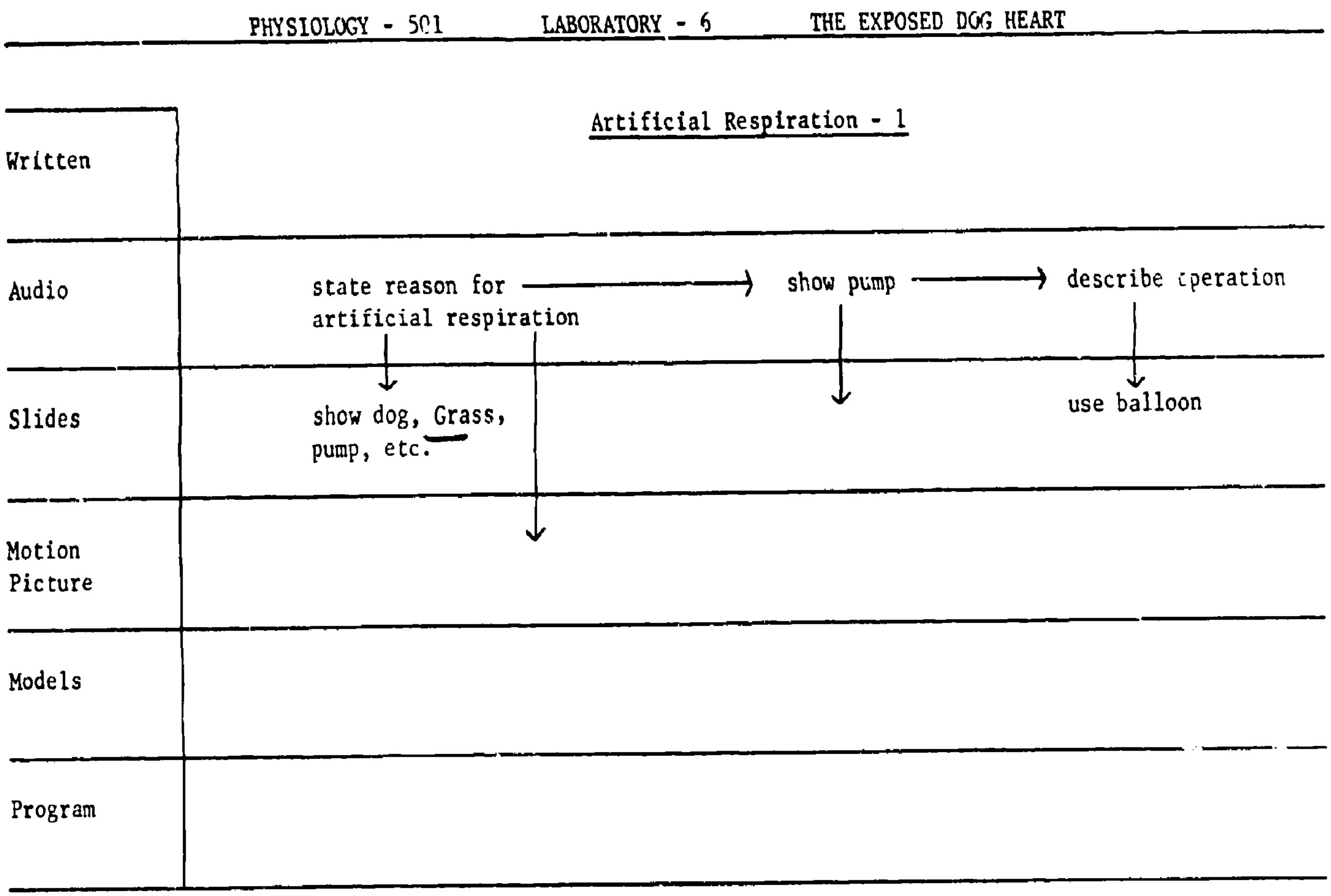
An Example of Entry and Exit Behaviors and Objectives for Part of a Single Laboratory Exercise.

PHYSIOLOGY - 501 LABORATORY - 6 THE EXPOSED DOG HEART

Action Laboratory		Preparation Laboratory			
Objectives	Entry Behavior	Objectives	Entry Behavior	Training	Exit Behavior
1) Can operate a setup for artificial respiration in the dog.	1) Can describe the setup for artificial respiration in the dog.	1) Teach to be able to describe the setup for artificial respiration in the dog.	1) Can anesthetize a dog. a) Can intubate a dog.	1) Train to be able to describe the setup for artificial respiration in the dog.	1) Can describe the setup for artificial respiration in the dog.
2) To be able to expose the heart of a dog by means of a mid-line incision thru the sternum.	2) Can describe how to expose the heart of a dog by means of a mid-line incision thru the sternum.	2) To teach to be able to describe how to make a mid-line incision thru the sternum of a dog.	2) Can record E.C.G. a) Can cannulate the carotid artery. b) Can isolate the vagus nerves. c) Can isolate the femoral vein.	2) Train to be able to describe how to make a mid-line incision thru the sternum of the dog.	2) Can describe how to make a mid-line incision thru the sternum of the dog.

Table 2

Flow Chart of Preparation Laboratory Media



AV 900 Kodak Carousel was chosen because its heavy duty motor requires minimal maintenance; the Viking decks, being playback units exclusively, reduced costs and prevented students from inadvertently erasing tapes. To minimize distractions from room noise and to create an atmosphere in which students could concentrate on the materials at hand, headphones, rather than external speakers, were used.

A photograph of a completely equipped carrel is shown in Picture 1. Shelves supporting the Kodak Carousels were made of ⅝ inch laminated plywood, covered with wood simulated vinyl paper, and held in place by steel I -rods.

Five other pieces of equipment completed the basic setup in the Preparation Laboratory: three "super-eight" Technicolor continuous feed movie projectors, a center work table and a storage cabinet. Pictures 2 and 3 show these items, the arrangement of carrels and the desk where students signed in and out of the Laboratory. Frosted glass partitions were used to isolate the Preparation Laboratory from the rest of the room.

Operation of Preparation Laboratory

Prior to their first laboratory assignment, students were introduced to the Preparation Laboratory and taught to operate the audiovisual equipment.

Undergraduate students were hired to work in the lab which was open five hours per day, Monday through Friday. Upon entering the laboratory, a student's time card was taken from the file and the following facts recorded:

1. Date.
2. Number of the experiment he was previewing.
3. The time he entered the laboratory.
4. The carrel to which he was assigned.

Upon leaving the laboratory, the time card was returned and the time recorded. From these cards, the time each student spent in the Preparation Laboratory per experiment, and the total time spent during the entire course, could be calculated.

It was the responsibility of the undergraduate assistants to organize the Preparation Laboratory for each new experiment and to help students in the operation of equipment. After a student had signed out and his time card was filed, the laboratory assistant would set up the carrel for the next student. This procedure kept equipment trouble to a minimum.

Table 3

Overview of Preparation Laboratory 6

A. Artificial Respiration

1. Picture of pump and endotracheal tube.

B. Chest Surgery

1. Picture of completed sternotomy.

C. Isolation and occlusion of arteries and veins

1. Picture of inferior vena cava being occluded.

D. Pericardial sac pressure

1. Picture of completed procedure.

E. Pericardial sac hammock

1. Picture of completed procedure.

F. Arrhythmias

1. Picture of normal E.C.G. and abnormal E.C.G.

Laboratory Procedure

Since nine Action Laboratory experiments are performed in the first quarter of the advanced mammalian physiology course (PSL 501), nine different preparation laboratories were developed. The following are the areas covered:

1. Osmosis
2. Blood—Coagulation, Osmotic Properties and Volume Relationships
3. Muscle Contraction
4. The Turtle Heart
5. Control of Blood Pressure in the Dog
6. The Exposed Dog Heart
7. Blood Pressure, Heart Sounds, and E.C.G. in Man
8. Respiration in the Dog
9. Renal Functions in the Dog

The Preparation Laboratories dealt with many different subjects, including the pithing of the frog, operation of the Grass polygraph machine, and open chest surgery. Because of the complexity and diversity of this material, two procedures were initiated:

1. Material was presented in the same sequence in the Preparation Laboratory as it would be in the Action Laboratory.
2. Students were given a written "overview" of the material to be covered at the beginning of the Preparation Laboratory, which included the title of the experiment and a list of subjects to be covered (Figure 4).

Instructions at the bottom of the overview sheet *always* directed students to put on the headphones and turn on the tape units. The introductory dialogue for the sixth preparation laboratory, which is typical of all others, begins as follows:

> "This is Preparation Laboratory 6. Today we want to prepare you for the sixth Action Laboratory which is concerned with the exposed dog heart. First, let's take a look at the overview slide. Turn on the slide projector and advance the machine to Slide 1."

The first slide always provided an overview to supplement the written material. The accompanying dialogue briefly outlined each procedure for the student. The overview slide for pr paration laboratory 6 and its associated dialogue is illustrated in Figure 5.

Following the overview slide, students were shown photographs depicting *each procedure* listed in the overview slide (that is, one photograph for each procedure). The last slide in this series listed

PHYSIOLOGY 501 PREPARATION LABORATORY

Experiment 6 The Exposed Dog Heart

I. Subject Matter Covered

A. Canine sternotomy

B. Isolation and occlusion of great vessels

C. Pericardial sac pressure

D. Pericardial sac hammock

E. Artificial respiration

F. Cardiac arrhythmias

II. Instructions

A. Put on the headphones

B. Turn on the tape recorder

Figure 4

Students' Written Overview of Experiment Six

OVERVIEW

I. CANINE STERNOTOMY

II. ISOLATION AND OCCLUSION OF GREAT VESSELS

   A. INFERIOR VENA CAVA

   B. SUPERIOR VENA CAVA

   C. AORTA

III. PERICARDIAL S PRESSURE

IV. PERICARDIAL SAC HAMMOCK

V. ARTIFICIAL RESPIRATION

VI. CARDIAC ARRHYTHMIAS

Figure 5

"The first procedure you will study today is the correct procedure for canine sternotomy. This will be followed by the technique for occluding the superior and inferior vena cava and the aorta. Third on the list is the pericardial sac pressure experiment which is followed by the pericardial sac hammock procedure. The two remaining items are: artificial respiration and cardiac arrhythmias. Now lets look at a representative slide of each of these -- Slide 2."

the duties of each item member. During the semester, groups consisted of five students, each with separate duties and responsibilities (upon entering the Preparation Laboratory, each student would refer to a posted list informing him of his team role that week).[2] The same five students worked together for the entire term, but their team positions rotated each week.

Following this orientation material, the first subject listed in the overview slide (canine sternotomy for Preparation Laboratory 6—see Figure 5) was described in detail. For many of the procedures, single concept films were developed; in these cases students were told first to view the single concept film of the procedure. This gave them a "gestalt"—a feeling for the entire procedure and insight into the "motion" involved. Students then returned to the carrels and followed the same procedure through a step at a time using the slides and audio tapes which explained each slide.

In addition to slides, tapes, and single concept films, linear programs were written for each Preparation Laboratory to cover largely cognitive material. In the fifth, sixth, and seventh Preparation Laboratories these linear programs were combined with overlays to better explain the normal and abnormal electrocardiograms.

Where feasible, psychomotor training was provided using m[illegible] and simulation. For this, students were directed to the center t[illegible] where they might, for example, muzzle a model of a dog's head after following the procedure on slides and tape.

Results

The final step was *Evaluation*. As stated in the analysis phase, the main objective of the Preparation Laboratory was to improve the student's entry behavior into the Action Laboratory so that the setup time for experiments could be reduced.

From the students' time cards the mean time required for completion of each preparation laboratory was computed (Table 5).

Six of the nine action laboratory experiments required major setup procedures ("pre-experiment" procedures) and the time from the beginning of the laboratory period until all of the students had completed their setups was recorded (Table 6).

Unfortunately, no comparable data are available for groups that had not had the benefit of the Preparation Laboratory. However, a

[2] Team duty charts were also posted in the Action Laboratory, eliminating the necessity for the student to memorize his specific duties.

Table 5

Mean Time Required for Completion of Each Preparation Laboratory

Preparation Laboratory	Title of Laboratory	Time (Minutes)
1	Osmosis	47.1
2	Blood	37.0
3	Muscle Contract[illegible]	38.6
4	Turtle Heart	26.2
5	Blood Pressure [illegible]g	61.8
6	Exposed Heart - [illegible]g	50.4
7	Blood Pressure - E.C.G. - Man	10.4
8	Respiration - Dog	15.7
9	Renal Function - Dog	19.8
	Overall Average	34.1

Table 6

Setup Time for Six of the Nine Action Laboratories

Action Laboratory	Title of Laboratory	Setup Time (Minutes)
3	Muscle Contraction	45
4	Turtle Heart	45
5	Blood Pressure - Dog	90
6	Exposed Heart - Dog	90
8	Respiration - Dog	65
9	Renal Function - Dog	90
	Overall Average	71

survey of the professors and graduate assistants who have been instructing in the Action Laboratories over the past three years provided the following estimates of setup time ("pre-experiment" time) without the Preparation Laboratories.

1. Estimated minimum setup time for experiments 3, 4, and 8 = 120 minutes.
2. Estimated minimum setup time for experiments 5, 6, and 9 = 150 minutes.
3. Average estimated setup time for experiments 3, 4, 5, 6, 8, and 9 = 135 minutes.

These estimates include the time required to explain and to demonstrate procedures as well as the time required by the students to perform the procedures.

When the average time spent in the preparation laboratory (Table 5—34 minutes) is added to the mean setup time in the action laboratory (Table 6—71 minutes), students who had the benefit of the preparation laboratory required an average of 105 minutes to complete their pre-experiment setups compared to 135 minutes (estimated average—see above) for students not using this facility; a net savings of 22% for each laboratory.

Moreover, when only the setup times in the action laboratory were compared, the students who had the Preparation Laboratory required only 71 minutes compared to 135 minutes for students without the preparation laboratory. This was a savings of 47% of Action Laboratory time.

Consequently, it was possible to reduce each Action Laboratory from 5 hours to 4 hours. Furthermore, instead of the Action Laboratory being devoted entirely to experimentation it was subdivided as follows:

1. One hour for setup procedures.
2. Two hours for experimentation.
3. One hour for discussion of results in group conferences held outside of the action laboratory

These discussion conferences have obvious advantages for increasing student learning in regard to the physiological principles manifested in the Action Laboratory experiments.

A questionnaire was used to assess student attitudes toward the Action Laboratories (Table 7). Comparisons were drawn among three groups including: two groups of students who had PSL 502 without the Preparation Laboratory and one group of students who

Table 7

Comparison of Imperfect Control (See Text) and Experimental Groups on Student Questionnaire. Percent of Students Agreeing, Uncertain, and Disagreeing with Each Item.

	PSL 502 (Spring '66)*			PSL 501 (Summer '66)**			PSL 502 (Fall '66)***		
	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree
1. This has been one of the most interesting and stimulating laboratories I've had in college.	31	22	47	79	9	12	14	13	73
2. Lecture material and laboratory experiments were closely coordinated.	35	21	44	63	7	30	41	23	36
3. The members of my surgical team always knew what they were expected to do.	20	[illegible]	62	62	13	25	18	18	64
4. I learned very little physiology in the laboratory.	34	3	34	7	14	79	53	16	31
5. I frequently found my attention wandering during laboratory hours.	67	13	20	12	10	78	55	14	21
6. Laboratories were an exciting learning experience.	17	[illegible]	51	72	13	15	12	39	49
7. A great deal of planning obviously went into the laboratory experiments.	10	33	57	74	21	5	21	32	37
8. There was always plenty of time for my group to complete experiments and discuss results.	64	12	24	44	7	49	89	4	7
9. I frequently found myself thinking about the laboratories outside of class.	23	20	57	63	16	21	18	25	57
10. A substantial amount of laboratory time was wasted each week because students didn't know what procedures to follow.	72	10	18	12	14	74	63	10	27

	PSL 502 (Spring '66)*			PSL 501 (Summer '66)**			PSL 502 (Fall '66)***		
	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree	Agree	Uncertain	Disagree
11. The labs were not a particularly valuable part of the course.	39	25	36	8	8	84	59	16	23
12. Laboratory exercises were well organized.	7	28	65	70	23	7	23	24	53
13. When I encountered difficulty performing an experiment, assistance was always available.	71	12	17	79	9	12	78	6	16
14. There was frequently confusion in regard to the physical or mechanical setup of the experiments.	68	14	18	17	11	72	54	15	31
15. I learned more physiology in the laboratory than in the lecture.	3	7	90	16	26	58	2	1	97
16. At the beginning of the laboratory hour, I always knew what my specific duties were.	10	17	73	93	3	4	18	19	63
17. Too much time was devoted to preparing for and conducting experiments relative to the amount I learned.	64	16	20	24	20	56	50	31	19

* PSL 502 Spring '66 - No Prep Lab available.
** PSL 501 Summer '66 - Prep Lab available.
*** PSL 502 Fall '66 - No Prep Lab available.

Table 8

Results of Questionnaire Administered to a Group of Students Which Had One Term of Physiology With the Preparation Laboratories (PSL 501) and One Term of Physiology Without the Preparation Laboratories (PSL 502).

	PSL 501 (Summer '66) vs PSL 502 (Fall '66)* Agree	Uncertain	Disagree
1. Preparation Labs were a waste of time.	4	4	92
2. I learned about the same amount of Physiology from an experiment with or without the preperation laboratory.	8	4	88
3. I was about as well prepared for the experiments in PSL 502 as in PSL 501.	4	8	88
4. Preparation laboratories would be a valuable addition to PSL 502.	84	8	8
5. Because there was no preparation laboratory, PSL 502 was not as interesting as it might have been.	59	26	15
6. As a result of the preparation labs, surgical teams were better prepared in PSL 501 than in PSL 502.	94	2	4
7. Experiments were better planned in PSL 502.	4	11	85
8. Considerable time was lost in PSL 502 because there were no preparation labs.	64	13	23
9. The preparation labs in PSL 501 did not add to my interest or increase my enthusiasm for experiments.		8	88
10. Preparation laboratories would be a valuable addition to many science courses	[illegible]	13	4
11. It would have been easier to set up my experiments in PSL 502 if there had been a preparation laboratory.	79	11	10
12. Preparation laboratories helped to reduce confusion in the action laboratories.	94	4	2
13. Very little experimental set up time was saved as a result of the preparation laboratories.	14	2	84

*The Prep Lab was available in PSL 501 (Summer 1966) but there was no Prep Lab for PSL 502 (Fall 1966).

had PSL 501 with the Preparation Laboratory. No control data exists for students taking PSL 501 without the Preparation Laboratory. However, PSL 501 and PSL 502 both deal with mammalian physiology; are considered to be comparable in format and difficulty; are taught by the same instructors and include virtually identical student bodies. Consequently, comparisons between the two appear justified.

Despite the use of an imperfect control, it is clear from an inspection of Table 7 that the expediency of the Preparation Laboratory concept is favored. Discussions with the faculty and graduate assistants substantiate this general impression.

Further support for the Preparation Laboratory (Table 8) is provided by a second questionnaire administered to a group of students after they had taken PSL 501 with the Preparation Laboratory and PSL 502 without the Preparation Laboratory. That is, the questionnaire was given after the students had completed both PSL 501 and 502. Again, it is obvious these students also favored the use of the Preparation Laboratory.

Summary

Because students were frequently not prepared to conduct complex experiments in the advanced mammalian physiology laboratory, a special multi-media Preparation Laboratory was developed by means of a systems approach. In this Preparation Laboratory students previewed experiments and acquired the necessary skills and information to conduct the experiments successfully.

On the basis of evaluations and questionnaires, the following conclusions were drawn:

1. Student setup time in the Action Laboratory was reduced by approximately one hour.
2. Student interest, attitude, and appreciation for the course were greatly improved.
3. Students were overwhelmingly in favor of the development of a Preparation Laboratory for another Physiology course.
4. Students felt Preparation Laboratories would be a valuable addition to many other science courses.

A Multimedia Approach to Biochemistry Laboratory Instruction

EUGENE N. GARCIA, Ph.D.,
E. WAYNE HULL, Ph.D.,
KENNETH H. IBSEN, Ph.D.,
and F. H. PASEMAN, Ph.D.*

THE FIRST STEP in an individualized learning program for medical students (1) was initiated several years ago when a programmed text was produced to cover the laboratory portion of the medical school Biochemistry course. A first year progress report was made at the Second Rochester Conference in Self-Instruction in Medical Education (2). Since then, we have continued our study on the effectiveness of this program. In this paper, we shall report briefly on the results obtained, and describe some other projects which have been added as we attempt to develop an individualized approach to teaching in the biochemistry laboratory. It is obvious that an individualized plan is a radical departure from tradition and entails a number of complex problems One of the first considerations is a validation of the various tools used in such a program. For this reason we have proceeded slowly in our efforts, taking time to test each next step.

To evaluate the effectiveness of the first unit, the programmed laboratory text, the first year medical school class was divided into two groups. For the first three weeks both sections of the class had one hour of laboratory time to study the programmed material. For the next three weeks, the first section of the class had an hour in which to study the programmed material for that week. The second section did not receive the programmed material, but was given a lecture on

*All of the Department of Biochemistry, University of California, Irvine California College of Medicine.

the same subject during the same hour. All students performed the same experiments during each week. Prior to the first lecture or study period, a pre-test was given to both sections. A post-test was given at the end of the week. After this second three week period, the groups were reversed, so that section two had the programmed materials for the next three weeks.

According to the design, the section receiving only the lecture was not to see the programmed material until after the post-test. Except for one instance, the lectures were given by a staff member other than the authors of the programmed text. The averages of the differences between the pre- and post-test scores for each section were calculated; and these differences were used as a criterion for the effectiveness of the programmed material over the lecture presentation. These data are summarized in Table I. It is of interest to note that in this particular topic, the nucleic acids, the post-test scores were almost the same for both sections, though section two seemed to have had a superior background knowledge as indicated by the higher pre-test average. The gain score of the programmed group is significantly better. In this particular case, the lectures paralleled the laboratory work, perhaps an indication that the use of programmed material reinforces the lectures. However, in Porphyrins II, when the lecture and laboratory topics again coincided, no such effect was evident.

As has been the case in several other studies, the conclusion we can draw when comparing a programmed text with a lecture, is that the self-instructional text can be at least as effective as a lecture and certainly is more efficient as concerns the amount of material covered in a given space of time. It seems that as long as the programmed material can substitute for a lecture, it qualifies as a proper tool for teaching on an individualized basis.

The quarter examination, approximately a month later, provided an opportunity to test retention of the material. The students had a choice of essay-type questions to answer. The results on six of these questions are shown in Table II. The overall performance does not warrant any conclusion that the programmed material was either superior or inferior on retention. Of course, by the time the quarter examination was given, both sections had access to the programmed material, as well as to other sources such as class lecture notes and library references, so that any difference stemming from the study material would be fairly well eliminated.

An example of the enhancing effect of having an author of the pro-

EFFECTIVENESS OF PROGRAMMED MATERIAL IMMEDIATE RESPONSE

TABLE I

		Section I - Programmed Material			Section II - Programmed Material			Both Sections-Programmed Material	
		Nucleic Acids	CHO	Lipids	Porph. I	Porph. II	Inorganic Ions	Amino Acids & Proteins	Enzymes I
Section I	Post	31.9	77.0	67.6	74.1	83.1	72.6	73.2	76.7
	Pre	51.4	14.8	22.4	53.1	35.5	23.5	45.6	34.9
	Diff.	30.5	62.8	45.2	21.0	47.6	49.1	27.6	41.8
Section II	Post	78.3	82.1	69.9	80.0	83.8	66.6	78.3	77.6
	Pre	61.6	15.0	27.5	53.9	37.6	23.3	51.5	40.2
	Diff.	16.7	67.1	42.4	26.1	46.2	43.3	26.8	37.4

EFFECTIVENESS OF PROGRAMMED MATERIAL AS MEASURED BY RETENTION

TABLE II

Section Averages on Essay Questions⁺							
Section	Enz. I	Steroids	Porph. I	Porph. II	Porph. II	Inorg. Ions	Lipids
I	12.7*	15.0*	9.9	10.5	9.3	13.9	9.70*
II	10.5*	14.4*	11.1*	9.7*	8.3*	14.4*	9.76
Total	11.[illegible]	14.9	10.5	10.2	8.3	14.1	9.74

* Section had programmed material

⁺ Total possible was 15.0

grammed material give the lecture and also construct the examination can be seen in the particularly high scores for the topic Inorganic Ions.

At the time of the last Conference, we were beginning the development of audiovisual programs for use in the laboratory instruction. Since that time, we have completed four other programs and have tested them on a small number of students. We will be using them with the entire class for the first time this Fall, and we plan to collect systematic data on their effectiveness. The equipment we are using is the Videosonic System, which employs a tape cartridge synchronized with a cartridge of color film slides. The average length of the programs developed so far is approximately ten minutes. These are single-topic programs, designed to present the features of a laboratory technique, so that the student will have some background knowledge when he starts to use the apparatus.

So far the program on Paper electrophoresis has been tested the most extensively, and it is now available as a demonstration lesson and as an instructional programmed unit. This latter consists of the demonstration and then a repetition of the key slides with a series of questions designed to test comprehension. The student gives a covert response which is reinforced, or corrected, by the taped narration. We think that an overt response is not necessary, at this point, since we intend to use the programs in the laboratory, and the student will go directly to actual operation of the apparatus. Once he has been given the correct instructions and information, it should be a better learning situation when working with the real equipment.

The Videosonic System machine is set up in a corner of a lab bench where the program is viewed by two students at a time. They can run through the program once and then proceed to the laboratory work, or they can run through the program more than once, or return to it during the session whenever there is need. We intend to run through a fourth of the class each week with each program, so that by the end of the first four weeks we will have covered all the common lab techniques with all members of the class. Individual instructors will be present each lab session to answer questions and give direction to the students as they actually operate the equipment.

The programs which have been developed thus far are: Paper Electrophoresis, Cellulose Acetate Electrophoresis, Thin Layer Chromatography, Enzymatic Digestion, and Paper Chromatography. Another unit on Electrophoresis of Lipoproteins is being revised and extended to include gel filtration techniques. By using these audio-visual programs, it should be possible to cover a number of fundamental techniques more rapidly and efficiently with the students. Once these techniques have been shown to the students, we can proceed to introduce them to actual research methods.

For some years, the students have engaged in a six week individual project near the end of the second trimester of the biochemistry course. This had been the only opportunity for individualized work presented to the student and from the reactions of the students, it was one of the better liked aspects of the laboratory course.

These individual projects were conducted in such a way that each student submitted a research proposal and one instructor was assigned to talk over the project with the student. As a result of this informal conversation, the project was then approved for completion, or modified as the two parties agreed on specifics. An oral report was required at the completion of the project.

The changes introduced for this year are designed to reduce the number of research topics, for obvious logistical reasons. These will be more structured than in the past. Each student will be guided more closely by an instructor when he begins his research project. There will be increased conference time with each student and suggestions concerning reference material which is related to the student's research background and knowledge. For example, a student with no previous courses in biochemistry and little laboratory experience would be directed to learn about glucose determinations before starting a project about diabetes; and it could happen—as an extreme case—that his experimental work might never progress beyond a blood glucose determination. On the other hand, a student with previous courses in biochemistry lecture and laboratory might begin by searching the literature for hormonal effects on blood glucose levels, or an immunological study of insulin from various species, and he might proceed so far as determining insulin effects in adipose tissue as compared to liver.

Posting a list of projects for research has the advantage of limiting the inventory of materials which must be available to the students. With the limited time available for these projects, some students have been frustratingly disappointed by having their reagents or other needed materials arrive in the last week of the time alloted. By knowing in advance the possible ramifications of the defined problems, it will be easier to order needed reagents in time. Such an approach also takes the burden off the students who do not have enough background to formulate a good research project themselves.

In this program, the novice researcher is led to consider a problem and define specific approaches; then he is guided toward various methods from which he may choose one approach to solve his problem. By this method, we hope to introduce the student to proper research methods, with proper controls, etc. Since these are pragmatic, narrowly-oriented students, the topics will have a definite medically-related importance, such as diabetes, porphyrias, anemias, cardiovascular, or endocrine problems.

It is in connection with this medical aspect of the laboratory problems that it seems computer-assisted programs can play an important role. After a firm foundation is formed by programmed units, clinical data and clearly-defined cases can be presented to the student as a problem-solving exercise. However, these computer programs can serve a wider purpose by teaching him to sift through data in a rational fashion and develop hypotheses which he will then be encouraged to test by actual experiments. These experiments may be as simple as an actual verification of standard laboratory analyses, or as sophisticated as improved modifications of clinical tests and attempts to elucidate a step in a metabolic pathway. Preliminary steps have been taken toward developing such a Computer Assisted Instructional program for use in conjunction with the individual experiments dealing with porphyrins.

Once we have been able to validate the effectiveness of programmed texts, slides, films, tapes and video as teaching tools, we hope to be in a position to attack the problem of the complete individualization of the biochemistry course—developing a system in which the traditional lecture system is replaced by this multi-media approach. As the hardware technology improves, we hope to improve the effectiveness of the "software," the essential and vital programs, which will have meaning and reality for the medical students who use them.

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The Development and Testing of a Programmed Course in Diabetic Acidosis

J. EDWARD AZNEER, Ph.D.,
EDWARD KESSLER, M.D.,
and LEONARD P. CACAMO, M.D.*

IT IS GENERALLY AGREED that one major problem confronting the medical educator is the constant escalation of the amount of knowledge that the physician must assimilate if he is to function effectively. Because of the length of time that the medical curriculum requires for completion, and the additional time spent in internship and residency programs, it is patently inadvisable to think of lengthening the training period. As a result the medical educator is confronted by the dilemma of having to teach more in the already crowded time limits. In some quarters, the argument has been advanced that the medical training period should even be reduced. When this happens, the medical educator is faced with the problem of having to teach more in less time. If this problem is to be solved the most effective teaching and/or learning techniques will have to be developed and utilized. In this connection, it has been suggested that programmed instruction may make a significant contribution towards resolving the dilemma of the medical educator.

The authors were faced with the problem of developing techniques for making the internship in a community hospital as educationally sound as possible. In order to do this they were immediately confronted by the basic difference in the psychological climate that exists in the "intern or resident community" as contrasted with the attitudes of the medical school student body. The latter have a built in

*Edlen R[illegible]rch, 2111 Belmont Avenue, Youngstown, Ohio 44505.

motivation to learn the materials in the curriculum because failure to do so precludes the possibility of achieving the coveted M.D. degree that leads to a professional future. As a result, one can expect that regardless of the method employed the medical student will learn that which is required of him. This is not true of the intern or the resident who already has acquired the M.D. degree. Such a person must be motivated to want to learn as much as possible in a situation where the coercive climate of the classroom is all but non-existent. Moreover, since time is a real factor in his busy schedule, the teaching and/or learning techniques must stimulate him to make maximum use of his already crowded hours.

In attempting to arrive at a decision as to what methods to employ the authors reviewed several other studies concerned with learning effectiveness. They found a diversity of opinion with respect to the effectiveness of teaching methodology. One researcher stated, ". . . the most consistent finding appears to be that programmed instruction allows students to learn as much as more conventional methods, and in less time."(1) Conversely, Allender *et al* reported, "There is no evidence of significant difference in instructional effectiveness or efficiency between a standard and a programmed text written by the same author(s)."(2) However, Cheris and Cheris reported, "Programmed instruction in radiology leads to greater achievement by medical students than does a text presentation, both immediately after learning and following a delay. However, more efficient learning results from a text presentation."(3)

The lack of any concurrence with respect to the findings, coupled with the fact that all populations in the foregoing studies were medical students rather than graduate physicians, led the authors to consider the possibility that programmed instruction might be a valuable educational technique in the instructional program of the community hospital. Based on the literature it seemed possible, because programmed instruction is self-pacing, that self-learning might be a motivational stimulus that could affect the learners. Accordingly, it was decided to develop a program and to design an experiment for testing these hypotheses.

Development of the Program

The initial decision concerned the selection of the subject matter to be programmed. Diabetic Acidosis was selected for two reasons. First, because it was a limited rather than a broad area. This factor would make possible the preparation of a comprehensive program. Secondly, since programmed learning seeks to elicit terminal behavior, it was felt that the subject matter represented a valid choice, since the problem of Diabetic Acidosis is that of an acute clinical emergency. The physician in dealing with it must be certain of the accuracy of his diagnosis. He must also initiate adequate therapeutic measures to meet the needs of the patient. For these reasons we felt that the effectiveness of the program in effecting terminal behavior would be readily measurable.

Having arrived at this decision, the physicians involved in the project organized a "course" of instruction. This meant that they decided what should or should not be included in the material to be learned. The material was then passed on to an educator familiar with the technique of programming. When he had familiarized himself with the material, he constructed the preliminary program which was then studied by the physicians involved in the project. After some revision, the programmed text was sent to an authority on metabolic diseases who made some suggestions which were also incorporated into the program. At this point, an experiment was designed to test the efficacy of the programmed text and to determine whether it provided a more effective teaching instrument than the conventional text.

Procedure

The hospital interns and residents were *invited* to participate in the experiment. It was made very clear to them that no one would be offended if they chose not to participate. Moreover, some of the residents were in other specialties than internal medicine. However, medical residents were specifically excluded from participation.

Twenty-nine members of the staff indicated a willingness to participate. They were then divided into two groups. One group numbered fifteen and the other fourteen. Moreover, care was exercised not to weight the groups, so that they were similar with respect to the number of American and foreign graduates. Since most of the foreign graduates came from the same schools, it could be assumed that they had similar training. A pre-test was then administered to all the participants in the experiment. The tests were then surrendered to the authors with the understanding that the participants would not be told how they scored. They were also requested to make no effort to determine the accuracy of their responses until the experiment was concluded.

Programmed texts were then distributed to the fifteen members of group I. The other fourteen participants were instructed to study the subject in any conventional text available to them either in their personal libraries or in the hospital library. The participants were further instructed that whenever they had finished the materials they would take another test. The respondents were asked to keep a record of how much time they spent studying the subject and to note this on the re-test. However, they were not told that the re-test would be the same test, so that an accurate evaluation could be made concerning the relative effectiveness of the programmed text in comparison to that of the conventional texts. We also hoped that some data would be derived concerning the relative efficiency of the two methodologies.

Results

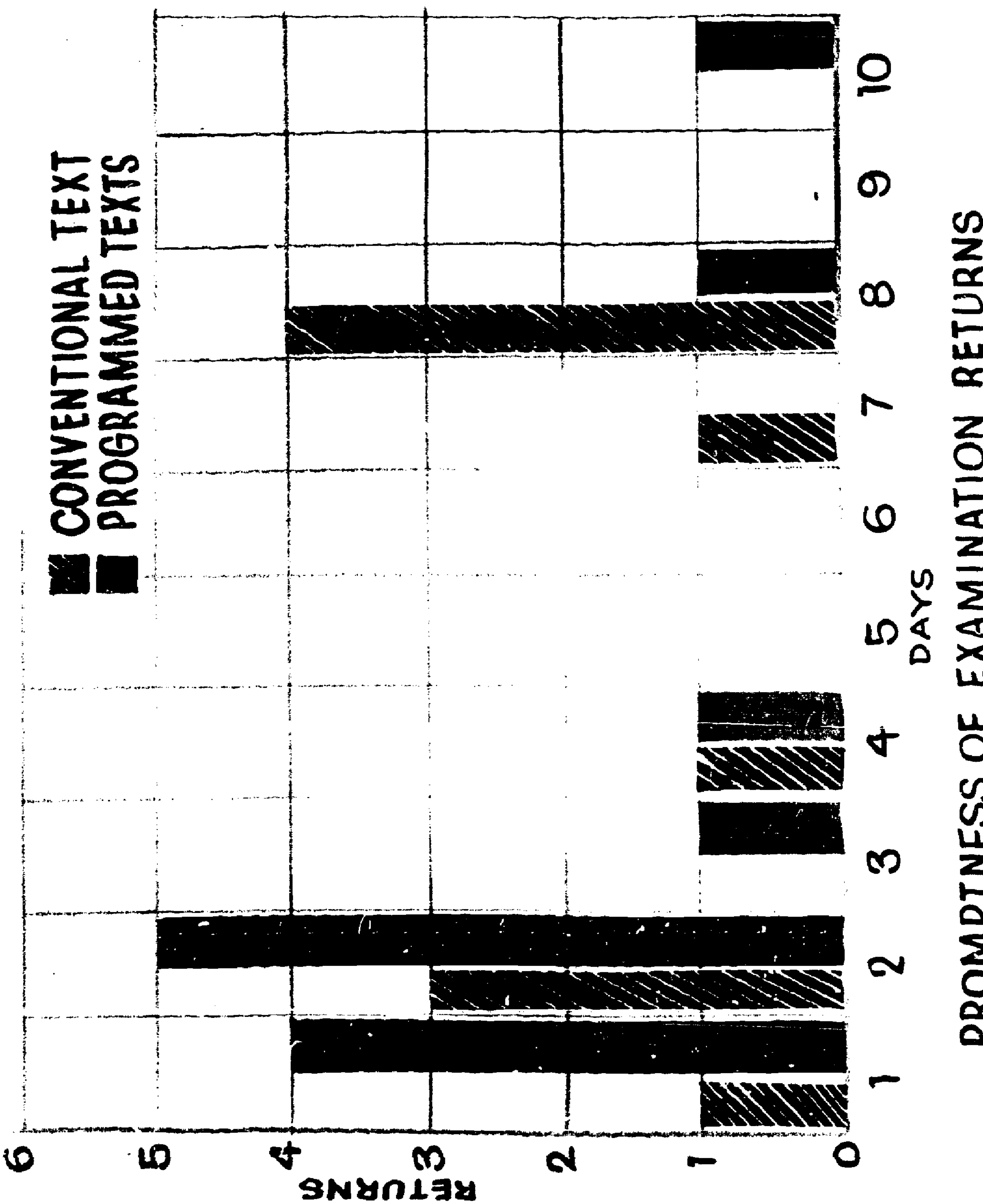
Twenty-nine participants began the experiment, however, only twenty-four were included in the final computation. (One potential participant had to be excluded from the group because the date when he completed the re-test was not recorded.) Four of the participants in the conventional text group never completed the re-test and one of the participants in the programmed text group did not complete the re-test.

The result of the pre-test showed that the two groups represented roughly equivalent populations since the error frequency for one group was 10.8 and the error frequency of the other was 11.2 out of a total of 42 answers. This does not constitute a significant difference. A comparison of the groups with respect to time spent in learning the material, revealed that the mean of the programmed text group was 4.1 hours, while the mean of the conventional group was 3.7 hours.

When the re-test was administered, several interesting factors emerged. Eleven re-tests were completed by members of the group using the programmed text within four days after receiving the text. In the same period of time, only five participants completed the materials and took the re-test in the conventional text group. (See figure I) Finally, error frequency was reduced by 72.6% in the programmed text group. However, in the conventional text group error frequency was reduced by only 41.6%. (See figure II).

Discussion

While an examination of the time spent in preparing for the re-test shows that the mean time was greater in the programmed text group


CONVENTIONAL TEXT
PROGRAMMED TEXTS
RETURNS
0
1
2
3
4
5
6
DAYS
1
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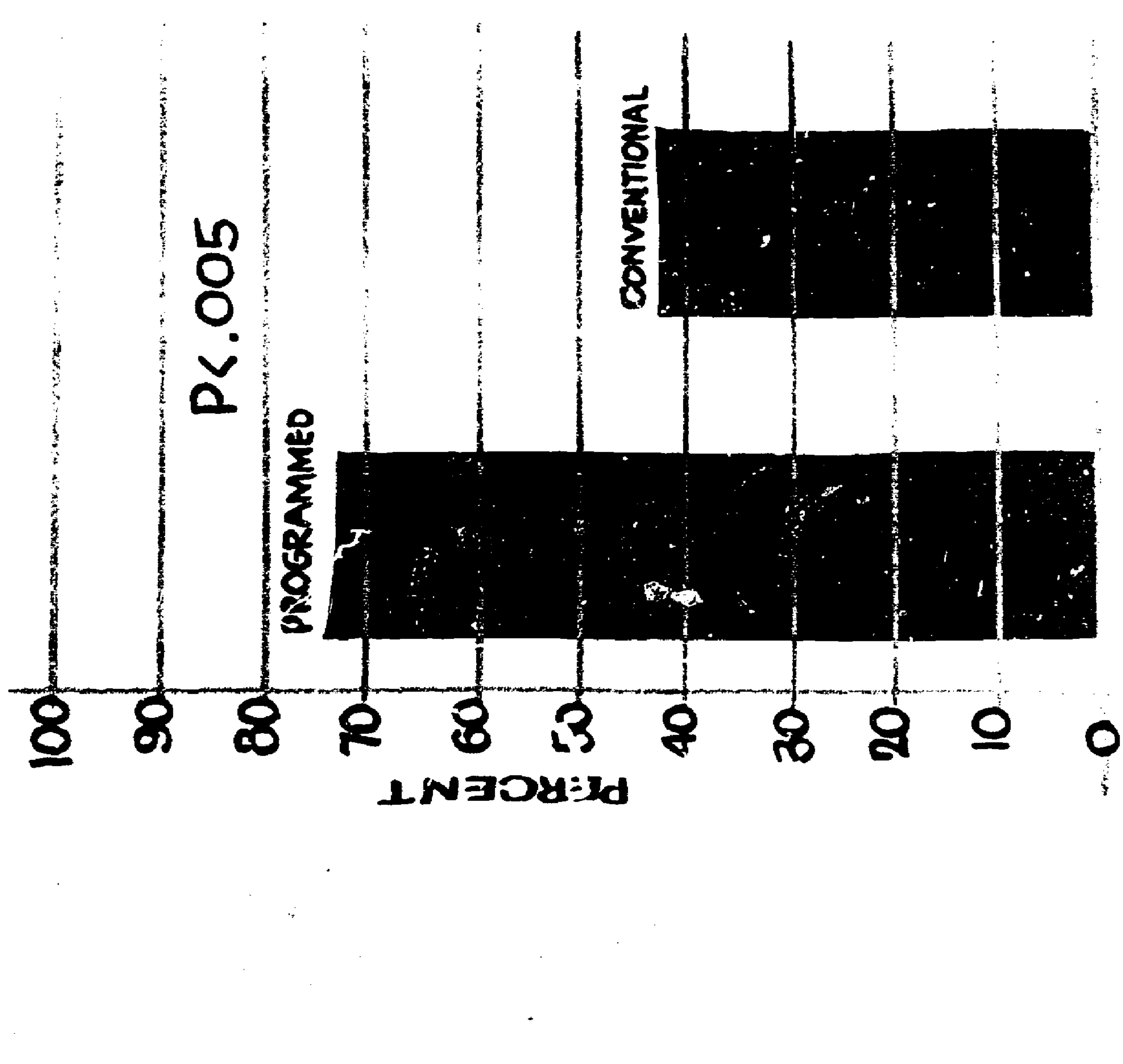
PROMPTNESS OF EXAMINATION RETURNS



PERCENT OF DECREASE IN FREQUENCY OF ERROR ON SAME EXAMINATION -- BEFORE & AFTER STUDY than among those using the conventional text, it should not therefore be concluded that the conventional text is in any way superior. It is actually somewhat misleading, because it must be considered in context with the other data which show that eleven out of fifteen persons, or 66.1%, using the programmed text completed the work and the pre-test in four days while only five out of fourteen persons, or 35.7%, using the conventional text completed the work leading to the re-test in the same period.

The above facts, coupled with the finding that four of the fourteen persons using the conventional text, or 28.6%, never completed the work and the re-test, while only one member of the group using the programmed text, or 6.1% did not complete the work and the re-test, lead the authors to feel that there may be a built in motivational stimulus in the programmed text, with its carefully ordered presentation of segments of the subject to be learned.

Finally, the difference in ratio of error frequency (72.6% in the programmed text group against 41.6% in the conventional text) leads the authors to the conclusion that the programmed text provides a superior vehicle for instruction than does the conventional text.

The authors are not suggesting that the programmed text is so effective a teaching instrument that it can replace the teacher. To the contrary, this study indicates that a well-prepared programmed text primarily affords the medical educator a better tool for his purpose than does the conventional text. The authors are firmly committed to the principle that the more modalities involved in the learning process, the greater the degree of reinforcement. It is this conviction that prompted them to prepare a taped lecture and a film strip to supplement the Diabetic Acidosis program. The lecture not only reinforces the text, but makes possible certain additional suggestions that might be difficult to include in the text, e.g. different approaches to therapy. We do feel strongly that the stimulus of a well prepared "program" makes it possible for the teacher to be freed from concentration upon basics that can be self-taught by means of a programmed text. To this foundation, he can add his own fund of knowledge and experience, thereby making his teaching much more effective and meaningful.

Conclusion

The programmed text takes longer to complete than the conventional text covering the same material, but the student is motivated to complete the work in less days than with a conventional text, thereby

making it possible to learn more in a given number of days. Students in this experiment using a programmed text reduced their frequency of error on re-test by 72.6% while those using the conventional text reduced their frequency of error by only 41.6%. Finally, it appears that the programmed text seems to have a built-in stimulus to learning for the student. This factor should be investigated by further study in order to determine whether the phenomenon holds true under varied circumstances.

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Experience with a Programmed Monograph on Cancer of the Colon and Rectum*

IRVING M. BUSH, M.D.**

IN OUR AGE of computers that "think" and space capsules that soar, endless attempts are being made to organize, systematize and "program" medical knowledge. Our command of what we should know and will be expected to know tomorrow continues to outpace all conventional methods of learning. As the medical educator today must impart more data with greater understanding in less time to more individuals than ever before, undergraduate and post-graduate students must be trained to conceptualize and integrate the newer ideas into their armamentarium as the only defense against inevitable obsolescence (1).

Medical educators over the past fifteen years have come to realize that these aims may only be achieved through a revision in the method and content of the traditional medical curriculum on all levels of medical education based on an increased awareness and understanding of the learning process (2). Realistic appraisals of the desired goals are at present being evaluated. In essence, this restatement of values and goals represents the antithesis of the traditional attitude of student responsibility for success or failure in the learning process. By merely postulating a concern with the how and why a given instructional modality either succeeds or fails in reaching its stated objectives, the burden of achievement is shifted from the learner to the teacher. With the realization that the manpower at the disposal of the

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**Department of Urology, Cook County Hospital and Hektoen Institute for Medical Research, Chicago, Illinois.

medical profession is not, in itself, a variable quantity, the quest for ways to develop this resource through the institution of more effective teaching techniques assumes even greater importance.

In conjunction with professional educators, educational psychologists and sociologists, the problems, objectives and methods of medical, pre- and post-graduate education have begun to be studied and clarified. While it is as yet too early to assess the over-all effect this will have, it appears that we are moving toward the formulation of a "new" theoretical statement which demands technologically modern methods for its implementation. Motion picture films, educational television, tape recorded lectures, programmed self-instruction, teaching machines and tutorial projection systems are but a few of the many techniques that have been and are being investigated (3). As programmed instruction is one of the youngest of these methods, it has been even more responsive to this burgeoning philosophy of medical education.

Caught up in this new teaching-learning methodology of programmed instruction, we began to hope for a new era. Programmed instruction would conserve the medical teacher's valuable time by effectively presenting didactic material, allowing him to spend more effort on relating basic knowledge to clinical problems. Auto-instructional techniques would also allow the student to use his decreasing time more efficiently since subject matter would be highly organized and logically presented. We reasoned, as others, that while the learner was able to study at his own pace, understanding and absorbing the succinctly presented information at each step, he would develop a problem-solving attitude rather than a skill for rote memory (4). Since the stimulus, response, reward, reinforcement method had produced increased "memory spans" in the laboratory (5), many believed the student's retention of learned actions would be enhanced. Developed to its ultimate parameter, computer supervised, programmed audio-visual branched, random access projection systems with self-testing and self-correcting features as are presently being developed at several institutions, could explore in depth any avenue of particular interest and in addition would be able to correlate with existing or newly developed motion picture films, slides, tapes, microscopic exercises or to the bedside itself (6).

Interest was not only expressed on an undergraduate medical level, but everyone began to think of applications in post-graduate study and review, nurses training, and patient education. Theorizing was not limited to national goals. It was postulated that programmed units on basic problems might have universal appeal. Simple machine versions and paperbound texts, adapted to the medical practice and languages of the individual countries might increase the exchange of medical knowledge on an international level and aid in spanning the information gap in developing countries (7).

Early Experimentation with Programs

With this background, the urology department of Memorial Hospital for Cancer and Allied Diseases, New York City, began to develop short urologic programs for use with or without teaching machines. We produced: two programs for teaching machines on pyelonephritis and one on the staging of bladder cancer; a linear program on genitourinary cancer for nurses; and a program on urinary cytology adapted to a standard Kodak Carousel Projector. Our experience with these programs was reported at the First Rochester Conference (8).

As experience in the field began to accumulate and more people became interested and concerned in a true evaluation of the method rather than with the newness, "gimmickry" or difference inapproach, it was realized that the construction of meaningful programmed learning units and modules was not as simple as initially thought. We soon discovered that the construction of a self-learning program, which once developed, might be more efficient (9), required the expenditure of a great if not an inordinate amount of concentrated effort, organization and planning. As neophyte medical programmers working by ourselves or with professional programmers, we found the defining of goal-actions, the atomization of ideas, the framing of pertinent questions, the structuring of quantity and quality controls, the logical rebuilding of the individual bits of information, and the constant use of new evaluative methods difficult, perplexing and frustrating. Though the producer of any successful book, journal, article or talk subconsciously or consciously predetermines what his purpose, audience, scope and mode of presentation will be prior to starting his endeavor, this new teaching technique demands, that before any writing activity begins, a clear, overt, integrated statement of all these variables must be formulated.

One by one, the problems were overcome and the program became available for evaluation. Initially, we became discouraged when the expected total educational miracle did not occur and students did not seem to learn significantly more with the newer techniques than with the more traditional methods. To a certain extent, this may be attributed to the basic nature of the medical student who can and does overcome any type of curriculum change (10). For the most part, however, it was due to our unfamiliarity with the technique; evaluating programs before adequate testing and rewriting; and lapses in communication between the programmer and the student. As revisions were made and experience gained, programming began to show some advantages. But, the question of the value of the increased effort when equated with the reward was still undecided.

Development of the Program

In 1963, a second revised edition of the highly successful American Cancer Society monograph, Cancer of the Colon and Rectum, by Frederick A. Coller and William J. Regan was published (11). It was felt that this well-written, well-illustrated 83-page booklet was admirably suited for adaptation to a self-instructional format. One of the rationales behind the venture was the idea that if an adequate programmed version could be developed, it might be an ideal situation to compare programmed and traditional presentations of the same information in a cancer field. Therefore, in 1964, under the stimulus of Doctor Roald Grant and an award from the American Cancer Society, the project was begun. The initial program was produced in conjunction with Doctor Beatriz Nava, G. Robin Elhert and the Educational Science Division of U. S. Industries. In order to have a valid comparison, it was decided that the program should not include any additional information or newer concepts not present in the original monograph. After several revisions, an initial testing program of 220 pages was completed early in 1965. It was mainly in branched format but used constructed responses and other forms of linear programming where the specific situation lent itself to this method of instruction. Since the first published form was multilithographed, many of the original color illustrations had to be temporarily deleted. Where this was the case, line drawings were substituted when feasible. Most of the x-rays, line drawings, and color pictures with definite contrasting colors were reproduced without difficulty. Of interest was the use of optional information tracks by which certain aspects of the program could be skipped, studied more intensively, or taken in different order at the discretion of the reader. In this way the programmed monograph became individually adapt-

TABLE I

Total Pretest Group

Test Group	Number	Score	Range
Interns	346	12.1	5-21
Residents	101	13.3	6-19
Generalists	57	7.5	4-14
Specialists	56	12.2	9-19

TABLE II

Intern Pretest Group

	Score	Gain
Pretest	12.3	
Repeat Pretest	12.55	+2%

able. In the final form, which will be discussed later, an additional rapid track was added which permitted the well-informed physician to quickly skim or review the presented information.

Conduct of the Study

The initial pretest, consisting of 25 key multiple choice questions taken from the monograph, was tested by 259 physicians: 160 interns, 43 residents and 56 specialists (surgeons, radiologists, internists and pathologists) from several New York and Chicago hospitals. After revising the pretest, 186 interns, 58 surgical residents and 57 practicing generalists were divided into two groups by a table of random numbers (12). One-half was given the pretest and the Coller and Regan traditional monograph and the other half was given the pretest and the programmed version. Table I shows the results of all pretest scores. Note the low score of the generalists.

It was desirable that the post-test cover exactly the same material as the pretest in order to determine whether there was any gain in knowledge due to the fact of having taken the examination twice. The initial pretest was given again, approximately three months later to 70 of the 160 interns who had originally taken it. The results, illustrated in Table II, revealed that there was essentially no gain in knowledge from repetition of the examination and it was deduced, perhaps erroneously, that the pretest could serve as an ideal post-test. Of the 301 physicians who entered the actual test group, 140 interns, 42 surgical residents and 31 practicing generalists finished the text or the monograph and took the post-test. In order to judge the comparative retention of the learned information, the research plan included an additional delayed post-test to be given three to six months later. Ninety-two interns, 16 surgical residents and 27 practicing generalists completed the full investigational protocol.

The 140 interns were volunteers from the 1965-66 and 1966-67 intern classes of Cook County Hospital. This group, by design, was divided into four sections of 35 interns each. Table III shows the pretest and post-test scores of the four sections. It demonstrates that the programmed groups did better than the readers of the original monograph. Ninety-two out of the 140 interns finished the delayed retention test protocol. Table IV, which has been adjusted to represent only these 92 interns, indicates that after three to six months the total gain of both groups was reduced. However, the programmed group still had slightly better scores. The results in the resident group

TABLE III

Initial Testing Intern Group

	Section	Pretest	Post-test	Gain
Monograph	I	12.8	17	+4.2
	II	12.5	16.4	+4.1
Program	III	13.1	20.7	+7.6
	IV	12.6	21.4	+9.2

TABLE IV

Retention Testing Intern Group

	Section	Pretest	Post-test	Delayed Test	Final Gain
Monograph	I	12.7	16.8	16.1	+3.5
	II	13.4	17.2	15.6	+2.2
					+3.1
Program	III	13.1	20.7	17	+3.9
	IV	12.9	20.5	17.4	+4.5
					+4.1

TABLE V

Initial Testing

Group	No.	Text	Pretest	Post-test	Gain
Surgical Residents	18	Monograph	13.7	18.4	+ 4.7
	24	Program	13.1	20.2	+ 7.1
Practicing Generalists	19	Monograph	8.1	18.4	+10.3
	12	Program	9.4	19.0	+9.6

TABLE VI

Retention Testing

Group	No.	Text	Pretest	Post-test	Delayed Test	Final Gain
Surgical	5	Monograph	13.5	18.1	17.4	+3.
Residents	11	Program	15.2	21.7	17.9	+2.7
Practicing	16	Monograph	8.5	18.6	14.2	+5.7
Generalists	11	Program	9.2	19.4	16.3	+7.1

TABLE VII

Tests Taken by Participating Physicians

Group	Pretest	Repeat Pretest	Post-test	Delayed Post-test
Interns	346	70	140	92
Residents	101		42	16
Generalists	57		31	27
Specialists	56			

(Tables V and VI) were similar to that of the interns, the programmed group doing better than the monograph group. However, the generalists initially did just as well, if not better, with the monograph. If all physicians participating in the experiment were tabulated (Table VII and VIII) the programmed version gave better results initially. Differences after three to six months were too small to be reliably evaluated.

In general, the physicians who were in the programmed group stated that the format gave them little difficulty. It was our impression that the physicians taking the program took slightly more time to finish. However, a constant comment was that when they finished they felt as if they had been through the material at least once correctly. The generalists, on the other hand, who were the most enthusiastic group, seemed to prove the point that where there is desire and motivation to learn, any acceptable method of presentation is adequate. Based on our testing experience, a fourth revision was completed and is undergoing production by the American Cancer Society for widespread distribution and testing.

Conclusions

1) A programmed version and a monograph on cancer of the colon and rectum have been tested and compared on three educational levels. 2) Though it would seem that the program was equally effective or possibly superior to the usual prose presentation, the test population did not score large enough for reliable statistical evaluation. 3) The presentation method of the program was not found to be cumbersome, even though students took slightly longer to complete it. 4) A fourth revised program will soon be published by the American Cancer Society. It is hoped that this program will be tested extensively by others as soon as it is available. 5) More programs will have to be developed, tested and evaluated under controlled conditions before any definitive opinions can be expressed about the extensive use of this modality. 6) Experience in this field has provoked great interest in the basics of medical education and has demonstrated that in those situations where the teacher and student accept responsibility maximum results are obtained.

ACKNOWLEDGMENTS

I wish to thank Robert J. Freeark, M. D. and Ronnie Beth Bush for their advice in the preparation of this study. I would also like to

TABLE VIII

Total Testing

Group	No.	Text	Pretest	Post-test	Delayed Test	Gain
All Physicians	107	Monograph	12.0	17.3		+5.3
	106	Program	12.5	20.6		+8.1
Physicians Finishing Protocol	62	Monograph	11.8	17.4	15.6	+3.8
	73	Program	12.7	20.6	17.1	+4.4

acknowledge my debt to Ann Marie Sundra and Genevieve M. Ebbers for their technical help.

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A Completed Psychiatric Program

JAMES L. MATHIS, M.D.*
CHESTER M. PIERCE, M.D.**
VLADIMIR PISHKIN, Ph.D.***

THE DEVELOPMENT of a program in Psychiatry may present unique problems in that many of its concepts are not concrete and subject to cross-validation. However, it is probable that most of the difficulties encountered will be present to some degree in all areas of programmed medical education. We previously reported in the First Rochester Conference on Programmed Instruction in Medical Education that at least three major difficulties appeared in our initial attempts to program psychiatric terminology (1). They were: 1) a very low inter-judge consensus as to the adequacy of standard definitions; 2) an inability of the programmers to decide upon the appropriateness of terms to be included; and 3) a resistance upon the part of students and residents in Psychiatry to the use of the programmed material.

The first two problems may vary considerably from one branch of medicine to the other. However, problem number three may be most common to all specialties, and it appeared to us to be related partly to the student's concept of his role in the educational system. It may be that he saw programmed instructions as an infringement upon his "free time," and that he also resisted a "do-it-yourself" departure from the usual student-instructor relationship. Students are dis-

*Assistant Professor, Department of Psychiatry, Neurology and Behavioral Sciences, University of Oklahoma School of Medicine, Oklahoma City, Oklahoma.
**Professor, Department of Psychiatry, Neurology and Behavioral Sciences, University of Oklahoma School of Medicine, Oklahoma City, Oklahoma and Chief, Research Psychiatry, Veterans Administration Hospital, Oklahoma City, Oklahoma.
***Professor, Department of Psychiatry, Neurology and Behavioral Sciences, University of Oklahoma School of Medicine and Chief Research Psychologist, Veterans Administration Hospital, Oklahoma City, Oklahoma.

comfited by a departure from traditional procedures, and residents may have resisted as a passive-aggressive method of expressing resentment to an authority who was adding to his already full schedule. There seemed to be, also, a general disinclination and fear to test one's knowledge against the supposedly impartially objective program. Some residents seemed to be more comfortable not knowing the extent of any academic deficiency.

A program of definitions was the originally designed research. It was thought that most students in psychiatry had initial trouble learning terminology and categories in which to conceptualize psychological medicine. Since the experiment required agreement by three investigators and three consulting professors of psychiatry, many important concepts were excluded from the final version because sufficient consensus could not be achieved. In fact only 174 definitions and terms out of 450 were able to survive this methodology.

The terms were then arranged from the least to the most difficult by giving them in examination form via a tape recorder to 87 Junior medical students who had completed at least 250 hours of traditional classroom instruction in basic psychiatry. Terms were ranked by percentage of students correctly identifying each item.

The last step in the research was when these terms were combined in this sequence with an outline of basic psychiatry which consisted of 77 double spaced pages. The outline was a prose text which attempted to focus on issues selected by the investigators to cover material deemed basic and essential for a student in mental health work. Ninety questions and statements were programmed from this outline so that it formed a continuum from personality theory through clinical syndromes. The complete Program therefore consisted of three parts: 1) 174 definitions, 2) a 77 page outline of Psychiatry, and 3) 90 programmed statements from the outline.

The next step was to test the embryonic program upon relatively unsophisticated students (2). Twenty-five volunteer Freshmen and Sophomores from a local seminary were asked to study the outline and to use the programmed sheets until they were 90% proficient in identifying the statements and concepts. This was to be done on their own time, and they were to record the number of hours necessary to reach this state of proficiency. At this time the definitions were not included because it was thought they might compromise the volunteers' time and that *per se* they might hamper enthusiasm. As it turned out the students spent the bulk of their study time looking up definitions. No seminarian completed the task to 90% efficiency. Time spent ranged from eight to twenty-five hours, with an average of 17.3 hours of study.

Testing was done by means of ten questions prepared by an examiner of the American Board of Psychiatry and Neurology. This examination was given to the volunteer seminarians and to the Junior medical students. A certified psychiatrist unconnected with the project in any way graded all examination papers without knowing the identity of any examinee. The seminarians made an average grade of 43.2%, and the third year medical students averaged 58.4%. One seminarian who used the program for only 17 hours made a grade of 82%; the highest medical student grade 78%.

The seminarians received no personal instruction from the authors; they were motivated only by the knowledge that they were aiding in an experiment. They had no clinical contacts. The medical students on the other hand, understood the test to be a routine examination over past clinical material. We felt that the results of this testing of the relatively crude program definitely justified further refinement and evaluation.

The entire program was revised. As upon previous evaluations, the number of errors and inaccuracies discovered was appalling. This finding has continued throughout the work upon the program, and it is obvious that the Law of Diminishing Returns takes over long before perfection can be achieved.

The revised program this time including all three parts, was given to 17 male Freshman college students and to two female secretaries with high school education who were working with the class (3). Over a period of six weeks each of the three investigators spent approximately 1½ hours with the entire group for a question and answer period. These students were then given the National Board Examination in Psychiatry even though the program contained no sections on psychology, neurology, neuropathology, E.E.G., or child psychiatry.

Only one of the volunteers studied the recommended 35 hours. Average time for use of the program was 12.3 hours, and the minimum time was three hours. The unadjusted grades from the National Board Examination ranged from a high of 77% to a low of 55%. The average was 61.1%. The secretary who passed the National Boards in Psychiatry with a grade of 77% had used the program for 12 hours. Adjustment of the grades to exclude the questions on material not included in the program for basic psychiatry (approximately 15% of the total) would have raised the grades considerably. As you know the National Board Examinations are constructed with much care. They are more comprehensive than instruments which most medical schools might develop individually. By statistical chance one could get only a 25% score.

We felt that the results justified a conclusion that programming was an effective and efficient method of presenting basic psychiatry to students unsophisticated in the behavioral sciences. Furthermore this material could be presented with a considerable reduction in time spent in teaching fundamentals of psychiatry.

As reported above, medical students had been used to measure the degree of difficulty for each item on the program of definitions and concepts. The results of this test were later re-evaluated to determine the validity of each of the 174 concepts finally chosen. Validity was interpreted to mean the correlation of the given item to the total programmed score. It was decided to determine if there were personality variables which affect student performance of programmed education.

MMPI scores, previously recorded on each of the students, were assessed to see if there was any relationship between individual performance on the program and personality factors as measured by tests. A similar correlation was made between the program scores and a battery of selected social attitude scales which had been administered to the students upon admission to medical school. Finally, the over-all standing of each student at the end of the last completed year of school was obtained and compared with the programmed performance. These studies showed that: a) There was a significant positive correlation between performance on the program and the over-all academic rank in the medical school; b) the students making the best scores on the program were most apt to show unconventional thinking, intellectual orientation, and a high level of drive according to the MMPI; and c) the students making the best scores on the program were most apt to show a lack of prejudice to minority groups and to have come from less authoritarian families.

These studies (4) hint that in the future personality attributes might be more closely considered in conducting programmed education. Refined research may indicate that content and timing of the courses should recognize personality variables. All learning would profit from such consideration of course, but programmed learning allows objective methods to be developed and connected to personality characteristics with more facility than can be done in traditional education.

The completed program in basic psychiatry is in the process of publication (5). We feel that it is an effective and efficient means of presenting basic psychiatry to beginning students in any field of behavioral science. We also suggest it as a quick review for more sophisticated students. Effectiveness, especially for those students without clinical exposure, could be markedly increased by seminars and/or case presentations by faculty members. This would appear to be a far more efficient use of curricular hours than many now devoted to lectures.

We found that the non-medical student volunteers were apt to use the seminar time in discussing material not specific to the program. Much time was spent in handling the anxieties which frequently arise in the study of emotional processes, and a considerable portion was spent talking about career opportunities and research progress in psychiatry. It occurred to the researchers that exposure to specific programs, along with access to role models, is a potentially valuable way to help recruit manpower into mental health professions.

The programmers had their psychological problems, also. We frequently found ourselves invested in certain concepts upon which there was not general agreement. One of us might feel a term was of major significance only to have it totally rejected by the others. This was especially noted in relationship to the major involvement of the programmer; research or clinical work. The old observation that total objectivity is difficult to achieve was reconfirmed!

Had we not been involved in a research design, we could have dispensed with many hours of work on the original terms and concepts. Elimination of the laborious attempts to reach inter-judge agreements would have saved not only time, but also would have prevented the exclusion of many terms of clinical value. Future programmers might profit from this experience.

The future of programming is unlimited. Our final form of an individual book can be adapted to audio-visual methods without great difficulty—and with an almost certain increase in effectiveness. The use of video-tape or movies to capture illustrative case material and combine it with the didactic program appears to be the ultimate goal. The basic material can be expanded to include the sub-specialties of psychiatry, and greater in-depth teaching can readily be obtained by detailed expansion of the clinical entities of psychoses, neuroses, organic brain syndromes, etc.

Multimedia programming can permit students to acquire, quickly, basic skills needed in order to move out into the wards and clinics. As yet, we don't know how much programmed psychiatric material is retained. However, both retention and motivation to learn are seemingly enhanced by any process that mobilizes the students more quickly to clinical responsibility. It is only with patients that the student can see what is "relevant." Programmed instruction will then become increasingly valuable as a review once the students begin to obtain "relevant" learning.

Summary

A completed program of psychiatry is in the publisher's office after almost four years of work by three authors, and with the assistance of several colleagues and many student volunteers. An enormous investment of time and hard work is necessary on the part of the programmers, and even then, it is improbable that they would ever be totally satisfied with the end result. As a method of communicating the basic concepts of psychiatry, the self-instructional program appears to be both effective and efficient.

Programmed instruction can be used to reduce the number of didactic classroom hours, thereby freeing faculty and student time for more pertinent small group interaction and clinical contacts. The program imparts facts; the curriculum time can then be used to increase understanding.

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Lactation—A Programmed Review

BRADFORD W. CLAXTON, B.Sc., M.Ed.*

A programmed course on lactation was prepared to aid student nurses in their study of lactation and its relationship to childbirth. The program was not intended as a basic course in endocrinology but rather as a review or refresher course on the mechanism of lactation for paramedical personnel.

The branching method of self-instruction was employed. The branching or re-cycling method allows for relatively large amounts of information to be incorporated into a single frame. The student is able to select the correct answer only if the information given in the learning frame has been mastered. If, on the other hand, the response is incorrect, the student is directed to another frame and given additional information to clarify the point under discussion. The more capable students who complete the course without error never see the repeat or clarifying frames.

The program in its final form consists of 47 frames, eight anatomical drawings, and two graphs.

Organization

In the first section the student is asked to name and locate the various endocrine glands before proceeding. The second section teaches the neural and physiological processes affecting lactation. Information is then presented on two theories concerning the cause of postpartum breast engorgement. Finally, preventive methods available to relieve breast engorgement are discussed.

*Professional Relations Department, The Wm. S. Merrell Company, Division of Richardson-Merrell Inc.

Field Evaluation

Two groups of third year nursing students were used to determine the teaching value of the programmed course. Group A consisted of 14 students; Group B, 15 students.

The program was administered to both groups immediately following a pre-test. In both cases the groups were proctored. The students were told the program was not a test but rather a method of instruction designed to aid their study. They were also instructed to take their time and move ahead at whatever speed suited them best.

The average time required to complete the course was 45 minutes. The fastest student completed the course in 28 minutes; the slowest, 57 minutes.

Administration of Tests

The students were given a pre-test to determine their prior knowledge of the subject. The results of the tests were also used to equate the two groups. Graph I depicts the cumulative distribution of the pre-test scores for groups A and B. As can be seen from the graph, the distributions appear comparable. The mean score of 71.4 and 73 respectively were not significantly different. ($p > 0.65$)

After completion of the program a test was given to evaluate performance. The students had not been informed that they would be given a post-test. The test was administered to Group A one week after completion of the program; Group B, three weeks after completion. The pre- and post-tests contained the same questions; however, the questions in the post-test were scrambled in an attempt to prevent cueing.

Analysis of Results

The post-test scores for Group A showed an average increase of 20.6 points, raising the average score from 71.4 to 92. Group B showed an average increase of 14 points, raising the average score from 73 to 87. (see Graph II)

In both groups the improvement was very pronounced:

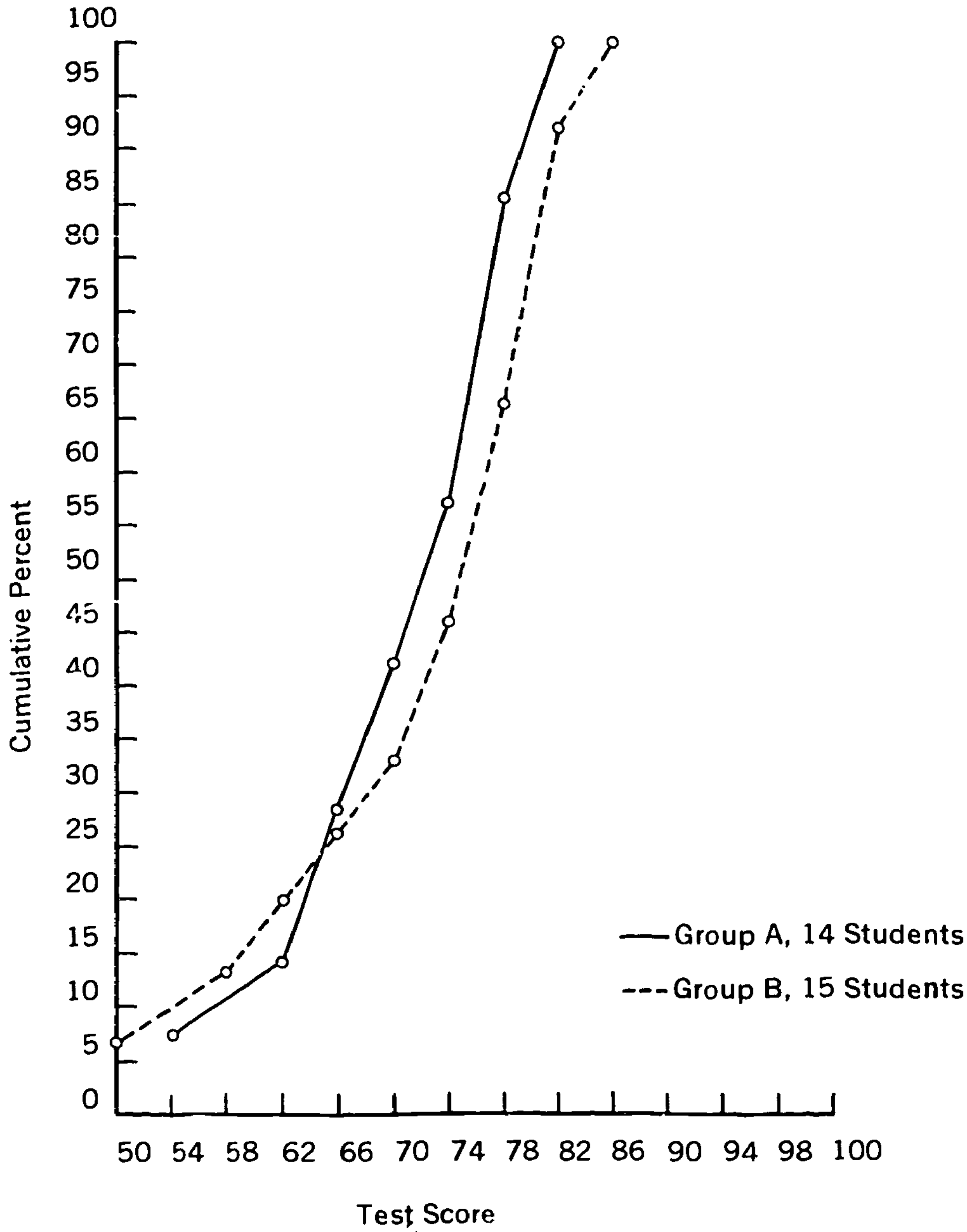
Group A ($t = 5.45$ based on 13 df)

Group B ($t = 5.01$ based on 14 df)

Initially it was thought that the difference in the post-test scores between Groups A and B could be attributed to a memory factor. However, no significant difference between the post-test means could be shown. The probability of seeing a decreased benefit of this nature could have occurred by chance alone $p > 16$.

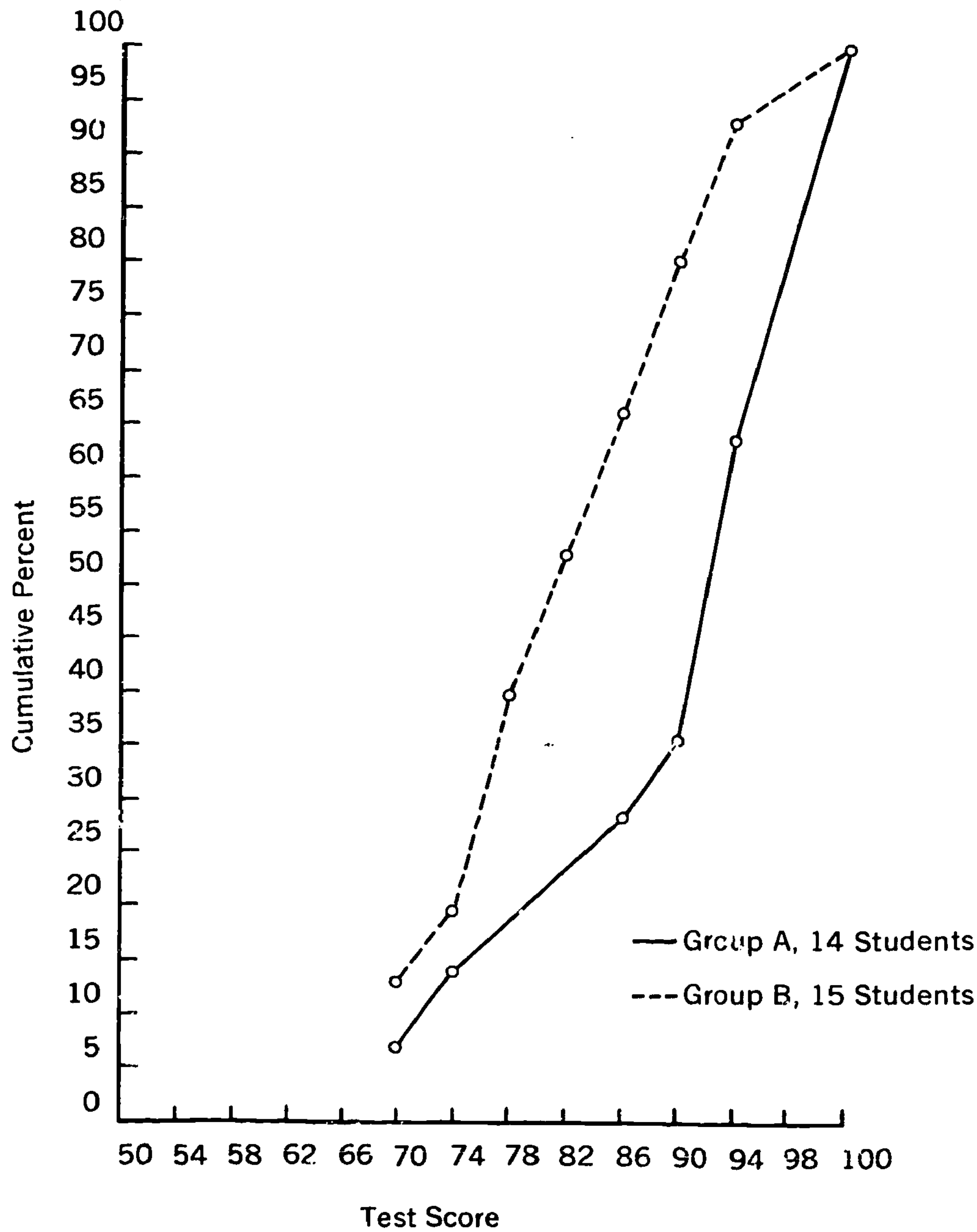
GRAPH I

SCORES FOR THIRD YEAR NURSING STUDENTS ON A TEST EVALUATING THEIR KNOWLEDGE OF LACTATION PRIOR TO ADMINISTRATION OF A PROGRAMMED COURSE ON LACTATION



GRAPH II

SCORES FOR THIRD YEAR NURSING STUDENTS ON A TEST EVALUATING LEARNING AND RETENTION OF A PROGRAMMED COURSE ON LACTATION



Discussion

While it cannot be shown that the post-test mean differed significantly between the two groups, a review of the observed scores reveals that five students in Group A obtained a maximum score of 100 on the post-test; whereas only one student in Group B scored at the maximum level. This could possibly be due to the relatively short time between pre- and post-tests for Group A.

In both groups the desired results, increased knowledge of the lactation processes, was pronounced.

Student Evaluation

Following administration of the programmed course the students were asked to complete an evaluation questionnaire.

Comments were overwhelmingly favorable, although a number of the students had criticism to offer. The comments, admittedly subjective measurements of student learning, indicated student attitude toward programmed instruction. Of the 29 students completing the evaluation questionaire 18 gave the program a top rating of 10; 7 a rating of 9. No student gave a rating below 7 on the 10 point scale. At this point reference should be made to the fact that only one of the 29 students had previously been exposed to programmed instruction. The newness of the technique, and the students' knowledge that they were being used as an experimental group, undoubtedly had a "halo" effect upon the evaluation scale.

A majority of the students (68%), in comparing programmed instruction with studying from textbooks, indicated that with the same amount of time and effort they learned much more from the programmed course.

The student comments also aided in identifying ambiguous frames, wording idiosyncrasies, and drawing discrepancies. The most frequent objection to the course as presented in its preliminary form was the random routing of frames. This caused confusion and in some cases the students lost their place. This was corrected in the final design and will be discussed under Graphics.

Graphics

One of the inadequacies of programmed instruction courses to date has been the lack of good graphics. Self-instruction courses that otherwise meet all the criteria of good programs (i.e. subject presented in small logical steps, active responding, immediate knowledge of results) (1) fail to present the program in an interesting and readable format. Researchers in advertising are constantly analyzing the effects of graphics on readership. Their studies show that pictures attract and hold attention more rapidly than words, and that type and size of print has a profound effect on the readers comprehension (2). Yet, very few of these findings have been applied to the layout and design of programmed instruction courses.

One of the most frequent criticisms of the lactation course as presented in its preliminary form was the random routing to frames from page to page. In four instances students reported losing their place. To over-come this inadequacy in the final design, only the right hand pages of the manual were used. The pages were numbered in the upper right corner in bold type one and one-half inches high. The open left hand page provides a restful area and functional space for illustrations used in conjunction with the learning frames. (see accompanying photograph)

No page carried more than three frames—the intent being to have the student refer to either the "top," "middle," or "bottom." To further aid the student, the frames were separated by red lines. Other important considerations in styling included the choice of non-glare paper, easy to read type, simple line illustrations, and functional use of color.

Summary

A programmed course designed to aid student nurses in their study of lactation has been developed. The program, utilizing the branching method, is organized into four sections consisting of 47 frames and 8 anatomical drawings. The program was tested on two comparable groups of nursing students. Follow-up tests indicated a pronounced improvement in learning. Student evaluation of the program was favorable. Ambiguous frames identified in preliminary testing were corrected in the final design. Major emphasis was given to the layout and design.

References

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Part III

Technology: Concept, Application, and Strategy

In the introductory paper of this section, Komoski traces the development of technology as an educational force and suggests a new view that should be taken toward its contribution. Fonkalsrud and Reine e discuss two new and promising ventures into the application of the computer—the highest present form of technology—to education. Wilds and Zachert in discussing the strategies for teaching inquiry simultaneously provide a model for a more complex application of technology to teaching in the kinds of decision matrices they suggest.

The Impact of Technology on Education

P. KENNETH KOMOSKI*

I HAVE been asked to talk to you about the impact of technology on education. It is my intention to articulate three distinct but related impacts of technology as they have affected and are now affecting education. The first of these is the broad, pervasive impact of what may be called "the world-making technologies" *on* education, the second is the narrower impact of the application of specific technological devices and concepts *to* education, and the third is the still largely unrealized impact of a growing technology *within* education.

The pervasive world-making force of newly emerged technologies in industry, agriculture, and medicine along with new developments in the technologies of energy, transportation, and communications made mass public education necessary and possible during the first half of the 19th Century. But the impact of these technologies on mass education also gave it that form which, for the most part, still pervasively affects most present day educational practice.

Today, new versions of the world-making technologies are simultaneously extending the limits of man's knowledge and reducing the limitations in form that 20th Century education has inherited from the technological forms and patterns of the last century. As a result, we are now being challenged to redefine our educational forms and re-design our teaching practices in order that they may effectively serve a world that is continually being remade by the force of these dynamic new technologies.

*President, Educational Products Information Institute for Educational Exchange, New York City.

All too often, this broad impact of technology *on* education is passed over in discussions of technology education which, rather short-sightedly, tend to center on the impact of various technological devices, concepts, and media, as applied *to* education. The mere application of these technological devices and processes to education fails to bring about any fundamental restructuring of out-moded, century-old technological forms which have so pervasively shaped 20th Century education. Moreover, until very recently we failed to see the need for an indigenous technology *within* education that might enable us to re-form the structure and patterns of education. This failure has, in turn, made it difficult to use potentially valuable technologies such as television and computers in ways other than those which conform to out-dated educational practice. For example, the broad but indirect impact of television *on* education has been far greater than the impact of television applied directly *to* education. In short, technologies applied *to* education tend to conform to existing patterns and practices rather than reform them.

This conference is convened to consider the development of new forms and practices within medical education. Much of this development will depend on what I am calling the growth of an indigenous technology *within* education. The potential impact of this technology stems not only from the promise that it will provide educators with tools and techniques that will make individually adaptive, highly flexible educational systems possible, but from the increasing probability that in the end such systems will provide the one truly economical form of education for a mass society that would remain democratic and pluralistic.

Thus, behind its promise, is the hope that through the nurture and artful use of this emerging educational technology we may rid education of the false economy of practices geared to managing mass responses within a mass society and transform it into the art of developing in each individual the ability to manage his own responsibilities within an increasingly massive society.

A Radical or Fundamental Meaning of the word "Technology"

In an effort to [illegible] these remarks [illegible] technology and education upon some common, if [illegible] rely familiar, ground, I would like to explain that my comments are made with a radical (in the sense of *root* or *fundamental)* meaning of the word "technology" in mind—a meaning to which both Scott Buchanan and Walter Ong have drawn attention in recent years. This radical or root meaning of technology is suggested by the fact that when the Greeks introduced the word technology or *technologia* into Western culture it was used to refer to the ordering of a particular bit of artistry in such a way that its make-up or functioning might be clearly understood and replicated by others, even though the originating artist might no longer be present. That is, if you want to understand something, make something similar. Thus, to the Greeks *technology* had to do with *techniques for logically* arranging an activity or function so that it could be systematically observed, understood (i.e., taught) and hence repeated in the absence of the person who had first done the arranging. Sometimes such an arrangement or ordering of a man's artistry had to do with a way of doing things, a process; frequently it took a more tangible form such as a mechanical device, a machine; in either case such artifacts (i.e., artfully made things) were an artist's or artisan's means of multiplying and spreading his effect.

If we allow ourselves to think of technology in this fundamental or radical sense, we can see, for instance, that the arrangement of thoughts that make up a computer program (and not just the computer, itself) is technology. The computer, like all machines, is a logical arrangement of thoughts designed to enable the computer to achieve a given purpose.

Thus, technology refers to any man-made device or process that may be analyzed, arranged, and systematically integrated for the purpose of producing a predictable result. Therefore, to the extent to which we, as educators, consciously analyze our tools and techniques, and logically arrange them into integrated systems in order to achieve educational purposes, we are contributing to the growth of technology within education. And when an individual educator systematically orders the elements of an environment such that learning is predictable, then he may be called an educational technologist. For an educational technologist is an educator who recognizes that his most fundamental function lies *in structuring* arrangements for learning—one who knows that the technology of *instructing* gives power to the art of education.

Let me pursue this important point a bit further. One does not become an educational technologist simply because one has learned to apply devices such as film projectors or teaching machines *to* an existing educational system. The use of such devices may qualify one as an audio visual technician or as an innovator, but not as an educational technologist in the radical sense. Today there are many innovative technicians in education—and, indeed, they fill an important role. But as technicians their activity is limited to the application of specific mechanical and electronic devices (i. e., the products of various technologies) *to* education and in doing so they have not produced any fundamental or radical restructuring of the traditional forms of learning. However, it does happen that traditional forms of teaching are sometimes restructured when technological devices are applied to education (the teacher may teach in a television studio instead of in the traditional classroom). Such restructuring of what the teacher does in order to apply a new technological medium *to* education does not necessarily mean that there has also been a restructuring of the process of learning as experienced by the student.

Unfortunately, too few of today's innovating technicians in education have been able to carry their activities beyond this type of essentially superficial application of other technologies *to* education. Too frequently these technicians become so caught up in the formidable technical problems of application, that they have neither time nor energy for the more fundamental, creative problem of what may be called *technological integration*. Consider for a moment our current concern for the "systems approach" to education.

Today the phrase "systems approach" is loosely used to describe any "system" for applying available devices and media (i.e., other technologies) to existing educational forms. However, the systems approach in its radical sense means a technologically integrated arrangement of teaching materials, equipment, teachers, techniques, and learners systematically interrelated to achieve a particular set of educational objectives. There are far too few qualified educational technologists to achieve such integration, and far too many unguided technicians leading us toward a continuing, fragmented application.

Put another way, there are very few technologically competent educators who are also creative enough to generate radically (i.e., fundamentally) different approaches to the systematic structuring of learning. To the contrary, there is an abundance of educators who consider education a creative enterprise and who practice education as an art. All too often these educators depreciate, and even abhor, technology's impact on education based on a frequently justified distaste for the helter skelter work of the technicians in education. As a result, in an age when musicians are extending the means of their rtistry to include new types of electronic devices and new forms of musical notation, and when practitioners of the medical arts are looking to such things as laser surgery, educators in an analogous sense, have barely begun to make use of the educational counterparts to the drum or scalpel, and still understand far too little about the principles of "orchestration" or effective "diagnosis."

There is a clear need today for educational practitioners who can contribute to the effective growth and management of technology *within* the art of education. In fact, one of the most important tasks ahead for our society is the development of educators who see and are capable of capitalizing on the potential of this growing technology. Since I assume one reason for your attending this conference is that you wish to increase the number of such persons in medical education, I will not belabor the importance of this need. Rather, I want to examine further the important relationships that exist among the three patterns: the broad, historical "impact of technology *on* education"; the narrower, more specific impact of particular technological devices and processes that have been applied *to* education; and the more recent attempts to harness the potential impact of this growing technology *within* education."

The Historical Impact of the World-Making Technologies on Education

As I have indicated, during the 19th Century, when the world-making technologies first began to shape the western world they created conditions which led not just to the possibility, but to the necessity of popular education; having done this, these technologies gave a then-appropriate form to the process of education, which is no longer appropriate for life in today's continually-in-the-remaking world. Let's examine this statement more closely.

Popular education in the 19th Century, was an urban invention born out of an urban need. First in England, and then later in this country, large "popular" or public schools became a necessity of city life because of, what one pioneer of popular schooling called, "the street urchins" who wandered about factory neighborhoods while mothers, fathers, and older brothers and sisters worked inside the factory from 14 to 16 hours a day. These large concentrations of factory-orphans, too young to work alongside their parents, were perhaps the first social by-product of the factory system that had brought together larger and larger groups of workers into towns and cities.

In the U. S., we like to think of our school system as stemming from "the little red school house" of a once agrarian society, and indeed our school year is still punctuated by the long summer vacation which was once necessitated by the need for hands, no matter how young, to help during the growing season on pre-mechanized farms. But before the 19th Century was very old the technologies of agriculture, steam-powered transportation, and manufacture had made us a country of cities with city schools. And it has been the practices and problems of city schools that have come to dominate the country's educational thinking. Of these problems the most ubiquitous was that of organizing and maintaining a standard quality of instruction for continually larger masses of students who were to be made into standard products of grammar school and later, of high school training. The history of 19th Century educational practice is a long quest for a solution to this problem.

The first schools designed to deal with this problem had appeared in mill towns around London by 1801. Of these the most famous were built by a social reformer turned educationist named Joseph Lancaster. The Lancastrian school typically was a very large single-roomed building housing up to 500 students with which Lancaster carried on a sort of instructional assembly-line. In the center of the building sat a "master teacher" on a raised platform. Around the walls of the room were located instructional stations each manned by what today would be called a "para-professional" who had been trained to teach as a specialist at any one of a small number of stations. Student groups progressed from one station to the next receiving highly routinized instruction in the Bible, reading, and arithmetic. There were "quality control" checkpoints built into the system; after a child had received instruction at a particular station, the master teacher could take him aside and test him. If he seemed to know what was to have been learned at that station he went on to the next; if not, he returned to his prior group. Graduations came individually any time a child had learned what the school had to teach. He then joined the rest of his family in the factory.

You can see, I'm sure, the elements of a 19th Century factory in Lancaster's school. Translated into industrial jargon, the system provided production-line instruction by means of a division of labor among specialized workers who could be used as interchangeable parts of Lancaster's instructional machinery. This is not to say that

Lancaster consciously modeled his school on the factory. Yet, the purpose of his school was, after all, to prepare children for work in factories and there was a need to prepare for that work as quickly as possible. Therefore Lancaster built a highly routinized, efficient instructional system that was designed to move the child swiftly through school and into routinized industrial work without delay. Whether it was a conscious achievement or not, Lancaster's school was a model of 19th Century technological efficiency.

During the rest of the 19th Century popular schools lost most of the individualization of instruction built into the Lancastrian school, and they came to concentrate more and more on teaching standard lessons in the "three R's" to diverse groups of individuals who were to be transformed into standard educated products taught in standard sized groups that could be appropriately "graded" into classes, not unlike the grading of raw material for industrial production. Where Lancaster had advocated maintaining good student behavior by the use of praise, token rewards, and "shame," many 19th Century schools used physical punishment to control students in the classroom in much the same way such punishment [illegible] used to control young workers in the factory. But if anything [illegible] loss of humaneness and allowance for individual progress, along with the increased routinization of instruction better prepared a child to join his elders in the factory than had Lancaster's earlier more liberal educational practices.

The Progressives—A Early Attempt to Re-Form Nineteenth Century Education

It was this deadening routinization and lack of individualization that stimulated Charles Pierce, John Dewey, and other end-of-the-century educational thinkers to call for a fundamental (i.e. radical) restructuring of educational forms and the invention of education practices that would free the development of the individual child. Dewey found many followers, but the majority of these followers were individuals who by temperament were unwilling to systematically analyze, operate, maintain, and improve upon Dewey's unstructured educational insights. In fact, they were as non-technological as the late 19th Century school has been non-individualistic. When it came to the need to generate an indigenous technology *within* education this blind spot, along with other factors, contributed to the failure of the so-called progressives in their attempts to re-form the standardized 19th Century mass education system which so strikingly paralleled the structure of the 19th Century system of standardized mass production.

But to have expected the progressives, who after all were vigorously trying to rid education of a surfeit of out-moded technological forms and practices, to have anticipated the potential of today's emergent technology *within* education would be to impute to the progressives a more radical conception of technology than any save Pierce and Dewey, themselves, probably possessed.

The few educators who did try to order their approach to teaching and learning into a system were at best split educational personalities with progressivism in their hearts and "scientific education" in their minds. But if their progressivism was unstructured, their "scientific" efforts tended to be little more than a conscientious translation of late 19th Century technological concepts with which they hoped to restructure education for life in the 20th Century. The origin of this thinking was the work of Fredrick Taylor, the founder of "scientific management," "time and motion studies," "job analysis," and scientific measurement of production," all of which were aimed at systematically arriving at *the one best way* of doing a particular thing. In education this meant an effort, for instance, to find the best way of teaching 9th grade algebra, first year French, or of building an entire curriculum. It stands today as one of the few examples of a conscious, direct, and wholesale application of increasingly efficient late 19th Century industrial processes to an education system already structured by early 19th Century technological forms.

However, during the years immediately preceding and following World War I the so-called "scientific curriculum" and "scientific measurement" and "management" movements, with their emphasis on "task analysis" and normative statistical evidence about "what children of a particular grade can and cannot be expected to do" probably mitigated some of the waste and harshness of traditional school practice. Nevertheless, most schools accepted the 19th Century technological premise that individuals were to adjust to the system or be rejected, (i.e. raw material that could not be efficiently processed was rejected for material of a more malleable, workable type). In short, 19th Century education had dealt with human resourcesmuch the way industrial technology and agricultural technology dealt with natural resources. Nineteenth Century industrial practice had a high tolerance of industrial wastes, civic eye-sores, and the mindless pollution of air and water; 19th Century educational practice had a similar tolerance for wasted human beings, who were just as mindlessly dumped into ghettos and onto the "other side of the tracks" in cities and towns across the country.

Twentieth Century Residuals of Nineteenth Century Technological-Educational "Efficiency"

Evidence of the pervasive impact of a no-longer appropriate 19th Century concept of efficiency on 20th Century education came when the Alpha Examination (the first nation-wide intelligence test) resulted in the rejection of thousands of draftees from military service in World War I. These men were the country's first identifiable dropouts (the fathers and grandfathers of today's hard core unemployed?) who had been rejected first by the existing educational system and then by the army.

Now, during the second half of the Century we are beginning to recognize that we cannot tolerate this kind of educational, social, and economic slippage and waste. We are learning that a society which is being constantly remade by new technological forces and forms must educate every individual if it is to remain democratic, and pluralistic. We are also learning that to do this means viewing education as an "investment" capable of releasing the potential growth of all of society's human capital, rather than a "trust" reserved for the more naturally or socially endowed members of the population. More than ever before, public education today means the education of every individual who seems to have the potential, interest, and motivation to learn any of the broad array of roles and skills that are constantly being created in our society by new technological developments.

If such a society would maintain its dynamism it can no longer retain educational forms, patterns and practices that lend themselves [illegible] the training of mass responses rather than individual responsibility and growth.

One does not have to look far for evidence that in medical education, as elsewhere in our schools, we are hampered by persistent, though inappropriate forms, patterns, practices, and attitudes which make it very difficult for us to restructure radically to fit education into the more dynamic emerging forms and practices of a world in the re-making.

We are now in a period where the professional educator is being asked to practice his art in a subtly, but profoundly different way; not

by concentrating on the design of improved teaching presentations, whether the traditional lecture or a modern multi-mediated version of it, but by basically shifting his role from that of presenter of knowledge to that of designer of learning systems whereby each individual student is able to learn as effectively as possible.

The Three-Sided Responsibility Upon Which the Successful Development of a Technology Within Education Depends

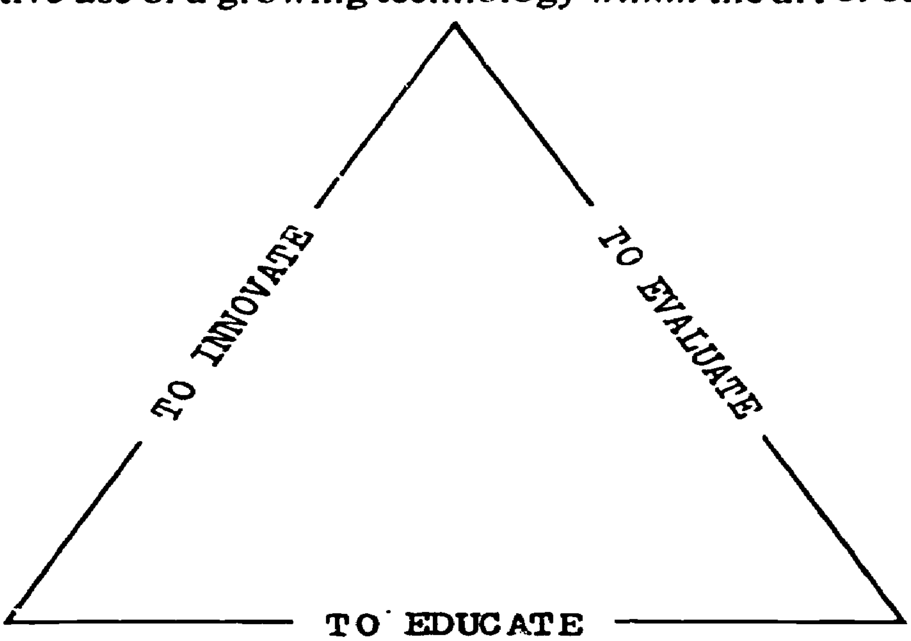
To make this shift the educator must see, first, that he not only has the responsibility to educate, but the responsibility to educate in radically new ways. He must innovate not simply by applying various available technological innovations *to* education, but by utilizing these emergent technologies *within* education to generate effectively integrated, highly adaptive, flexible environments for learning. And then, in order to further improve these accomplishments, the educator must evaluate. What I'm outlining here is what I've come to picture as a dynamic triangle (See Figure 1) of professional responsibility which society clearly has the right to expect from the educational community. The triangle's base represents the professional's fundamental, on-going responsibility—to educate. Its first side represents a new, 20th Century-generated responsibility; to question accepted on-going methods and, having done so, to innovate. Finally the third side represents the professional's increasingly critical responsibility to question his innovations, i.e. to evaluate every attempt to innovate by assessing the extent to which that innovation continues to possess the potential to advance significantly his basic on-going responsibility; *to educate*. If we as educators concern ourselves with this tri-partite responsibility there may indeed be a continuing growth of a technology *within* education.

This growing educational technology, like all technology, requires that the artist who would use it effectively first of all know what he wishes to accomplish by using it. Even here the emerging technology can be helpful by providing the educational artist with some of the intellectual tools necessary for translating intuition into a rational structuring of what's to be done. Once the educator has done this, the emerging technology *within* education can then offer him not "scientific" but, nevertheless, helpful empirical techniques for logically analyzing learning behavior as well as techniques to be used in structuring flexible and effective individualized, small group, and large group learning systems. "Learning systems" in which the devices and processes being used are not unrelated technologies applied *to* education, but ones which use evidence of a radically integrative force *within* education.

In Conclusion

I stated a moment ago that the responsibility to evaluate such learning systems is an increasingly critical one for the educational professional. In closing, I would add to this the thought that unless we develop better tools with which to evaluate the innovations that we discover through technology we will run an increasing risk of being overly influenced by: (a) educational zealots who will continue mindlessly to apply each new technology to essentially unreconstructed educational forms; (b) commercial salesmen who will encourage us to become zealots ourselves in an effort to keep us buying our way into today's educational "in group" called "the innovators"; (c) cultists for whom educational evaluation admits only "scientific" results, i.e., those arrived at by applying the technology of statistical measurement to education and who seem convinced that a report of "no significant statistical difference" means that nothing of educational significance has occurred. This is an intolerable destiny.

From now on our success as educators will turn increasingly on how well we manage the dynamic tension among our responsibilities to educate, to innovate, and to evaluate. It is by fulfilling this tripartite responsibility that individual educators and the educational profession, in general, can move with increasing confidence toward the productive use of a growing technology *within* the art of education.



Computer Assisted Instructional Entry and Exit Systems to an Information Center Data Bank*

ROBERT D. REINECKE, M.D.**

THE LAST DECADE has been an era of increased awareness of the problems inherent in medical education. This conference and others like it give open evidence of the serious thought that is being expended on the techniques and science of education. Programmed instruction and more recently computer assisted instruction (or CAI) are excellent examples of the successful introduction of new concepts which will probably be adopted to solve some of the pedagogical problems. Even if our success is overwhelming in the medical schools of this country, we must face up to the fact that medical knowledge is estimated to grow currently at the rate of nine per cent per year (1). The medical student often is not handed the latest information initially; this, coupled with the literature explosion, could create a serious individual void in five years, and a ten year void would be a most serious drawback to decent medical practice.

The time-honored solution to the literature explosion has been the perusal of libraries by the students, doctors, and others who need the

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**Howe Laboratory of Ophthalmology, Harvard Medical School, Massachusetts Eye & Ear Infirmary, 243 Charles Street, Boston, Massachusetts 02114.

material carefully stored there. However, a curious decrease in the use of libraries has come about at the very time when their use would seem most obvious (2). The size of the literature on any given topic often cows the most stalwart and makes any lesser personage almost run from the library in despair. The need for something more than libraries was brought to public attention by the "Weinberg Report" in 1963 (3). The report concluded that a "specialized information center" was the only apparent solution to the complex problem of information retrieval and processing. Pursuant to that conclusion, the National Institute of Neurological Diseases and Blindness of the National Institutes of Health has established a network of national information centers.

The field of vision was selected as an area which needed a specialized information center. One year ago a contract was made by NIH with Harvard to experiment with possible methods of effectively creating such an information center.

As we investigated information centers across the United States and read of those elsewhere (primarily in Russia), I became discouraged at the prospect of training information specialists to handle all queries which might come to such a clearinghouse. Even more discouraging was the prospect of replacing such people. Most of the operational information centers were composed of an isolated data bank which was only accessible to the information specialists and entirely dependent on their skills and expertise. An alternative to the present systems seemed a worthwhile goal.

Creation of a user accessible data bank with appropriate bibliographic material and facts seemed essential to any good information system. The problem was how a questioner might use the data bank without the necessity of going through a buffer, an information specialist. A form of programmed instruction presented by a computer, that is, computer assisted instruction, seemed a possible solution.

The basic problem became how to tie together an instructional system, a thesaurus, and a data bank. The solution has been an hierarchical thesaurus which is complete enough to encompass any descriptor which may be needed, either in the instructional mode or in the retrieval system.

Instructional Subject Matter Analysis

A recently completed linear program on Basic Ophthalmology (4) was used to evaluate the subject material's fit in the hierarchical thesaurus. All of the program was entered into the Coursewriter instructional language. The text of the course was run through a program to arrange every word in the program in alphabetical form. Such a sort enabled us to assure ourselves that the thesaurus was compatible with the instructional material.

During the experimentation we began to enter material into our data bank by utilizing the services of *Excerpta Medica* in Amsterdam. Our thesaurus is generated in such a fashion that only material in the data bank or instructional system is listed in the thesaurus. A weekly printout of the thesaurus in both hierarchical form and alphabetical form is obtained for use by our indexers and users.

Model Demonstration Program

A demonstration program was written to evaluate our concepts. The program consisted of a CAI course on an IBM 1401 computer system which did the following: first, the student was taught how to use the computer and console. This part of the program was short, easy to use and worked well. Following that, we told the student that only a limited amount of instructional material was available, but if he was interested in vision testing, pathological conditions of the eye, clinical anatomy of the eye, or diagnostic ophthalmological instruments he should so indicate by typing in the appropriate title. After the student had declared his interest and further defined that interest with several alternative subheadings, a short CAI program was given. At the termination of the program, such as one on amblyopia, the student is asked if he would like a list of the most recent appropriate references to this subject. If he indicated that he would, the references were typed out. (These references are on microfiche copy and available to the student.) After the reference listings, the student is asked if he would like to see the hierarchical arrangement of the thesaurus immediately about the subject under consideration. If he types "yes," he is shown the appropriate portion of the thesaurus on the display screen. If the student desires more references he can go to the data bank directly using the descriptor(s) which he feels is (are) most appropriate. Simultaneous descriptors will limit the drop-out from the data bank to those articles which are indexed as appropriate to the various terms in the thesaurus.

Present Data Bank

Our present system is not sufficiently sophisticated to allow the meshing of the data bank retrieval system with the CAI effort. The meshing will be done in the future as larger and more complex hardware and software become availabl In the interim we will use the CAI system as described and send the user to another console, which is coupled to an S.D.S. 940 computer. The 940 maintains our files in such a way that the student can enter the hierarchical number (or numbers) and obtain an immediate printout of the acquisition numbers of the appropriate articles. The articles are available to the user in the form of microfiche copy. If the drop-out is too large from the search, the user either adds descriptors or adds another figure to the right of the original term which makes the search more specific. If the user originally used the number A02 00 00 00 00 00 and found the drop-out too large he might decide that the appropriate material would be filed under *sella tursica*, rather than the initial heading which was Anatomy. He would enter the number A02 06 02 07 01 00 which would provide a smaller number of appropriate references. We will be able to program the volume to references which the user may specify as appropriate to his needs. If the drop-out is larger than the number he has indicated, the user will be given instructions as to how he may reduce the number of references in the drop-out. The reversal of the above would be carried out if the drop-out were too small. An alternative to being more or less specific in reference to a single descriptor will be to add or delete descriptors Such changes will reduce or enlarge the drop-out of the search.

Philosophy of the Instructional Mode

We hope to be able to have random access to every bit of CAI material in our system. Despite the random accessability, subject matter will be requested for which we will have no available instructional material. If we were the usual information center such queries would be handled by a person who would either look up the bit of information or call an expert who might know the information. We plan to answer the query in much the same manner, but the answer will be coded in the data bank in such fashion that at any time the same query is received again the response will be automatic and redundant effort will not be required. The more important aspect is that the later questioner would have an immediate response to his request.

The best instruction for a neophyte approaching a new problem is probably to go to the professor in that field who is a good instructor and a true expert on that particular subject. We would hope to simu-

GENERAL FLOW CHART VISION INFORMATION CENTER

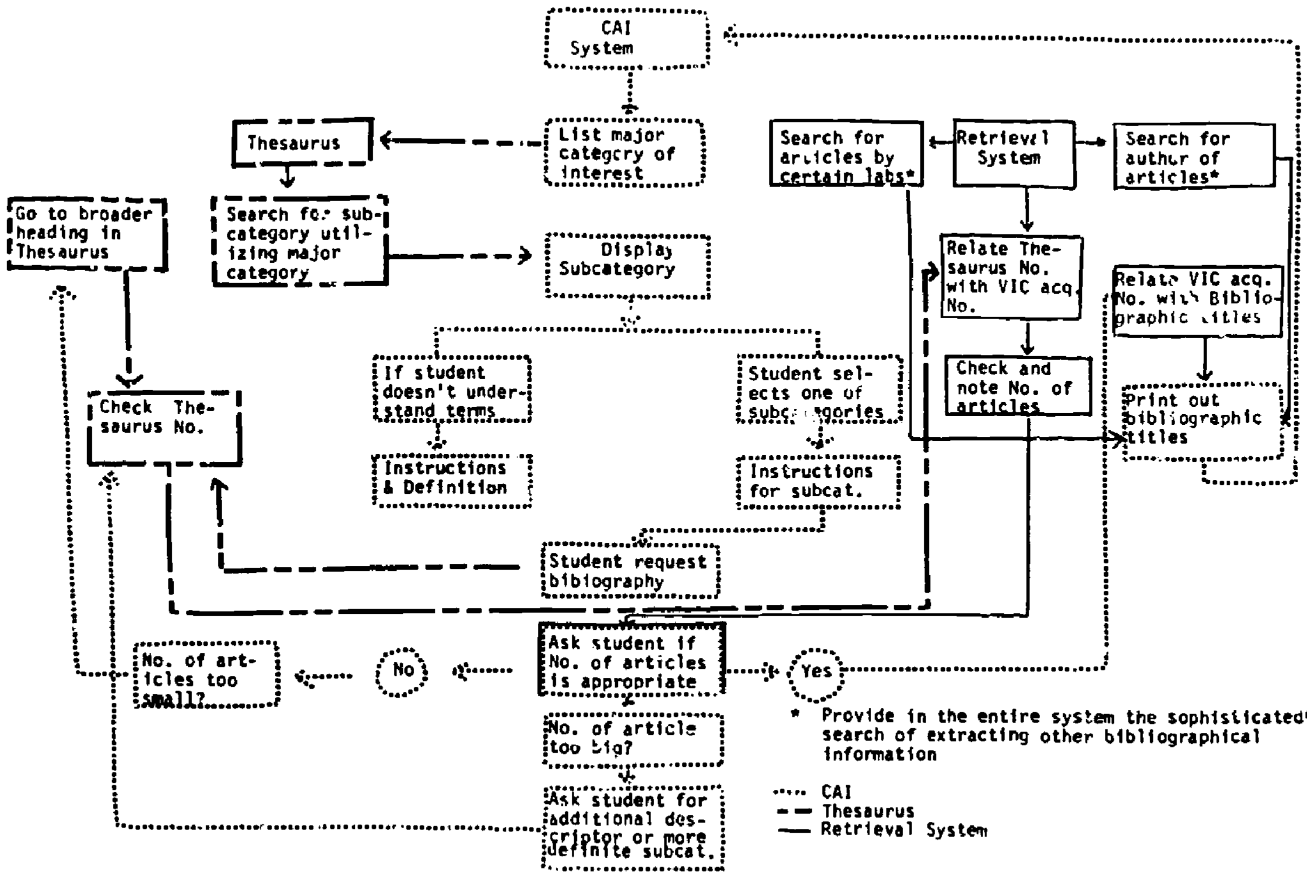

Table 1

Organizational and general flow chart for the vision information center - - - information retrieval and computer assisted instruction - - - random access.

late that kind of dialogue in such a fashion that the user at the computer could get a "feeling" for the new subject while learning the basic facts about the general subject of interest before attempting to ask for a detailed bibliography. Such a utopia will be some time in perfecting, but the end product justifies our efforts.

Comments

The present effort represents our continuing attempt to amalgamate retrieval systems with computer assisted instruction which actually represents automated programmed instruction. The joining of these two systems should provide a self instructional mode which has far greater depth than anything to date. The initial cost of this system will ultimately be justified by the wide-spread potential use of the system which could be used anywhere that a suitable console is available.

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Computer Assisted Instruction in Surgical Education of Medical Students*

ERIC W. FONKALSRUD, M.D., I. B. HAMMIDI, Ph.D., and JAMES V. MALONEY, JR., M.D.**

THE ESSENTIAL FEATURES of a good medical education consist of the acquisition of a vast quantity of factual knowledge and a broad exposure to patients, but perhaps of even more importance, the opportunity to develop judgment and the decision-making capacity necessary for good medical practice. The current methods of teaching surgery in the majority of medical schools may not adequately fulfill the last goal since students spend most of their time on the wards and in the operating room without the opportunity to develop and exercise their logic and decision making ability. In response to these shortcomings, a program of computer-assisted instruction (CAI) has been used to supplement the usual fourth year clerkship insurgery at the UCLA School of Medicine during the past year. This program presents the student with clinical cases and allows him to request laboratory studies, evaluate results, establish diagnoses and make decisions regarding treatment.

Methods

Forty students were individually taken to an IBM 1050 typewriter terminal located in the UCLA Hospital or to an IBM 2250 Graphic Display Unit located in the Health Sciences Computing Facility. The

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**From the Department of Surgery, UCLA School of Medicine, and IBM Scientific Center, Los Angeles, California 90024. Professor Fonkalsrud is the John and Mary R. Markle Scholar in Academic Medicine.

IBM 1050 terminal is connected by voice grade telephone lines to an IBM 1410 computer located at the Irvine Campus of the University of California which is approximately 100 miles distant (Fig. 1).

The computer presented the student serially with the brief histories and physical examinations from a series of clinical cases. The student was directed to proceed with a sequential evaluation of the patient in order to establish the correct diagnosis as efficiently as possible and then to recommend the most logical course of treatment. A numbered selection list (Fig. 2) was provided to the first group of 20 students to serve as a guide to possible requests which might be made to the computer. For the second group of students the accompanying technician kept the selection list and the student made spontaneous requests which were converted to appropriate numbers by the technician and entered on the terminal.

The student was encouraged to request laboratory studies from the computer which might assist in making a diagnosis. When blood counts, chemistries, or skin tests were requested, the results were given by the computer as they might be by the laboratory in the hospital. When roentgenograms were ordered, the films were given to the student and he was asked to interpret them for himself using a view box adjacent to the terminal. If a biopsy was requested, or tissue was excised, the student was given a slide and asked to develop his own histological diagnosis using a microscope. If the study requested was illogical, the computer responded correspondingly, e.g., if bronchograms were requested in an inappropriate situation the response might be "The radiologist does not believe that there is sufficient indication for this procedure at this time." In some situations in which the student made an inappropriate response, the computer cited a group of references concerning that particular laboratory study. The student was encouraged to make a clinical diagnosis as soon as he believed that adequate studies were available. If a diagnosis was entered on the computer before sufficient information was available, the student was reprimanded—"you do not have adequate information to make a diagnosis at this time."

Once the computer recognized the correct diagnosis, the student was requested to outline an appropriate course of therapy. When certain medications, e.g., antibiotics or digitalis, were recommended, the dosage schedule and indications were requested. When specific forms of treatment such as insertion of a chest tube were requested the student was asked to describe in detail how he would perform

SELECTION LIST

STUDIES

1. BLOOD COUNT
2. BRONCHOGRAMS
3. BRONCHOSCOPY
4. CARDIAC CATHETERIZATION (LEFT SIDE)
5. CARDIAC CATHETERIZATION (RIGHT SIDE)
6. CHEST X-RAYS
7. OLD CHEST X-RAYS
8. EKG
9. ESOPHAGRAM
10. EXPLORATORY THORACOTOMY
11. FOLLOW PATIENT WITHOUT STUDIES AT PRESENT TIME
12. FUNGUS COMPLEMENT FIXATION AND PRECIPITIN TESTS
13. MEASURE GASTRIC ACIDITY
14. GASTRIC WASHINGS
15. LAMINOGRAMS
16. LIVER AND RENAL FUNCTION TESTS
17. LUNG BIOPSY
18. LUNG SCAN
19. PULMONARY FUNCTION TESTS
20. SCALENE NODE BIOPSY
21. SERUM ELECTROLYTES AND BLOOD GAS STUDIES
22. SKIN TESTS
23. SPUTUM CULTURE
24. THORACENTESIS

DIAGNOSES

25. ADENOCARCINOMA OF LUNG
26. AORTIC STENOSIS
27. ATRIAL SEPTAL DEFECT
28. COARCTATION OF AORTA
29. DIAPHRAGMATIC HERNIA
30. EPIDERMOID CARCINOMA OF ESOPHAGUS
31. EPIDERMOID CARCINOMA OF LUNG
32. GRANULOMA (FUNGUS) OF LUNG
33. HAMARTOMA OF LUNG
34. HEMOTHORAX
35. HIATUS HERNIA
36. INSUFFICIENT INFORMATION AVAILABLE TO GIVE EXACT DIAGNOSIS
37. LUNG ABSCESS
38. LYE STRICTURE OF ESOPHAGUS
39. LYMPHOMA
40. MITRAL STENOSIS
41. PATENT DUCTUS ARTERIOSUS
42. PNEUMOTHORAX
43. PULMONARY EMBOLUS
44. RIB FRACTURE
45. TETRALOGY OF FALLOT
46. THYMOMA
47. TRACHEOESOPHAGEAL FISTULA
48. TUBERCULOMA OF LUNG
49. VENTRICULAR SEPTAL DEFECT

THERAPY

50. ACTINOMYCIN D
51. AMPHOTERICIN B
52. ANTACIDS
53. ANTIBIOTICS
54. BLALOCK TAUSSIG OPERATION
55. COMPLETE REPAIR OF DEFECT USING HEART LUNG MACHINE
56. COMPLETE REPAIR OF DEFECT WITHOUT USING HEART LUNG MACHINE
57. CREATION OF ATRIAL SEPTAL DEFECT
58. DIGITALIS
59. ENDOTRACHEAL TUBE
60. ESOPHAGEAL DILATATION
61. ESOPHAGEAL RESECTION
62. 5 FLUOROURACIL
63. HERNIORRHAPHY
64. I.N.H. OR P.A.S.
65. INSERTION OF CHEST TUBE
66. LOBECTOMY
67. MEDIAN STERNOTOMY AND EXCISION OF LESION
68. NASOGASTRIC TUBE
69. NO SURGICAL TREATMENT
70. PNEUMONECTOMY
71. POSITIVE PRESSURE RESPIRATOR
72. PULMONARY ARTERY BANDING
73. RADIOTHERAPY
74. SEGMENTAL RESECTION
75. THORACENTESIS
76. THORACOTOMY AND LOCAL EXCISION OF LESION
77. TRACHEOSTOMY
78. VINCRISTINE OR CYTOXAN

Figure 2.

the procedure.

Each student "treated" 2-4 patients in a one-hour session with the computer. The student was given his typewriter record which summarized all his conversation with the computer to serve as a work sheet. The following is an example of a portion of one student's dialogue with the computer:

COMPUTER: Patient 3. A 51-year-old man was driving his car when he was struck head-on by a truck. He did not lose consciousness but did complain of severe right chest pain and dyspnea when examined 5 minutes later. There were no apparent injuries to the extremities or head and no lacerations when he was examined in the Emergency Room 20 minutes later. The BP was 80/0, R 42 and P 132.
No breath sounds were heard over the right chest and the percussion note was resonant. The abdomen was moderately tender but bowel sounds were audible and there was minimal distention. Rectal examination revealed no unusual findings. Weak, but equal pulses were present in all extremities.
Proceed with your sequential workup to establish the correct diagnosis as efficiently as possible and recommend the most logical courses of treatment. Your answers should be concerned with the first 8 hours of management.

STUDENT: Get a chest x-ray.

COMPUTER: Place roentgenogram F on viewbox. What do you see?

STUDENT: Six rib fractures and a pneumothorax on the right.

COMPUTER: What else?

STUDENT: Fluid in the right chest.

COMPUTER: What would you do next?

STUDENT: Do a thoracentesis.

COMPUTER: Large quantities of air and 75 cc of blood were removed with subsequent slight decrease in respiratory effort.

STUDENT: Put in a chest tube.

COMPUTER: What might be more important first?

STUDENT: Start an i. v.

COMPUTER: What would you give?

STUDENT: Ringer's lactate or saline until blood was ready.

COMPUTER: Now put in the chest tube and be prepared to describe where the tube should be placed, th[illegible] technique of insertion, and the mechanics of three-bottle suction. What should you do next?

STUDENT: Do a tracheostomy.

COMPUTER: Explain why you would do this rather than insert an endotracheal tube. How will you stabilize the chest?

STUDENT: Use a positive pressure respirator.

COMPUTER: What would you do next?

STUDENT: Get an EKG.

COMPUTER: The EKG is normal.

STUDENT: Put in a nasogastric tube.

COMPUTER: Large amounts of air and 100 cc of gastric fluid were removed.

Discussion

Factual medical knowledge is now so extensive that only a small part of it can be taught in 4 years of medical school. In the future [illegible] struction may be largely oriented toward developing judgme[illegible] developing the techniques for continued learning, i.e., how to a[illegible] information, how to evaluate it properly, and how to apply it.

It has recently been realized that computers might be ideally suited to programmed instruction. They can accept and evaluate student responses quickly, can provide large branching capabilities, and in many ways provide greater flexibility than is possible with the linear programs of "teaching machines." The incorporation of visual information such as roentgenograms and slides for microscopic interpretation, challenges the student in other parameters of his medical knowledge. Subsequent discussion of the student-and-computer dialogue with a member of the surgery staff may direct the clinical teaching to the individual needs of the student.

The computer course in surgery is recommended only as a supplement in decision-making to the foundation of medical education, the lectures and reading that provide the factual information and the clinical experiences with patients.

Initial Program

The first cases were developed in COURSEWRITER (II), a pro-

TABLE I

A Subset of COURSEWRITER Instructions

NAME	CODE	RESULT
Question	QU	Type the following text on student's terminal and wait for student's input.
Type	TY	Type the following text on student's terminal.
Correct Answer	CA	Compare student's input to a stored text. If correct execute following statement, otherwise go to next CA.
Branch	BR	Go to location indicated.

TABLE II

Sample Program Using COURSEWRITER

TY		You are called to the newborn nursery to see an infant born 45 minutes ago who is now having severe difficulties with respirations. The mother's pregnancy was normal and the delivery was an uncomplicated elective low forceps. The birth weight was 7 lbs. 4 oz. There is severe nasal flaring. The R. is 72, P. is 164, T. is 36.6, and B.P. 84/. No breath sounds are heard over the left chest and only faint sounds are heard on the right. The heart sounds are heard more to the right than usual. The abdomen is soft and not distended.
QU	A1.	How should this patient be managed?
CA		Blood count
BR		A2
CA		Chest x-rays
BR		A3
.		
.		
.		
.		
	A2.	
TY		Hematocrit 46 per cent, Hemoglobin 15.3, WBC 9,200.
BR		A1
	A3.	
TY		See Roentgenogram F.
BR		A1
.		
.		
.		

gramming language by means of which the teacher directs the computer to present instructional material to a student and evaluate his responses (Fig. 3). A subset of COURSEWRITER is shown in Table I. Using these instructions a program is written as shown in Table II. Thus when the student requests to see the patient, he is given the summary record: "You are called to the newborn nursery . . ." The system then waits. If he enters the request "blood count," the response will be as indicated by the program, namely

STUDENT: Blood count.

COMPUTER: Hematocrit 46 per cent . . . and so on.

Five surgical cases are presently available under the system. Several observations have been made following our experience with COURSEWRITER to-date:

1. Following early experimentation, it became apparent that the logical structure of the surgical cases was almost identical. Consequently, a "kernel" program representing the logic structure was designed. The coding time was reduced to about one-third, since the kernel deck can be simply reproduced. Detailed checking out of the programs is greatly simplified by the kernel program since a thorough check on one of the cases indicates that the others are probably also checked. The program representing a new case is checked only for the items specific to it.
2. Entry of new programs and later revisions were found to be more efficient when done by cards at the central computing facility rather than on-line from the terminal.
3. The limited number of switches and counters and the limited computational capabilities of the language, restricted the design of the logic structure, although the existing capabilities were adequate to initiate the study and learn about the requirements of the application.
4. The system's response to a student's inquiry was generally acceptable.
5. Recovery from a malfunction of the computer meant that a student had to request the same case again, resulting in an unnecessary and possibly annoying repetition. This problem was partially solved by periodically printing out at the student's terminal a label which marked his progress through the program. When a malfunction occurred, the student restarted the case and then branched to the most recent label on his printout.

A second set was coded to experiment with a relatively new graphic

FIGURE 3

Language:	COURSEWRITER
Computer:	IBM 1410 (University of California, Irvine)
Terminal:	IBM 1050

FIGURE 4

Language:	FORTRAN (with GRAF)
Computer:	IBM S/360 (UCLA, Health Sciences Computing Facility)
Terminal:	IBM 2250 Graphic Display Unit

device and a new set of language statements (Fig. 4). Graphic Additions to FORTRAN (GRAF) (7) provide a FORTRAN user an easy way to address graphic consoles. The IBM 2250 Graphic Display Unit was evaluated in this teaching experiment. The unit consists of a cathode ray tube (CRT) on which computer-programmed graphic (points, straight lines) and alphanumeric (alphabetics, numerics and special symbols) information is displayed. A keyboard and a light pen provided the user with a means of entering and modifying computer information. The student was given the operating instructions (Fig. 5) on the terminal itself and he could display at will the various selection lists.

Figure 5

Operating Instructions as Displayed on the IBM 2250

```
DEPRESS FUNCTION KEY 1 TO DISPLAY PATIENT DESCRIPTION
DEPRESS FUNCTION KEY 2 TO DISPLAY STUDY SELECTION LIST
DEPRESS FUNCTION KEY 3 TO DISPLAY DIAGNOSIS SELECTION LIST
DEPRESS FUNCTION KEY 4 TO DISPLAY THERAPY SELECTION LIST
DEPRESS FUNCTION KEY 31 TO SIGN OFF
DEPRESS FUNCTION KEY 0 TO DISPLAY THESE INSTRUCTIONS AGAIN
```

FORTRAN, however, is not designed to manipulate character strings as required by this teaching program and consequently the coding of a surgical case is lengthy. The quick response on a CRT, however, does reduce appreciably the time needed to work through a case. Auxiliary hard copy, needed for later review with the instructor and for general evaluation of the program, was easily obtained on a line printer. The requirement for a more conveniently located "remote" terminal, however, prevented our frequent use of the device.

Responses from the students using this method indicate that use of a visual selection list is not acceptable since it biases the student and gives him unnecessary hints.

The general computational requirements of the clinical problem solving process entail several factors. First, a continuous natural language dialogue should be conducted between the student and the computer in such a way that the communication is natural, logical and meaningful. Such an interchange would require the existence or development of a program that would

1. Retrieve and print out appropriate stored or constructed responses on the basis of the results of the syntax analysis (5), and
2. Ultimately, perform a syntax analysis of the input string.

Second, one of the main attributes of a good dialogue is the ability of the computer not only to work at the pace of the student but also to adapt the instruction to the reaction of the student with a constant modification of the constructed responses depending on the student's progress and difficulties. This adaptive mode, in which neither the student nor the tutor is dominant (6), precludes the multiple choice device (machine or programmed text) proposed [illegible] which does not allow constructed responses. The so-called "computer-based right-wrong machine" (7) which compares student responses with correct responses and decides on the basis of the outcome which stimulus to display next, is also constrained by its inability to construct responses, although it does allow the student much more flexibility in determining the direction of the path taken. Such a mode can present remedial information on the recognition of an erroneous response, although it cannot be sure of selecting appropriate remedial work.

The problem of patient management requires a more general problem solving process (8, 9). The development of a program which allows a student to develop his clinical problem solving process by exploring branches of decision trees to whatever extent is needed, requires special capabilities in the computer terminal and the programming language. The determination of these special requirements are part of our current interest and research.

A typewriter terminal is an inefficient interface in a man-machine communication; it can slow a student's rate of work and potenital progress. Appropriate CAI terminals are necessary if full advantage is to be taken of the new technology. The following terminal capabilities would greatly enhance the flexibility of such a man-machine communication (10):

1. Remote access to a computer.
2. Keyboard and light pen input.
3. Output of computer-generated or computer controlled displays.

On the basis of some preliminary work with an experimental conversational language, APL/360, it would seem to be quite feasible to process a natural language input, thus eliminating the multiple-choice list (Fig. 6). The length and organization of the dictionary required, the degree of synonym classes provided and other transformations of the input all affect the response time of the system, which must remain "fast." Provision has to be made to edit the dictionary conveniently from a terminal by adding or deleting descriptors, creating or rearranging synonym classes, and so on. Also essential is the ability to create special routines and functions, expressed in a general programming language with string handling and logical trees processing capabilities.

Figure 6

Language:	APL
Computer:	IBM System/360 (IBM Research, Yorktown Heights, N.Y.)
Terminal:	IBM 1050

Summary

In an effort to improve current methods of surgical education in medical schools, a program of computer assisted instruction was initiated at the UCLA School of Medicine. The clerkship in surgery was supplemented with this program for 40 fourth year students in an attempt to develop their clinical decision-making ability. The student was presented by the computer with clinical cases for which he requested laboratory studies, evaluated results, and made decisions regarding treatment. An IBM 1050 computer and a graphic display unit (IBM 2250) were employed in the program which was expressed in COURSEWRITER language. Subsequent discussion of the student and computer dialogue with a member of the surgery staff provided an individual guide for instruction based on the specific needs of the student.

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Strategies for Teaching Comprehensiveness in Inquiry

PRESTON LEA WILDS, M.D.* and
VIRGINIA ZACHERT, Ph.D.*

MEDICAL STUDENTS during clinical clerkships and house officers during their internships and residencies work with real patients who confront them with real clinical problems. Whether they see patients in a broad medical field or a narrow clinical specialty, they are faced with problems in a random sequence. From the learner's standpoint, a random sequence of patients probably resembles a textbook with the pages and chapters in a random order. Certainly, learning takes place, but the cost in terms of frustration and inefficiency may be somewhat higher than necessary.

The person who is preparing programmed case materials has the opportunity to arrange his cases as he pleases. He may choose a random sequence, or he may even camouflage his efforts so that in the end, his carefully planned sequence appears to the learner as a random arrangement full of surprises.

Appropriate problem solving behavior requires the following attributes:

1. Comprehensiveness in the approach.
2. Responsiveness to new information as it evolves.
3. Selectiveness in the acquisition of further information.
4. Decisiveness, a willingness to take action on the basis of available information.

*From the Department of Obstetrics and Gynecology, Medical College of Georgia.
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The purpose of this presentation is to show how programmed cases can be arranged to encourage the learner to develop these attributes.

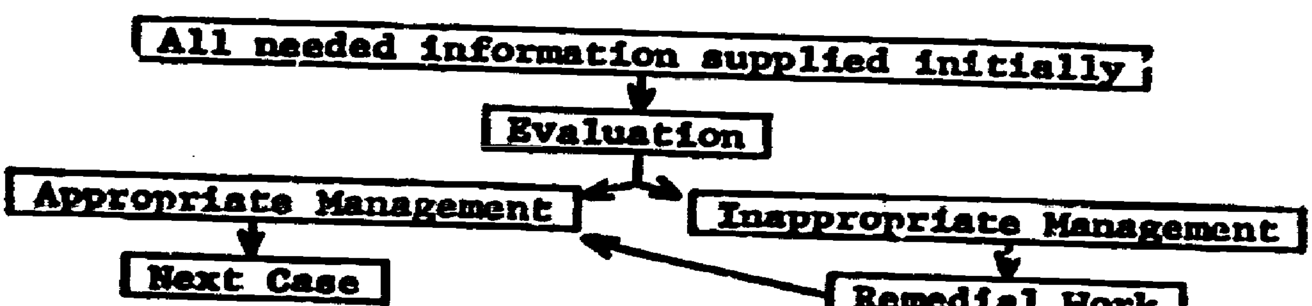
Clinical problem solving requires special skills in inquiry as well as in answer finding. It is appropriate to divide the teaching of these skills into separate phases. The divisions, however, are arbitrary and are useful only to illustrate the sequence in which new material may be introduced, phase by phase, In a completed sequence of programmed cases, the phases all overlap, run concurrently, and blend into each other with no clear distinctions.

Phases in Teaching Inquiry

Phase I. The first phase begins with the mathetic assumption that the proper place to start the learning process is at the end. Learners of clinical problem solving seem to be more interested in answers than in questions. "Don't confuse me with the facts, just tell me the answer; how do I handle the problem?" In teaching clinical problem solving by means of programmed instruction, the proper starting point is *problem resolution*, rather than inquiry. The students are asked to find answers for problems in which all the necessary information is supplied. This type of case presentation may be diagrammed as follows:

In effect, the student is asked, "Here is the problem, what is your answer?" This is the simplest type of case presentation since it is a single phase process. Within this framework, however, a series of

FIGURE I



PHASE I

DECISION WITH COMPLETE DATA

problems of increasing complexity can be developed. The student learns that appropriate management requires him to evaluate carefully all the information presented to him and relate this to his fund of medical knowledge. The initial protocol for the case can be brief, or it can present a detailed history and physical examination and large amounts of pertinent and irrelevant laboratory work, all of which the learner must evaluate critically before he can develop a plan of management, which also can be quite complicated. The simpler cases usually present only relevant information; more complicated ones mix the relevant information with the irrelevant. Therefore, in the first phase of the conditioning process, the student must distinguish between:

1. Relevant information
2. Irrelevant information

He must then take appropriate actions based on his evaluation of the relevant information. The change from short, simple problems to complex, sophisticated ones should be developed gradually over a series of case presentations so that the student is not caught by surprise and frustrated by a case which is too demanding for him.

Phase II. In the second phase of the conditioning process, he must learn to respond to the *absence* of pertinent information, which can be diagrammed like this:

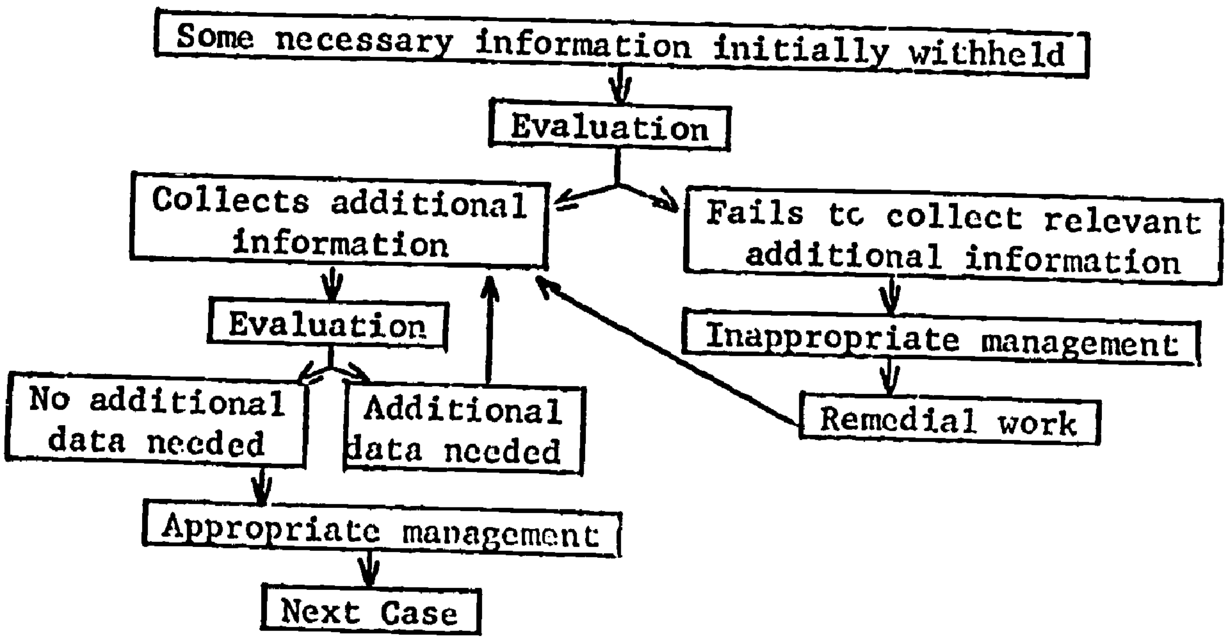
The learner must evaluate the information given him initially and then decide what additional information he needs in order to take appropriate action. The student must make three distinctions:

1. Relevant information
2. Irrelevant information
3. Missing information

Depending upon how the student has evaluated the information given him initially, the missing information he collects from the data gathering sections of programmed cases may be relevant or irrelevant. If he collects and evaluates relevant information, he may proceed rapidly toward a solution for the problem. If he flounders helplessly in the collection of irrelevancies, it becomes apparent that he has not yet learned to distinguish the relevant from the irrelevant and he needs additional or remedial work at the first phase level.

Phase III. At the end of the second phase, the student should have learned how much, and what additional, information he needs to define a problem with the precision necessary for appropriate management. In the third phase of the conditioning process, the student is

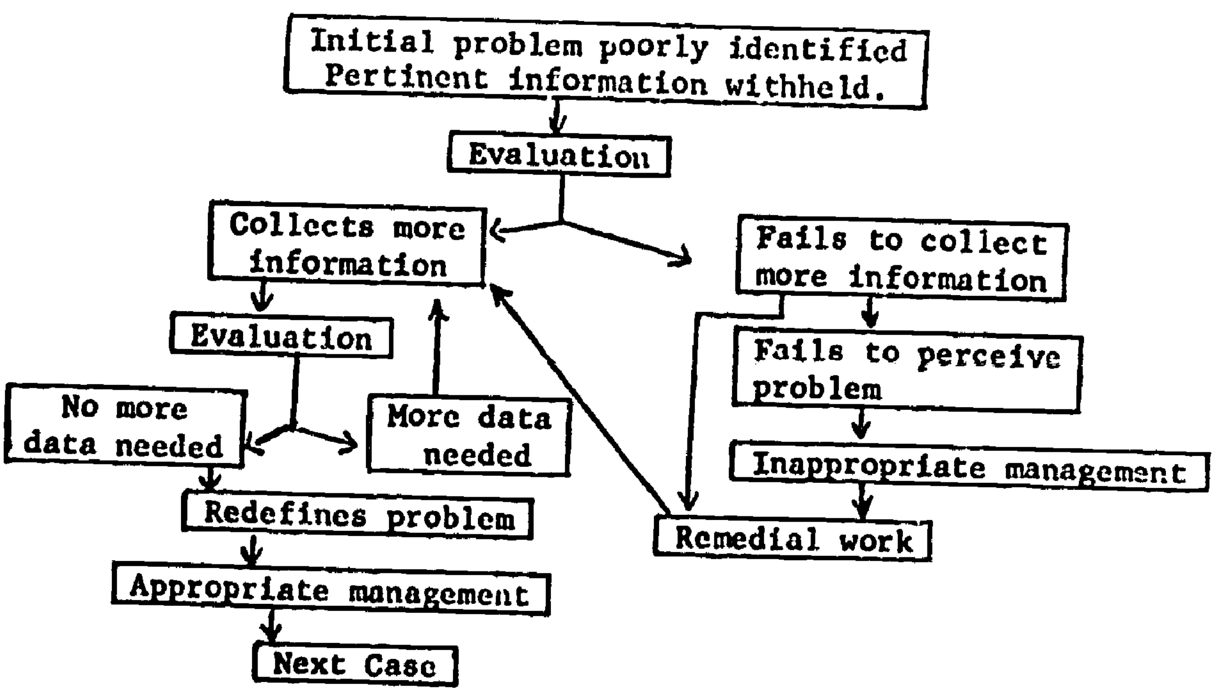
FIGURE 2



PHASE II

DISCOVERY OF ABSENT INFORMATION

FIGURE 3



PHASE III DEFINING THE PROBLEM

now asked to identify or discover the problem. The process may be diagrammed like this:

Initially the patient's difficulties are poorly identified or concealed altogether. The learner, in developing his habits of inquiry, must add another category to his discriminations:

1. Relevant information
2. Irrelevant information
3. Missing information
4. Survey information

He is asked to make use of appropriate portions of history, physical examination, and laboratory work in looking for problems which initially may be unsuspected. He is asked to develop habits of obtaining survey or screening information and also to develop responsiveness to positive findings from his survey. He must follow up each lead and modify his plan of management for the patient in accordance with his findings. At the conclusion of this third phase of the process, the student should recognize that the patient's initial statement of the problem is only a starting point for investigation, and may represent only a small portion of the problem which must be recognized, defined and resolved.

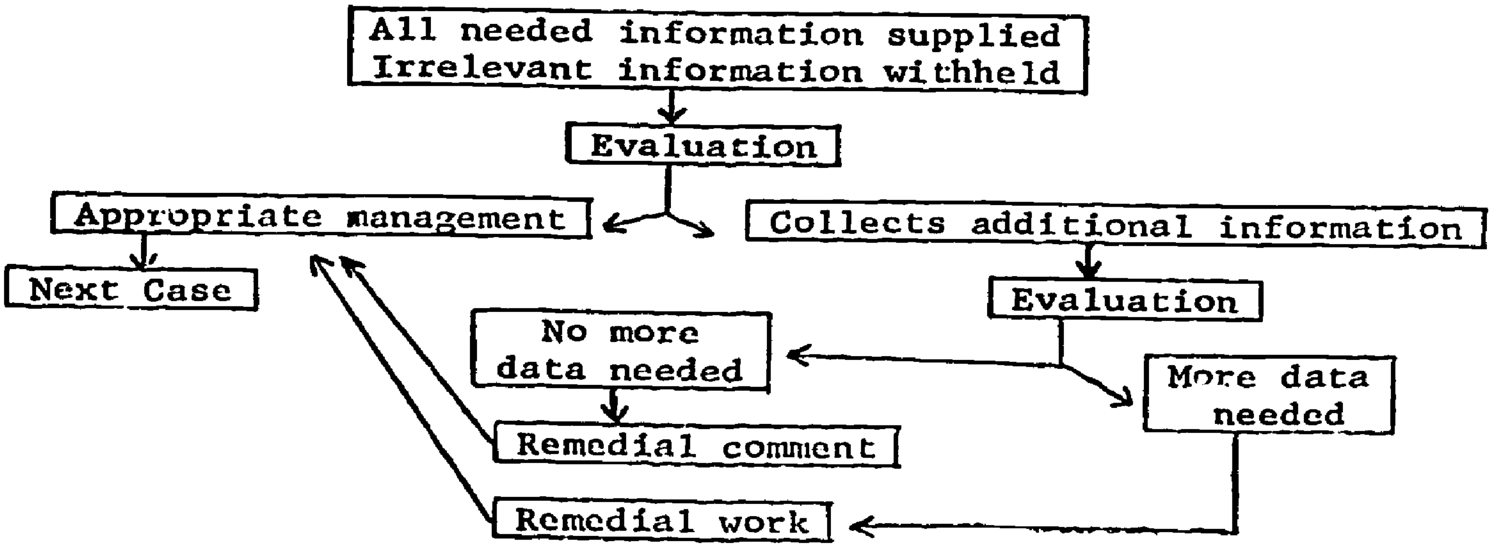
The three strategies, Phases I, II and III, for teaching inquiry that have thus far been discussed all tend to emphasize the need for responsible, comprehensive information-gathering and tend to de-emphasize the importance of efficient, decisive action in patient management.

Phase IV. If all programmed cases went no farther than Phase III, they would give the false impression that the ideal clinician is invariably an obsessive-compulsive information collector. Certainly there are times when this kind of behavior is appropriate. There are other times, however, when compulsive information-gathering must be bypassed in favor of decisive action. This can be diagrammed as follows:

In effect, the student is asked, "Can you recognize immediately how much information is enough, or must you waste time and effort in collecting unnecessary information?" Cases designed to teach this discrimination have the same essential structure as the simple puzzle solving cases in Phase I; in addition, they carry as unnecessary baggage the data gathering frames added in Phases II and III to give practice in the art of inquiry.

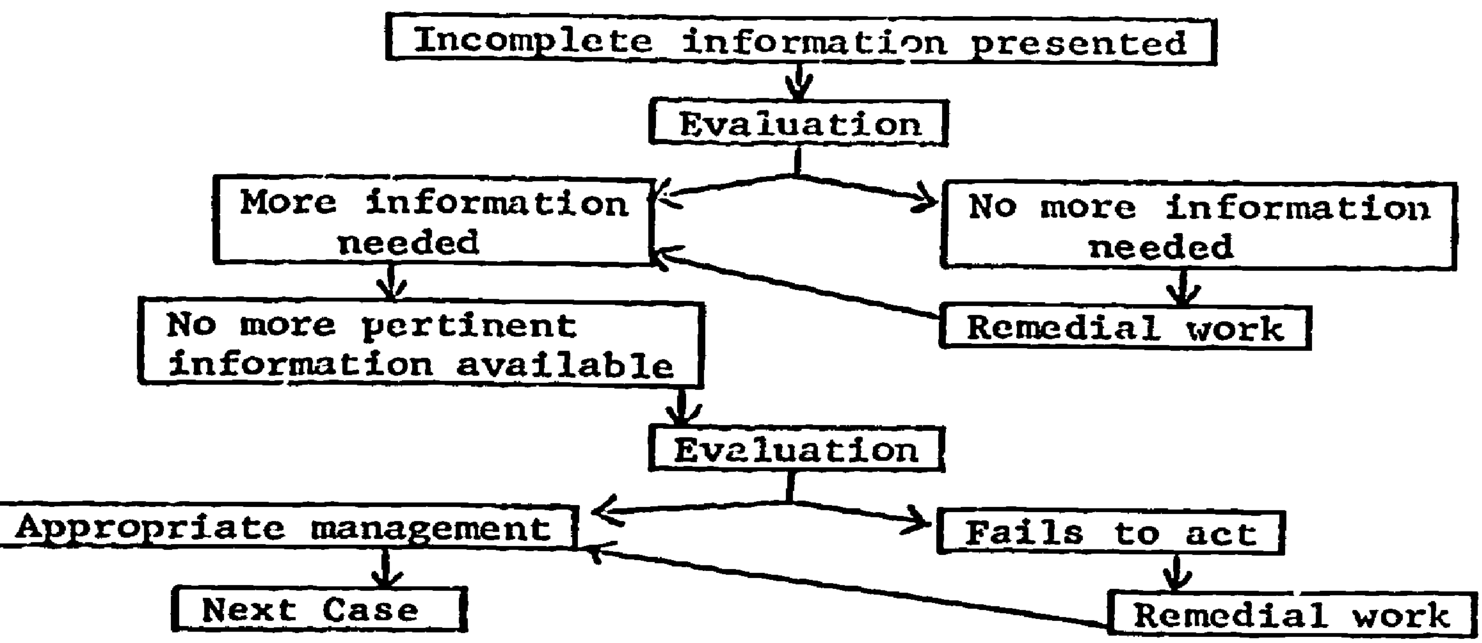
Phase V. At this point the student should have become adept at evaluating the completeness and relevance of the information he

FIGURE 4



PHASE IV

FIGURE 5



PHASE V

DECISIVE ACTION WHEN INQUIRY IS FRUSTRATED needs to investigate the patient's difficulties. In many clinical problems, however, action must be taken on the basis of incomplete information. The learner must learn to make vital decisions based on probability estimates which in some instances must be based upon very inadequate information. Up to now, most of the conditioning has moved in the direction of requiring him to be comprehensive, responsive, and selective in his collection of information, and yet he must also learn to be decisive when information he needs is unavailable to him. This is diagrammed like this:

Here the question seems to be, "Can you take action in the patient's interest and accept responsibility for uncertainties which you have been unable to evaluate?" A series of cases in this category is designed to teach the student to look at the information he has, not only from the standpoint of completeness and certainty, but also to recognize instances where the need for decision-making requires action in spite of incompleteness and uncertainty. In short, when inquiry has been frustrated, can the student resolve the problem anyhow?

Emphasis On Inquiry Training

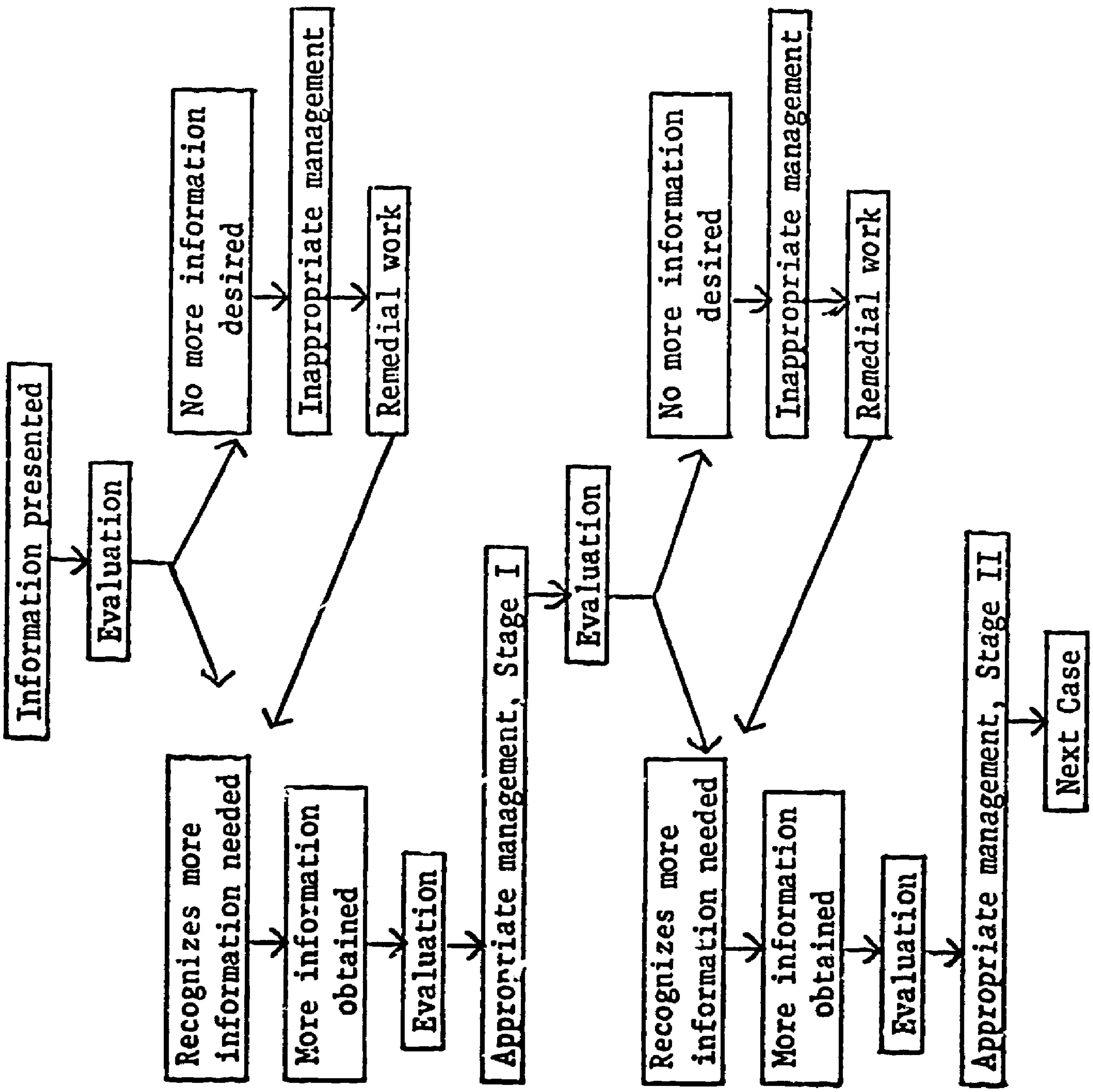
Programmed case materials designed for undergraduate medical students tend to emphasize the development of *skills* in *inquiry* and *diagnosis*, rather than *skills* in *therapy*. This emphasis may be appropriate in helping to correct the de-emphasis of inquiry in the medical school curriculum. In conventional teaching, even when the case study method is used, as in rounds, clinicopathological conferences, etc., the participation of students in learning is limited to the Phase I level. Furthermore, conventional methods of testing tend to ignore the art of inquiry altogether. These deficiencies in the curriculum may have a bearing on the findings of Peterson (1) and Clute (2) who noted that the most striking deficiency of physicians in general practice was their inadequacy of inquiry, their failure to obtain essential information from history, physical examination and laboratory work.

Management Training

The political usefulness of programmed cases in teaching a wide spectrum of inquiry skills is still largely unexplored. The teaching of management skills, like the teaching of inquiry skills, requires similar explorations. Undoubtedly, it can be divided into phases. A two-stage management problem could be diagrammed like this:

In this illustration, the student, after completing the usual stages of

FIGURE 6


Information presented
Evaluation
No more information desired
Inappropriate management
Remedial work
Recognizes more information needed
More information obtained
Evaluation
Appropriate management, Stage I
Evaluation
No more information desired
Inappropriate management
Remedial work
Recognizes more information needed
More information obtained
Evaluation
Appropriate management, Stage II
Next Case

inquiry, is asked to formulate therapeutic trials. Each stage of management requires the collection and evaluation of further information before the next stage in management can be formulated appropriately.

Once case presentations reach this point of complexity, the possible branches and ramifications of management problems are endless, especially if cases are programmed for computer presentation rather than simple paper and pencil formats. Technologies have been developed to permit the programmed presentation of the most complex problems, and strategies of programmed instruction are available to teach almost any desired pattern of problem-solving behavior, from "shooting from the hip," to information-gathering. The limiting factors are human and require that the teacher and the student work together. "What do you want him to learn?" "How far into this jungle will he travel in order to learn it?"

Summary

Students of problem-solving can learn to be comprehensive, responsive, selective, and decisive through practice in solving problems. The types of problems requiring inquiry can be classified and presented in the following sequence:

Phase I—All information supplied initially.

Phase III—Some necessary information initially withheld.

Phase III—Initial problem mis-identified and pertinent information withheld.

Phase IV—All needed information supplied; irrelevant information withheld.

Phase V—Essential information presented; desirable additional information unavailable.

A programmed approach permits the student to practice the solving of a wide variety of problems which require inquiry. This variety is not available to the student with conventional group instruction.

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1. Peterson, O. L., M.D. "An Analytical Study of North Carolina General Practice," *J. Med. Education* 31:12, 1956.

2. Clute, Kenneth F. *The General Practitioner*. Toronto, Canada: University of Toronto Press, 1963.

Part IV

Instructional Systems for Individualized Learning

Not all self-instruction takes place solely within the teaching program—certainly not within the program as it is traditionally conceived. Nor is self-instruction incapable of invoking technology at a level below that of the electronic computer. Blyth suggests some of the enduring problems in his discussion of the impact of theory on educational practice. Ramey describes how simulation and role playing can be incorporated into an individualized learning system. Graves and Harden describe for us some utilitarian and simple applications of audio-visuals to self-teaching—and in so doing tell us about the growth of such efforts in Great Britain. Potts takes a more general look at an integrated audio-video retrieval system. Finally, Reynolds reports on the development of instructional guides, developed in accordance with programming techniques, but designedly seeking to teach a lower order of end behaviors.

Impact of Theory on Educational Practice

JOHN W. BLYTH, Ph.D.*

IN PREPARATION for this session this afternoon, I reviewed a number of the comments that were made in the First Conference, a pioneer effort planned by Dr. Lysaught and his colleagues. In looking back over those earlier statements, I note that some of the things that were of concern to us four years ago have become history. Other problems which we were grappling with then are still with us. We have learned much in some directions, but we still have a long way to go in clarifying many of the questions that still confront us.

In summary, however, of where we stand in comparison to our posture at the first meeting, I would suggest that the broad outline of the general theory that started this movement in self-instruction has stood up well to the test of practice. In particular, these general points of our learning theory have been substantiated beyond refutation:

1. The importance of the active participation of the student in the process of instruction;
2. The importance of reinforcement either immediate or slightly delayed;
3. The importance of preparing very detailed specifications for the behavioral objectives of instruction;
4. The importance of analyzing the instructional problem into a series of steps and preparing instruction in that step-wise fashion;

*Director of Medical Programming, Argyle Publishing, Inc.

5. The importance of the empirical testing and revision of instructional sequences.

Notice that I omitted a number of the considerations that we might have included four years ago. For example, I didn't speak of "small" steps. I don't think there is any longer any orthodoxy on that now since there is little agreement on what constitutes or describes a small step of instruction.

Some of the questions which concerned many people four or five years ago seem to have become less prominent—if, indeed, they haven't disappeared altogether from discussion. There was, at one point, considerable controversy as to whether a program should be branched or linear—and which was *the* correct method of programming. I haven't heard anything about that for quite a while.

About a month ago, I was talking with somebody about a programming problem and showed him a sample of one of the programs we are developing. He took one look at it and said, "But, that's not a program!" The reason he said this was that the material didn't look like a page of print with a few of the words left out. That was his concept of a program. Now, I'm not saying that there are not perfectly good programs with that form, but it's getting rare for persons to believe that a program is typed into a particular visual pattern or set format.

We are, today, much more flexible with regard to the development and presentation of the program. We are much more versatile in our use of media for presenting self-instructional sequences. If we are concerned with oral skills, we use equipment that permits oral responses. If we are concerned with listening skills, we must provide something to listen to, rather than read. We're now at the point of using video tape as a playback medium to reinforce some of our learning principles. In short, there is far more flexibility in the type of "frame" that is written, the type of program in which it is used, the mode of presentation, and the total system in which the program may be used. We have seen in these four years, particularly in health education, a remarkable experimentation with diverse approaches and different techniques. Out of such a ferment, we will inevitably come to better and better methods.

Continuing Problems in Self-Instruction

Now I'd like to discuss some of the areas in which we still find ourselves with problems. First, there is the formulation of behavioral objectives. The attention that has been devoted to the development of specific instructional goals may be the most significant thing to have come out of the programming movement. It is not that we haven't been concerned about the ends of teaching for a good many years—as long, indeed, as education has been discussed. But the impact of the self-instructional movement has forced us to specify these ends of instruction more precisely and clearly than ever before. As one evidence of this impact, I would mention that there is currently a large-scale, long-range project underway to formulate behavioral objectives for the secondary school curriculum. It will probably take at least one year to arrive at a satisfactory statement of goals, but consider for how long we have worried, argued, accused, and lamented about secondary schools—without a specific statement of what the outcomes of that school should be.

Thus, the formulation of behavioral objectives, while still a problematic part of instructional technology, is having its impact far beyond the original concept of programmed instruction.

A second problem related to the development of sound teaching lies in the movement from behavioral objectives to instructional sequences. Working with one group of subject matter experts, we found that the program we were trying to develop could be analyzed into a sequence of decision points and that appropriate actions had to be based on the decisions made at each juncture. When we tried to determine how a certain decision was reached at one of these points, however, we most frequently were told that this was a "matter of judgment!" There was a reluctance, or perhaps more an inability, to say anything specific about how such a judgment should be formed—or what criteria were used in making a determination. When we suggested that the only valid instruction to be given to the student under such a circumstance might be, "All right, gentlemen; at this point take out your crystal ball, take a good look into it, and then decide what you should do in the cited case," however, we were met with cries of anguish.

This task of specifying the criteria and judgmental aspects of problem situations is no doubt one of the most troublesome and pervasive in all education. As we begin to develop strong rationales, not only for objectives that we wish to teach, but for the logical parameters in which those objectives should be taught, then we are coming closer and closer to an idealized educational system.

A final problem related to objectives, their determination, and

their logical environment lies in the transfer from learning behaviors—however behavioral—to task behavior with the patient. That is, there can be excellent objectives developed in terms of clear, specific, observable operations, but these behaviors can truly be academic, or bookish, or paper and pencil kinds of things that fall far short of the true terminal behavior that we should be seeking. What I am really trying to suggest is that a continuing problem in self-instruction lies in our own tendency to teach as in the past and not to exploit the full capability of a new technology that would allow us to do much more than ever before. We have, perhaps, taught some subjects in medicine in a highly theoretic way simply because the lecture permitted only that kind of approach. Now, we can not only teach theory, but we should be teaching a better form of application and treatment—and our technology not only allows it, but provides for tangible enhancement. We do not, in short, challenge our new technology nearly enough.

Difficulties in Program Validation

The greatest single problem we are facing, however, is in the area of program validation. We look with considerable distress on efforts to standardize requirements for the validation of programs—for a number of reasons. One is that we find it difficult to control variables in health care situations to the point where we can say with scientific accuracy that the program did or did not meet all of our objectives. This does not mean that we can't develop generally good and conclusive results, but to demand laboratory results requires laboratory conditions, and the patient wards and treatment rooms are not an equivalent situation to the experimental psychologist's apparatus.

If we follow the lead of those who insist on rigid standardization of program validation, however, we shall inevitably back off from the applied setting where controls vanish in the face of emergency situations, or where personality variables may alter with the arrival of a single resident. When we back off from the applied situation, we may be entrapped in the psychometrician's web of objective, highly controlled testing. That, in turn, usually turns out to be some form of verbal behavior that can be tested thoroughly and reliably. But recognize you are now testing your ability to teach students to talk about conditions, or answer paper and pencil problems, rather than *do* what they have learned is best practice,

In doing this sort of thing, we inevitably restrict our teaching to the limited horizons of our current testing techniques. Add to this the temptation to arrange teaching objectives to just those things that are most easily—or even most reliably—measured in a particular form of paper test, and you have the classic example of the tail wagging the dog.

We have encountered a further problem in relation to standardized techniques for validating programs. We believe that a great number of the well-developed self-instructional programs for health care specialties have utility for a wider range of learners. Programs for the medical student may be easily adapted to some nursing students, some technologists, some public health students, and others. But each of these variant sets of learners, despite certain common elements of background, also possess individual and group differences. If you are to adapt a program to suit their requirements, there are some persons who would argue that you need to carry out an involved, standardized validation study for each variation. Now, we have had some experience with this, and we find that within reasonable limits we can "customize" a program for different groups merely by changing a little vocabulary and a few examples.

Now some individuals would insist that an extensive standardized protocol be followed in the validation of each application of the basic program. This would be almost prohibitively expensive—not to mention time consuming and laborious. Certainly, we would be concerned with evaluative testing with small groups of each set of intended learners, but we can hardly see the necessity for beginning anew the entire set of initial and developmental tests when we know that the basic purposes of the program have been attained. All we are really attempting to determine is whether the modifications are effective and understandable.

This leads to the final problem that we have encountered in the validation of programs. Even if your program is thoroughly tested and evaluated, you may find that it fails for reasons which have nothing to do with the technical proficiency or accuracy of the program. We need to pay much more attention to the principles of learning connected with the *administration* of the program. The use of the program itself needs to be reinforced. Too many people have thought that a good program removes all responsibility from their shoulders. Give it to the learner; forget about the rest. It just doesn't work that way, of course.

If you want a program to work effectively and efficiently, then you must make conditions for its administration as favorable as possible. Then, you must ensure that the learnings gained in the program are reinforced in actual behavior. The medical student should *have* to practice the skills learned in the program. Otherwise, like all other learnings, retention and accuracy and finesse will suffer. In short, some of our greatest problem is bound up in learning how to make the most effective use of the effective programs already developed.

The Physician's Responsibility to the Patient: Videotape Problem-Solving in a Self-Instructional Mode

JAMES W. RAMEY, Ed.D.*

THE TEACHING TECHNIQUE I am about to describe is one of a series of teaching innovations with which we have been working over the past eighteen months. Through an academic appointment at Drexel Institute of Technology, I have been using a graduate course in library administration to test some of these innovations before introducing them into the medical and other professional areas. Videotape simulation, the first of these innovations, has now been successfully used a number of times. It was demonstrated at the first-year medical student level at the University of Missouri Medical School in Columbia last spring (1), and this fall we are using it in a continuing education course in psychiatry for general practitioners at the Institute of Pennsylvania Hospital. The self-instructional format which we will be talking about today is currently in the "dry run" phase.

Two of the most serious drawbacks to self-instructional courses have been their lack of provision for student interaction and their closed structure, even when branching programs are used. These drawbacks can be overcome by introducing open-ended problems and providing a form of feedback that involves total group response and interactive sharpening of perspective as each student measures his perceptions, logic, and the appropriateness of his response against that of his peers. The technique is primarily suggested for

*Executive Director, Institute for Advancement of Medical Communication and Adjunct Professor, Drexel Institute of Technology.

courses in which there are no cut-and-dried "right" answers. Conflicting approaches, conflicting value systems, diagnostic judgment, or differences in perception can lead to many different degrees of "right" solution to a problem. An important aspect of learning is the realization that there are many situations in which several "right" answers are possible and choices have to be made to determine the most appropriate of these answers in that given situation.

Synopsis of the Procedure

Students are given a topic sheet and a written case that illustrates the topic by means of a problem. The topic sheet includes suggested readings and source material, particular points that the student should look for in his reading, and typical questions that might be raised about the topic. After he has read and studied this preliminary content, he is asked to respond to the case. He is not, of course, expected to digest all the suggested readings. Indeed, this would be impossible. He is expected to consider several points of view, however, and of the thirty or forty books and articles suggested on each topic, several are underlined to provide a core and to ensure that the class has some commonality of background. The reading list covers a wide range of approaches, including biological, behavioral, philosophical, and legal material, as well as technical and diagnostic procedures.

Each student must indicate in writing the nature of the problem, the underlying issues in the case, and how he would effect a solution. Each student then receives a composite response sheet comprising all student responses and is asked to review his own position in the light of the reaction of his peers, defending those of his responses that deviate from the cluster responses, citing authority, again in writing. The student submits this second response sheet to the audiovisual department where he is then permitted to view a videotaped version of the problem.

Until now he has been considering a static case involving "facts" and characters. The videotape introduces the dynamics of interaction among the characters, their differing personalities, their perception of the situation, the non-verbal communication occurring in the situation that is so vital an aspect of many problem situations, and last but not least, a time dimension is added, lending a great deal more depth to the problem.

On the basis of his reaction to the videotaped version of the problem, the student is again asked to jot down his decisions concerning the nature of the problem, the issues involved, and the most appropriate solution. Again he receives a composite group response sheet and must defend, in a reaction paper, his personal position as well as indicate further responses based on the group reaction to the videotape. When he turns in this reaction paper he receives the next topic and case, and repeats the procedure.

Five topics are presented in this manner during the first ten weeks of the term, and during the eleventh week the total class meets to take the final examination, which consists of viewing a sixth videotaped problem and writing a reaction paper in class indicating the nature of the problem, the underlying issues, and the most appropriate solution.

Two other aspects of the course should be mentioned at this point. The first is that students are required to write an outside reading paper which is due the fourth week of the course. The paper serves the purpose of immersing the student in the subject matter of the course early in the semester. He is asked to analyze, compare, and evaluate the position of twelve authors from the reading list with regard to one of several relevant subjects covered in the course. The other point I wish to make clear is that the instructor is available for personal consultation throughout the semester.

Course Content

The content for this course is indicated in the title of my paper—The Physician's Responsibility to the Patient. This particular choice of subject matter is appropriate to two different situations. Originally, it was conceived for the undergraduate medical student's need to consider conflicting value systems. This fact of life, which he will frequently have to deal with in practice, is seldom made a formal part of the medical school curriculum. The Institute of Pennsylvania Hospital, however, now view these materials as useful for the continuing education course in Psychiatry for general practitioners.

The five cases presented in this course include: "The Heart Patient," in which a physician is called in on an emergency basis to handle another doctor's patient and makes a radically different diagnosis of the problem; "Crochety Mr. Smith," in which the family of a man the practitioner has treated for many years wants the doctor to help have the man committed; "The Dying Patient," in which the new attending physician must deal with his first terminal patient; "The Malpractice Suit," in which the physician must decide whether to go along with the advice of his insurance agent to settle out of court; and "Problem Children," a case dealing with community structure and the reporting of venereal disease. A copy of this last case is enclosed with this paper.

The Videotape Simulation Technique

I am reminded at this point of the big church wedding that was progressing along the usual course until the minister intoned the traditional words "let him speak now, or forever hold his peace," at which point a tall, lanky citizen got up and said, "Wal now, if nobody else plans to speak up, I'd like to say just a few words about Texas!" I think that it might be much more appropriate for me to say a few words about videotape simulation before telling you how we have set up the experimental comparison between teaching a course through videotape simulation and teaching it in the self-instructional mode.

The object of videotape simulation is to make use of the positive values of role playing without such hampering side effects as embarrassment to the players, group reluctance to tear apart the performance, and inability to get outside the part and comment on the action while it is taking place (2). Role players are selected in advance and given the written case for study. At a convenient time before class they assemble to tape the problem and are at this time assigned their individual roles. Each is asked to use this two or three sentence statement as a point of departure, drawing on his experience, readings, and perception of the developing situation for elaboration. Each is reminded that the point of the exercise is to get at the underlying issues so as to help the group better understand the dynamics of the problem. With no more instruction than this, role playing begins. Situations and timing are usually suggested, but may be left up to the players.

The entire problem is usually taped in less than thirty minutes. Players are allowed in the taping studio only while on camera, and no other students are about. Tapes may be made anywhere. Classrooms, studios, motel rooms, or offices are equally appropriate, since no props are needed and players become so completely immersed in the problem within the first thirty seconds that nothing distracts them.

The taped problem is played back to the class discussion group after they have first considered the case in its written form and formed tentative conclusions about the nature of the problem, the issues involved, and possible solutions. The role players are now just another part of the group and can comment as freely as the rest on various aspects of the tape. In addition, however, they are resource people who can explain some of the whys and wherefores of their actions. Since the discussion leader can start, stop, reverse, or replay portions of the tape, it is possible to follow several simultaneous lines of action, concentrate on nonverbal communication, and/or stop the tape and attempt to anticipate the next move. The house rule is that anyone can stop the tape by raising his hand.

The group disassociates the tape images from its peers and seems to have little difficulty in dispassionately getting directly to the point without fear of bruising egos. At the same time the students continue to share a sense of involvement, a need to work the problem through together to a satisfactory conclusion. After the class discussion each participant is asked to write a two page (maximum) typed double-spaced reaction paper. This paper is open ended. Students are encouraged to react to whatever seems important about the course at the moment, the case, the players, the solutions, the discussion, the methodology, or the reading list. The kind of outside reading paper mentioned previously is also required in this course format, which is otherwise actually very similar to the self-instructional mode, in that it alternates theory and problem sessions and has the same goals, which are to acquaint students with the parameters of the subject, including the various theoretical positions with regard to it, and to give them first hand, "gut-level" experience at dealing with typical problems in the area.

Experimental Design

The purpose of the experiment is to find out whether students in the self-instructional section of the course do as well on the final examination as students in the videotape simulation (or control) section. Three hypotheses suggest themselves with regard to the experimental group: 1) that informal structure will develop within the group to replace the missing formal structure; 2) that informal discussion clusters will develop within the group to replace the missing formal discussion sessions; and 3) that a convergence of responses will occur over the length of the semester.

The experimental subjects will be chosen on a random basis from the class of 46 students. Every other student will become a "section B" student as he enters the room during the first class session. He will be handed a red 3x5 card instead of a white one. When all students are seated, those who have red cards will be told that because of its large size the class is being split into two sections. They will then be asked to leave the room and return in 90 minutes. The remaining control section will then receive the usual orientation briefing, which takes 90 minutes. The experimental section will then get its 90 minute orientation briefing. Both sections will cover exactly the same material, but in different order. Having taught the course four times, each time using a different order of presentation, I am relatively certain this will not introduce an unwanted variable.

There will be several major differences in the two sections. The control section will make and view tapes. The experimental section will only view tapes. The control section will have both formal theory discussions and formal problem discussions. The experimental section will have no formal discussions. The control section will write reaction papers only after each videotape discussion. The experimental section will write two responses to each case and also two responses to each videotape. The control section will write an abstract paper due near the end of the semester, involving the chapter by chapter abstracting of the work of any five authors on the reading list. The experimental section will not write an abstract. The control section will have to meet a specific schedule at only ten points in time during the semester. The experimental section will have to meet a schedule at 25 points during the semester, although five of these points will each be self-selected within three days (the points at which they view the five videotapes).

Both sections will view the final exam tape simultaneously and record their reactions in class, indicating what they consider to be the problem, what they believe the issues to be, and how they feel the problem can be most appropriately resolved. A jury of experts will also view the videotape, come to a consensus on these points, and then evaluate the student responses as a means of comparing the effectiveness of the two methods. A six month followup is planned, to be conducted in a similar manner, to compare retention under the two modes of presentation.

Students will be given a questionnaire consisting largely of open-ended questions aimed at determining their general reaction to the experimental teaching method, particularly with respect to its open-endedness and to student interaction during the course. It should be possible to determine whether the hypotheses regarding the development of informal structure and informal discussion groups were correct as a result of student responses to the questionnaire which will be handed to the student as he leaves the examination room with the understanding that when he brings it to the office he will receive his grade in exchange for the completed questionnaire.

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2. Ramey, J. W. Videotape Simulation: Versatile New TV Tool in the Medical Center. *Health Sciences TV Bull.* 4: No. 3, 1967, PP 7-10.

Videotape Case No. 5

Problem Children

Dr. Brown has just recently set up practice in Small City. He has been most fortunate in being introduced to the community by an old college friend, Joe Fuller, who is the county judge, a vestryman in the Episcopal church, and a member of the board of trustees of the community hospital. Dr. Brown is very likeable as well as being an exceptionally able internist and diagnostician and his practice has grown swiftly.

In the midst of this success a sticky problem has arisen. Joe Fuller's teenage son came to the office a few minutes ago with the Episcopal rector's daughter. A look at their faces first led Dr. Brown to suspect that the girl was pregnant. Instead, they expressed the suspicion that they had a social disease. Examination proved them right—both are infected with gonorrhea. They came to him rather than to their family physician because they wanted to keep the matter private. Dr. Brown spoke to each one privately while treating them and discovered, to his surprise, that each assumed responsibility for infecting the other. Each acknowledged other contacts, mentioning the names of other influential families in the city.

Dr. Brown is aware of his responsibility to report cases of venereal disease to the county health officer for follow up. On the other hand, he feels a personal responsibility to the people involved, and since he is not personally acquainted with the county health officer but has heard several rather derogatory remarks about the way in which he discharges his office, Dr. Brown is hesitant to involve him in the situation. Although he has never heard of a case in which a scandal actually resulted from such a report, Dr. Brown is very sensitive to the kind of upheaval that could result if word of such a situation as this ever did get around.

Sequence

TAKE I—Doctor, Rector's Daughter, Judge's Son.

Open ended insofar as time is concerned. Could be ten to thirty minutes depending on whether or not Doctor presses them to either bring in the parents or allow him to speak to them privately.

TAKE II—Participants depend on outcome of Take 1.

If students resolve problem in I then there is no II. Should not run over thirty minutes no matter how long I is.

Assignment Sheet: Dr. Brown

You are really in a dilemma. As a physician you are duty bound to report VD cases to the county health officer, yet you are afraid that in a small city like this the story of the judge's son and the rector's daughter might be just too juicy to keep quiet, especially since a number of other notable families are also involved. Should you reveal to the boy and girl that each has been involved with other young people sexually? If you go to their parents this will certainly come out, and unless you do so without consulting the kids, they will find out then. Can you ethically go to the parents without consulting them? Since they are minors, do you have a duty to involve the families? Can the medical problem be handled without going to the health officer? What are the moral implications of protecting the families involved? Are you willing to take responsibility for potentially exposing these families to a public scandal, especially the rector and the judge, who are particularly vulnerable? What are the ethics of the situation?

Elaborate as you see fit, based on your own training, experience, and perception of the situation. Remember that our aim is to uncover as many as possible of the issues involved in the physician's responsibility to the patient.

Assignment Sheet: The Judge's Son

I don't know what Dad would do, aside from skinning me alive.

That's why we've got to keep it secret. I don't see why the doctor has to go stirring up trouble by filing a report and getting a lot of other people involved. I wouldn't have mentioned any other names if I had had any idea somebody was likely to be going around to talk to them. It's bound to get out if they talk to everybody. If someone else is infected too that is that person's problem. We took care of it ourselves. So can other individuals.

Elaborate in any way you choose, drawing on your training, reading, experience, and perception of the situation. Our aim is to bring out as many issues as possible in the area of the physician's responsibility to the patient.

Assignment Sheet: The Rector's Daughter

We came to you in good faith, expecting you to respect our privacy. We could have gone to another town or I could have come in alone and sworn I got it from a toilet seat. I answered your questions honestly—you can't ethically turn around and tell me about your responsibility to society. Your responsibility is to me. If you were even to breathe this to my father he would be likely to preach a sermon about it next Sunday. Sometimes I think he's more fundamentalist than Episcopalian. He would want to take full responsibility for "letting me down." If you make a report to someone else, then I will be responsible for having violated their confidence. I don't think you have the right.

Elaborate in any way you see fit. Draw on your training, experience, and perception of the situation to uncover the issues involved in the physician's responsibility to the patient.

Assignment Sheet: The Judge

Thank goodness the kids decided to go to Brown. At least this way we have some opportunity to consider and perhaps influence the situation. If they had gone somewhere else who knows what might have happened. Surely Brown realizes that this sort of thing must be handled privately. If my political opponents got wind of it I'd be finished. I know the records in the health department are supposed to be confidential, but I don't want to take the chance if it can be avoided. I feel sure all the families involved will cooperate, so that from the medical standpoint Brown can take care of the situation. Too much is at stake to do it any other way.

Elaborate in any way you choose. Use your training, your experience, your imagination, your perception of the situation. Remember, our aim is to uncover as many as possible of the issues involved in the physician's responsibility to the patient.

Assignment Sheet: The Rector

You are numb. While you appreciate the reasons for Dr. Brown discussing the situation with you and the judge, you realize that the decision is really his to make, and you almost wish he had not spoken to you about it, for now you have the burden without the decision-making power. Somewhere you have failed your daughter. Surely there can be no doubt in Dr. Brown's mind about how he should proceed. He would have no compunction if the children involved were from poor lower class families. "Lo, how the mighty have fallen!" It is a bitter pill to swallow, but apparently it is God's will.

Elaborate as you see fit. Use your own experience, your readings, your perception of the developing situation to get at as many of the issues as possible, to enlarge our understanding of the physician's responsibility to the patient.

Audiotape in Medical Teaching

JOHN GRAVES, O.B.E., M.R.C.S., L.R.C.P.*

If teaching is not effective, it is a waste of time: we should fire the teacher, not the student. Not everyone learns in the same way—some learn best by reading, others by doing, others by listening or discussion. There is no one perfect method. Some techniques are more suitable for a particular subject or for a particular person, but a wide variety should be available to the learner. Many studies have been made in this area: Asher (1) (teaching physiology); Owen (2) electrocardiography); Joyce (3) (pharmocology); Greenhill (4) (naval studies); and Postlethwait (5) (botany) have compared the effects of different techniques and different types of student.

One problem is that teachers tend to come from the top half of the class and so fail to understand the difficulties of less gifted people. If a principle seems clear to them they may not see that others need a diagram or laborious explanations. I have often tried to demonstrate this to teachers (6) but Abercrombie's book (7) "The Anatomy of Judgment" is perhaps the best work on misunderstanding between teacher and taught.

Teachers must teach, but (as Miller (8) emphasises) it is learning that is the active process and only the student can do it. So we shall do well to think, regarding a given objective, "how can the student understand and learn this?" rather than "how can we teach this?". Whenever a method involves a student in some active effort of learning or checking what he has learned, it is more likely to be successful. This is shown in computer teaching (9, 10) and in programmed teaching (11). However, if we have used a particular technique and found it useful, we must not conclude that it is the only useful technique. Enthusiasts can easily lose their sense of proportion.

*Director. Medical Recording Service and Sound Library. Royal College of General Practitioners. Kitts Croft, Writtle, Chelmsford, Essex, England.

The Physicians' Need for Continuing Education

It was as a member of the Education Committee of the Royal College of General Practitioners that I first became involved in teaching. I helped analyse a survey into the needs of general practitioners in Britain for continuing education in 1956 (12). Their problems were those of community doctors everywhere: not enough time; no suitable courses; no deputy, and—ominously—loss of the habit of regular study. These findings reflect those of Peterson (13) in North Carolina in 1954. Most felt the need but did not know how to start.

In the decade that has followed, we have seen in Britain a remarkable upsurge of interest in continuing education (comparable to your Regional Medical Program) culminating in the building of hundreds of teaching centers in community hospitals. A national conference on the building, administration, and financing of these centers was held last year (14). Financial help on a generous scale (though not usually adequate for elaborate hardware such as computers) has come from government and commercial sources and—significantly—from the local doctor's own pocket.

How the Recording Service Started

To return to 1956, I was at that time involved in many teaching projects for general practitioners and was convinced of the need (especially among isolated up-country doctors) for regular opportunities for study rather than attendance perhaps once a year at a formal course. If they could not attend meetings, could we not take meetings to them? So I had the idea of tape-recording meetings and loaning the tapes. Almost at once we discovered that it was not only the isolated doctors who needed help, and also that recordings made at meetings were not as good as commissioned talks made in the studio. But that is how it started, and by 1958 (15) it was obvious that there was a real need for this kind of service. Our original tapes were not very good but people liked them and loudly asked for more. We are still astonished by the continuing cry for "more!" which keeps growing although we do virtually no advertising. The demand—from new kinds of learners, and for new kinds of material—is such that we can barely keep up with its growth, although we have greatly enlarged our staff and equipment.

Essentials of a Good Audiotape

We have always tried to satisfy these criteria:

1. The material (lecture, talk, discussion, description of visuals) must be informal and intimate as if speaking to a small group.
2. The audience must be defined, and the material suitable for it.
3. Acoustic quality and general style and finish must be very good.
4. It must be spoken by the original author (or interest and conviction will be lacking).
5. Slides should be used to accompany tapes wherever possible.
6. Slides must be of very good quality.
7. The best audiotapes are those that stimulate argument, discussion, and further reading, rather than those that attempt to cover a subject completely.

Value of Comments and Criticism

We felt so strongly about the need for high quality subject matter, recording, and photography that we wrote a book (16) to answer the questions we were always being asked about these things.

(Several extracts from typical audiotapes were played at the meeting).

We have been fortunate in our listeners, who have never failed to stimulate us with critical comment and suggestions, and in our colleagues who are using audiotape in various ways in medical teaching. I now feel equally fortunate in being able to travel round the U.S.A. to meet other colleagues using audiovisual and self-instructional techniques, especially at this Conference in Rochester. We have ourselves held two conferences on the use of audiotape: the first in 1963 (17) when the method was beginning to be used by a number of different organizations in Britain, and the second in June of this year (18) to celebrate the tenth year of our own service.

Some of the interesting aspects of audiotape teaching that have arisen from listener's comments have been: its increasing use by small discussion groups in hospital common rooms and in doctors' own homes (this has become so popular that we wrote a short guide (19) to help people start up a group); increased use of illustrations; question-and-answer tapes with pictures and problems of diagnosis; and soon we hope to make tapes for self-testing with multiple-choice questions.

Arguments for the Use of Audiotape with Slides

I would not for a moment suggest that audiotape is a better teaching medium than others in current use. But it does have certain advantages which merit it being given a larger place than at present in our teaching programs:

1. It is cheap, easy to use and distribute by post, or around the teaching center.
2. Though providing a permanent record without any processing, it can be erased, altered, and re-used again and again. Multiple copies can be made and erased for classroom use.
3. Teachers' time is saved for more valuable tasks such as individual tutoring and group discussion. The best use is made of good teachers, and time and effort spent perfecting a lecture are not lost after one occasi‹
4. The learner's eyes are freed to concentrate on visuals or practical work while instruction comes through the ear. This is an ideal way of demonstrating collections of slides, or objects in a museum.
5. Recordings of patients can, for instance, demonstrate sounds, voices, histories and interviews, collections of similar or rare cases, conditions before and after treatment. They can be combined with photographs, X-rays, case-histories, and other documentation as a permanent collection in the school.
6. For individual study, the listener can stop, go back, replay, make notes and responses, study visual and other material and work at his own pace.
7. For group study, a tape provides the material for discussion without the distraction of the speaker's actual presence. The group can feel free to criticise and disagree.
8. Recordings can bring famous men and occasions to the homes of students and doctors in remote places.

I think it is high time that medical school and hospital libraries included audio-visual material as well as books. Using headphones and individual study carrels (5) a student can work with all the necessary material at hand. Many universities have devised complicated hardware for use in this way, but I would make a plea for simple equipment wherever possible, to encourage exchange of material between schools—surely one of the most valuable uses of this medium.

The Royal College of General Practitioners' Sound Library

Perhaps I may finish with a few facts about my own library of audiotapes. Now ten years old, this is a non-profit-making subsidiary (supported partly by grants, partly by loan charges) of the Royal College of General Practitioners. My wife and I, both in part-time general medical practice, run it with a staff of eight, using good professional recording, copying, and photographic equipment.

We now have nearly 400 different recordings, the average playing time being 30 minutes, with an average of 20 illustrations. Originally only for general practice, tapes now also cover specialist and nursing subjects and are lent to people in every branch of medicine all over the world. The service is almost entirely postal, loans now numbering about 10,000 a year, with a known annual audience of over 50,000, but as an increasing number of centers now have tapes on permanent loan for regular use and do not give us listening figures, this audience must, in fact, be very much larger. The scale of this demand, made on a small non-commercial service that does almost no advertising, and has none of the teaching resources of a medical school, suggests that here is a real need that should be considered by anyone planning programs of continuing education.

Most of our tapes we have planned, recorded and produced ourselves. But now we are happy to be able to include an increasing number made by medical schools, notably by Dr. R. McG. Harden of Glasgow, whose paper you have heard today. We hope one day to have tapes from many medical schools, including American schools. I hope to track some down while I am over here. I should be very happy to hear from anyone who would like us to include his material in our library, or who would like to borrow any of those that we have, or to have more information about the service.

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Self-Instruction Using an Audiovisual Tutor Machine

R. McG. HARDEN*

Sir George Pickering reported a number of years ago a visitor to Britain who said "no country has produced so many excellent analyses of the defects of medical education as has Britain—and no country has done less to implement them." I feel certain that should this gentleman revisit us he would be impressed by the increasing efforts being made particularly in the field of audiovisual aids. Evidence of this is the newly formed Education Section of the Royal Society of Medicine, the new British Journal of Medical Education, and the activities of the Association for the Study of Medical Education.

In Glasgow four years ago it became obvious that our undergraduate and postgraduate teaching commitments could no longer be met using conventional methods. There was, in short, a need for some self-instruction technique which could be used within the department of medicine for individual student instruction and at the same time be appropriate to the General Practitioner who was unable to leave his practice for more than an occasional visit to the teaching hospital. We decided that the system to be adopted should fulfill certain criteria. (See Table 1).

Firstly, the material should be readily available for repeated use: it should be as available as the textbook on the library shelf, able to be used immediately in the library or borrowed for use later.

Secondly, the system should use both sound and vision and these should be automatically synchronised.

Thirdly, the materials used should allow corrections to be easily made. In this way the content could be updated either because of advances in medical knowledge or for other reasons. For example, an otherwise excellent nursing film may have to be discarded simply

*Lecturer in Medicine, Gardiner Institute of Medicine, Western Infirmary, Glasgow, Scotland.

Table I

Criteria for a Self-Instructional System

1. Readily available for repeated use
2. Sound & Vision - automatically synchronised
3. Corrections easily made
4. Equipment standard and inexpensive
5. Within Resources of University Department

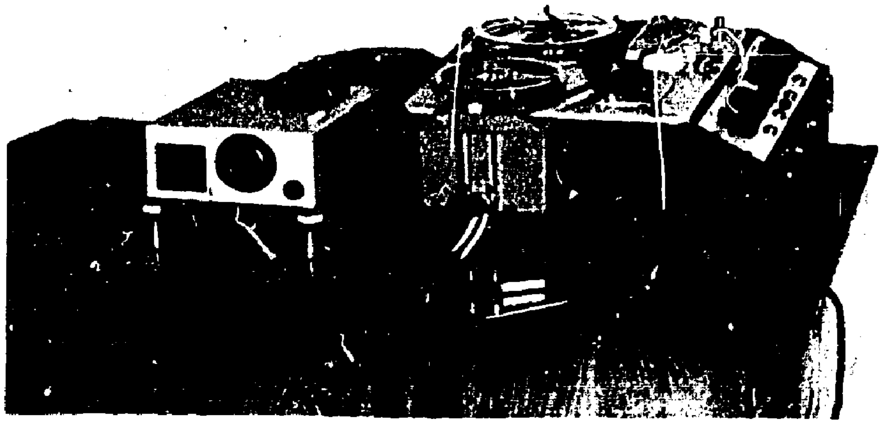
because of a change in fashion. The reaction to a serious film in which the nurses are wearing skirts 6 inches too long may be only one of amusement and the message is lost.

Fourthly, the equipment should be standard and inexpensive.

Finally, and very important, the preparation and production of the material should be within the resources of a University department. By all means let centers exchange their material—this should be encouraged—but let each center be capable of production of its own. Even if central pools of material were available—which they are not—some material is best produced locally. A library with only a few good books is little used. This is the main defect today of programmed texts. Only using the system I shall describe, has it been possible for us to build up a reasonably comprehensive collection of material covering most aspects of medicine.

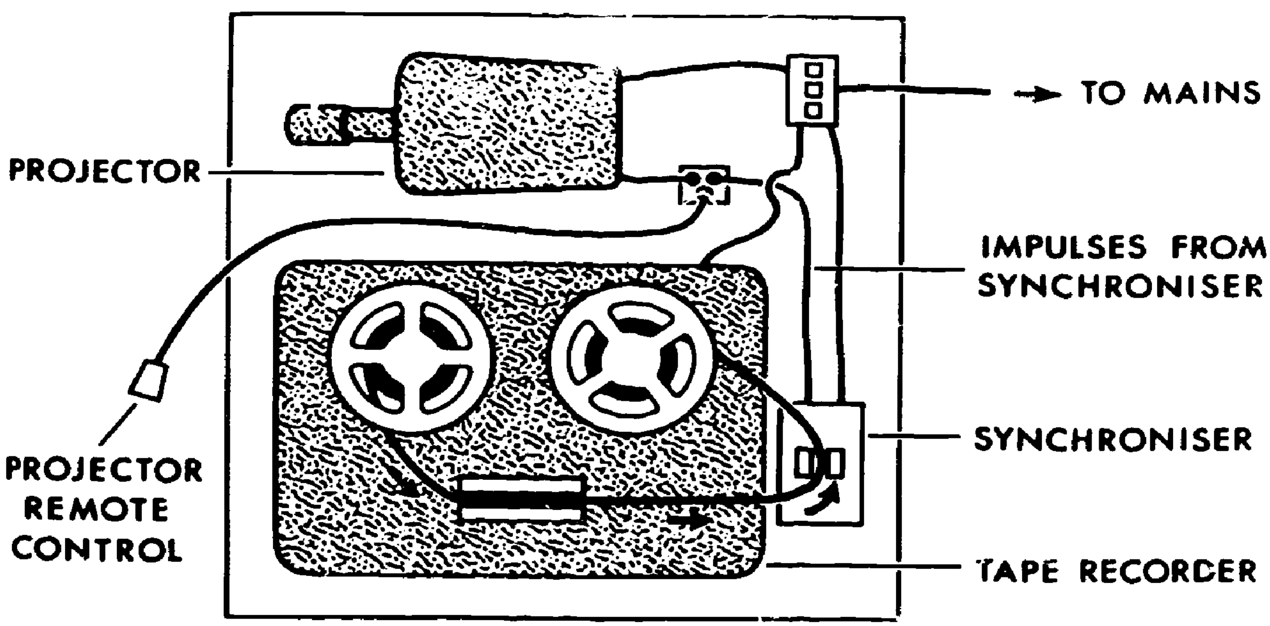
The system we have adopted uses sound, recorded on magnetic tape, synchronised automatically with 35 mm coloured slides. (See Figure 1). A tape recorder and automatic projector—standard equipment in most departments—were mounted on a cabinet along with a Philips synchroniser. With this, impulses were recorded on the second track of the tape. During playback these impulses operated a relay thus allowing slides to be automatically shown in synchronisation with the sound commentary.

This is a diagram (Figure 2) of the same system. The tape recorder, projector and synchroniser are permanently connected as shown. Using the remote control lead the projector can also be used for



standard lectures without disconnecting any of the wires. This system does, however, have certain disadvantages. It occupies an entire lecture room when in use. For the novice the projector and tape recorder are not easy to operate. There seemed therefore a need for a more compact machine with the projector, tape recorder and synchroniser combined in one cabinet.

The Kindermann tutor (Figure 3) is such a machine. It incorporates a tape recorder with built in synchroniser, an automatic projector, and back screen projection. Two machines are permanently available in our library. Using a simple set of instructions mounted on the machine and with the controls clearly labelled, even the first-time user requires no additional instruction in operation of the machine.



The student obtains a tape along with the appropriate tray of slides from the librarian. The tape is easily loaded on the sprocket and does not require to be fed through a separate synchroniser. The slide tray is easily loaded on the projector. The slides are never handled and even if the tray is turned upside down they are prevented from slipping by spring clips. Once started, the tape and slides automatically proceed until the end of the lecture is reached. There is a pause button control on the machine and a control for "blacking out" the picture. The student can, therefore, stop, think, make notes and test his memory. For use in the library the external speaker is silenced and headphones are used.

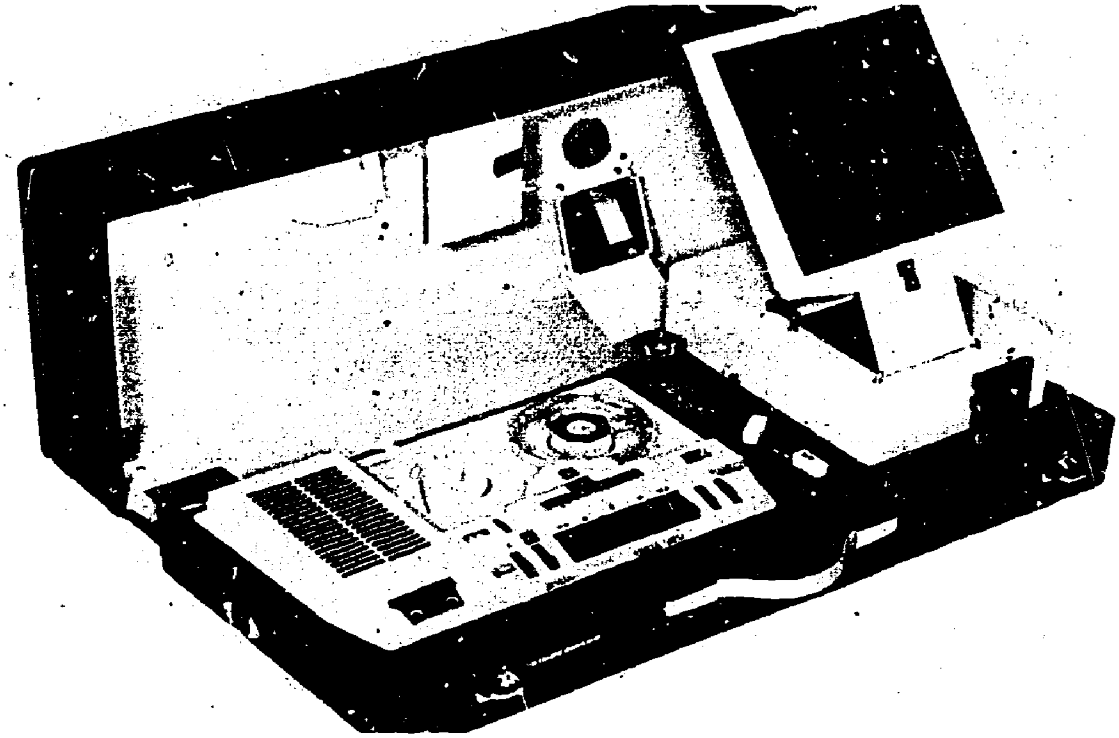
In most instances the emphasis should be on the visual material and the script should be written around the slides. The presentation is dull and uninteresting if these are not varied. They should be in colour where possible and should include clinical photographs, X-rays, and ECGs. Diagrams should be used to emphasize some symptom or to summarize important points.

Most subjects can be dealt with in this way. The technique is very suitable for the "spot diagnosis" where the student is invited to interpret a clinical photograph, an X-ray, a microscope slide, or an ECG. Only after he has written down his interpretation does he release the pause control and the "correct" interpretation is then presented perhaps with supplementary slides.

I first thought of titling this paper "The poor man's teaching machine." Perhaps in Britain we are all poor men and the cost of producing large numbers of programmed texts would be prohibitive. I avoided this title, however, because the system I have described has many advantages other than expense. What are these advantages?

First—a good speaker can reach a much wider audience and listeners can hear the views of acknowledged experts. Some of our tapes and slides have already travelled as far afield as Greece, India, and even the United States of America. Many of the users may not have the facility of synchronisation but the material can still be used by manually changing the slides. Alternatively a hand viewer can be substituted for the projector.

One advantage is that by listening to his own lecture and to criticisms by other members of the department, substantial improvements in the lecture are usually made. Seegal, in his "Lament for Better Teaching," stated that it is the "rare department which satisfies the wishes and even the demands of students that more of the staff members be great teachers. Truly great teachers are rare." With this system, however, those who *are*, can reach a wider audience, and those who *are not* can stand on the shoulders of those who are.



As for the student, the use of both auditory and visual senses makes distraction less likely. It has been demonstrated in several studies that learning is facilitated by the combined use of sound and vision. Vision plus sound is better than either alone.

The system is convenient in so far as the student can choose the time and place best suited to him. Because the tapes and slides are relatively easy and inexpensive to produce, and because interchange with other centers is quite easy, large libraries can be quickly built up covering most academic areas. Finally, the capital and running expenses, compared to other audiovisual aids, are quite small.

For the future, I feel certain that the use of tapes synchronised with slides as a self-instructional method will increase. The interest in, and the demand for, the material we have produced has been phenomenal and the scope for the technique is tremendous. One exciting line we are at present pursuing, using programmed instruction methods, is the construction by the student, as the tape and slides proceed, of a summary of the subject. This is retained for quick review later.

I would finally like to thank you for giving me this opportunity of presenting to you one method of self-instruction currently being used in Britain.

The Planning and Development of Random Access Audio-Video Retrieval Systems

ROBERT E. POTTS*

THERE ARE SEVERAL WAYS of going about building a program in communications. I use the term communications in the broad sense of the word. I do not believe in building a program in any one of the areas of this media, but rather of establishing the idea that all areas of communications should be utilized. First of all, underline it firmly in your mind that this is not a cheap undertaking. If you are trying to find an inexpensive way of solving your institutional problems, this is not destined to be one of them.

Organization

First, make a decision on how sophisticated you think you should be with your program. Do you want television, radio, audio-visual, or a retrieval system? You may decide that you want to use all of them. After this decision is made, consider the introduction of a new box in your organizational chart at the highest level possible called the "Division of Medical Communications." Your next important job is to bring your faculty into the picture. It is imperative that they understand, feel a part of, and support your program in the use of visual materials. Without their cooperation your entire program is lost, and they must be included right from the planning stage. Next, start looking for a man who will be the director of the division. He should be an expert in the several areas of media programming so that he can direct and provide the leadership necessary to initiate your program. Finding this man is not going to be easy; and when

*The Ohio State University, College of Medicine, Columbus, Ohio.

you find him, he is not likely to be inexpensive. Remember, the right man is a professional in every sense of the word, and should receive the same recognition that you would expect to accord any other faculty appointment.

In almost every medical school there are already forms of organized communication. They come under several headings such as Medical Illustrations, Medical Photography, small audio-visual departments, and some units owning their own types of projectors and television equipment. Without exception, I am sure that every member of your faculty has films or slides in his office.

The several units, groups, or departments should be centralized and brought under the umbrella of the Division of Medical Communications. Now I know that such organization initially takes time, effort, and occasionally even additional staff, but too much duplication of equipment and materials can kill a program before it ever has a chance to get off the ground. When centralization takes place, it generally eliminates possible feelings of competition; it improves cooperation between departments; and, in the long run, it enables each department to have more and better equipment at its disposal without duplication. Time schedules can be met, and a general improvement in staff and workmanship can be the result.

As I said in the beginning, this is not an inexpensive undertaking, and a Division of Communications must have continuous financial support for any program. This commitment must be made from the very beginning. The budget, recognizably, will be difficult to determine at first, but this is where your expert in the field will be able to advise you. There is no doubt that grants can and will aid in helping to make your program develop faster and make it stronger, but such money should be seen as an adjunct, and not as the primary source of support for your program.

Staff

We now come to the problem of staffing. If your plans include television capability, it will be extremely important for you to hire *TV* electronic engineers. I stress the word *TV*, because not all electronic engineers know how to maintain and operate TV equipment. Possession of a first class license is desirable and is required if you intend to do any broadcasting. But don't let that first class license be your only consideration. Background and experience are prime ingredients.

I must stress that unless you intend to hire these people, you should not get involved in TV. Without them, you are lost. Where do you find these people? If you look in the trade journals, you will find that schools and industry all over the country are looking for good TV engineers. This, again, is one of the areas in which your chosen director can be of great help. He may not always be able to locate an engineer immediately, but at least he'll know where to start looking.

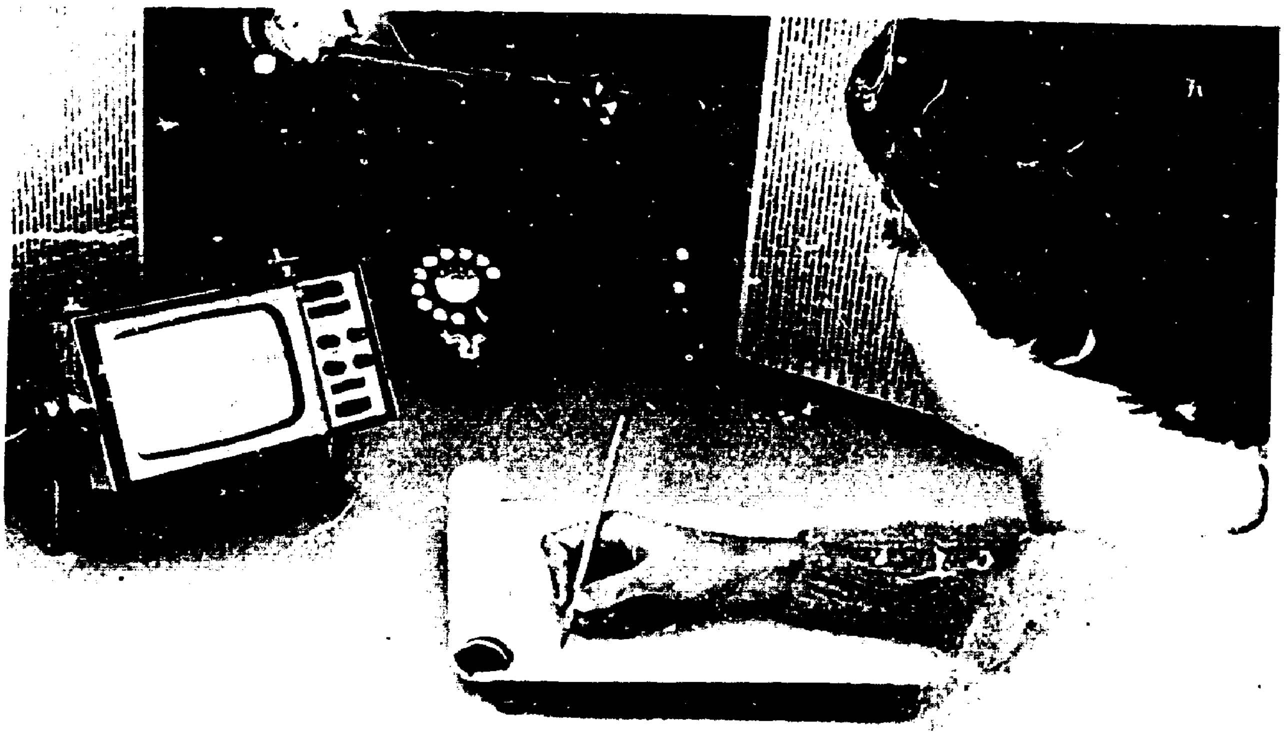
Next, you must acquire your production staff. Without experienced production personnel, you cannot function. I don't mean to imply that all your staff need be professionally trained. There is also a need for support personnel. These people can be students. How should these students be used? Use them for the distribution and operation of all your A-V equipment and materials, for making copies of your audio tapes, for filing materials, and for the hundred and one different tasks of a non-professional nature that do take place. Keep your professional people free to do the things they are trained to do.

Faculty Orientation

After you have hired a director and developed some engineering and production support, your next job is to bring the faculty into the picture. A teaching seminar on the use of visual materials is very much in order. Most of your instructors will already have been using visuals of one type or another and some individuals may represent a good source of new ideas on the subject. Those few who don't use visuals can be shown just how much more effective their presentations in the classroom can be made by using illustrative materials. Such a seminar requires proper planning and execution of examples to prove to the faculty that there is value in A-V usage; otherwise, they will say, "I can do better than that without using such stuff." In some cases, they're right! If this should happen, it becomes a long uphill struggle to remove the bad taste of the first experience.

There are five steps I like to follow in developing a program: 1. hire leadership; 2. plan faculty orientation; 3. hire technical and production staff; 4. develop software; 5. purchase hardware. There is no doubt that you will have to purchase some hardware to function efficiently, but this should be the last consideration in terms of overall development.

Make it easy for your faculty to use these services. No member of your faculty should ever have to worry about making slides, overhead transparencies, films, audio tapes, video tapes, or how to operate any



Individual student carrel complete with television set, dial-access equipment, and two way communications.

of the equipment con[illegible]ith these materials. If a faculty member has to worry about carting a 16mm film projector to the classroom, setting it up and wondering if it is going to work when he throws the switch, he is not going to use it. The same holds true for any operation of a visual or mechanical nature. This is the task of the Division of Communications. It is their job to help the faculty obtain equipment and arrange for the professor to use it effectively, efficiently, and comfortably.

Development of Software

The development of your software begins with what you have already. Every professor has slides and films in his office. Bring these slides and films together into a central file, make copies of the slides, and give a set back to the faculty member. In this way, if a slide is broken or lost, it can be replaced just by making a phone call. This also eliminates the danger of destroying the slide of a case that occurs once in your lifetime. It also makes generally available to all the faculty a resource greater than they probably realized. This is a big job, and one that will take a great deal of time. As these materials are collected, however, they can be the nucleus for self-study units and review programs for students as well as source material for faculty and staff.

During this time, you can begin the purchase of some hardware. If TV is part of your program, then two or three cameras, switching controls and video tape machines should be purchased. Plan from the beginning for the integration of these components to exploit your software. The synchronization of audio tapes and slides is an effective way of presenting materials to students and is relatively inexpensive—an ideal first marriage of soft and hard wares.

Material Retrieval Areas

As you develop your software, you must also bear in mind how, and where, you intend this material to be used. Do not plan your materials solely for the purpose of enrichment. Develop them as a part of your main course material. Make it a must that students view this material it [illegible] full uti[illegible] [illegible] then make it easy for them to obtain the material. If [illegible]y, locate and equip areas throughout your school so that the student or staff member can go, in off hours, to view the instructional material. We use the term Autodidactic Laboratory, at Ohio State. You should equip this area with slide

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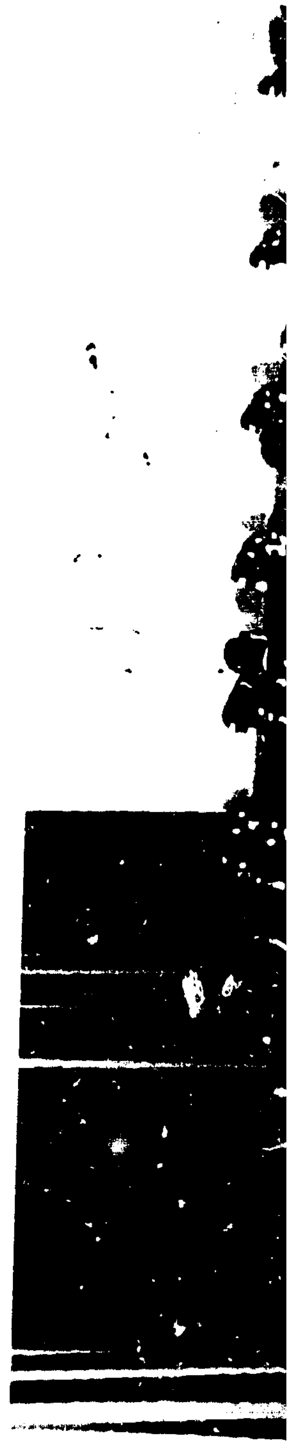

Figure 1. Autoclidactic carrels in the Ohio Union. There are 48 self-instructional units located here.

DIFFERENCES BETWEEN GVSC AND OSU DIAL ACCESS SYSTEMS

	GVSC	OSU
COMPUTER	NO	YES
NUMBER OF AUDIO TRACKS PER REEL	4	1 **
TYPE OF EQUIPMENT	CHESTER	NORTH ELECTRIC
NUMBER OF AUDIO PROGRAMS RECEIVED BY DIALING	120	92
NUMBER OF VIDEO DIALING STATIONS	NONE	18 *
NUMBER OF PROGRAMS POSSIBLE ON VIDEO	8	2 *
TYPE OF AUDIO PLAYBACK UNITS	VIKING + CHESTER	MAGNECORD
NUMBER OF PLAYBACK UNITS	30 (4 TRACK)	76 ** (FULL TRACK)
TYPES OF VIDEO TAPE MACHINES AND NUMBER	2 AMPEX 1500 2 AMPEX 660B	2 AMPEX 660B *
NUMBER OF CARRELS EQUIPPED	140	389 ***

* BEING INSTALLED FOR USE THIS FALL
** 16 ARE 2 TRACK
*** ONLY 18 ARE EQUIPPED WITH VIDEO

projectors, film projectors, audio tape machines, record players, cartridge film projectors and, of course, reading materials. You may, alternatively, have a central location for this function. Whichever your case may be, do make it convenient.

Sophistication of System

All of this talk has been leading, I hope, to the development of a much more sophisticated presentation of material than just the use of TV, radio, or any other single form of audiovisual presentation. In more recent years new activities have entered our departments—retrieval systems, computers, programmed learning, and random access retrieval for both audio and video material.

Now we are going to go one step further and add the possibility for the student and the staff to select at random, just by dialing, programs of slides, video tapes, films and, of course, audio tapes. Schools all over the country have embarked on a program that will make it possible to receive this material day or night anywhere on campus. Student response systems have also become an integral part of such circuits.

During the winter quarter 1967, the system at Ohio State University received 507,463 calls: 487,995 were from on campus locations and 19,478 were from off campus locations like the dormitories, fraternity houses, and sorority houses. These figures should be compared with those of the winter quarter of 1966. During that period a total of 311,952 calls were received. This reflects an increase of 195,501 calls in a single year. The cost of this system, including the computer, is $450,000. This figure includes the addition of 18 video carrels that are currently being installed for use this fall.

Table I illustrates the differences between two large dial access systems, those at Ohio State University and Grand Valley State College. The total cost of the latter system was approximately $300,000.

If you eliminate the cost and sophistication of the computer, the flexibility of the system at Grand Valley State College is somewhat greater. However, the equipment used at OSU is far superior to that used at GVSC. The advantages of having better equipment can only serve to enhance the material programmed, and build it into a system of much higher quality. The student, therefore, receives his material faster, easier, and at much higher fidelity; and after all, this is our primary reason for providing this system.

It is essential that you know what you want your system to do before you start. With this knowledge, you can plan personnel, materials, and equipment in proper fashion. With adequate planning and help, you can arrive at the "right" degree of sophistication for your facility.

Guidance vs. Teaching: An Old Concept Needing A New Look

ROBERT L. REYNOLDS*

IT IS NOW APPARENT that the value of programmed self-ins[illegible]ction as a training/education tool has been far outweighed by the c[illegible]ibution its exploration and development have made to the develop[illegible]nt and use of broader concepts. These concepts are reflected in our concern for an instructional technology and a systems approach to training/education. Pursuant to these concepts, an instructor will, in part, establish measurable, behavioral learning objectives, relate these objectives to the eventual use of the learned knowledge and skill, and perform the necessary validation procedures. It is in the application of these techniques that a major contradiction in the training/education process can be brought vividly to one's attention.

Of the many possible contradictions in our instructional processes, none are m[illegible]re common than the tendency to encourage unnecessary learning. This occurs when the instructor intentionally has his students commit to memory knowledge and skills which will be forgotten or outdated before its use. There are procedures and techniques that students are encouraged to commit totally to memory—then they are warned not to trust their memory for fear of making a serious or costly error! There are instances when students should be so warned and are not.

Such contradictions in our instructional processes can be lessened by determining more precisely what a student will *need* to do com-

*Educational Consultant, Atlanta, Georgia.

pletely from memory and what will be *permissible and/or best* to do while receiving explicit guidance. In the former instance, the student will be taught (i.e., he will be required to learn) to an extent that promises to insure a minimum degree of retention loss. In the latter instance, the student will be required to learn only that sufficient to make the subsequent use of a guide effective.

This guidance vs teaching concept is certainly not new, but it is not being sufficiently and properly exploited. The inadequate application of the concept is culturally reflected in our scorn for the "cook book" approach and our consistent failure to perform satisfactorily when following how-to-do-it instructions—notably, those accompanying unassembled toys and appliances during Christmas.

LABORATORY PROCEDURES

From its inception in 1963, the Instructive Communications Unit of the National Communicable Disease Center has addressed itself to the development and use of guidance materials where analysis reveals it to be most appropriate. One of the first products of the Unit was a three-part course on laboratory diagnosis of [illegible]biasis (1). A portion of the part on laboratory procedures had t[illegible] with certain staining, concentration, and cultivation. Since absolute accuracy is demanded in these complex procedures, it was recognized that memorizing all the detailed steps is not feasible. Therefore, laboratory personnel would be required to use printed "cook books" already provided by the laboratories. The negligible increase in time required by the concurrent use of the "cook books" was determined *not* to be a precluding factor in their use. Although these procedural guides were to be used, the curriculum planners felt rather strongly that the performance of laboratory personnel could be improved if they learned to recognize the rationale for various steps in the procedures.

In applying the precise behavioral analysis characteristic of "good" programming, it was soon discovered that the "cook books" already in use (and which were to be used as the object of the rationales to be taught) were in fact grossly inadequate, possessed frequent omissions, and ambiguities. Therefore, it became necessary for valid guides to be developed, and they were subsequently recommended as replacements for those previously used. Although the lesson covering rationales was also developed, the question remained as to whether the more carefully prepared guides might not have been adequate in themselves to correct any previous performance deficiency. With such poor examples as the earlier "cook books, it is not surprising that guidance material falls into disrepute.

Experience on the amebiasis project has been more recently applied in the development of similar materials for the laboratory diagnosis of malaria (2). These materials, under the sponsorship of AID, are being prepared for use in world-wide malaria eradication programs. It was decided at the onset of the project that staining procedures should be presented in guides for use by the proposed laboratory personnel. Using the guides during actual on-the-job work would keep the prior, non-productive training period relatively brief and inexpensive. Again, the negligible time required in the use of guides is not a precluding factor and the dependence on guides would also insure a high degree of accuracy and a minimum of retention loss. Preliminary evidence on the use of the guides by relatively naive students has shown that they can successfully stain slides appropriate for microscopic examination. These students had no prior training in staining procedure and were successful in their *first use of the guides.*

ADMINISTRATIVE PROCEDURES

The professional person is beset by a multitude of administrative procedures. To perform adequately he must be given training or other assistance; training time, if appropriate, is at a premium. Such a problem was posed to the Instructive Communications Unit by the organization's personnel department. The problem was how to help supervisors (mostly professional persons) perform certain routine duties more effectively. After analysis, the duties were discovered to include the preparation of certain documents required by civil service and the local organization. The complexity of the documents, and their infrequent and irregular use, made a one-time-teaching format unsatisfactory. The time required away from the job and the certainty of retention loss prior to eventual use of knowledge and skill learned militated against such an approach. The obvious solution was to prepare and validate *self-sufficient* guidance materials (3) for use by the supervisor when needed. An added value accruing to that of having an explicit guide was that, in its preparation, many ambiguities in personnel procedures were uncovered. This alone added significantly to a correction of the pre-guide performance deficiency of supervisors.

MECHANICAL PROCEDURES

The advance made in mechanical and electronic hardware has been a blessing to the medical sciences. It has also required that medical and paramedical personnel be able to operate, maintain, and repair various pieces of equipment. Here again, infrequent and irregular use, probable retention loss, and need for training time can be effectively circumvented by the use of guidance materials. This was done by the Instructive Communications Unit when it prepared and validated maintenance and repair guides for use by medical and paramedical personnel with two jet injector models (4,5). Operation, maintenance, and repair guides (6,7) were also prepared for use by United States and West African Nationals in the West African smallpox eradication program. Operation of the equipment was also included in guidance format, and the personnel was trained to make frequent reference to it, because the entrance repertoire of the personnel was particularly deficient in basic mechanical skills.

COMMUNICATION PROCEDURES

Most professional persons are called on occasionally to make formal presentations. Few things have proved more frustrating in training circles than attempts to provide satisfactory training to help these occasional speakers. Lecture preparation is a formidable task for which most of us are ill-prepared and for which insufficient occasions arise to allow us to *retain* a high degree of skill, even if had once been obtained. No doubt the most popular product produced by the Instructive Communications Unit is the Lecture Preparation Guide (8). Although it may be used in a formal training setting, it was prepared primarily for private use by the health professional when he is called on to make an occasional presentation. The Guide serves as the professional's personal, on-call-anytime, expert tutor and provides succinct, but complete, step-by-step directions. Although lecture preparation is often thought of as a skill just short of pure art, the behavioral analysis used in developing the guide transforms lecture preparation to a system that can be applied surely and confidently—by the most inartistic.

CRITICAL PROCEDURES

No one directly involved in using the procedure discussed so far would agree that completeness and precision in their performance are not critical. But how can such procedures compare with those performed by the physician as he manipulates the balance of life and death. *In such extreme situations concurrent guidance finds no better* *place*; in fact, it is found far less frequently than should be the case. Recent experience in establishing performance objectives for airline pilot training revealed the frequent use of written checklists (guides). These guides are used to insure no omission that could result in aircraft failure and almost certain loss of human life. Routine as well as the most critical emergency procedures are performed while under concurrent direction from guidance materials.

Investigation has revealed the use of a checklist (guidance) in the highly critical space industry. For example, maintenance procedures that may change overnight are under direct control of guidance. This concurrent guidance may be delivered by a compact tape recorder which allows the engineer to maneuver and manipulate freely. The engineer, with the appropriate basic training and a properly prepared guide, can perform specific procedures on specific equipment—both of which he may be seeing for the first time.

GUIDANCE AS A TEACHING TOOL

Thus far it has been suggested that guidance is usually used in lieu of attempting to teach total recall or of full reliance on memory. This is probably true, but guidance can be also used as an intermediary instructional device that enables a job to be done effectively with little initial, specific training. If the guide is then used often enough, and conditions permit performance without a guide, one will find himself gradually and painlessly relying more and more on his memory. That is, a greater degree of learning with respect to the task will take place during the frequent, guidance directed, on-the-job performance. With the exception of the procedures involving the airline pilots and space engineers, all of the previously cited guides could, in actual practice, be omitted from concurrent use once their frequent use has permitted complete mastery of the procedures.

Guidance material can be produced and used with the express intention that the on-the-job trainee must be able to perform *without* assistance from the guide within a specified time period. The Instructive Communications Unit did, in fact, produce such a guide for nonprofessionals employed to perform maintenance on portable insecticide sprayers (9) after a minimum of formal training.

CRITERIA FOR USING GUIDANCE MATERIALS

On the basis of the examples cited, the following conditions can be said to be favorable toward the use of guidance materials:

1. Procedures are rather complex, requiring set patterns of behavior and precise actions.
2. Procedures are done infrequently, thus permitting retention loss between occurrences.
3. Effective performance of procedures is required after little or no initial, specific, formal training.
4. Limited time and physical circumstances do not preclude the use of concurrent guidance.

There are four pitfalls to avoid, however, in using the guidance technique. Two of these have to do with making the decision to develop guidance materials and the other two pitfalls have to do with the actual preparation.

MAKING THE DECISION

Making the decision to use the guidance technique often encounters the same type of resistance that meets decisions to develop measurable behavioral learning objectives. The resistance comes in the form, "It can't be done!" That is it is the belief of the opponent that a procedure, or a general application of knowledge and skill, cannot be defined sufficiently to make explicit precisely what should be done and when. The illogic of this negative position becomes apparent when witnessing the effective repetition of a procedure, even if highly varied. If correct repetition is better than chance, it must be assumed that performance is not trial and error even if, at the moment, the performer cannot give overt expression as to the "whys" and "whats" of his behavior. The personnel and lecture preparation guides are examples of procedures whose promise of being precisely defined was constantly challenged. However, the opponent of guidance is granted one point: the time and effort required to make a procedure precisely overt may preclude the development of a guide. In such cases, it is usually assumed that the trainee or performer will somehow, perhaps intuitively manage to find the appropriate answers from the general instruction that can be provided.

Making the decision to use guidance materials may also threaten the vulnerable ego—especially that of the professional. Too often we behave as if a person is not competent unless he has absolute and comprehensive recall of his subject specialty. How does one react to the physician about to administer an injection with the jet injector if he seeks out and uses the repair and maintenance guide to service the injector? Since we know the guide is well prepared and validated, *we should have complete confidence in the physician's use of the injector!* In fact, if he uses the guide, we can be *surer* that he will not overlook some critical step in the procedure than if he were to rely entirely on his memory. This position seems more compatible with a familiar definition of an educated man: "He knows when to seek help, he knows where to find it, and he knows how to use it."

ACTUAL PREPARATION

Once the decision is made to prepare and use guidance materials, it must be remembered that the principles and techniques known as instructional programming are applicable. Guides are very much a type of instruction and as such are no less subject to programming. Making overt and precise that which is to be done and when, provides the measurable behavioral performance objectives of the procedure. These behavioral statements are presented to the user in instructional increments and in a format that insure correct performance. The instruction (guide) is revised on the basis of actual use (tryout), and the final version eventually validated in mass tryouts so as to provide publishable data on its effectiveness. The initial skills of the anticipated users must be taken into full account in lesson preparation and validation. Also, the language used in the guide must be meaningful even at the risk of offending "certain professional standards." For example, in the guide on staining procedures, the instruction says, in part, "Dip a piece of pH paper at least 2 cm. into the buffered water. . . ." It was discovered that proposed guide users could not estimate 2 cm.; therefore, the instructions were changed to include a graduated line 2 cm. long placed directly beneath the words. There may be those who would say that the user *should* know how to estimate 2 cm. In an attempt to enforce this notion, they would not include the additional instructions (graduated line) even if such omission meant invalidating the guide.

This leads to the second pitfall to avoid in actual preparation of guidance materials. Those of us who may be accustomed to writing instructions directed toward establishing "understanding," that is, various degrees of generalization and discrimination, find ourselves tending to build unnecessary understanding into guides. For example, in the guide on staining procedure, the instruction directs the user to, "Place slides into support with thin film down. . . ." No attempt is made to explain that this is done to prevent the residual of fixing solution into which the thin films are dipped from running onto the thick films. This information may have been included as meaningful context in an instruction directed toward having the student learn the procedure to the point of total recall over an extended period of time. This is just not the primary purpose of the guide. However, the curriculum planners desired that the guide users have a modest degree of understanding regarding the procedure. This led to the preparation of a *separate lesson* explaining the reasons for major portions of the procedure, even though it was not essential to the satisfactory use of the guide.

It has already been stated that the language of a guide should be appropriate to the initial behaviors of the proposed user. It is also essential that other skills and knowledge prerequisite to the use of a guide be made explicit so that users can be properly prepared. In the guide on staining procedures, the user is expected to have at least a minimal degree of knowledge and skill regarding the use of basic laboratory equipment. The guide makes this clear, but does *not* attempt to provide the necessary prerequisite instruction.

IMPLICATIONS FOR MEDICAL EDUCATION

Few, if any, professions are represented by a greater investment in instruction, both qualitative and quantitative, than is the broad field of medical science. Therefore, it is to be expected that those in the medical profession are particularly sensitive to the current shortcomings in instruction and to possible solutions. For the latter, the development and use of guides offer much, both directly and indirectly, to medical students and to those in medical practice.

THE MEDICAL STUDENT

Increasing concern is being voiced as to how the medical student of today, and especially those of the future, can master the rapidly multiplying store of medical knowledge. The medical student has already been transformed into a kind of human sponge—required to absorb great quantities of fact by rote and without discrimination toward its relative value and eventual application. Told to pause a moment to seek and think about broader relationships and implications, the student replys, "No time; I'll do that later!" An attempt to explain increased retention and understanding through the Socratic teaching technique receives cool reception. What may appear to be a slower, more demanding, method of having the student actively derive new knowledge from his appropriately cued prior repertoire does not seem to fit into the medical student's packed curriculum. Because the didatic approach appears less time consuming, it is too often favored over the Socratic. Tell the student what to learn (memorize) and he will—at least enough to pass an upcoming exam.

We suggest, to help conserve the student's time, that his study be made more relevant and productive. To make his long-range performance more reliable, we must recognize that learning and knowing are not non-dimensional absolutes. If this were not obvious before, instructional programming with its stress on *meaningful*, measurable behavioral learning objectives should have made it clear by now. The medical student should never be required to learn to recall from memory a procedure, a process, or a complex of terms if learning to use a relevant guide could be just as effective in the operational setting. The energy and time thus saved could be put to better use acquiring more meaningful knowledge regarding relationships and applications.

THE MEDICAL PRACTITIONER

All medical professionals know that rocess of learning really begins *after* medical school. Critical k wledge learned during the last month of formal training can be dated before the shingle is hung. As the time lag increases betw acquisition of knowledge and application, retention loss becon s an even greater enemy to effective performance. Guidance materials can be especially helpful to the physician who has only a minimum of time available for formal training and is forced to do most of his new learning and relearning on-the-job. Is there any reason why guides on new or esoteric diagnostic procedures—both clinical and laboratory—cannot be used by the physician as the need arises? They would certainly insure accuracy and minimize the expenditure of unnecessary training time.

Guidance materials in an appropriate format (e.g., dial access systems) can certainly be kept up-to-date more readily than can the active physician. Therefore, if the physician can be encouraged to use such a guide, the lag between discovery and application would be greatly reduced. Consider for yourself the implications of such guides in the area of pharmacology alone.

GENERAL IMPLICATIONS

Barring some major upset, it is a certainty that within the life time of the present medical student, he will participate in the effective and common use of the computer in taking case histories, making diagnoses, and recommending treatment. There may appear at first glance little relationship between the mammoth computer and the examples cited. Even so, both represent an application of the guidance technique; in the development of computer software, the kinds of analyses and decisions made are essentially the same. If medical educators and medical institutions could begin now to accept, develop, and use the simpler guidance materials within everyone's reach, this would provide a smoother and more effective transition to the eventual acceptance, development, and use of the computer.

CONCLUSION

Perhaps the specific examples cited have been overextended in making a general case for the guidance technique. At least some caution has been shown in not suggesting specific subject areas (behaviors) in medicine that can be best served by guides. These specific decisions will have to be made by experienced medical practitioners and academecians.

However, as difficult as it may seem, making these specific decisions is not the greatest barrier to effective use of the guidance technique. Rather, it is the egocentric position in which man often finds himself. Being a creator, he cannot often subject himself to the directing and addictive influences of that which he creates—thinking himself above it. However, by doing so, man has continually freed himself for pursuits more appropriate to his stature. This was accomplished when the wheel and lever were allowed to extend the effectiveness of man's muscle power. Perhaps the guidance technique, whether in the form of simple printed lists or complex systems computers, will be allowed to extend the effectiveness of man's mental power.

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Part V

Outcomes of Self-Instruction: For User and Developer

In the first three papers of this section, we are provided information on the utility of programmed instruction for a varied population of students. Forney and Pedersen tested learning sequences with physically handicapped students and found them successful. Mackenzie and his colleagues are continuing to investigate the advantages of individualized learning for adult "problem" learners who must be taught how to care for their diabetic condition. Soltesz reports on the development of a program to teach supervisors how to train non-professional hospital employees. In contrast, Wilds and Zachert present an intriguing analysis of case presentation teaching that proceeds from their preceding work with learning programs; Summit likewise attempts to specify the learnings that came from developing programs, not for the user, but for the writers and programmers.

The Use of Programmed Instruction With Severely Physically Handicapped Students*

RUSSELL FORNEY, Ph.D.**
EUGENE PEDERSEN, M.A.***

IN THE physically handicapped student population, factors of paralysis, diminished sensory reception, social isolation and physical immobilization following surgery can markedly impair the abilities of those students in an institutional educational program. Too often, the handicapped student suffers a progressive decline in educational level because of the interruptions in the normal learning sequence for repeated illness or hospitalizations. Automated teaching devices have shown promise in alleviating some of the problems in acquiring and retaining knowledge in such educational settings.

Results supporting the superiority of automated instruction methods over "conventional" classroom methods, when the subject material has been ordered or sequential, have been reported in the literature (Lumsdaine & Glaser, 1960). This relation has been demonstrated both in terms of the amount of material learned and the efficiency of learning (Goldbert, Myles, Dawson, and Barrett, 1964, and Hughes & McNamara, 1961). However, none of the studies reported have sampled directly the effect of automated instruction or learning in a physically handicapped population.

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**Chief, Clinical Psychology and Rehabilitation Unit, Department of Preventive Medicine and Community Health, University of Rochester School of Medicine and Dentistry.
***Research Assistant, Behavioral Medical Sciences, Rancho Los Amigos, Downey, California.

The project reported here was primarily concerned with the evaluation of one automated instruction method in teaching a sequential and rational subject material (mathematics) to a sample of severely physically handicapped students. Other relevant questions included: (1) What is the nature of the relationship between intellectual ability and the possible differential effectiveness of automated instruction and classroom instruction? (2) What is the relationship between the complexity of the subject material and the effectiveness of the two teaching modalities? (3) When the two teaching methods are combined, which sequence of instruction produces the greatest behavioral change (i.e., with machine instruction preceding the classroom instruction, or classroom instruction preceding the machine)? (4) How is the sequence of instruction related to the intellectual level of the students?

METHOD

Subjects

Thirty-two inpatients at Rancho Los Amigos Hospital, a unit of the Los Angeles County system, were included in the study. The ages of the subjects ranged from 12-21 years with an average of 16.64 years. Subjects had a mean IQ of 95.84 (Wechsler Adult Intelligence Scale or Wechsler Intelligence Scale for Children). The sample consisted of 5 postpoliomyelitis, 11 traumatic quadraplegics, 10 traumatic paraplegics, 1 arthritic, and 5 muscular dystrophy patients. The average length of disability for the sample was 9.58 years.

As indicated by performance on the STEP 3A Reading Test (The Sequential Test of Educational Progress), the mean reading level for the sample was 267.91 in terms of converted score. This is comparable to the reading level of the eighth-grade sample presented in the publisher's norms (viz., 268.00).

The subjects ranged in grade placement from seventh through the twelfth grade with a mean of the tenth grade. While the experimental *S*s performed at the eighth grade level with respect to reading, they had an average grade placement of the tenth grade. Thus, in terms of reading ability, a two-year lag is evident when comparing the hospital students with national norms.

A seventh grade reading ability was recommended for a successful program. Therefore, a cutoff point for screening subjects on the STEP Reading Test was established at the third quartile of the seventh grade national norms.

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As indicated by performance on the STEP 3A Reading Test (The Sequential Test of Educational Progress), the mean reading level for the sample was 267.91 in terms of converted score. This is comparable to the reading level of the eighth-grade sample presented in the publisher's norms (viz., 268.00).

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Design

Subjects in the four groups were matched in terms of reading level and intellectual ability. A description of the four treatment modes follows:

1. The first group, N = 7, received the teaching machine (TM) mode of instruction over the first half of the unit and the classroom (C) mode of instruction over the second half of the unit. This group is symbolized as TM → C.
2. A second group, N = 7, received a counterbalance order, i.e., classroom instruction over half of unit and teaching machine over the second half of unit. This group is symbolized as C → TM.

To assess any possible effects that might have resulted from making the transition from one mode of instruction to another (e.g., novelty) and to allow for the evaluation of the longitudinal effects of each of the teaching modes, two "continuous" groups were established.

3. The third group, N = 7, received the teaching machine mode of instruction across both halves of the instruction units (viz., TM → TM).
4. The fourth group, N = 7, received the classroom mode of instruction across all subject material (viz., C → C).

Subjects within each group were divided at the mean into high and low intelligence groups.

Independent Variables

1. Instruction material (covering fractions and decimals): units were split at the mid-points, thus, making four units of instruction.
2. Teaching machine mode of instruction.
3. Classroom mode of instruction. Teachers used course outlines prepared from the material covered by the TM.
4. Matching criteria: STEP 3A Reading Test, and WAIS or WISC.

Dependent Variables

1. Amount of instruction time required to complete units (TM vs C).
2. Performance on the arithmetic achievement test in terms of mean difference scores (i.e., pretest, midtest, posttests).
3. Rate of learning material presented on TM (% errors/

frames/minute): Since the rate with which the *S* progressed through the program was partially dependent upon the correctness of response, this derived measure took into account the percentage of error made over any unit of material.

Apparatus

The teaching machine used in this study is normally operated by ten pushbuttons located on the right side of the viewing screen. For this project, the machines were modified by replacing the mechanical pushbuttons with a separate unit containing a series of five two-way microswitches and electrical relays. Since the mechanical pushbuttons required considerable muscular effort to activate them, it was necessary to replace them with the microswitches which could be operated with relatively little exertion and with any functionally intact body part, including the tongue.

The programmed materials were presented on 35 mm film strips. Each frame or page of the film was projected onto an opaque viewing screen. Each unit of information or concept was followed by a multiple-choice question (four possible alternate responses were generally provided). Choice was indicated by pressing the corresponding microswitch. There were two possible outcomes for any choice made. If the correct alternative was selected, the succeeding frame contained verbal re-enforcement and new material. If the alternative was incorrect, a "corrective lesson," directed at the specific nature of the erroneous response, was presented. Following this, the original frame appeared and the question was answered again. If another error was made, the same process was repeated. As long as success was attained, new material was presented. Hence, mastery of the concepts was demonstrated before progress through the program could have been achieved. An error-counter attachment on the teaching machine recorded the number of errors made by each subject (i.e., the number of times the "return" button had been used).

Three-sided wooden booths fabricated from ¾" x 4' x 4' plywood sheets and painted a flat white were used with each of the machine units. These booths reduced the sources of distraction arising from extraneous visual and auditory stimuli.

To equate instruction material presented by the two teaching modalities (i.e., TM and C instruction), a teaching manual and text were prepared from the commercial material with the consent of the publisher. These texts were used by the instructors during the C instruction phase.

Procedure

The subjects who were to receive TM instruction were given preliminary training in the operation of the machine to establish a stable rate of response. For this training phase, a film strip covering English grammar was used. For one week preceding the experimental phase the *S*s were given a daily half-hour training session.

During the experimental portion, the subjects using the teaching machine were given a 25-minute daily session, while those receiving classroom instruction were given the normal 50-minute daily arithmetic session.

During the course of instruction, no assistance with regard to the subject material being presented was offered by the examiner.

Since the programmed instruction included some "homework" assignments, it was necessary for the attendant or the examiner to assist those unable to write by transcribing the written portions of the program.

In the classroom, the teacher presented material that was equivalent to the programmed material by using the prepared text.

The experimental procedure can be summarized in the following manner:

a. Pretest on fractions administered.
b. Instruction over first half of fractions unit.
c. Midtest covering fractions administered.
d. Instruction over second half of fractions unit.
e. Posttest covering fractions administered.
f. The same procedure was repeated during the units on decimals.

RESULTS

Table 2 presents the mean IQ, and the mean reading scores for each of the treatment groups. Relative to these matching criteria, it will be noted that the treatment groups are comparable. None of the differences presented in Table 2 were found to be statistically significant.

The two criterion measures employed for the experimental analysis were the mean difference scores between performance on the pretest and midtest and between performance on the midtest and posttest.

Three factors were taken into account in the analysis of variance: (1) Sequence of instruction methods (TM → C,C → TM, C → C, TM →TM); (2) Units of instruction (Fractions and Decimals); and (3)

TABLE 2

SUMMARY TABLE
MATCHING CRITERIA

	Treatment Groups			
Criteria	**TM → C**	**C → TM**	**TM → TM**	**C → C**
Mean IQ	91.67	97.50	99.89	94.71
Mean Reading*	258.20	271.00	271.55	260.00
N	7	7	7	7

*Reading Scores are cited in terms of STEP converted score.

TABLE 3

MEAN DIFFERENCE SCORES FOR SUBTESTS IN THE HIGH AND LOW INTELLIGENCE GROUPS RUN UNDER THE FOUR EXPERIMENTAL CONDITIONS

	Treatment Groups							
	TM → C		C → TM		TM → TM		C → C	
Intelligence	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo
Diff. Score	23.34	57.50	12.67	25.32	15.75	32.00	32.99	14.00

Intelligence (high and low). Table 3 contains the appropriate mean difference scores that were obtained under the four treatment conditions. Table 4 contains the mean difference scores for each unit of subject material.

The summary of the analysis of variance is represented in Table 5. All of the main effects (sequence of instruction methods, intelligence, and subject material) were found to be significant. ($P < .05$).

TABLE 4

MEAN DIFFERENCE SCORES FOR STUDENTS IN THE HIGH AND LOW INTELLIGENCE GROUPS AS A FUNCTION OF SUBJECT MATERIAL

	1st half Fractions		2nd half Fractions		1st half Decimals		2nd half Decimals	
Intelligence	Hi	Lo	[illegible]	Lo	Hi	Lo	Hi	Lo
Diff. Score	9.00	15.17	[illegible]	34.92	29.09	52.16	22.08	26.25

TABLE 5

SUMMARY TABLE

ANALYSIS OF VARIANCE PERFORMED ON THE [illegible] DIFFERENCE SCORES

Source of Variance Within Subjects	SS	df	MS	F
(A) Sequence of Instruction Methods	872.02	3	290.67	10.41*
(B) Intelligence	270.73	1	270.73	9.70*
A x B	1,329.58	[illegible]	443.19	15.87*
Sub.: W. Groups				
(error: within)	1,339.63	48	27.91	
Between Subjects				
(C) Subject Material	1,349.20	3	449.73	11.58*
A x C	1,761.82	9	195.76	5.04*
B x C	316.85	3	105.62	2.72*
A x B x C	499.94	9	55.55	1.43
C x Subj.; W. Groups (error: between)	5,590.77	144	38.82	

* $P < .05$

The two-way interaction effects (sequence x intelligence, sequence x subject material, and intelligence [illegible] subject material) were all significant at $P < .05$ level of confidence.

Simultaneous comparisons were performed on the marginal differences presented in Table 3 and 4 to ascertain which of these differences were statistically significant. Table 6 and 7 present the results

TABLE 6

POST HOC SIMULATANEOUS COMPARISON OF
MARGINAL DIFFERENCES*
(IQ x Teaching Method)

Order	1	2	3	4	5	6	7	8
	c	h	e	a	d	f	g	b
Means:	12.67	14.00	15.75	23.34	25.32	32.00	32.99	57.50
g	-	1.33	3.08	10.67	12.67	19.33	20.32	44.63**
d		-	1.75	9.34	11.32	18.00	18.99	43.50**
a			-	7.59	9.57	16.25	17.24	41.75**
e				-	1.98	8.66	9.65	34.16**
h					-	6.68	7.67	32.18**
b						-	.99	25.50**
c							-	24.51**
f								-

S_b - 5.28

Range		2	3	4	5	6	7	8
Q.95 (r, 48)		2.85	8.43	3.77	4.01	4.20	4.35	4.58
Q.95(r,48)		115.04	18.06	19.91	21.17	22.17	22.97	24.18

* Newman-Kuels Test: Winer, B. M. (2), Statistical Principles in Experimental Design.

P < .05

TABLE 7

POST HOC SIMULTANEOUS COMPARISONS OF
MARGINAL DIFFERENCES*
(IQ x SUBJECT MATTER)

1	2	3	4	5	6	7	8
a	b	g	c	h	e	d	f
9.00	15.17	22.08	25.25	26.25	29.09	34.92	52.16
-	6.17	18.08	16.25	17.25	20.09	25.92	43.16**
	-	6.91	10.08	11.08	13.92	19.75	36.99**
		-	3.17	4.17	7.01	12.84	30.08**
			-	1.00	3.84	9.67	26.91**
				-	2.84	8.67	25.91**
					-	5.83	23.07**
						-	17.24**
							-

	2	3	4	5	6	7	8
	2.85	3.43	3.77	4.01	4.20	4.35	4.58
48)	15.04	18.06	19.91	21.17	22.17	22.97	24.18

Test: Winer, B.J., (2) Statistical Principles in Experimental Design.

of these comparisons. The results indicate that the low intelligence subjects run under the TM → C condition, demonstrated the greatest amount of learning (viz., values listed under column 8), and that the low intelligence *S*s demonstrated the greatest amount of learning during the 1st half of the decimals unit (values in column 8).

The instruction time required to complete the fraction and decimal units for the Ss receiving machine and classroom instruction is summarized in Table 8. Subjects on the average took one-third as much time to complete the units of instruction when receiving machine instruction than when [illegible]eiving classroom instruction ($P < .05$).

TABLE 8

A COMPARISON OF THE TIME REQUIRED TO COMPLETE INSTRUCTION UNITS

	Machine (25 min. session)	Classroom (50 min. session)
1st half Fractions	5.88 hrs.	20.00 hrs.
2nd half Fractions	9.46 hrs.	27.17 hrs.
1st half Decimals	4.84 hrs.	14.17 hrs.
2nd half Decimals	5.55 hrs.	19.17 hrs.
Average	M - 6.43 hrs.	[illegible].*

*t - 12.95 / 2.32 - 5.58 (P <.05).

To evaluate the relationship between performance during machine instruction and the amount of learning, correlations were performed between the acquisition data or machine data (errors/frames/minutes) and the difference scores for the high and low intelligence Ss. The results of these correlations appear in Table 9. Significant posi-

TABLE 9

CORRELATIONS COEFFICIENTS BETWEEN MEAN NUMBER OF ERRORS/FRAMES/MINUTES AND MEAN DIFFERENCE SCORES FOR THE HIGH AND LOW INTELLIGENCE Ss

		Subject Material: 1st half Fractions	2nd half Fractions	1st half Decimals	2nd half Decimals
Intelligence	High	.45	.59	.92*	.80*
	Low	.90*	.85*	.41	.02

*P <.05

tive correlations ($P < .05$) were obtained for the high intelligence Ss over the first and second halves of the decimal unit, and for the low intelligence Ss over the two halves of the fractions unit.

DISCUSSION

Three factors were taken into account in the analysis of variance: (1) Sequence of instruction methods (C → C, C → TM, TM → TM, TM → C); (2) units of instruction (fractions and decimals); and (3) intelligence (high and low). Table 3 presents the appropriate mean difference scores that were obtained under each of the conditions.

The summary of the analysis of variance is represented in Table 5. Three main effects were found to be significant ($P < .05$): the sequence of instruction, the complexity of the units of instruction, and the intelligence level of the students. The significant sequence of instruction effect affirms the reported concept that automated methods are superior in the over-all learning effect to conventional methods. The marginal totals of Table 3 [illegible] ordering effect among the presentation modes. In terms [illegible]veness, the rank ordering would be C → TM lowest, C → C, TM → TM, and TM → C highest. The obvious relation is that TM either alone or followed by C is a more effective type of presentation for physically handicapped students than is C alone or the C → TM arrangement.

The significant units of instruction effect illustrates that the mean difference scores increase as the content complexity increases, an expected a priori relationship.

The third main effect, intelligence, demonstrated that the lower IQ groups derive a greater benefit from TM instruction than from C alone.

All of the two-way interaction effects, sequence x intelligence (A x B), sequence x subject material (A x C), and intelligence x subject material (B x C), were found to be significant ($P < .05$). Simultaneous comparisons were performed on the marginal differences presented in Table 3 and Table 4 to ascertain which of these differences were statistically significant. Tables 6 and 7 contain the results of these post hoc comparisons. The sequence x intelligence (A x B) interaction effect (Table 6) suggests that the TM → C sequence (viz., the values listed under column 8) demonstrated the greatest amount of learning. In fact, differences occur in the lower IQ groups in all the treatment sequences. However, the differences are significant only in the TM → C group. This suggests that the lower IQ groups derive the greatest benefit from the automated learning techniques when presented in tandem with C.

The B x C interaction (Table 4 and 7), Subject Material by Intelligence, show that the brighter students in this handicapped group did effectively use the automated method although not as effectively as the duller student. As the complexity of the content increased the brighter group derived more benefit from classroom interaction. The duller students continued to show positive incremental changes throughout, with the automated methods being definite'y superior.

This suggests that task complexity, as related to abstract concepts, may be more effectively handled in the classroom setting for the brighter students.

The instruction time required to complete the fraction and decimal units for the Ss receiving machine and classroom instruction is summarized in Tabl 8. Ss on the average took one-third as much time to complete the units while receiving machine instruction than when receiving classroom instruction ($P < .05$). When this result is considered, together with the amount of learning demonstrated under the two teaching modalities (i.e., Ss learned as much, or more, when with TM than with C) the TM method would appear to be the more efficient teaching modality.

The physically handicapped group included in this study responded differentially to the teaching methods used and to the complexity of the content.

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Programmed Instructional Material for the Adult Diabetic Patient With Grade School Education: Development, Use, and Evaluation In a Clinic Population*

GARY M. ARSHAM, M.D.,
MARY F. B. MOHAMMED, R.N., M.N.,
RUTH LAIDIG, M.A., DOVRE H. BUSCH, B.A.,
MAX MILLER, M.D., and
MALCOLM S. MacKENZIE, M.D.

IN DESCRIBING the present report as preliminary we seek to achieve two things. First, we would establish for ourselves the customary way out through the back should any onslaught be more vigorous than we now choose to entertain. But tempered onslaughts we welcome, else we would not be here. And second, you must know that this is very much work "in progress." Something over three years ago a group of us at the University Hospitals of Cleveland organized ourselves to produce a product—a product which is not yet at hand. Our objective is to produce a program which will teach diabetic patients with limited verbal skills how to take care of their disease.

Other contributors to this symposium have been concerned with educating groups (or individuals) with demonstrated high learning

*This project has been conducted at the University Hospitals of Cleveland and supported by Community Health Services Grant No. CH 37-21, United States Public Health Services.

ability, whose learning skills at the time of contact are in a good to excellent state of training. The subjects we are concerned with are, on the average, over 40 years removed from their formal educational experience, and this experience, even at the time, was for most of them insufficient to develop more than minimal verbal skills. But one great advantage we do have. The new departures in self-instructional education reported here by others must win their way over traditional teaching methods, which may be far from ideal, but which have by and large served American medical education well. A strong stimulus for our group has been the assured knowledge that conventional teaching methods, used with the population we are concerned with, will fail—and fail by a margin so wide as to make the effort expended probably not worth-while. One outstanding exception must be mentioned and that is individual instruction—proficient, personal, patient, and persistent.

We are convinced that no teaching system, no aids, no machine will excel this one-to-one tutorial method with its unique responsiveness to the student's progress and problems. But teaching time available to physician, nurse, and dietitian is limited. If our program makes these individual tutors more effective by having taught the patient a major amount of basic content, we will feel rewarded. Except for this individual instruction our program need win out over nothing!

How fortunate then that the trial and error process of program development has an inherent self-editing feature. One other aspect of programmed instruction I would mention here because of its peculiar fitness for our "student" group. These people, when placed in the unfamiliar area of a learning situation, tend to fall into a self-protecting passivity which further inhibits any educational yield. The *active response* feature of programmed instruction seems almost made to order for our population.

Education for the Diabetic Patient

We have said that the use of conventional teaching methods with our patient group, when measured by the effort expended, is probably not worth-while. One equivocates only because of the over-riding educational need. For in diabetes the patient's understanding and practice of a self-care regimen are widely held to be indispensable ingredients of proper medical management.

It is an incurable disease—often progressive over its course in severity and complications. The here and now is a metabolic imbalance, the hereafter is for too many a damaged vascular bed. Medical opinion has not reached full consensus on a cause and effect relationship between the metabolic imbalance and late vascular complications. But clearly predominant is the view that restoration, to the greatest degree feasible, of the metabolic balance—and this on a continuing basis—promises best for the diabetic's present and future well-being. It is the impairment or restoration of balance that is assessed under the heading of diabetes "control." It is subject to daily, even hourly fluctuation; it is the measure of the patient's self-care regimen. For only when hospitalized, does the diabetic patient share any part of his diabetic management with medical or para-medical personnel. At all other times he is uniquely in charge. Other personages, regardless of how skilled or how devoted, influence his diabetic care only through him. Their assistance can be effective only through his informed cooperation. It is for this reason that education of the patient is an almost universal objective of those who deal professionally with this disease.

So much for the need. Here is what we set out to do. We had available to us a well established diabetes out-patient clinic with a total enrollment of about 800 adult diabetics, the vast majority of whom had the stable middle-aged onset type of diabetes. From 1948 on, this clinic had fostered a whole series of ventures aimed at patient education. Why these successively failed was in large measure explained by a study published in 1964. This produced quantitative documentation of the severely limited language skills of the very population we were concerned with (1). It was found that 43 per cent of the patients in this diabetes clinic were unable to profit from any health material written at a fourth grade level or above.

The project we are embarked upon is distinctive perhaps in four ways: we were relatively early in utilizing programmed instruction in health education; we seek to educate by this new means a group with heretofore marginal educability; we seek to teach behaviorial skills through a behaviorally mediated program; and we will evaluate our success, in part, through the rigorous criterion of whether improved diabetes control can actually be demonstrated.

At the time our project was initiated, we knew of only one program designed for diabetic patients (2). Analysis of this program for reading level (3) showed major portions of it to be at the 11th to 12th grade level, and therefore far beyond the reading skills of a great majority of our patients.

PHASE ONE

Write initial Mast program on: 1) specimen collection
2) urine sugar testing
3) urine test record use

Random selection of patients; Collection of descriptive data.

Pre-test - ADMINISTER PROGRAM (272 patients) - Post-test.

PHASE TWO

Data collection on diabetes control: (each clinic visit)
1) weight
2) daily urine sugar tests
3) 4 before-meal urines
4) fasting blood sugar

Write full program.

PHASE THREE

Continue data collection on diabetes control for 136 experimental and 136 control patients.

Pre-test for information and attitude -

ADMINISTER FULL PROGRAM TO EXPERIMENTAL GROUP -

Post-test for information and attitude.

PHASE FOUR

Continue data collection on diabetes control for both groups.

Post-test experimental group for retention.

Figure 1

Organization of the Cleveland Project

Our total project, which is summarized in Figure 1, involves four phases. In Phase I we secure a study population and teach them certain behavioral skills, which, necessary for data collection, we ask them to perform throughout the balance of the project. In Phase II we make a year-long observation of each patient's level of diabetes control, and we prepare the full program of everything we want to teach them about diabetes. In Phase III we administer this program. And in Phase IV we assess diabetes control for a year after instruction. It will be noted that only one half of the study population receives final programmed instruction. The remaining patients have the usual instruction from physician, nurse, or dietitian available to them, but receive no special instruction. We have felt this group to be necessary because of the betterment of diabetes control that may well ensue from merely making regular standardized assessments of this control. It should be understood that our experimental design does not include a direct comparison of programmed versus conventional instruction.

At the present time we are nearing the end of Phase II. We have adequate pre-instructional observations on our patients and are in the process of trial and revision of late versions of the total program.

We began Phase I by writing a linear program of about 120 frames for use on the Mast Teaching Machine. We sought to teach three things: how to collect urine specimens, how to test them, and how to record the results. These represented specific terminal behavior skills which we wanted our patients to utilize thereafter in order to provide us the necessary data on diabetes control. Figure 2 shows this program in use with some of its associated "properties." During the course of the program the patient physically manipulates specimen bottles, simulated urine, test tubes, dropper, testing tablets, color comparison tubes and chart, and makes entries on a test record form.

This program we gave to 272 patients, the residual of 457 patients randomly selected from the total clinic population. From the gross random sample, 117 patients were excluded: for inadequate vision—47; for inadequate reading skill—43; for prolonged planned absence from the clinic—12; for physical incapacitation—11; and for poor clinic attendance—4. Inadequate vision and inadequate reading skills were determined by failure to respond appropriately to the first six frames of the instructional program as reproduced in Figure 3. Poor clinic attendance was defined as loss to clinic follow-up for

1. We have something new for you.
It's fun to use.
It's called a Teaching Machine.
Now press ANSWER button.

Good!
Now press ADVANCE button.

2. Look at the paper tape below.
Write your name on it.
Do this now.
Then press ANSWER button.

Look at paper tape.
Did you write your name on it? Good!
Press ADVANCE button.

3. As you answer the questions,
you will learn about Diabetes.
This machine will teach you about ______.
Fill in the blank with the best answer.
Then press ANSWER button.

Diabetes
Now press ADVANCE button.

4. It's important for diabetics to take
good care of themselves.
We'll help you learn to take
good _____ of your diabetes.
Please write the word.
Then press ANSWER button.

care
Now press ADVANCE button.

5. Your body can work normally even
with diabetes.
When your body works normally,
we say your diabetes is under control.
It's important to take good care of
yourself and keep your
diabetes under ________.
Write the word.
Then press ANSWER button.

control
Now press ADVANCE button.

6. One good way to see if your diabetes
is in control is to test your urine
for sugar.
You can help keep your diabetes
under ________ if you _____ your urine
every day.

control
test (or check)

Figure 3

Urine Sugar Test Record

Name ______________________ Diabetes Teaching

Phone Mrs. Busch, 791-7300 ext. 478 if you have any questions.

Date	Day	1 Before Breakfast	2 Before Lunch	3 Before Supper	4 Bedtime before eating	
	Sun.					
	Mon.					
	Tues.					
	Wed.					
	Thurs.					
	Fri.					
	Sat.					
	Sun.					
	Mon.					
	Tues.					
	Wed.					
	Thurs.					
	Fri.					
	Sat.					
	Sun.					
	Mon.					
	Tues.					
	Wed.					

88. Now pick up the paper beside you marked "Urine Sugar Test Record".

Find the 4 columns where you write how much sugar is in your urine.

These are marked "Before Breakfast", "Before Lunch", "Before Supper", and

"______________ before __________."

Bedtime before eating (Error rate: 109/243)

Figure 4

periods greater than six months. Irregular attenders were not excluded. Of the remaining 340 patients, 21 refused to participate in the project and 33 consistently failed to keep appointments to take the programmed instruction. Fourteen failed to return to complete the programmed instruction once begun, despite persistent attempts at follow-up. This left 272 patients who completed the program and constitute our study population.

Characteristics of the Study Population

Either at the time of intake screening or program administration, demographic and descriptive data were obtained on each patient which included: age, sex, race, interval since diagnosis, duration of attendance in our diabetes clinic, percentage overweight or under-weight, last school grade completed, present occupation, and "highest" occupational level achieved (4), number of persons in family unit, who in family unit does the shopping and cooking, and the average money expended weekly for food. Additionally, a short screening test ("QT" for Quick Test) affording an estimate of "verbal perceptual ability" or general intelligence was also administered to all the patients (5).

Only certain of these data are pertinent to the present report. Of the total 272 patients, 86% were Negro, and 79% were female. The mean age was 56.9 years with a range from 16 to 83 years. Patients 45 years of age or older comprised 84% of the study group. The following table shows the percentage distribution by last school grade completed:

Grade	*Percentage Distribution*
4 or less	13
5 - 8	43
9 - 12	39
over 12	5

Mean ± 1 s.d. = 8.0 ± 3.1 grades.

For reasons given above, presently elicitable verbal skills fall short even of these grade levels nominally reached.

The mean age at diagnosis for our study group was 47.1 years with seventy-four percent acquiring diabetes in their fifth decade or later. The mean duration of diabetes was 9.8 years, and for an average of 6.3 years they had attended our diabetes clinic. At the time of intake into the study, 62% of the patients were 30% or more overweight (6). The morbidity conditions associated with diabetes and obseity may not be fully additive, but assuredly they are in excess of either alone. A successful diet teaching plan giving attention both to kinds of food and amounts will have a usefulness beyond diabetes.

The results of the intelligence testing of the 272 patients are given in the table below. The mean IQ score was 80.5 with a standard deviation of 21.5. It should be noted that the QT Test was developed and standardized on the Wechsler Adult Intelligence Scale (WAIS) using an entirely white population.

IQ Score	*Percentage Distribution*
40-75	31
76-90	37
91-130	28
Unobserved	4

Ammons and Ammons have presented much data which support its validity as a measure of general intelligence. The QT is short, easy to administer, and relatively non-threatening.

Experience with the Instructional Program

With the 272 patients who completed the Phase I instruction, actually three versions of the program were used. Our experimental design did not require constancy in the program at this stage in the project, so towards the end of the instruction period two successively modified versions were given to 13 and 16 subjects. Data will be presented only for the original version taken by 243 patients

It will be subsequently seen in some sample frame sequences that the content of this program on urine testing and recording is actually very simple, and the responses called for, hardly challenging. From our earliest planning we viewed this Phase I program as affording us invaluable experience in the use of programmed instruction in our population. Shown below is the percentage distribution of 243 patients according to the time taken to complete the program:

Time (hours)	*Percentage Distribution*
less than 1	9
1-2	39
2-3	30
over 3	22

Mean ± 1 s.d. = 2.35 hrs. ± 1.63 hrs.

Although our clinic is composed primarily of middle aged stable diabetics we do have a few younger diabetics in their late teens or twenties. They fell almost entirely in the 9 percent who finished in less than an hour. Similar rapid performance was seen in a small group of 5th and 6th graders who knew nothing of diabetes. Responses from both these younger groups were almost error-free. But it is the 22% who required more than three hours that are most notable: for them the constructed response of the Mast teaching machine proved to be too demanding. For teaching the more complex content of other areas of diabetes, a different vehicle for program presentation would have to be found.

Another measure often used to evaluate programmed instruction is the percentage of correct responses made on the program. This in itself, however, is not necessarily a good index, for it may be quite easy to answer correctly a frame which teaches nothing. In general we subscribe to Holland's statement that "while low error level is usually a necessary condition of good programs, it is not a sufficient one" (7). In the completion of our program of 123 frames, our patients over-all made correct responses 76 per cent of the time. This is lower than we would have wished, so we have been at pains to identify the causes of error. Some patients hesitated to follow the "machine" instructions. These patients we had failed to make understand that we really wanted them to *perform* the behavior which the machine directed. Certain errors on frames of instruction were made because of a language deficiency rather than failure to understand. For example, one frame dealing with a urine specimen collection requires filling in the word "supper" in the phrase "Before ......". Many patients put "3"; this is a correct identification of the bottle to be used (bottle number 3) but does not make verbal sense. The behavior has been learned, which is our objective. But the frame of programmed instruction is not really appropriate for the population. This type of response error we would hope to eliminate.

In Figure 4 there is reproduced a portion of the Urine Sugar Test Record which we wanted to teach the patients to use. Super-imposed is the frame which initiates this teaching. The constructed response called for was beyond the capacities of 109 out of 243 patients. Thus painfully we learned that this wordy but actually simple frame would have to be subdivided, with the establishment of response feedback, to show that the columns were actually being "found." As it stands, the frame illustrates, I think, that with this populatior one will not realistically look for much in the way of mental "leaps" or interpolations.

The more difficult matter of teaching a concept that will govern a contingency is illustrated in Figure 5. The high error rate on frame 40 shows disappointingly poor learning from frames 36 and 37, although the fact that this was the first frame presented in this format, undoubtedly contributed significantly to the error rate.

	Frame	Answer	Error rate
36.	What if you do forget? Then please leave the bottle empty. Would it be all right to fill it with urine from some other time? ____ (Write yes or no.)	no	41/243
37.	The doctor would rather get an empty bottle than a bottle with the ____ urine in it.	wrong	78/243
38.	You're doing fine. Now let's review a little. How many urines will you bring the doctor? ____	4	13/243
39.	You make each one just before you ____ any food.	eat	29/243
40.	Suppose you eat before you save your "Before Supper" urine. What should you do? Choose A, B, or C. A. Save some anyway so the doctor will get some. B. Leave the "Before Supper" bottle empty. C. Fill the bottle with urine you saved before lunch.	B	122/243

Figure 5

An additional sequence of frames is reproduced in Figure 6. These are from a revised version of the program that was given to 13 patients. The ideas we sought to teach were the "just before" relationship of urine collections to meals, the sequential use of numbered specimen bottles, and the saving of only an aliquot of the urine voided. The high error rate on frame 26—even with the strong visual prompt—is disquieting. It illustrates a difficulty our population has with generalizing even the simplest information.

Progression to a New Vehicle

The program on urine collection, testing, and recording served its purpose well. Augmented by some individual coaching, when necessary, it taught our patients the behavioral pattern we wanted them to follow. And it taught us some of the hard facts about programming for this population. First, it taught us that too many of our patients will not be reached by the Mast Teaching Machine with its demands for reading and the writing of a constructed response. Secondly, it became clear that the time commitment that we would need ask of our patients in order to teach them the full content of diabetes instruction on a Mast machine was totally unrealistic. And thirdly, we

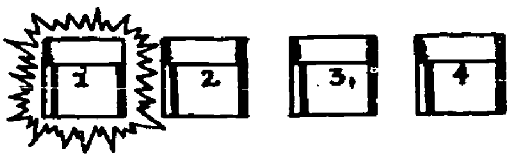
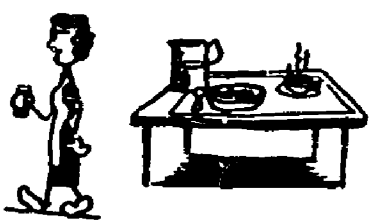
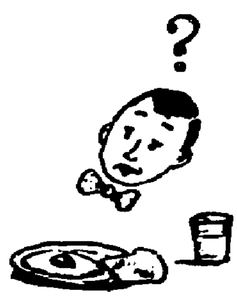
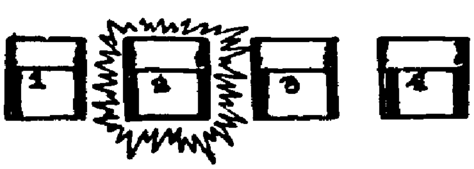
		Answer	Error rate
21.	 Look at the brown bottles on table. Pick up the bottle marked 1. What words are painted on it? _______ _________	Before Breakfast	2/13
22.	Here is how to fill bottle 1. Save your urine just before you eat breakfast. Put this urine in the bottle marked number ___.	1	2/13
23.	Go to the bathroom just before breakfast. You only need to save a little urine. Do you have to save all your urine? ____ (Write yes or no)	no	1/13
24.	"BREAKFAST"  Just save some urine _______ you eat breakfast.	before	3/13
25.	Would it be all right to eat a little food before you save your "Before Breakfast" urine? (Write yes or no) 	no	3/13
26.	 The next bottle you fill is marked "Before ______".	Lunch	5/13

Figure 6

were confirmed in our belief that these patients can probably be taught patterns of behavior through performance, but not as predictable *sequellae* of verbal concepts.

From its inception our project has been dominated by the idea that the diabetic diet is the most important area in patient education, and the area that has traditionally been most difficult to teach. It was through our efforts to set objectives for terminal behavior in the diet teaching that we were led to a major recasting of diabetic meal planning (8). The new system will not be given in detail here. Suffice it to say that it is based on fewer food lists, fewer foods to be measured, and fewer measurements to be used. It is theoretically less precise than currently used diet plans, but simplification carries the promise of better net adherence. It fosters interchangeability between starch-derived carbohydrate and that from vegetables or fruit. And it is compatible with presently used dietary prescriptions.

To present this new diet plan in a programmed format we are utilizing a new vehicle for program presentation, which has been developed in collaboration with the programming department of Appleton-Century-Crofts. This is pictured in a pilot set-up in Figure 7. A tape-recorder, its progression controlled by the student by means of an advance button, directs the use of a workbook in which responses, discriminating between alternatives, are made with a special pen. Prior chemical impregnation of the correct answer provides prompt confirmation. Qualitative and quantitative diet information is obtained from a teaching wall chart color-coded for the three main food groups: meat-milk, vegetable-fruit, and starch. The color-coding is carried over onto a plate that is used for mock meal assembly at the direction of the program. Also shown in the picture is the half-cup scoop which has become the standard measure for most foods.

The completion of this program on diabetic meal planning, plus some shorter attendant programs which cover other areas of diabetes self-care, will allow us to move into Phase III to administer the full instruction to one-half of our study patients, randomly selected after stratification according to years of schooling and IQ scores. During Phase IV we will, in addition to gathering data on diabetes control in all the patients, have an opportunity for program revision on the basis of the extensive testing that will have been provided by Phase III use.

Self-instructional booth for diabetic patient. Note audio player, programmed text, and illustrative panels for use by the learner.

Summary

Programmed instruction has been written for adult diabetic patients with limited verbal skills. Conventional teaching methods have largely failed to teach these patients the medically critical self-care regimen which they should follow. A study group of 272 patients, randomly selected from the Diabetes Clinic of the University Hospitals of Cleveland, demonstrates a mean age of 57 years, a mean duration of diabetes of 10 years, a mean IQ of 81, and a mean educational level of 8 grades. Experience with the presentation to this group of a linear program, calling for simple written responses and covering the subjects of urine collection, testing, and recording, is presented. The program included actual performance of the desired behavior as an integral part of its structure. The appropriateness of this teaching method for this population was confirmed, but problems encountered with the need for a constructed response and the time taken to complete the program (mean time 2.35 hrs. for 123 frames; mean of 75% correct responses), have pointed the way to a new vehicle for program presentation. A patient-controlled audio tape directs the use of a work book in which discriminatory choices are marked with a special pen, confirmation being seen by a color change in the correct response box. The study group will be observed for level of diabetes control for a year before and a year after taking a behaviorally oriented program on diabetic meal planning presented through this vehicle.

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Programmed Instruction to Train Hospital Employees How to Train Others

SHIRLEY SOLTESZ, R.N., B.S.*

THIS PAPER is a review of the steps involved in designing and producing the self-instructional program, "How to Train Hospital Employees." The areas I want to cover are: defining the target population, setting the course objectives, determining the course content, establishing a teaching strategy, and testing and using the program.

The Target Population

Communicating to the target population denotes tossing a unit of relevant, comprehensible concepts at the right people. So the author needs to know who the *right* people are: when he starts talking, who's listening?

We wanted this programmed course to be read by as many hospital employees as possible, but we realized it would be necessary to narrow down the universe to those employees who will say: "I want to learn." We set about sifting the crowd by asking two questions. First, where are those potential trainers who have basic needs that can be met by the concepts to be put forward in the program. And second, what is a typical target student like? For instance, what position does he hold? Where does he work? What is he already able to do? What does he already know? And how does he see himself in relation to his co-workers?

In order to locate our target group we conducted a moderately extensive field study. We visited various sized hospitals, from a suburban general hospital of approximately eighty bed capacity to an urban institution with over two thousand beds. Most information was

*Programming Project Director, Argyle Publishing Corporation, New York, New York.

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It was felt, generally, that every student trainer would benefit directly. Those with minimal experience would be provided with an organized, proven mode of changing behavior. In departments with multiple trainers and many employees working on rotating shifts, uniformly trained trainers would introduce consistency to the training goals and training techniques, thereby fostering a degree of security in both trainees and trainers. Experienced trainers, of course, would add another method of training to their repertoire, perhaps a better method, offering them a choice of methods, and allowing more time for individual problem solving.

It was felt that trainees would benefit indirectly from improved trainers. A qualified trainer would recognize individual needs more readily. Planning, execution, and follow-up of indoctrination training would be based on goals that are different from those required for up-grading on a continuing basis, or for refresher training. And the benefit of increased job satisfaction for both trainers and trainees alike, was not to be minimized. In general the supervisors felt that greater *esprit de corps* would be a likely bonus.

There were varying opinions regarding the area that demonstrates the most critical need for improved trainers. For instance, a supervisor of special billing clerks felt that her department needed good trainers as critically as any. She felt that a good trainer would be able to motivate the trainee to be fast, accurate, and relatively independent fo direct supervision.

On the other hand, a housekeeping supervisor felt that the trainer must be able to evaluate the limitations of each employee he plans to train and should train him individually for each task he would be expected to perform on the job. Then the trainer must be able to evalu-

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

In the nursing department, the supervisor felt that the minimum available training time makes it imperative that the trainer be effective as well as efficient. The time factor usually results in minimum, haphazard training by multiple trainers who are not the most effective. Indeed the trainer may be the newest or youngest member of the staff, with little or no training experience.

A laboratory supervisor looked at the other side of the coin. He felt that a trainer must know "how to train." He explained that what makes a technician competent does not necessarily make him a good trainer of others. Yet, in his own department new assistant technicians receive indoctrination training from the most efficient technician.

These observations and others were reinforced by information we gleaned from a report of a personnel research project conducted at St. Vincent's Hospital, New York City, and published in 1964 (1).

After talks with the supervisors (in most cases, trainers as well) we began to draw some conclusions. Generally speaking every area has its own critical need for improved trainers. In each case the need expressed was based on what the supervisor saw as the major function of a good trainer. They stressed the need for trainers to be able to carry out such functions as motivation, evaluation of limitations and individual training, preparation to meet individual goals, efficiency and effectiveness.

Most supervisors we spoke to agreed that the greatest number of employees would benefit in the housekeeping, dietary and nursing departments. These areas have a continuing need for indoctrination training of large numbers of employees due to the very high rate of personnel turnover. In addition, these departments have the greatest number of lowest skilled employees. This creates a continuing need for initial on-the-job training, up-grading to fill vacant job classifications in the higher skill levels, and up-grading to improve job satisfaction and retention of partially skilled employees. Although these three areas have the greatest number who would benefit directly and indirectly, all other departments have certain selected employees who would also gain measurably.

The next step was to describe the potential student trainer as we found him. We analyzed such factors as educational level, verbal facility, and background experience. We evaluated the relative complexity of the skills to be learned (taught) in various departments.

Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
2. He has a minimum of 1 year job related experience.
3. He is actively performing at least some of the skills being performed by the person or persons he is responsible to train.
4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

Our field study also indicated that the terms "supervisor" or "supervisory functions" were interpreted in a limiting way. Most employees we talked to associated these terms only with the job titles "Supervisor," "Director" and "Department Head." However, when the general descriptive characteristics of the target population are applied to each department trainer, we find the job title varies, may not include the term "supervisor," but often does include supervisory functions. It was agreed that throughout the program we would try to avoid references to the trainer as a "supervisor" in order to avoid ambiguity.

For each of the following departments, we have underlined the proposed target student according to his job title. This classification would be most accurate for an urban general hospital of approximately two hundred beds.

Admissions

1. <u>Department Head</u>
2. Admitting Clerks

Accounting:

1. Department Head
2. <u>Supervisors of Special Billing</u>
3. Special Billing Clerks

Dietary:

1. Department Head (Dietitian)
2. <u>Chef or Food Service Supervisor</u>
3. Diet Aids

ECG, X-ray and Lab:

1. Department Head
2. <u>Supervisors</u>
3. Technicians

Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses
4. Head Nurses
5. Team Leaders
6. R.N.'s
7. L.P.N.'s
8. Nursing Aids

Medical Records:

1. Department Head (Med. Rec. Lib.)
2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head
2. Ass't Department Head
3. Social Workers
4. Case Workers
5. Social Work Secretaries

The above listing is not intended to designate the limits of possible use of the program. It is intended only to identify the group to whom the program primarily addresses itself.

The Course Objectives

The purpose of the program is to develop real training skills in the student trainer, and not just the verbal skill of stating what a good trainer should know or be able to do. Therefore, after making another careful analysis of the terminal behaviors we wanted to bring about, we stated the objectives of the course in behavioral terms. For example, after completing the course, the student will be able to *do* the following:

Make appropriate preparations for training
- Determine training needs
- Plan the order of training
- Prepare the trainee for training

Train individuals to execute a task or procedure
- Determine the training steps
- Give the trainee an overview of what he's to learn
- Instruct the trainee
- Give the trainee feedback on his performance
- Consolidate trainee's learning as he goes along
- Withdraw trainer assistance and put the trainee on his own

Maintain a high level of performance
- Evaluate trainee's performance periodically
- Motivate trainee to maintain performance standards
- Retrain as needed

The Course Content

The next step was to determine what specific concepts would be taught and how they would be presented. On the basis of the field study, we established the following criteria to help us determine the content of the course: 1) The basic training principles to be taught must be based on modern industrial training psychology. They must be few in number, clear-cut, and underly techniques and skills that are easy to apply. 2) The specific case examples used to demonstrate these principles must provide a high degree of face validity. That is, the learner must immediately perceive the relevance of each example to his own unique situation. And 3) The level of the language and vocabulary must communicate easily to a high school graduate, but contain enough professional and medical jargon to maintain the involvement of a technically advanced reader.

Four basic training principles were selected—the principles of performance, feedback, withdrawal of support, and consolidation of learning. These have been used and tested in many training situations similar to those found in hospitals to meet the objectives of both indoctrination and refresher training. Therefore, we felt that these same principles could be applied effectively by most hospital trainers to meet the specific needs of their own department.

The principle of performance implies that the trainee should perform during training what he must do on the job. Immediate performance helps to "lock in" appropriate behavior so that subsequently, the appropriate response behavior is more likely to result whenever similar stimuli are presented. To apply this principle the program prescribes a well defined procedure for easy recall: *tell* him what to do; *show* him how to do it; *review* what you've covered; and lastly, let him *perform* the step, task or procedure.

The second principle to be taught is feedback. There are two aspects of feedback that could be taught. The verb form of the word means sending back information in response to a bit of information transmitted. But this is a two-way street. After the trainer communicates information to the trainee, he evaluates the verbal and visual factors in the environment to determine whether or not the student's

reactions are appropriate to the information transmitted. The trainer can then change his own behavior in accordance with the trainee's responses. But, conversely, the student, who is hesitantly performing, needs to know whether or not his actions are appropriate before he's secure enough to go on, or can adjust his performance. This is the aspect of feedback which we decided to stress. To apply this principle we specify a clear-cut procedure. The trainer should *tell* him whether he's right or wrong. When he's wrong, point out his mistake and *correct* him; when he's right, point out he's right and *support* him; occasionally praise his appropriate behavior.

Withdrawing support gradually implies letting the trainee work more and more on his own. Application of this principle depends on the judgment of the trainer in the immediate time and place. We recommend three kinds of support which can subsequently be withdrawn in accordance with the stages of competence displayed by the trainee. When the student performs the task with a degree of finesse, the trainer should *stop telling him he's right*. He probably already knows he's right at this point and may feel the support is patronizing. If, on the second or third performance he performs inaccurately, the trainer should remind him he's not correct but *stop reinstructing him when he's wrong*. He will probably be able to correct himself at this point. The third step is to *stop telling him when he's wrong*. Usually at this point he will catch his own error within seconds, and feel a certain pride in recognizing his own error.

Consolidation is the last principle to be taught, that is, pulling together small units of information so that they become a unified whole. We recommend teaching one small unit of information at a time. The size of the step is arbitrary, but is usually governed by the ability of the student and the difficulty of the material being taught. After presenting two or three steps, the trainer would have his trainee perform all units that make up the entire procedure.

Preparation for Training

After the trainee learns how to apply the principles of good training, he studies how to prepare for training. Although preparation should always precede the actual training, we decided that when the student knows what good training requires, he would better understand the necessity for careful preparation. And besides, the program tries in every way possible to apply the principles of training it teaches. The first principle—Get the trainee to perform—is applied with

greater impact by teaching "How to Train" before "Preparation for Training."

We selected three sub-terminal behaviors we wanted to bring about in a trainer who must be able to make appropriate preparations for training: he must be able to determine training needs, plan the order of training and prepare his trainee for training.

The program prescribes a clear-cut procedure for determining the indoctrination training needs of a new employee. Preparation for refresher training applies the same basic rules, but the resultant training needs are usually fewer. First, the trainer must state the overall training goal. Generally, the goal is determined by the trainee's job title. Then he is taught how to use a job breakdown form to determine what behaviors are required to reach the goal, and what behaviors the trainee already is able to perform. Lastly, the trainer must subtract what the trainee already is able to do from the required behaviors. The difference is the training needs.

Preparation includes ordering the tasks to be taught. Since the order is partly determined by the demands of the job itself, the relative interdependence of separate tasks and the ability of the trainee, we composed three questions the trainer can ask himself to establish the order in which he will train several tasks. First, he asks himself which tasks the trainee must be able to accomplish at once, on his own, and which can be postponed? Analyzing these categories separately, he asks if any of the functions or tasks depend on any others, and, if so, which ones? Finally, with the tasks listed in their order of interdependence, he asks which ones are easier to learn? The order of training is established by a final analysis.

Having determined the order in which to present the material, we wanted the trainer to prepare his student to get the most out of his training. This behavior requires attention to a couple of physical and psychological factors preliminary to the actual training. The procedure taught is straightforward. The student learns how to select a comfortable, undisturbed location to carry on training, and how to minimize apprehension and put the trainee at ease. Finally, the text suggests some ways to strengthen the trainee's motivation to learn.

Follow-up of Training

We felt that follow-up behavior requires two sub-terminal behaviors. The trainer must be able to evaluate the trainee's performance and then take appropriate action on the basis of his evaluation.

A periodic review is the recommended mode of evaluation and we felt that simple guidelines would help the student internalize a workable evaluation procedure. He is taught *what* to check, *when* to check and *how* to check.

Using the job breakdown form, the trainer learns to check most often on those tasks or functions which are most important. Generally speaking, the most important tasks would be the ones that affect the patient's welfare most directly. He is taught to check on a regular basis, that is daily, weekly, monthly, etc. Whether he should check more often or less often depends on how reliable the trainee is and how recently he has learned the tasks. The trainer must then find yardsticks with which to measure both the quantity and quality of his employee's performance. Some objective measures are suggested. It's not enough to decide which tasks are the most important and to measure them regularly. He must know what to do with the measurement. The trainer must be able to identify acceptable performance from unacceptable performance by comparing his measurements against a good standard. Where no standard exists, he is taught to establish an objective criterion of his own.

The second subterminal follow-up behavior is to enable the student to take appropriate action on the basis of the evaluation. This involves teaching him what action to take in order to maintain good performance and an alternative action if the performance is unsatisfactory.

Let's begin with the assumption that a person who is recognized for doing his best is more likely to continue putting his best foot forward. Therefore, the trainer is taught to reward good performance. Admittedly, the kind of reward which the trainer may offer depends on his own job position. But there are usually some things which affect an employee's willingness to do his best that a trainer can do something about. For example, every trainer can offer praise for a job well done. In addition, he may be able to recommend a raise or a promotion. The program encourages him to tell higher-ups about his trainee's good work.

Taking action to improve poor performance is a little more involved. Again we start with another assumption that the trainee is rarely 100% unsatisfactory. The trainer is taught to maintain the employee's good performance by rewarding him in some appropriate way, but in areas where his performance is weak or unsatisfactory, he must first determine the causes of poor performance before he can

take action to improve performance.

The trainer is taught to classify causes of poor performance into three groups.

1. The trainee may be *unaware* of what is acceptable performance. Clearly, improving the trainee's performance would involve telling him what's expected.
2. The trainee may be *unwilling* to meet acceptable performance because of personal or interpersonal problems. This can be considered a problem of motivation and would be too difficult to handle in this program. The program only recommends that the trainer attempt to motivate his trainee by explaining the need or importance of performing up to standard.
3. The trainee may be *unable* to meet acceptable performance standards. The trainer is taught to recognize that inability to perform, due to weak skills, requires retraining. He is also taught that retraining will not solve a problem of poor health or malfunctioning equipment.

Case Examples

Determining the specific case examples is the last task before the programmer begins writing the program. Our objective was to tailor the program for a hospital, giving a high degree of face validity to every example used. This meant that situational examples had to be selected so that they helped the reader: 1) to perceive the common factors that exist in training and supervising throughout all departments; and 2) to appreciate the relationship of any specific example to his own unique department.

Information gathered during the field study made it possible to develop the schema of existing functional relationships which follows. On the basis of this schema it was possible to determine which examples would be most relevant to the greatest number of readers. We selected the largest number of examples to demonstrate the ties between the accounting, admitting, and nursing departments. For instance, an example based on job functions of a special billing clerk in the accounting department (such as recording charges for drugs, supplies and equipment, etc.) is likely to be relevant to the nurse on a particular unit who initiates the charge cards. And the same example is relevant to an admitting clerk who assigns room accommodations and must submit charges for basic room and board. (See Table 1)

The next largest group of examples exhibits the ties between the

SCHEMA OF FUNCTIONAL RELATIONSHIPS

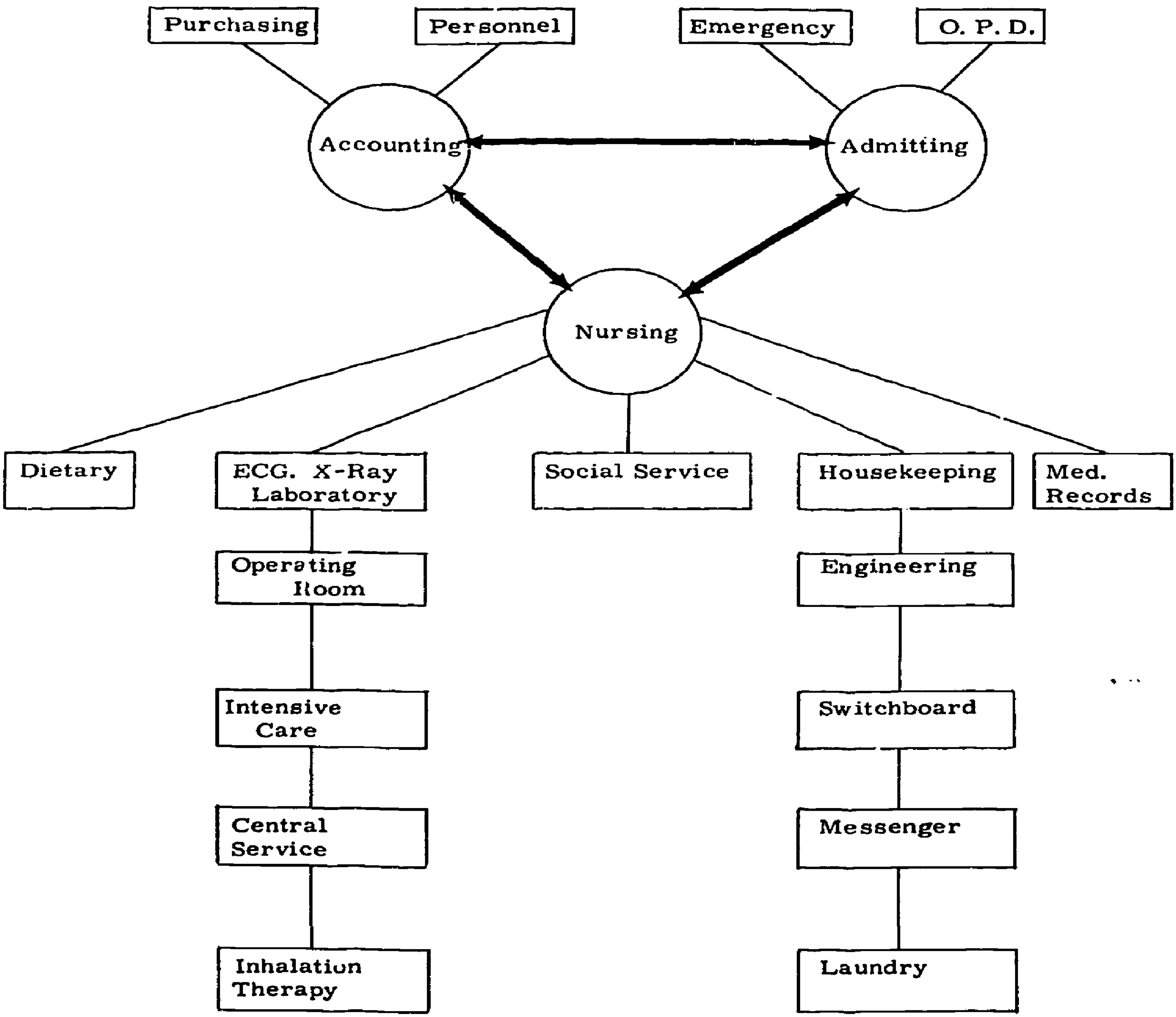

Figure 1.

nursing department and other supporting departments such as dietary, technical medical services, housekeeping, medical records, and social service. A few examples were taken from the top of the chart indicating that the strongest relationships are with departments other than nursing. A final analysis shows that examples were selected from 14 different departments.

Language and Vocabulary

Another objective was to communicate easily, yet keep the reader involved. The choice of language used and the selection of the vocabulary were left to the discretion of the programmer. Analysis of a randomly chosen sample of 100 consecutive words indicates a Flesch Index of reading difficulty of 5-6 (2). Material exhibiting this index assumes that the reader is a high school graduate and may have some college.

Testing

How do we know the completed program will teach what we say it will? First of all, experience tells us it will. But we can't rely solely on experience and intuition to be sure it works, so after each chapter was completed, a developmental test was conducted on a sample of the target population. This afforded the programmer the opportunity to check the relative complexity of the language, the sophistication of the vocabulary, as well as the facilitation of syntax and strategy used in presenting the concepts.

During testing the programmer observed student reponses, noted the areas of difficulty and encouraged each student to express the reasons for his difficulty and incorrect responses. Our objective was not to get 90% of the students to respond correctly on 90% of the frames (or some other arbitrary percentage), but rather to enable him to accomplish the terminal behavior at the end of each carefully planned sequence of teaching frames.

All developmental testing was conducted at Lenox Hill Hospital, New York City, with five employees who exhibited the relevant characteristics of our target population, with the exception of the level of formal education completed. The selection of trainees included a supervisor of accounting clerks (M.S. degree), an admitting officer (B.S.), a patient unit nurse (R.N.), a dietary aide (High School), and an assistant foreman of porters (incomplete High School). The average completion time for the entire program was 6-6½ hrs.

Programmed Instruction to Train Hospital Employees How to Train Others

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

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Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses

Medical Records:

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2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head

Maintain a high level of performance

Evaluate trainee's performance periodically

Motivate trainee to maintain performance standards

Retrain as needed

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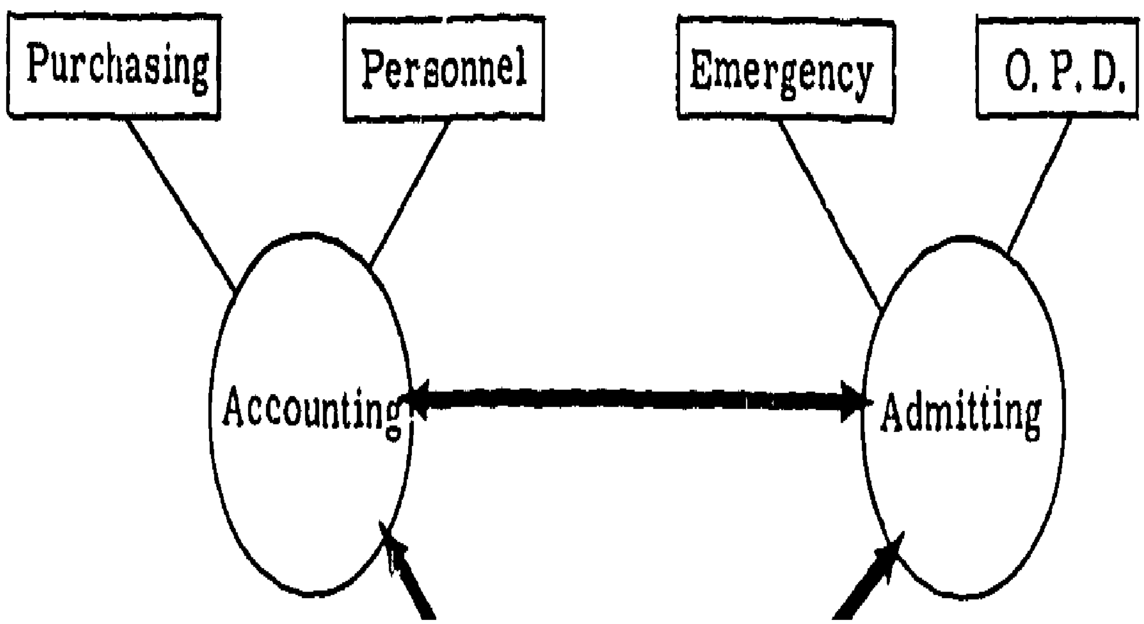

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Another objective was to communicate easily, yet keep the reader involved. The choice of language used and the selection of the vocabulary were left to the discretion of the programmer. Analysis of a randomly chosen sample of 100 consecutive words indicates a Flesch

Programmed Instruction to Train Hospital Employees How to Train Others

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

In the nursing department, the supervisor felt that the minimum available training time makes it imperative that the trainer be effective as well as efficient. The time factor usually results in minimum, haphazard training by multiple trainers who are not the most effective. Indeed the trainer may be the newest or youngest member of the staff, with little or no training experience.

A laboratory supervisor looked at the other side of the coin. He felt that a trainer must know "how to train." He explained that what makes a technician competent does not necessarily make him a good trainer of others. Yet, in his own department new assistant techni-

Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
2. He has a minimum of 1 year job related experience.
3. He is actively performing at least some of the skills being performed by the person or persons he is responsible to train.
4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses

Medical Records:

1. Department Head (Med. Rec. Lib.)
2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head

Maintain a high level of performance

Evaluate trainee's performance periodically

Motivate trainee to maintain performance standards

Retrain as needed

The Course Content

The next step was to determine what specific concepts would be taught and how they would be presented. On the basis of the field study, we established the following criteria to help us determine the content of the course: 1) The basic training principles to be taught must be based on modern industrial training psychology. They must

reactions are appropriate to the information transmitted. The trainer can then change his own behavior in accordance with the trainee's responses. But, conversely, the student, who is hesitantly performing, needs to know whether or not his actions are appropriate before he's secure enough to go on, or can adjust his performance. This is the aspect of feedback which we decided to stress. To apply this principle we specify a clear-cut procedure. The trainer should *tell* him whether he's right or wrong. When he's wrong, point out his mistake and *correct* him; when he's right, point out he's right and *support* him; occasionally praise his appropriate behavior.

Withdrawing support gradually implies letting the trainee work

greater impact by teaching "How to Train" before "Preparation for Training."

We selected three sub-terminal behaviors we wanted to bring about in a trainer who must be able to make appropriate preparations for training: he must be able to determine training needs, plan the order of training and prepare his trainee for training.

The program prescribes a clear-cut procedure for determining the indoctrination training needs of a new employee. Preparation for refresher training applies the same basic rules, but the resultant training needs are usually fewer. First, the trainer must state the overall training goal. Generally, the goal is determined by the trainee's job

A periodic review is the recommended mode of evaluation and we felt that simple guidelines would help the student internalize a workable evaluation procedure. He is taught *what* to check, *when* to check and *how* to check.

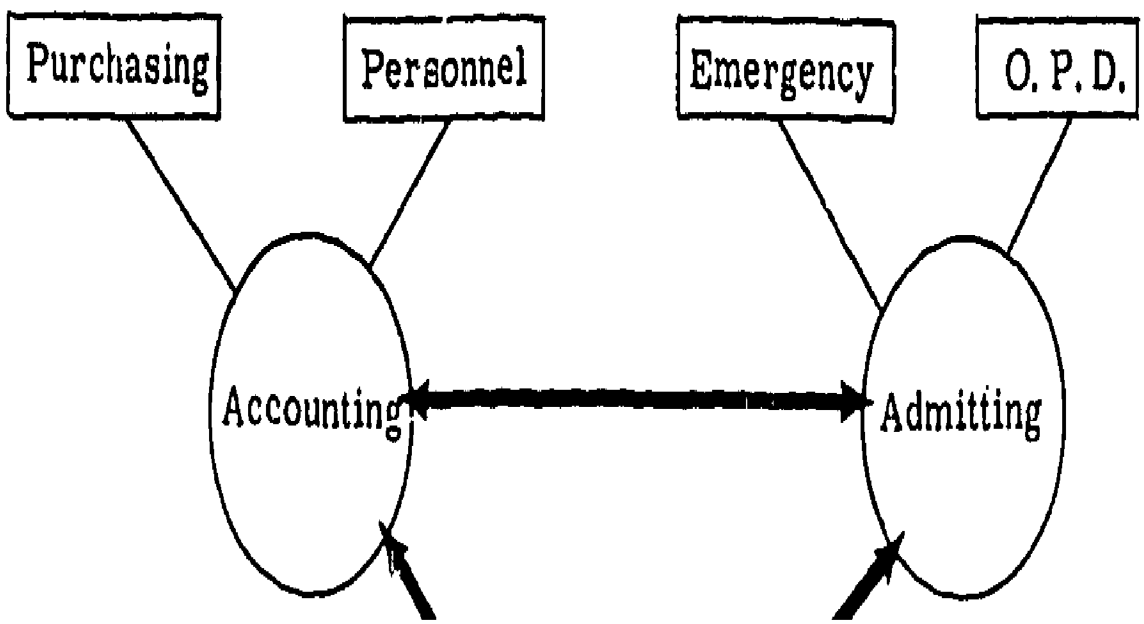
Using the job breakdown form, the trainer learns to check most often on those tasks or functions which are most important. Generally speaking, the most important tasks would be the ones that affect the patient's welfare most directly. He is taught to check on a regular basis, that is daily, weekly, monthly, etc. Whether he should check more often or less often depends on how reliable the trainee is and how recently he has learned the tasks. The trainer must then find

take action to improve performance.

The trainer is taught to classify causes of poor performance into three groups.

1. The trainee may be *unaware* of what is acceptable performance. Clearly, improving the trainee's performance would involve telling him what's expected.
2. The trainee may be *unwilling* to meet acceptable performance because of personal or interpersonal problems. This can be considered a problem of motivation and would be too difficult to handle in this program. The program only recommends that the trainer attempt to motivate his trainee by explaining the need or

SCHEMA OF FUNCTIONAL RELATIONSHIPS



nursing department and other supporting departments such as dietary, technical medical services, housekeeping, medical records, and social service. A few examples were taken from the top of the chart indicating that the strongest relationships are with departments other than nursing. A final analysis shows that examples were selected from 14 different departments.

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As anticipated, the foreman of porters was at a considerable disadvantage; the programmer observed that his reading ability was minimal. All other students responded well with little or no difficulty. The kind and extent of revisions undertaken were most often determined on the basis of difficulties and suggestions received from the dietary aide. All students seemed enthusiastic throughout testing, and reported that the program kept them interested and involved.

Using the Program

Putting the program to use involves two considerations: the mode of employing the programmed text, and the problem of gaining faculty acceptance and administrative support. An accompanying Leader's Guide offers assistance in both these areas. It provides a description of programmed instruction, its advantages and recommended ways to use it. It also includes how to select prospective student trainers, the objectives of a program coordinator or group leader, and an integrated step-by-step lesson plan for each chapter of the program.

We recommend three ways to use the program: independent study, supervised individual study and supervised group study. Some employees are personally motivated toward self-improvement and seek ways to improve their own job performance. In such cases, the training coordinator or personnel director should be able to answer inquiries about materials available, or supply the program, or report hospital policy on the supply or purchase of the program. The employee can study on his own time, with minimum supervision and guidance from the training coordinator (or personnel director).

How to Train Hospital Employees may be used in supervised individual study. On occasion it becomes apparent that certain employees would benefit measurably from learning how to train better. Or they may need to learn how to train for possible promotion, skill level increase, or review of previously learned training skills. These individuals are selected for training on the basis of their needs; they may be recommended by their supervisors. The students are supplied with materials and their training is supervised from beginning to end by their own immediate supervisors, who have been appointed as their personal training coordinators.

Although classrooms and scheduled classes are unnecessary, supervised group study is often used to increase learning. In any hospital there are usually employees in different departments who have similar training needs and can benefit from group study. In such cases, five to twenty-five employees may be selected from various departments for group training. The group meets with a group leader one hour a week for five or six weeks. They study one chapter at a time away from class, and at the group session they review the course material. The accompanying Leader's Guide provides the group leader with questions and specially designed problems to stimulate discussion. Both the discussion and the problems help the student trainers to apply the principles learned to real life situations.

Conclusion

The opening sentence of this paper claims that what follows is a "review" of the steps involved in designing and producing the program. At this point most readers will consider it a misrepresentation of the fact. But, indeed, it is only a review, when all the facts are considered, and this is the point we hope to have made.

The program is not simply a chunk of instructive material "packaged" in a new format; rather it is a painstakingly analyzed, detailed plan for changing behavior. Our goal, simply stated, was to make the reader an effective trainer. Our first series of analyses determined the potential target population and the characteristics of a representative member. The analyses which followed helped us to determine all the skills which must be exhibited by an effective trainer and to establish specific training needs by eliminating those skills he already possesses.

Still, before we could begin writing the program we had to determine what concepts, principles and attitudes the student must internalize in order to be able to perform the desired skills, and then we had to decide how to present them. We had to establish an efficient sequence for all the information to be taught, then establish the most effective sequence for each smaller unit of information, select relevant examples, and then prescribe the language and vocabulary within which we would deliver the information to the student. At this point the programmer sat down to create a behavior changing program, one word, one sentence, one frame at a time.

After all this, the programmer still believes that if the student hasn't learned, the programmer hasn't taught. So early in the development of the program, we had to test the thoroughness of our analyses, the accuracy of our judgment, the clarity of our writing, and the value of our experience, against a sample of the predetermined audience. Seldom are results of testing so devastating that the programmer doesn't recover; however, revisions are made wherever they are required, and, if extensive revisions are necessary, the same unit would be tested again to ensure attaining the desired behavioral objectives.

Finally, we come to using the program. A student working on his own time, at his own pace, should be able to meet his own objectives and the objectives of the program. Supervised group study is known to increase learning, and provides additional benefits not attainable by independent study. But, using the program for independent study or adapting it to a classroom situation implies confidence in and acceptance of this new technology.

We hope this paper has contributed in some way to both.

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Objectives and Rationale of Case Presentation Teaching Using Programmed Materials

PRESTON LEA WILDS, M.D.* and
VIRGINIA ZACHERT, Ph.D.*

THE TRANSFORMATION of a medical student into a skilled clinician is a process which requires experience with hundreds of patients distributed over a learning period of four or more years. Programmed instruction is not likely to accomplish four years' work overnight; in fact, programmed instruction has not been proven to be inherently more efficient or effective than other methods of instruction. The increased efficiency or effectiveness of programmed instruction relates most surely to the methods of preparing programmed instruction which lead to the recognition and removal of inefficiencies that persist unnoticed in most of the other instructional media. Programmed instruction, in order to function at all, must have defined or definable objectives. It must communicate; otherwise, self-instruction does not occur. In comparison, a lecturer can give classes for years without even considering problems of objectives, communication, or evaluation.

A proper starting point is to look at the nature of what the student must learn. Patient management is a complex and highly variable process. It is appropriate to consider two stages of clinical problem solving:

1. The stage of inquiry
2. The stage of problem resolution

*From the Department of Obstetrics and Gynecology, Medical College of Georgia.
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The stage of inquiry usually involves two steps: finding the problem; then, defining it. Finding the problem may be easy or may be extremely difficult. Sometimes the patient tells you, "My problem is such and such." On the other hand, large amounts of information may need to be obtained and evaluated in order to recognize the full scope of the patient's difficulties--which may be perceived quite differently by the physician than by the patient. The possible approaches for collecting information leading to the problem are many and varied, but the process is not a random one; information must be collected with a proper consideration for effectiveness, efficiency and patient safety.

After the problem or problems have n identified, the stage of inquiry continues with attempts to define them. The majority of clinical problems require that a surprisingly large amount of information be collected and evaluated in order to define the patient's problem precisely and rule out complicating conditions. In history and physical examination alone, the work-up of the usual medical or surgical patient calls for collecting and evaluating information in more than 50 different categories. The more information the physician collects, the more he must call upon and apply his fund of specialized medical knowledge and the more selective he must be to obtain this information in a safe and efficient sequence, constantly modifying his plan in the light of new information as he receives it. During this process he must decide when he has collected enough information to proceed with formulating a plan for treatment or disposition of the patient. The decision, "How much information is enough?", may be based on only a few items in extreme emergency conditions, or on hundreds of items in many chronic conditions. But in every case, it involves a series of complex probability estimates which the physician often makes unconsciously.

The stage of problem resolution differs from simpler and more static types of "puzzle solving" because it involves concurrent inquiry or discovery as well as answer finding. Part of the problem is that the patient's difficulties must be recognized and defined in the process of being resolved. Sometimes, a clear separation is possible. Management, therapy, or disposition of the patient's problems, once they have been defined, can often be represented on paper as simple "Yes-No" decisions. The process of making these decisions, however, is seldom so simple. It often requires the physician to handle dozens of items of highly specialized information, much of which is incomplete or conflicting, before he can reach conclusions which permit overt action. For other problems, the stages of inquiry and resolution remain inseparably intertwined. Appropriate management requires a prolonged series of therapeutic trials which must be carried out concurrently with gathering and evaluating further information about the patient's response to the trials.

Effective, efficient clinical problem solving has some characteristics which are generally recognized as desirable. In attempting to describe the characteristics of clinical problem solving, people will differ in their language and in what they select and emphasize.

Here is one such attempt:

1. The initial approach to the problem is comprehensive in scope.
2. As information accumulates, the goals of inquiry are continually re-evaluated and the problems are redefined.
3. The acquisition of information becomes increasingly selective:
   a. Unnecessary risks are minimized
   b. Important problems are given priority over inconsequential ones
   c. Efficient sequences are preferable to less efficient ones.
4. Urgent situations, needing prompt action, often require responsible decision-making with incomplete or unreliable information.

These statements may seem more meaningful when rephrased as questions:

1. How does the student learn to be comprehensive, responsive, selective, and decisive in his approach to patient care?
2. How does he learn to distinguish between necessary risks and unnecessary ones?
3. How does he recognize the important details from trivial ones, and distinguish the efficient approaches from the less efficient ones?
4. How does he know when he has enough information to make a decision?

The person who would use programmed instruction in an attempt to teach patient management cannot avoid facing these questions seriously and looking for usable answers. These answers are, at best, tentative and incomplete.

Skill in clinical problem solving can be considered as having three special attributes:

1. Facility in handling complex, conflicting probability estimates;
2. Development of unique, personal strategies for problem solving;
3. Maintenance of an open approach to inquiry.

1. Facility in handling probability estimates. Almost every clinical decision which requires "experience" or "judgment" can be thought of as a probability estimate involving conflicting data. Whether the decision involves an item of history taking, or of physical examination, or of laboratory work, it must be made after a consideration of such as the following (the list is incomplete and the items in it are not mutually exclusive):

Sometimes only one factor is involved in making a decision. It can be plotted on one axis.

FIGURE 1

ONE FACTOR DECISION

Sometimes two factors must be considered which, in the abstract, have no correlation with each other and could be plotted as independent variables.

FIGURE 2

TWO FACTOR DECISION

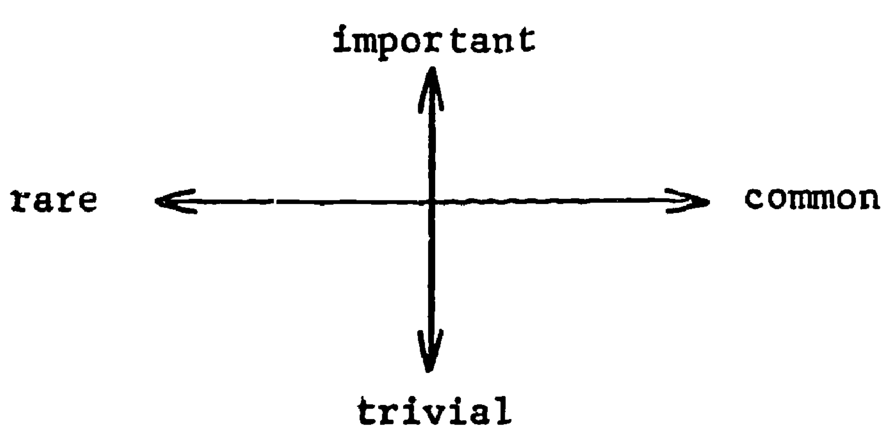


Table I

LIST OF FACTORS WITH JUDGMENTS

JUDGMENT		FACTORS		JUDGMENT
low	←	reliability	→	high
incomplete	←	data completeness	→	complete
absent	←	confirming data	→	plentiful
high	←	risk	→	low
low	←	benefit	→	high
random	←	sequence	→	ordered
rare	←	incidence	→	frequent
trivial	←	consequence	→	serious

In some decisions, there may be three independent variables. For a given clinical decision, they could be plotted in three dimensional space.

In most clinical decisions, however, the number of independent and interdependent factors or variables is more than three. Skilled clinicians handle questions involving multiple simultaneous independent variables as a matter of routine and with few signs of discomfort.

Perhaps it is just as well that they seldom attempt to illustrate their decisions graphically, because to do so requires the use of multi-dimensional space. Each independent factor requires a dimension at right angles to all the other dimensions.

It is a comfort to realize that many clinicians and computers resemble each other in sharing an ability to work efficiently at solving problems in multi-dimensional space, and also in sharing an inability to visualize the process. A clinician in evaluating one patient may make a hundred or more complicated data processing efforts, each of which involves multi-dimensional decision making.

FIGURE 3

THREE FACTOR DECISION

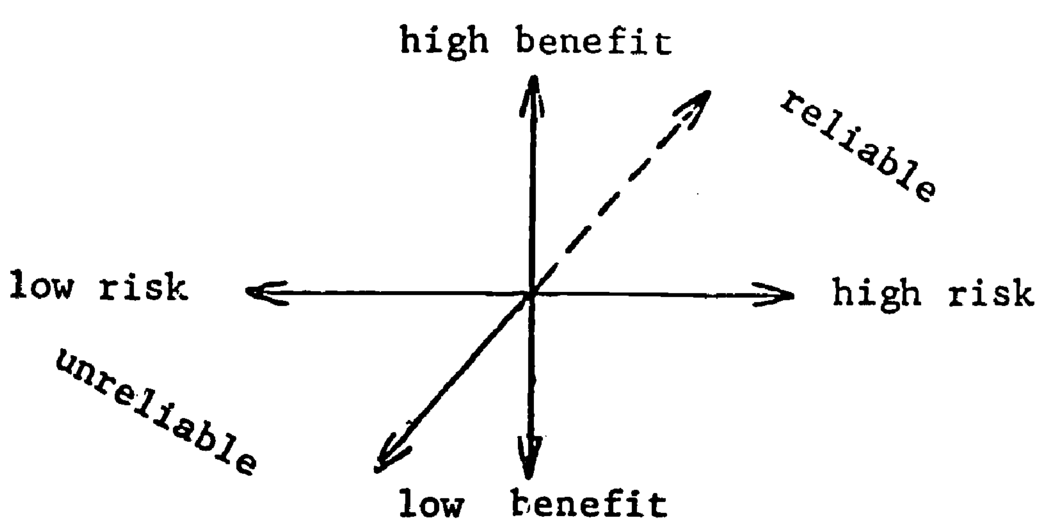
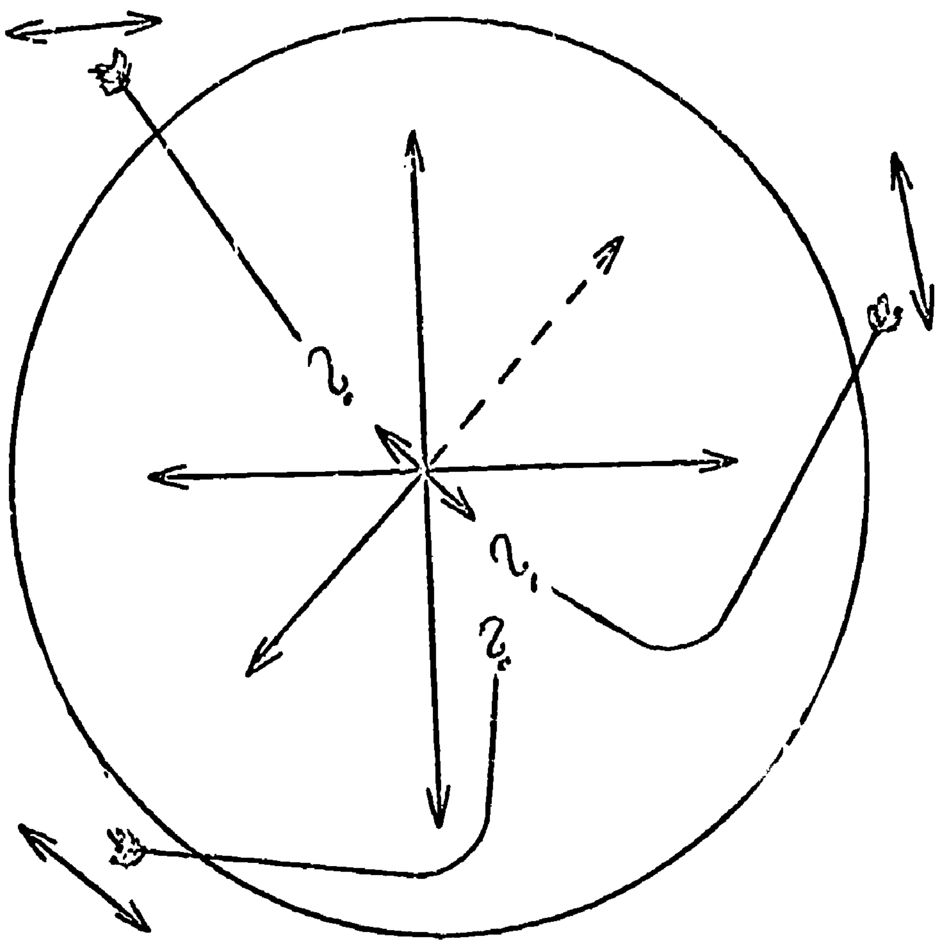


FIGURE 4

SIX FACTOR DECISION



2. *Development of unique personal strategies.* The student, in learning the clinician's skill in making rapid, largely unconscious probability estimates, has to develop these skills in his own unique way. Clinical problem solving, as has been emphasized, requires skills in inquiry and discovery. Learning of clinical problem solving is principally "discovery learning." Much recent theoretical work in this area has come from Dr. Jerome Bruner of the Center for Cognitive Studies at Harvard University. He has written:

> "It is only through the exercise of problem solving and the effort of discovery that one learns the working heuristic of discovery, and the more one has practice, the more likely is one to generalize what one has learned into a style of problem solving or inquiry that serves for any kind of task one may encounter . . . I have never seen anybody improve in the art and technique of inquiry by any means other than engaging in inquiry . . . The principal problem of human memory is not storage, but retrieval. The key to retrieval is organization or, in even simpler terms, knowing where to find information and how to get there . . .

Dr. Bruner summarizes:

> "The very attitudes and activities that characterize 'figuring out' or 'discovering' things for oneself also seem to have the effect of making material more readily accessible in memory."

To translate Dr. Bruner's hypothesis to the practical problems of teaching clinical problem solving, the student is given practice cases to solve and develops his unique personalized strategies for problem solving. He improves his efficiency in retrieving information from his own storage system. In teaching clinical problem solving, one must help him develop his skills by offering him practice cases that are representative, realistic, and properly sequenced.

3. *Maintenance of an open approach to inquiry.* If the student's experience in problem solving is adequate in quantity, quality, and representativeness, his personalized problem solving strategies will include characteristics which one may hope will be maintained as lifelong habits of inquiry. These include the following:

1. Comprehensiveness
2. Responsiveness
3. Selectiveness
4. Decisiveness

The transformation of an inefficient or incompetent information-gatherer into a clinician who is skilled in the art of inquiry is a learning process. Programmed cases, if they are to help bring about this transformation, should be planned and organized into a pattern which permits effective learning. Such a planned sequence might differ rather sharply from the unplanned, random sequence of patients seeking care at a hospital emergency room or clinic.

Summary

1. Problem solving is complicated, but may be divided into two stages:
   a. Inquiry
   b. Problem resolution
2. Problem solving requires many skills such as:
   a. Facility in handling probability estimates
   b. Unique, personal strategies of problem solving
   c. Open approach to inquiry
3. Problem solving or inquiry skills are learned by practicing inquiry.
4. Skilled problem solving behavior has several characteristics:
   a. Comprehensiveness
   b. Responsiveness
   c. Selectiveness
   d. Decisiveness

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Three Medical Programmed Courses and What They Taught Us

LEON SUMMIT*

MANY OF YOU are familiar with one or more of the three programmed medical courses we developed and distributed through *Spectrum*. If you have copies of any of them, hold on to them, because Pfizer is no longer reprinting them and they are rapidly becoming collectors' items.

The courses are "Allergy and Hypersensitivity," "Current Concepts of Thyroid Disease," and "Physician's Liability for Battery, Negligence, and Acts of Others."

The goal of the courses was to teach much about allergy, thyroid disease and medical law to many people in little time. There is ample evidence that they achieved this goal, but I am not going to discuss this aspect of the courses except by implication.

I will focus, instead, on other things these courses taught us—on what we learned from the experience of developing and distributing them, from the response to them, and from the exciting way this experience began and the unfortunate way it ended. I will try to put in perspective some things we learned about the virtues of programmed instruction and the faults of some of its early examples; about the reasons why these three courses were so well received, and why both bad programs and good ones are turned out by experts as well as amateurs; and about the hazard of relying on the generosity of the government, foundations, or business to sustain the creation of worthwhile teaching materials.

*Director of Publications, Media Medica, Inc., New York, New York.

It is basic to my point of view that I came into programmed instruction not as a psychologist or teacher, but as a journalist and editor. I was not an expert in either the new or the old methods of education, and had no vested interest in either. This has influenced not only what I did and how I did it, but also my interpretation of the r is.

In the fall of 1962, as editor of *Spectrum*, I stumbled into programmed instruction by running an article on it.

Reaction to the article was so phenomenally favorable that I was suddenly over my depth in the new educational technology, and in self-defense I quickly acquired a smattering of knowledge about it.

Soon after that, I was invited to join three other speakers in a panel discussion of programmed instruction before an audience of medical writers.

The first two speakers said that as Ph.D.'s in psychology they had been involved in pigeon experiments that illustrated some of the concepts of programmed instruction. The third panelist, an extremely articulate and forceful speaker, said that be, too, had a doctorate in psychology and had experimented with pigeons; this, he added, was before he decided to find "a more useful way" to earn his living, enrolled in medical school, and acquired an M.D. He then delivered a savage attack on programmed instruction, camouflaging in articulate glibness and vocal thunder what he lacked in information and perspective.

Everybody was stunned, including the next speaker, me. I had no doctorate in medicine, psychology, or anything else, and no pigeon experiment I could boast about. So there I stood, naked and defenseless before a hushed and spellbound audience. Armed only with my dangerously little bit of knowledge about programmed instruction, I groped for words to break the cold chill left by the previous speaker.

If it was a cruel fate that had pushed me into this predicament, a kinder providence evened the score by putting into my mouth some lucky words that broke the ice and broke up the audience: "Obviously," I said, "I'm the only pigeon on the program."

Today I am a somewhat more sophisticated pigeon. And I ask each of you, in order to understand my point of view, to remember that you, too, in respect to teachers and textbooks and classroom procedures, were for many years just one of the pigeons. You, too, were at some time victimized by inadequate, untested teaching materials and by teachers skilled in presenting a facade of pedagogy but almost totally unaware of how people learn.

The faults still dominate our educational structure at every level. They feed on the fallacy of the traditional viewpoint of education. This view is that the teacher, out of the undoubted goodness of his heart and the not-so-certain goodness of his materials and methods, opens a vast fund of knowledge to the student—and if the student does not learn, the student has failed, not the teacher. This rationale is the crutch for the development and dissemination of relatively unevaluated teaching materials and methods, and their uncritical acceptance by many school boards, administrators and teachers.

Today we are witnessing the beginning of a reversal of this viewpoint. We see the student as an eager receptacle of knowledge, with a mind uncluttered and ready to learn. If with such receptivity learning does not occur, or motivational problems arise, it may well be that the *teacher* has failed—*not* the student.

This view supports the premise that *all* educational materials should be tested and validated before release—just as drugs are tested—to make sure they achieve their purpose before they are imposed large-scale on the educational public.

Once we accept this point of view, teachers, textbooks, and the whole educational structure become opened to a far more honest and far more critical evaluation.

If this had been done many years ago, we would not today still be creating teaching materials by an indefensibly archaic process that lets unvalidated textbooks, written by inexpert writers, superficially reviewed by junior copy-editors, and accepted by uncritical or unperceptive teachers, be used to waste the time of students who deserve better.

Many textbooks and related materials, perhaps most of them, are today still being created by methods that long ago became obsolete, if ever they were defensible. Many textbooks currently in use could not survive a test of their effectiveness or efficiency—nor could many other teaching materials, methods, and, unfortunately, teachers.

If we strip the learning process down to its barest essentials, we find that most if not all learning is self-instruction. The prime role of the teacher, the textbook, the audiovisual aid and the entire school plant is to create a favorable environment for self-instruction. The student's own mind must do the rest.

To perceive these things does not require great intuitive genius or training in behavioral psychology; but we owe a debt to the behavioral psychologists for making us take a harder look at what we have been doing in education, and why.

The advent of programmed instruction has sharpened our insights into these things. Its underlying philosophy emphasizes the need for more individualized instruction and for validation of materials and methods, and its successful applications have demonstrated that these goals are not only desirable but practicable.

Some of you may remember the *Spectrum* article I mentioned earlier. It included a brief programmed sequence on how to read an electrocardiogram, and asked physicians whether this technique could help with their continuing education.

The favorable response was staggering--more than 30,000 in 30 days, more than 65,000 in a year, and less than a dozen unfavorable replies.

Then we discovered we had a bear by the tail, because thousands of practicing physicians and medical educators read our article as a promise to provide programmed courses.

At that time virtually nobody, including the alleged experts, knew how to develop high-quality programmed materials in medical subject matter, or how much work it would take. This was in the early post-Sputnik era, when teaching machines were being oversold and fast-buck artists were making big profits on expensive hardware stuffed witn shoddy software purporting to be programmed instruction.

By 1962, some educators were denying that programmed instruction had any merit at all. Others were saying its virtue was limited to rote material and simple subjects. Even among its advocates, some were saying you couldn't program complex and unstructured subjects like medicine, or material that was controversial. They discounted the remarkable response to *Spectrum's* article as a wave of naive enthusiasm evoked by the novelty of programmed instruction and the over simplification of a brief example. They said that physicians "know a gimmick when they see one," and predicted that full-length medical programmed courses would never survive the acid test of use.

Unaware that a bumpy road lay ahead, we committed ourselves to the production of one or more programmed courses. Out of this commitment eventually came the three programs I have mentioned, two of which we did in collaboration with Basic Systems, and one with Educational Design.

We developed and distributed the courses over a [illegible] of four years as an educational service of *Spectrum*. (By "we," I [illegible] a small group of people representing a wide range of technical, editorial and graphic skills, working together as an informally constituted team on which I served as editor and director.)

The courses were not released until repeated field tests showed a high rate of gain in knowledge. Since then, they have gone through what amounted to profession-wide field tests, with perhaps more critical review than any other medical texts have ever had to face.

As to their educational impact, there is no question: More than a half-million copies were requested over a period of four years. The requests came from the great majority of practicing physicians in this country and from many overseas, and from tens of thousands of residents, interns, medical educators and students, nurses, dentists and veterinarians. Though they were designed for the continuing education of physicians long out of medical school, they were adopted for teaching purposes in almost every medical school and training hospital in this country and in many overseas—usually after intensive critical review by a curriculum committee, department head or director of education.

In English and in translations, they went into use in many other countries, and at the time Pfizer dropped this service to the medical profession they were reputedly the three most widely used programmed courses in the world.

All this is cold statistical evidence. Supporting it is the warm documentation of tens of thousands of grateful letters, postcards, telegrams and phone calls expressing astonishment at how much was learned from this material, and how much faster than from any previously available instructional matter.

So it is clear that these courses achieved their primary goal of teaching much in little time to many people. They also demonstrated that self-instructional programmed material was a valuable adjunct to conventional teaching methods.

There had been much talk about the physician's need for continuing education materials, and h[illegible] the need could be [illegible] The response to these courses undersco[illegible] need, dramati[illegible] willingness of physicians to try any new approaches, [illegible] hat if innovations were good enough they could even fi[illegible] ir way to acceptance by the establishment of medical education.

People concerned with medical education have asked many questions about these courses. Some questions have been difficult, but with time and experience I believe we have arrived at reasonably correct answers.

One of the most frequent questions is, "Why did these courses have so much more impact than other programmed courses developed under comparable conditions?"

To compare the impact of one programmed course with that of another is tricky, especially in a field like medicine. Among the many aspects that must be taken into account are organization, accuracy, clarity, graphic presentation, format, interest of subject matter, consultants, etc., and it is difficult to make a fair comparison. Even when all things else are the same, difference in interest or relevance of subject matter may be the ultimate determinant.

The subjects of the Pfizer courses were chosen with a view to mass interest and usefulness. The goal was to serve the continuing education needs of the largest possible number of general practitioners. From this "box-office" point of view, allergy and medical law were obviously excellent choices. In the case of thyroid, we nearly abandoned it as a subject of too little interest after most physicians responding to a questionnaire said they knew all they needed to know about thyroid disease; but a few responses alerted us to the fact that most physicians did not realize how deficient their knowledge was, and how faulty were some of their practices in cases of suspected thyroid dysfunction. Thus thyroid, too, turned out to be an excellent choice.

But among the medical programmed courses released by other drug companies and commercial publishers were some of equally universal interest, and some of these were well programmed. Yet they had distinctly less impact. Why?

To whatever extent the difference in impact reflects a difference in quality, it is probably a tribute to team programming—to what may have been an unprecedented intensity and quality of collaboration.

When we went into this project, we contracted with the largest and probably the best of the commercial programming organizations around at that time. This was Basic Systems (now a part of Xerox). We soon discovered that the supposed experts still had much to learn about programmed instruction, and so did we. The problems were deep and critical. The primitive state of programmed instruction was one of them. Another was the general "badness" of medical writing, especially that found in many textbooks. Still another was that, like the writers of typical medical texts and journal articles, the writers of programmed instruction had much to learn about simple, clear and unambiguous writing.

As in the beginning of any new discipline, the early development of programmed instruction saw the growth of many schools of thought, around each of which proponents rallied as the "one true church" of programming. The apostles laid down strict rules as to what constituted "correct programming," and their disciples often rushed into print with hasty products whose hallmark was mediocrity. But even these took on a false aura of excellence when compared with conventional teaching materials.

At the same time, the esoteric language used to describe programmed instruction to the uninitiated and to differentiate one school of programming from another, became a whirlpool of behavioral jargon in which the "baptized" were drowning even some of their fellow programmers.

These were some of the factors that led initially to serious friction between the *Spectrum* editorial staff and the Basic Systems programming staff. But the early friction led to an important benefit, because with better understanding we achieved a degree and quality of teamwork that became the unique and distinctive feature of the project. We developed collaboration to a high degree of perfection in the allergy course, and carried it out again in the thyroid and law courses. Thus it proved its merit three times in a row.

So the reason for the impact of these courses lies partly in the additional quality that resulted from team programming—from the pooling of many skills (subject matter, educational, programming, testing, editorial, graphic, etc.) in intensive collaboration uninhibited by the obsolete single-author concept which underlies the mediocrity of much conventional teaching material.

But quality is not alone the explanation. We cannot overlook methods of communication and distribution. In *Spectrum* we had a uniquely well read and widely distributed means of publicizing the Pfizer courses. Long before the first course, "Allergy and Hypersensitivity," came off press, a 3-page preview in *Spectrum* had elicited the unbelievable total of 70,000 prepublication requests. Quality could not have been a factor, since the allergy course was not yet finished and nobody had ever seen it—though its quality no doubt played a role in the later prepublication requests of 90,000 for thyroid and 115,000 for medical law.

Many other excellent courses, developed as school or private projects as well as by commercial publishers, do not become well known because no effective medium of communication tells their story to enough interested people. It is a sad fact that there is not one publication today which offers a high quality of educational journalism and stirs interest and excitement with bold and objective coverage of educational innovations. When the educational journals do venture into new fields, they do so superficially, and without a strong challenge to the built-in prejudices of teachers and resistances of the educational establishment.

Because of the absence of such a publication, many outstanding pieces of work—books, programs, films, visual aids, etc.—serve the local or limited purpose for which they were developed, but remain otherwise unknown. In many cases this represents a great social loss.

Another factor in the impact of the three courses was that they were interesting. This was especially gratifying because it was no accident. We know that programmed courses were being described as dull and boring, no matter how effective, so we tried deliberately to build and hold interest. We took a hard look at the do's and don'ts laid down by the programming experts, rejected some as little more than sectarian dogma, and thus avoided some of the traps and straitjackets with which they were building dullness into their work. We kept the format simple—varied frame size—intermingled well-written prose with programmed matter—permitted an occasional light touch to warm the page, without self-conscious and patronizing attempts to force humor into the program. We did whatever seemed to work, and avoided whatever didn't.

We took enormous pains with language, avoiding technical jargon and complicated formulations. We tried to show that teaching material needn't be dull to be scientific—that it can be both simple and interesting, even in programmed form, and that dullness is not inherent in programmed instruction.

There is no reason why teaching material dealing with scientific subject matter has to be presented in complex language that guarantees dullness. This great universe of ours is held together by simple principles. There is nothing complicated about science except the complicated straitjacket of language in which we lock up ideas. In the language of the courses we developed, we tried to break the verbal straitjackets and liberate the ideas.

Our only standard was excellence of communication. When practicality made compromise necessa compromised—but never on a significant point of fact or clarity. We tried to prove that excellence is a feasible standard.

Apparently we succeeded—as many thousands of letters attested, with comments such as "the most interesting thing I've read in years," and "better than a good mystery story," or "so interesting I couldn't put it down till the last page."

The interest of the material was undoubtedly enhanced by the fact that we ignored advice to omit controversial material, and instead included it on a large scale, especially in the allergy and law courses.

Some people argue that differing points of view can't be presented in programmed form without communicating advocacy of one. Behind this false notion is the equally false one, to which the statements of some people in programmed instruction have contributed, that it is useful for rote, well-organized subject matter such as mathematics, but not for material that cannot be so well organized and integrated. Differences in subject matter call for differences in handling, of course, but the underlying philosophy of programmed instruction remains the same, and remains applicable.

One of the most difficult of all questions to answer is that of the cost of good programming. Answers based on commercial experience, or the cost of getting programs done non-commercially, may be misleading because there is no certain correlation between cost and quality in either commercial or noncommercial programming. Contracting with a commercial organization does not necessarily guarantee a higher quality of performance than might be achieved by turning to purely local resources of known people in a school or on a campus. Local people often discover unknown or unappreciated resources within themselves when they are given a challenge to their untested abilities, and a friendly environment within which to develop them. A team of such people working together in constructive, noncompetitive collaboration may turn out a finer product than they could have bought for any price they could afford.

When the first edition of the allergy course came out, many people asked its cost and were discouraged by the answer—$100,000. But this was a highly unusual cost. It came at a pioneering stage, when not enough was known; much of this cost was usefully spent in experimentation, and some was unfortunately misspent in false starts. This was the price of acquiring a body of experience in a new discipline. But the hundred thousand dollars also paid for a hundred thousand copies, at only $1 each—a rather *low* cost per copy.

From this point on, the cost dropped sharply. We learned better and less expensive ways to do the job without compromising quality. Six months after the 1st edition we put out a massively revised and updated 2nd edition for about $40,000 for a run of 100,000—40¢ a copy. The thyroid course, comparable in size and difficulty, co about 65¢ a copy for the original run of 100,000, and could have been reprinted in a similar run for about 20¢ a copy.

The law course, roughly half the size of allergy and thyroid, cost only about 18¢ a copy for the first 100,000, and could have been reprinted in a similar run for about 10¢ a copy.

All these costs reflected on the one hand the high initial costs of commercial programming organizations, and on the other hand the per-unit economies of large print runs. With more experience initial creative costs will go down. As for the unit cost, it must not be overlooked that the Pfizer courses were designed to be given away. Commercial publishers, gearing their print runs to present-day sales expectancies based on outmoded methods of distribution, print short runs for much higher cost. Perhaps if their methods of creating, promoting, and distributing such materials were modernized, they could produce more copies of worthwhile books at a considerably lower unit cost, and sell them at a much lower price for a sufficient profit. In so doing, they would assure greater distribution and increase the usefulness of excellent teaching materials.

I am often asked why Pfizer dropped this program, which had won it so much good will for so little cost as compared with the enormous sums spent for conventional advertising. This is an important question, and more people should ask it— not of me, but of Pfizer. I prefer not to deal with the question except in the context of a broader question: Can we depend on drug company advertising or generosity for a continuing flow of objective educational material unrelated to product advertising? More and more I have become convinced that the answer is, "No!" In a drug company such material is, and must by definition remain, secondary to drug sales, and therefore be always at the mercy of the balance sheet, a dip in a sales curve or the whim of an executive, without regard for social consequences—and who is to say this is wrong?

In the same way, government and foundation grants are sensitive to the philosophy and competence of elected or appointed officials, and to changes in the country's political, social, and economic climate. They are a shaky foundation for long-term, uninterrupted production of worthwhile educational materials.

Then what is the answer? To develop another innovation—a creative and marketing structure which can produce high-quality educational materials and reach a large market with low enough prices to gain the economies of long print runs, and still make a reasonable profit.

The job can't be done by continued use of antiquated methods of creating and marketing textbooks. There must be a method of supplying a full range of quality educational materials that can pay their own way, and are therefore secure against capricious abandonment.

Scenes from the Third Rochester Conferences

Upper left: Chester M. Pierce, M.D., Professor in the Department of Psychiatry, Neurology, and Behavioral Sciences at the University of Oklahoma Medical Center.

Upper right: T. Hale Ham, M.D., of the Western Reserve University School of Medicine.

Center, left to right: Joseph E. Markee, Ph.D., James B. Duke, Professor of Anatomy at Duke University and J. P. Lysaught, Ed.D., Associate Professor of Education and Research Associate in Medical Education at the University of Rochester.

Lower left: Irving M. Bush, M.D., Chairman of the Department of Urology at Cook County Hospital, Chicago, Illinois.

Lower right: Virginia Zachert, Ph.D., of the Medical College of Georgia.

Medical Tribune Photo—Jim Laragy

Part VI

Programming Specifics and Variables

Rubadeau introduces this section with a report of research involving learner-centered instruction, and suggests this as a variant of programmed learning. Millar, in discussing the phases of testing and revising, and Wilds and Zachert, in analyzing the mechanics of frame writing, seek to provide specific guidance to the programmer —and the reviewer. Peterson and her colleague proffer their experience in taking a program out to learners other than the initial target populations, and discuss the variations they found. Wilds and Zachert, in a second paper, discuss the variable treatment of controversial subject-matter, and suggest analytic designs for ha[illegible] hese problems. Lastly, Grop[illegible]er suggests an explicit trea[illegible] of instructional strategies as a means for arriving at the choice of programming media to use in a specific situation.

A Comparison of Learner-Centered and Teacher-Centered Learning: An Experimental Test in the Academic Setting

DUANE O. RUBADEAU*

IN THE YEARS since World War II much interest has been centered around the measurement and the improvement of teaching effectiveness. In many of the research studies, the teaching methods and techniques examined fall into two classifications; those associated with student-centered instruction, and those associated with teacher-centered instruction.

The present study was based on the findings of research on programmed instruction in the industrial setting, where the investigators were interested in the sequencing of materials for programming, and inadvertently came upon an approach for improving the effectiveness and efficiency of instruction. (1,2,3) In this approach, called learner-controlled instruction, the learners could ask any questions in any order of the instructor who acted as an "infinite bag of knowledge." Results showed the subjects in these studies learned more effectively and efficiently than those taking the course by the regular instructional method.

The purpose of the present study was to determine which of three learning situations, learner-centered, teacher-centered, and independent study was most effective (better) and most efficient (faster). In addition ability level and preference were studied to determine their relationship to instructional method.

*Associate Professor, Department of Psychology, State University College, Geneseo, New York.

THE DESIGN OF THE STUDY

The sample consisted of four sections of General Psychology and one section of Health Education students. Three of the sections of General Psychology and the single Health Education section were from the State University College at Geneseo, New York. The other section of General Psychology was from the University of Rochester's Eastman School of Music. The total number of students involved in the study was 141, with 26 from the University of Rochester and 115 from Geneseo State. All of the students serving as subjects in this study were first semester freshmen.

The criterion instruments consisted of two measures of effectiveness, one measure of efficiency and two reaction scales. One measure of effectiveness was a 100-item objective test of knowledge about total course content administered prior to the beginning and at the termination of instruction. The second measure of effectiveness was a 50-item objective test designed to assess knowledge of the "principles of learning" part of the course (the experimental phase). These 50 items were included in the 100 item test of total course content. The learning test was administered at the beginning of the course as part of the total test, immediately following the unit dealing with principles of learning and again nine weeks later at the end of the course as part of the total test.

The measure of efficiency was the amount of reported study-learning time recorded in study-learning time logs.

Two reaction scales were utilized to obtain a quantitative measure of students' reactions to instructional methods.

To test the subsidiary hypotheses on the effect of ability level and preference for type of instruction, the following instruments were used. To test for preference, the Preferred Learning Procedure Scale was developed. In this scale, a learner-centered to instructor-centered continuum of instructional characteristics was presented. Learner-centered instruction was defined as allowing the student a great deal more freedom in choosing the direction of learning, as well as placing a great deal of the responsibility for organizing and assembling the various principles and concepts on the student. The instructor-centered method was defined as the instructor taking the primary responsibility for establishing the direction of learning. Each learner-centered item was paired with each instructor-centered item to form a 25-item paired-comparison forced-choice instrument. The PLPS was scored in such a way that a high score indicated that the student preferred a learner-centered approach, while a low score indicated a preference for an instructor-centered approach. The maximum score was 25, while the minimum score was zero.

Ability level was determined by the combined verbal and quantitative scores from the Scholastic Aptitude Test of the College Entrance Examination Board.

The experimental procedure was composed of six phases (See Figure 1). Phase I consisted of two 50 minute class periods. On the first day of class, a general introduction, the presentation of reading assignments, an explanation of the general objectives for the course and an explanation of the study-learning time logs was given. This was followed by the administration of the PLPS. On the second day of class, all subjects were given the total test, which included the test on principles of learning.

Phase II consisted of a three-week period in which the groups received lecture-discussions on material covering scientific method, psychology as a science and design of experiments.

In Phase III, also a three-week period, the subjects were first assigned to the various experimental and control groups. In this phase of the study the experimental groups were exposed to the three instructional approaches being tested. The material on learning was covered during this part of the course.

Phase IV refers to the two class periods immediately after the experimental phase of the study. The learning test was administered in the first period and the two student reaction scales were administered in the second period. During this phase and for the rest of the semester, all subjects in the experimental and control groups returned to their regular class sections, and received the lecture-discussion type of instruction.

During Phase V, a nine-week period, other aspects of the course were covered, e.g., sensation, perception, personality, etc.

Phase VI, the final phase of the study, includes the last class period and the final examination period. During the last class period, the reaction scales were re-administered. On the scheduled final examination day, all subjects were administered the 100-item objective test of total course content.

Procedure

Subjects for the three experimental groups were selected on the basis of their scores on the Scholastic Aptitude Test. The Geneseo

TREATMENT	N	ABILITY	PHASE / TIME / TASK / PREF	I 2 DAYS* ORIENT. PRETEST	II 3 WKS. OTHER MATERIAL	III 3 WKS. UNIT ON LEARNING	IV 2 DAYS EVALUATION & TESTING	V 9 WKS. OTHER MATERIAL	VI 2 DAYS EVALUATION & POSTTEST
TCL	12	HI		DAY 1: ORIENT.		EXPERIMENTAL PERIOD	DAY 1: ADMIN.: SRS & SOO.		DAY 1: ADMIN.: SRS SOO
TCL	12	LO		ADMIN.: PLPS					
LCL	10	HI					DAY 2: ADMIN. LEARNING TEST.		DAY 1: ADMIN.: POSTTEST
LCL	10	LO		DAY 2:					
NIL	11	HI		ADMIN.: PRETEST					
NIL	11	LO							
COR	28	UR CONTROL TCL INSTRUCT.							
COG	21	GEN. CONTROL TCL INSTRUCT.							
NIP	26	NO INSTRUCT. IN PSYCHOL.		PRETEST ONLY			LEARNING TEST ONLY		POSTTEST ONLY
LCL	15		TCL						
TCL	16		TCL						
LCL	5		LCL						
TCL	11		LCL						
NIL	19		TCL						
NIL	4		LCL						

*A CLASS DAY REFERS TO A 50 MINUTE PERIOD. CLASSES MET THREE TIMES A WEEK.

FIG. 1 SUMMARY OF THE BASIC EXPERIMENTAL DESIGN.

mean for combined verbal and math scores on this test was 1080 with a standard deviation of 105. Low ability was defined as those scores one standard deviation or more below this mean and high ability as one standard deviation or more above the mean. Of the 197 entering freshmen who had taken the College Boards, 33 of high ability and 33 of low ability were randomly selected for the sample. These students were assigned to groups on the following basis: 12 low ability and 12 high ability to Teacher-Centered Lear..ing; 10 low ability and 10 high ability to Learner-Centered Learning; and 11 low ability and 11 high ability to No-Instructor Learning.

Students making up the control groups were not preselected on the basis of ability.

Methods of Instruction

Three methods of instruction e used to test the hypotheses of this investigation: Learner-Cer d Learning (LCL), Teacher-Centered Learning (TCL), and nstructor Learning (NIL). All three of the experimental group ived identical assignments and sets of objectives related to the nciples of learning material.

Teacher-Centered Learning re s to traditional classroom instruction, including lecture and discu on, where the direction of what is to be learned reposes largely in t e hands of the instructor. Learner-Centered Learning refers to the situation in which the learners, during individual interviews, were allowed to ask the instructor any questions, in any order desired. The instructor was "turned on" when the student asked a question, and "turned off" when the question was answered, or when the student felt he had enough information. Answers were as brief or as long, as specific or as general as the student desired. No-Instructor Learning refers to the situation in which the learner studied independently, i.e., they did not meet with the instructor, but gathered and organized the material by themselves.

During the experimental period (Phase III), while the learning unit was being covered via lecture-discussion in the TCL and Control groups, the 20 students in the LCL group met with the instructor on an individual basis. The students in the LCL group were required to sign in with the instructor during their scheduled meeting times. If they had no questions they were free to leave. During this same period, the students in the NIL group did not meet with the instructor at all. The students in the TCL group were required to attend all lectures.

In this study, the same instructor was involved in TCL and LCL learning. This instructor also taught the Geneseo and Rochester Control groups. The instructor was a doctoral candidate with a major in educational psychology and a minor in psychology who had seven years experience teaching a wide variety of psychology courses, and who has taught the general psychology course on numerous occasions.

Analysis of variance and covariance were the primary statistical tools. The accepted level for significance was set at .01 or less for this study.

Results

Differences in effectiveness as measured by the total test and learning test were not significant for the three methods of instruction. The learner-centered group, however, learned more efficiently than the teacher-centered group and the no-instructor group (See Figure 2). The LCL averaged 9.7 hours in study-learning over the three week period. The NIL group mean study-learning time for the three week period was 13.5 hours. The traditional instruction group (TCL) mean study-learning time for the three week period was 17.3 hours. For the LCL group, this averaged out to approximately eight minutes/person/week with the instructor.

Differences in student reactions to instructional approaches as measured by the two reaction scales were not significant among any of the instructional methods.

When students were categorized on the basis of their preference of instructional mode, no significant differences were found between those preferring LCL and those preferring TCL. There was, however, a trend for the students preferring LCL to perform better than TCL or NIL on the measures of effectiveness, although this difference did not reach significance.

When students were categorized on the basis of scholastic aptitude into high and low ability levels, the high ability group performed significantly better on all effectiveness and efficiency measures; however, the high and low ability students in one instructional mode did not have significantly different outcomes than high and low ability students in the other instructional modes. Again, there was a trend for both high and low ability students in the LCL group to perform better on the effectiveness criterion measures.

Implications

One of the major implications is that learner-centered learning does allow the students a great deal more freedom than the regimen-

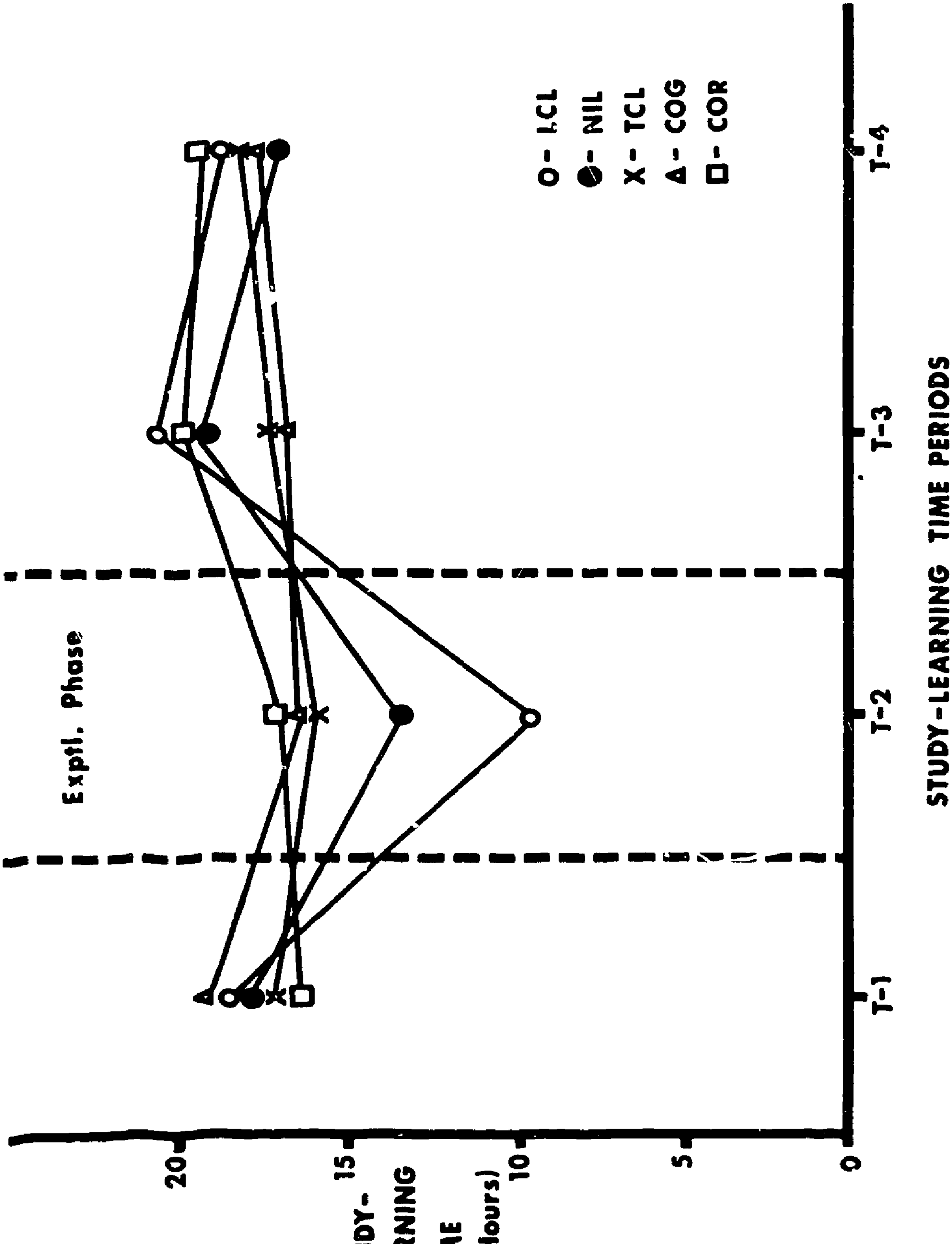

Figure 2 **Mean time spent in study-learning for each group during the four time periods involved in the study. Each time period is three weeks in length.**

tation found in the conventional instructional setting. Furthermore, learner-centered learning may well provide added stimulus for students to take the initiative in directing and promoting their own learning.

Further research needs to be conducted to determine whether the LCL technique can be used with total course content and on what type of material is most amenable to the LCL instruction.

Summary

The purpose of this investigation was to determine whether learner-centered learning would produce more effective and efficient learning than teacher-centered learning or independent study. In addition, the subsidiary problems of the effect of preference for instructional mode and effect of ability level on effectiveness and efficiency of learning were also studied. For the learner-centered learning, a procedure was devised which allowed the learner some degree of control over the direction of instruction. Results indicated no significant differences on criterion measures of effectiveness; however, on the criterion measure of efficiency, the learner-centered learning students learned significantly faster. When students were categorized on the basis of preference for instructional mode, no significant differences were found. High ability students performed significantly better than low ability students on all measures of effectiveness and efficiency as expected. There was, however, no significant difference in performance between high or low ability students under one instructional mode and those instructed by the other instructional modes. Learner-centered instruction emerges as a viable, and an interesting, alternative to traditional forms of teaching.

ACKNOWLEDGEMENTS

The author expresses his gratitude to Professors Irene Athey, Clarence Williams and Jerome Lysaught of the University of Rochester, for their personal interest and for the significant help they have given, and to Miss Linda Ryan of the State University College at Geneseo for technical assistance.

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An Empirical Guide to Program Revision

MARY L. MILLAR, M.A., R.N.*

PROGRAMMED INSTRUCTION, if well prepared, has proved to be a useful learning tool in a variety of subjects and in a variety of situations. However, it is difficult to write a good program. Possibly this is one reason why few good programs are yet available and why programmed instruction is still used only on a limited basis. And, also, why programs have generally been so effective.

No way has been found to make program writing easier or faster, but experience has led to the development of a modification in the preparation of programs which facilitates the testing and revision phase and improves the quality of the final product. It is the purpose of this discussion to describe this modification and show some examples of revisions that resulted from its application.

A Suggestion for Modification

The basic steps in the process of writing a self-instructional program remain unchanged. These steps as described by Lysaught and Williams (1) are illustrated in Figure 1. The diagram shows the interdependence between the steps in the process, with each step modifying the preceding step and leading to the next. This is most clearly seen in the phase where the modification is applied, which begins with the construction of items. As a number of items or frames are written, according to criteria determined by the preceding steps, they are tried out (initially field tested) by a student who typifies the group for whom the program is designed. Errors and comments made by

*Programming Specialist and Editor, General Learning Corporation.

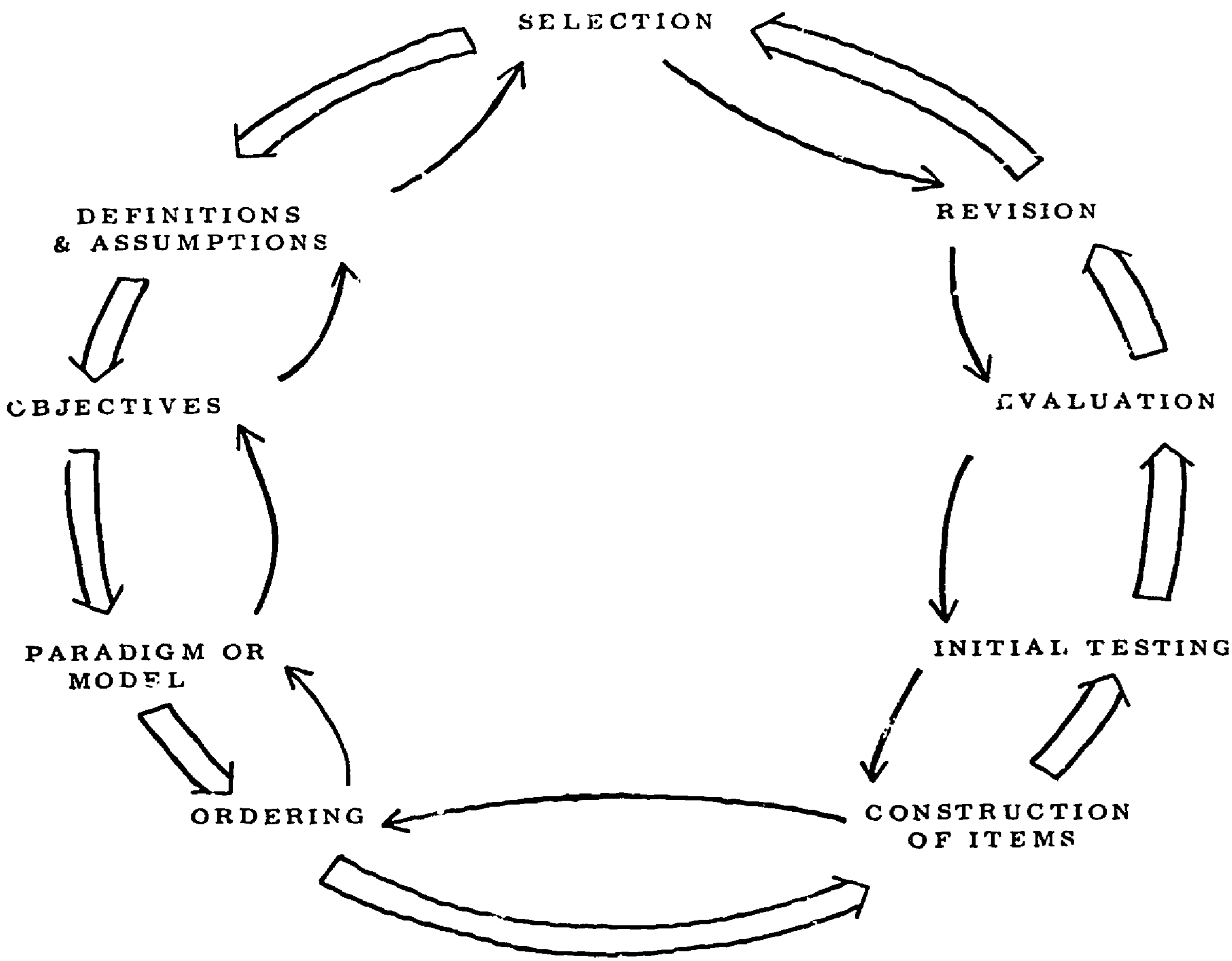


Figure 1

From: Lysaught, J. P., and Williams, C. M. A Guide to Programmed Instruction. New York: John Wiley and Sons, Inc., 1963. P. 26.

the student serve as a basis for changing frames to eliminate sources of error, delete unnecessary repetition, or increase the amount of practice, and then the revised program is tried out by another student.

The faults which arise from student trials are usually of three types: subject matter, programming, and editorial. Instead of relying solely on data from these student trials as a basis for revision, it is suggested that this programming phase be modified by the addition of a review by at least one person with knowledge and experience in each of the three categories.

The complementary nature of student trials and specialists' reviews makes the revision phase of program writing more efficient and more precise. For one thing, if a student and one or more reviewers find fault with the same frame, the need for revision is verified. For another, students often are unable to specify the reason a frame causes them difficulty. A reviewer's comment on the same frame may identify the source of difficulty, and thereby simplify the revision. Also, competent reviewers frequently do detect faults that students do not.

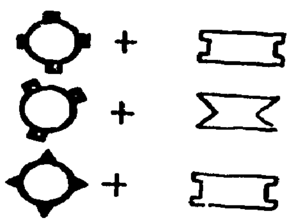
Examples of Faulty Frames

The nature of these faults can be understood most easily by looking at a few frames which contain typical examples. These examples were collected during the preparation of the third edition of *Allergy and Hypersensitivity* published by Pfizer *Spectrum*. They are particularily appropriate to this discussion because most of them were detected by subject matter, programming, or editorial reviewers and they demonstrate that refinement is always possible, even in a carefully prepared, widely used program.

Figure 2, frame 5 from the second edition of *Allergy and Hypersensitivity*, illustrates two common programming faults. The first fault is insufficient information. Compare Figure 2 with Figure 2A, the same frame as revised for the third edition. The headings "antigen" and "antibody" have been added to indicate clearly which symbol represents which chemical entity. Without the headings, this relationship is only implied.

The other fault is the presentation of a difficult discrimination before the student is prepared to make it. Notice in Figure 2 the subtle difference between the antibody symbol used in the second example in the frame and the antibody symb . in the correct response column

The geometric forms below symbolize the relation between antigens and antibodies. In reality, these substances are complex chemical entities.



When we say that an antigen reacts with antibody SPECIFIC for it, we mean that their configurations are ☐ complementary ☐ identical.

Draw the shape of the antibody that is specific for the antigen shown below:

complementary

Figure 2

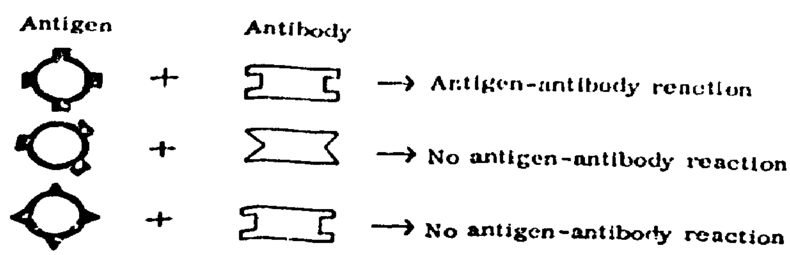
From: Allergy and Hypersensitivity. 2nd Edition. Chas. Pfizer & Co., Inc. 1964.

to the right of the frame. A student could easily assume that the symbol in the second example is the one to be drawn to match the antigen below. Changing the configuration of the antigen for which a specific antibody must be drawn requires the same response from the student but eliminates needless difficulty.

Figure 3 is frame 8 from the second edition of *Allergy and Hypersensitivity*. In this instance, the programming fault is calling for a response that doesn't use the information presented in the frame. Revision of this frame poses difficulties and there is good argument for leaving it as is. As the frame stands in the second edition it performs two functions. It introduces and defines sensitization and it requires the student to distinguish between sensitization and specificity, the topic of the frames immediately preceding frame 8. If the frame were revised to require "sensitization" as a response, a copy frame could easily result and the opportunity for the student to distinguish between the two ideas would be lost. Either occurrence would reduce the challenge and the value of the frame.

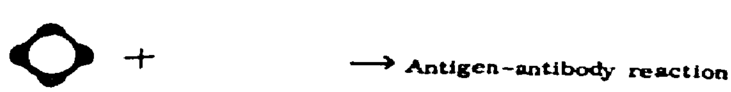
The revision as shown in Figure 3A is perhaps little improvement over the version in the Figure 3, but it does emphasize and make explicit the distinction between "specificity" and "sensitization." Another argument in support of this revision is the behavior required of the student. In the revised frame, the focus is on comparing the two ideas and selecting the term consistent with the meaning of the sentence. This behavior is more relevant to the objectives of the program than writing out the word.

The geometric forms below symbolize the relation between antigens and antibodies. In reality, these substances are complex chemical entities.



When we say that an antigen reacts with antibody SPECIFIC for it, we mean that their configurations are ☐ complementary ☐ identical.

Draw the shape of the antibody that is specific for the antigen shown below:



complementary

Figure 2A

From: Allergy and Hypersensitivity. 3rd Edition Chas. Pfizer & Co., Inc. 1966.

A third programming fault detected by review is shown in Figure 4 and the resulting revision is shown in Figure 4A. The fault occurs in frame 20. Frame 19 is included to show that the prompt for the first response in frame 20 is totally unnecessary. The simplest solution is to remove it.

The frame used as the last example of programming faults contains two faults. The frames immediately preceding frame 88, which is shown in Figure 5, deal with the number of reactive sites on antigens

Whenever a person is exposed to an antigen to which he is not allergic, he may develop antibodies for it. These will make him allergic to it. This is called SENSITIZATION. This process may not occur until after repeated exposures to the antigen. Some people are more easily sensitized than others.	
The antibodies produced as a result of exposure to the antigen are ________________ for that antigen.	specific

Figure 3
From: Allergy and Hypersensitivity. 2nd Edition.
Chas. Pfizer & Co., Inc. 1964.

ANTIGENICITY is the ability of an antigen to elicit antibody formation.	
In general, the greater the antigenicity of a substance, the ☐less likely ☐more likely it is that antibodies will be formed.	more likely
The antigenicity of the albu[illegible] is greater than that of the ovomucoid [illegible] of the albumin fraction of milk is greater than that of the casein fraction. Of the substances mentioned above, which is most likely to elicit antibody formation? ☐albumin ☐ovomucoid ☐casein	albumin
The ability of a substance to elicit antibody formation is referred to as ________________icity.	antigenicity
This is one of the factors that determine the likelihood of ________________.	sensitization

Figure 4
From: Allergy and Hypersensitivity. 2nd Edition.
Chas. Pfizer & Co., Inc. 1964.

and antibodies. The purpose of frame 88 is to summarize and reinforce these facts. The revised version of this frame, shown in Figure 5A, points out the faults. First, the critical response in this context is the number of reactive sites, rather than antigen or antibody molecules. Second, the response portion is better placed at the end of the sentence after all necessary information has been given, rather than at the beginning.

Other programming faults that may be detected during the revision phase include improper frame sequence, unnecessary repetition, and inclusion of irrelevant material.

Whenever a person is exposed to an antigen to which he is not allergic, he may develop antibodies for it. These will make him allergic to it. This is called SENSITIZATION. This process may not occur until after repeated exposures to the antigen. Some people are more easily sensitized than others.	
The antibodies produced as a result of exposure to the antigen are ☐ specific for that antigen ☐ sensitized to that antigen.	specific for that antigen

Figure 3A
From: Allergy and Hypersens ity. 3rd Edition. Chas. Pfizer & Co., Inc. 1966.

The ability of a substance to elicit antibody formation is referred to as ____________________.	
This is one of the factors that determine the likelihood of __________________________.	antigenicity sensitization

Figure 4A
From: Allergy and Hypersensitivity. 3rd Edition. Chas. Pfizer & Co., Inc. 1966.

Faults relating to subject matter will depend, of course, on the topic of the program and are not difficult to imagine. One example will suffice here. In Figure 6, frame 334 contains the statement that chloral hydrate can be used in intractable asthma because it does not depress respiration. Missing is the dosage limitation which is needed to make the statement completely accurate. The specification of

All ☐antigen molecules ☐antibody molecules are thought to have no more than two reactive sites. Most, if not all, ☐antigen molecules ☐antibody molecules have more than two.	antibody molecules antigen molecules

Figure 5
From: Allergy and Hypersensitivity. 2nd Edition.
Chas. Pfizer & Co., Inc. 1964.

barbiturates → decrease anxiety barbiturates → depress respiration → carbon dioxide narcosis chloral hydrate → decreases anxiety tranquilizer → decreases anxiety Barbiturates, particularly in large doses, should not be used in intractable asthma because of the possibility of carbon dioxide narcosis. However, chloral hydrate and tranquilizers can be used because they apparently ☐depress respiration ☐do not depress respiration.	do not depress respiration

Figure 6
From: Allergy and Hypersensitivity. 2nd Edition.
Chas. Pfizer & Co., Inc. 1964.

dosage is included in the revised frame shown in Figure 6A. Figure 6A also shows a change in the sequence of frames. In the second edition, the frames were reversed. The frame providing practice preceded the frame presenting the information.

Most, if not all, antigen molecules are thought to have ☐ no more than two reactive sites ☐ three or more reactive sites.

three or more reactive sites

Antibody molecules are thought to have ☐ no more than two r[illegible] sites ☐ three or more reactive sites.

no more than two reactive sites

Figure 5A

From: A'lergy and Hypersensitivity. 3rd Edition. Chas. Pfizer & Co., Inc. 1966.

barbiturates → decrease anxiety
barbiturates → depress respiration → carbon dioxide narcosis
chloral hydrate → decreases
tranquilizer → decreases anxiety

Barbiturates, particularly in large doses, should not be used in intractable asthma because of the possibility of carbon dioxide narcosis. However, chloral hydrate (in doses of no more that 0.5 Gm., 4 times a day) and tranquilizers can be used because they apparently ☐ depress respiration ☐ do not depress respiration.

do not depress respiration

Barbiturates that relieve anxiety caused by difficulty in breathing may, at the same time, cause respiratory depression and possibly ☐ anoxia ☐ carbon dioxide narcosis.

carbon dioxide narcosis

Figure 6A

From: Allergy and Hypersensitivity. 3rd Edition. Chas. Pfizer & Co., Inc. 1966.

Editorial faults are difficult to predict or classify, but a few examples will suggest their nature. In Figure 7, the fault is redundancy and the remedy is removal of the word "artificially" from each sentence as shown in Figure 7A.

Some editorial faults are amusing and cause one to wonder how they escaped earlier notice. The first sentence of a frame in a sequence on the treatment of anaphylaxis shows this very nicely (see Figure 8). The revised sentence appears in Figure 8A.

Check the correct statements below:

- ☐ Anaphylactic sensitivity can be induced artifically by injection of antigen.
- ☐ Anaphylactic sensitivity cannot be induced artificially by injection of antigen.
- ☐ Atopic sensitivity can be induced artificially by injection of antigen.
- ☐ Atopic sensitivity cannot be induced artifi[illegible] by injection of antigen.
- Both types of sensitivity can be [illegible] artifically by injection of antigen.
- ☐ Neither type of sensitivity can be induced artifically by injection of antigen.

Anaphylactic sensitivity can be induced artificial[illegible] by [illegible]ection of anti[illegible]

Atopic sensitivity cannot be induced artifically by injection of antigen.

Figure 7
From: Allergy and Hypersensitivity. 2nd Edition. Chas. Pfizer & Co., Inc. 1964.

If blood pressure has fallen to shock levels and does not respond to injections into or above site of tourniquet, it is necessary to administer drugs intravenously.

Figure 8
From: Allergy and Hypersensitivity. 2nd Edition. Chas. Pfizer & Co., Inc. 1964.

100 per cent oxygen should be used only with intermittent breathing of ambient air in order to prevent respiratory
☐ depression ☐ stimulation and resulting ☐ anoxia
☐ carbon dioxide narcosis.

depression

carbon dioxide narcosis

Figure 9
From: Allergy and Hypersensitivity. 2nd Edition. Chas. Pfizer & Co., Inc. 1964.

Perhaps there is a pattern to editorial faults after all. This last example is typical of a group that fall under the heading "ambiguous wording." It is the type of editorial fault that not only occurs most frequently but also is the most difficult to detect and to remedy. Compare the versions in Figure 9 and 9A. This particular example is

Check the correct statements below: ☐ Anaphylactic sensitivity can be induced by injection of antigen. ☐ Anaphylactic sensitivity cannot be induced by injection of antigen. ☐ Atopic sensitivity can be induced by injection of antigen. ☐ Atopic sensitivity cannot be induced by injection of antigen. ☐ Both types of sensitivity can be induced by injection of antigen. ☐ Neither type of sensitivity can be induced by injection of antigen.	Anaphylactic sensitivity can be induced by injection of antigen. Atopic sensitivity cannot be induced by injection of antigen.

Figure 7A
From: Allergy and Hypersensitivity. 3rd Edition.
Chas. Pfizer & Co., Inc. 1966.

If blood pressure has fallen to shock levels and does not respond to injections above the tourniquet or into the other arm, it is necessary to administer drugs intravenously.	

Figure 8A
From: Allergy and Hypersensitivity. 3rd Edition.
Chas. Pfizer & Co., Inc. 1966.

It is important for the patient to breathe ambient air intermittently during administration of 100 per cent oxygen, in order to prevent respiratory ☐ depression ☐ stimulation and resulting ☐ anoxia ☐ carbon dioxide narcosis.	depression carbon dioxide narcosis

Figure 9A
From: Allergy and Hypersensitivity. 3rd Edition.
Chas. Pfizer & Co., Inc. 1966.

merely nonsensical, and in context the meaning of the sentence probably would be interpreted correctly. However, a badly worded frame could be harmful if it caused a student undue difficulty, and it could be dangerous if it caused a student to learn an incorrect fact or concept.

Exactly when in the revision phase the review by subject matter, programming, and editorial experts should take place can vary. If the program is being written as a team effort, as suggested by Leon Summit at the First Rochester Conference (2), the review may occur before, during *and* after the student trials. If the program is being written by an individual, a more limited review may be the only feasible course. If students are more available than reviewers, the reviews may best be scheduled after the entire program has been written, but before student trials are completed.

If reviewers are more available than students, the reviews preceding student tryouts will eliminate many faults that might distract the student, and thereby increase the value of the student trial.

Conclusion

Whatever the circumstance in which a self-instructional program is written, extension of the testing and revision phase to include review of the program by people with knowledge and experience in the subject matter being taught, in programming and in editing will improve the quality of the completed program.

There is a familiar saying which goes something like this: if a little is good, more is better. To follow this advice in the application of medical treatment is to court disaster. To follow this advice in the review and revision of programs is to court success.

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2. Summit, L. "Team Programming in Medical Instruction." in Lysaught, J. P. (Ed.) *Programmed Instruction in Medical Education*. Rochester, New York: Rochester Clearinghouse, 1965. pp 77-86.

Mechanics of Frame Writing Using Formats With Alternates

PRESTON LEA WILDS, M.D.* and
VIRGINIA ZACHERT, Ph.D.*

IN RECENT YEARS techniques of writing frames for programmed materials have become much less rigid than they used to be. There was a time when there seemed to be only two irreconcilable techniques, the linear and the branching. These were defended by opposed learning theories which seemed just as irreconcilable as the techniques themselves. Both methods led to the production of some programmed materials which were brilliantly successful, and some others which proved to be wasted effort. In recent years more eclectic approaches to frame writing have become fashionable, and an experienced programmed writer is assumed to be a master of several different techniques and devices, which he should use in virtuoso fashion, matching his methods to the needs of the moment.

For the student program writer, the need for versatility in using unfamiliar, dissimilar formats is confusing. Because of his inexperience he has a tendency to select one format which seems congenial to him and use it to the exclusion of other formats which at times might be more appropriate to his chosen subject matter and to the objectives for his course. This paper is intended for the student who has actually started to write frames, and who is looking for help in selecting the formats which meet his needs.

*From the Department of Obstetrics and Gynecology, Medical College of Georgia.
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Programmed texts can give the appearance of great flexibility and sophistication in the style of writing, using relatively simple means. In case presentation programming, and in the programmed teaching of didactic material, great flexibility can be achieved using a total of five building blocks. These consist of three "question" formats and two "answer" formats.

Here are the question formats:

1. Multiple choice
2. Completion
3. Branching

Here are the answer formats:

1. Linear——next frame
2. Branching (directory)——branches

Question Formats

I. The first question format to be discussed is the question requiring a multiple choice response.

The most common adenocarcinoma found in women is cancer of which of these sites?

/_/ Brain	/_/ Cervix
/_/ Tongue	/_/ Ovary
/_/ Lung	/_/ Skin
/_/ Breast	

(Check your answer, then turn to the next page.)

Figure 1. Multiple choice question

A multiple choice question differs from a completion, "fill-in-the-blank," type question in the help it gives the student. A multiple choice question gives the student a built-in check list. It requires *discrimination* rather than *recall*. A multiple choice question can be used most effectively in a programmed text when there is a need for these special characteristics:

1. The student needs help in the form of a check list to answer the question correctly.
2. The emphasis of the question is such that the student's attention should be focused upon discrimination between items, rather than on supplying of information himself.

II. The next question format to consider is the completion format.

```
The most common adenocarcinoma found in women

is cancer of the ________________.

(Write your answer, then turn to the next page.)
```

Figure 2. Completion question

The completion format is most commonly used in conventional linear programs designed to teach didactic material. When it is used appropriately, it usually has these characteristics:

1. It should require the student to supply critical information.
2. It should have a high probability of being completed correctly.
3. It requires previous preparation or prompting.
4. The prompting should precede the required response.

The sample question meets all the criteria for a typical constructed response question. It is a "test" question, however, rather than a "teaching" question because the student must depend upon previous information to answer the question correctly. It contains no *prompts* to help the unprepared student come up with the right answer.

What is a prompt? Here are samples taken from a programmed text called "What is a Macadamia?" (1)

These three frames illustrate *thematic prompting*. There are other methods of prompting or cueing the student to come up with the right answer, but for most adults thematic prompting is the least irritating.

1. Pecans, cashews, almonds, and macadamias are all ______________.

2. Because macadamias are eaten mostly by hula girls, surf boarders and beach-combers, we can guess that they are grown in ________________.

3. You have now learned that macadamias are ____________ that are grown in ____________________.

Figure 3. Frames from "What is a Macadamia?"

As an illustration of *thematic prompting* in eliciting a correct response to the sample question, "The most common adenocarcinoma in women is . . . etc.," here is a not-very-inspired effort:

> In self examination for cancer, women with spectacular figures may be at a disadvantage as compared with less bosomy types. The most common adenocarcinoma in women--often first noticed by the patient herself as a small lump--is cancer of the ____________

Figure 4. Sample of Thematic Prompting

III. The third question format is branching. It is simply a combination of a multiple choice question with a directory.

> The most common adenocarcinoma found in women is cancer of which of these sites?
>
> - [ ] Brain, page 3
> - [ ] Tongue, page 4
> - [ ] Lung, page 5
> - [ ] Breast, page 6
> - [ ] Cervix, page 7
> - [ ] Ovary, page 8
> - [ ] Skin, page 9
> - [ ] None of the above, page 10
>
> (Check your answer and turn to the page indicated.)

Figure 5. Branching question

The cancer which women fear most is cancer of the ____________.

(Write your answer, then turn to the next page.)

Figure 6. Completion question

The cancer which women fear most is cancer of which one of these?

- [ ] Brain
- [ ] Tongue
- [ ] Lung
- [ ] Breast
- [ ] Cervix
- [ ] Ovary
- [ ] Skin

(Check your answer, then turn to the next page.)

Figure 7. Multiple choice question

The cancer which women fear most is cancer of which one of these?

- [ ] Brain, page 3
- [ ] Tongue, page 4
- [ ] Lung, page 5
- [ ] Breast, page 6
- [ ] Cervix, page 7
- [ ] Ovary, page 8
- [ ] Skin, page 9
- [ ] None of the above, page 10

(Check your answer, then turn to the page indicated.)

Figure 8. Branching question

Characteristics of a question in this format are these:

1. It encourages debate and digression, and sets up a kind of Socratic dialogue between the student and the text.
2. It limits debate to the options given in the question.
3. If often blunts the student's incentive to select the right answer on his first try.
4. It is particularly effective as a method of eliciting the student's opinion.

The sample branching question, as given, is probably inappropriate for a group of previously prepared learners who would be expected to recognize or recall the correct answer without much effort. For such a group, branches add little to the text except bulk and inconvenience.

If the question is changed to a highly *debatable* one, however, the appropriateness of the question format may change accordingly. Here is a new question prepared in three question formats:

One may assume that the learner will recognize that his answer to this question (in all of the formats) is a matter of personal opinion rather than scientific fact. He can express his opinion in any of the three formats, but only the branching format permits his opinion to differ from that of the programmer and still be accepted by the program.

```
                    BREAST

(Skin cancers are more common, but they usually
 derive from squamous rather than glandular
 elements, and hence are not adenocarcinoma.)

              ____________

(Next frame)

The importance of early detection, etc....
```

Figure 9. Linear answer (in capitals)

Answer Formats

IV. Flexibility in programming can be achieved by combining the three question formats with two answer formats, *linear* and *branching*. Here is a sample linear answer to the question "The most common adenocarcinoma found in women is . . . etc."

From the list below, select the response which most nearly corresponds to your own, then turn to the page indicated.

- [ ] Brain, page 3
- [ ] Tongue, page 4
- [ ] Lung, page 5
- [ ] Breast, page 6
- [ ] Cervix, page 7
- [ ] Ovary, page 8
- [ ] Skin, page 9
- [ ] None of the above, page 10

Figure 10. Branching answer

The linear confirmation or answer has these characteristics:

1. It prevents digression and defers debate.
2. It leads directly to the next question frame.

It should be assumed that answers in this format often go unread. The student who is confident that he is correct will often proceed to the next question frame without so much as a glance at the confirming words in the answer. On the other hand, the student who is less confident of his own response usually checks it against the confirmation in the answer frame before proceeding to the next question. Additional secondary information, shown in parentheses in the sample, is likely to be read only by the student who is unsure of his answer or who has made an error. In general, linear answers rely on the erring student's initiative and ingenuity to discover the nature of his errors. They supply the correct answer, but do not help the student diagnose his own deficiencies.

FINDINGS

1. None felt (I)
2. Abnormality found, see other items (I)
3. Unob-tructed (R)
4. Not felt (R)
5. L.d mastectomy scar on left, right negative. No nodes (I)
6. Obstructed (S)
7. DTR's physiologic (R)
8. Well developed, mod. obese, W.F. (R)
9. 2 cm ulcer on right lateral wall (lower third) (I)
10. No abnormalities noted (R)
11. 37°, 80, 24, 110/80 (S)
12. Atrophic (I)
13. Well-formed (R)
14. Moist (R)
15. Midline (R)
16. Atrophic (R)
17. Obese (I)
18. Undistended (R)
19. No abnormalities noted (I)
20. Grade II changes, capillary microaneurisms (R)
21. Not noted (R)
22. 37°, 80, 18 (R)
23. Sounds normal (S)
24. 5'6", 170 lbs., 180/112 (R)
25. All present and equal (R)
26. Not enlarged (I)
27. Intact (R)
28. Unremarkable (R) (I)
29. Supple (R)
30. Left drum perforated (R)

GENERAL PHYSICAL EXAMINATION

Please check the parts below which interest you, then look up the results with the corresponding code number in the column on the left.

General description.........8 ( )
TPR.........................22 ( )
BP, hgt., wgt,..............24 ( )
Skin........................14 ( )
Lymph nodes.................26 ( )
Head and face...............13 ( )
  Ears......................30 ( )
  Eyes......................20 ( )
  Nose.......................3 ( )
  Mouth and throat..........28 ( )
Neck........................29 ( )
  Thyroid....................4 ( )
  Trachea...................15 ( )
  Vessels...................18 ( )
Chest.......................28 ( )
  Breasts and axillae........5 ( )
  Heart.....................28 ( )
  Lungs.....................19 ( )
Abdomen.....................17 ( )
  LSK........................4 ( )
  Masses....................21 ( )
  Tenderness................10 ( )
Pelvic examination...........2 ( )
  Ext. genitalia............16 ( )
  SUB glands.................4 ( )
  Vagina.....................9 ( )
  Cervix....................12 ( )
  Uterus....................19 ( )
  Adnexa....................26 ( )
Rectal......................10 ( )
  Sphincter.................27 ( )
  Masses.....................1 ( )
Extremities.................13 ( )
  Pulses....................25 ( )
Reflexes.....................7 ( )
Neurological................10 ( )

CODE

I= INDICATED, required by presenting problem.
R= ROUTINE, for screening or completeness of evaluation.
U= Probably USELESS but harmless in this case.
C= CONTRAINDICATED, not in patient's interest.
S= SPURIOUS, bogus answer.

DIRECTORY (your next step)

Diagnostic studies, page 281b
History, page 279b
Your diagnostic opinion, page 284b
Your plan of therapy, page 286b

Figure 11. Coded Multiple Choice Page

V. The other type of confirmation or answer frame is the branching.

This answer format has two important characteristics:

1. It provides for digression and debate.
2. It interposes an additional step between the student's response and his confirmation, feedback, or remedial instruction.

This format should be used only when the need to give the student an opportunity for digression and debate is sufficient to justify the delay caused by the additional step. Furthermore, a branching answer is appropriate only when it follows a completion-type question. A multiple choice question leading to a branching answer would be an obvious redundancy, involving unnecessary busy-work for the student.

It should be replaced by a branching question, which combines the question and the directory on one page. Branching questions and branching answers can lead to subsequent frames in *any* format.

VI. *Coded Multiple Choice* pages can be prepared in a variety of formats, depending on how many items are indicated and how much commentary is desired on each item. Such pages should be looked on as devices for presenting many branching frames on a single page, eliminating unnecessary page-turning, and reducing the bulk and inconvenience of the text. The programming principles for preparing a page with many frames on it are the same as for preparing the same frames on separate pages.

Conclusion

Great flexibility can be achieved in writing programmed texts by using various combinations of five basic units. These consist of three "question" formàts and two "confirmation" formats. The choice of a particular format to meet a given learning situation should be related to the outcome desired by the programmer, and is governed by rather simple rules.

References

1. Jones, Pat. "*What is a Macadamia?*" Programmed Instruction Department, United Services Automobile Association, San Antonio, Texas: 1963. (22 pages)

Institutional Differences in Students Using a Programmed Text

MARGARET H. PETERSON, M.D.,
FRED D. STRIDER, Ph.D.*

Defining the characteristics of the learners who are expected to use programed materials and formulating the objectives of the program are basic preliminary steps in all program writing. Once the program has been written, field testing is essential. This field testing should attempt to determine whether or not the description of the learners was appropriate; whether or not the program is actually appropriate to the learners for whom it was intended; whether changes need to be made in the description of the learners to insure that the program will be used appropriately or if changes must be made in the program to make if conform better to the needs of the group for which it was intended.

In addition, the field testing should aid in revision of those items which may be ambiguous or unduly time consuming and, through the use of pre- and post-tests, should indicate whether or not the objectives originally specified have, in fact, been achieved. The problems which can arise in each step of the process from defining the learners to evaluating the results were evident in our recent experience with preparing and testing a brief programed unit on the defense mechanisms.

*Both of the University of Nebraska College of Medicine.

Assumptions

The program was designed for sophomore medical students at the University of Nebraska College of Medicine. It was constructed in linear style presenting examples and definitions of some of the more common ego defense mechanisms. It was assumed that, since the undergraduate backgrounds of these students were more heavily weighted with physical and biological science courses than with the humanities or social sciences, their knowledge of the vocabulary of dynamic psychiatry would be limited. It was also assumed that they would have learned something of normal personality development in their freshman psychiatry lectures but would not yet be familiar with psychopathology. Because most of the students in the University of Nebraska sophomore class are from Nebraska, or surrounding states, it seemed appropriate to consider whether or not the same material could also be used in other parts of the country where students might vary in their degree of psychiatric sophistication.

Participants in The Field Tests

Because of this likelihood that students in different parts of the country would differ in their psychiatric sophistication, medical students at several different schools were asked to participate in the field testing. In addition to the Nebraska students, for whom it was specifically written, sophomore students at a state university medical school in a neighboring state, sophomore students at three eastern university medical schools and groups of junior students on clerkship at an eastern metropolitan psychiatric hospital were asked to use the programed text during the 1965-1966 school year. A group of Nebraska ministers enrolled in a seminary sponsored counselling course were also asked to participate to assess the suitability of the materials for groups other than that for which it was originally written.

Students in the University of Nebraska group represented only one-half of the sophomore class. This class had previously been divided into matched groups on the basis of their weighted grade averages for the freshman year. One-half of the class used the programed text and the other was instructed by an experienced senior staff member using the lecture method. The two halves of the class did not differ significantly on the pre- or post-tests. Only those who used the program were compared with students from the other institutions.

Of the three eastern university groups originally contacted to participate in the study, only one provided sufficient data in time to be included in this report. The students from this university represented the majority of the sophomore medical class. However, this group, unlike the University of Nebraska sophomores, had previously had some exposure to defense mechanisms. The eastern metropolitan psychiatric hospital was located in the same city as the eastern university. The students who participated were junior clerks from 3 medical schools and were presumed to be familiar with the defense mechanisms.

The data submitted by the other midwestern university was unusable because the tests and program were not administered in the same way as in the other schools.

Ministers enrolled in the seminary counselling courses were presumed to have had minimal training in psychiatric nomenclature but because of the nature of their counselling duties and the fact that they had chosen to enroll in the course to learn more about human behavior, it was anticipated that they would have done some reading in the field.

Procedure

All of the students (and ministers) were asked to take a pre-test consisting of definitions of fourteen of the most common defense mechanisms to determine their knowledge before using the program. In keeping with the objectives of the program, the post-test following completion of the program presented behavioral examples of defense mechanisms to test whether or not the students were able to recognize the mechanisms involved from a description of the behavior.

On separate response sheets, students were asked to record their responses to each item in the program, enter the correct response if theirs did not agree with the one indicated on the program, and note their comments on individual items as well as their reactions to the entire program. They were also asked to record the amount of time they used in completing the programed text.

Results

Comparison of the pre-test scores of the student groups for which complete data was available showed that these conformed to the expected predictions that the students would differ in their knowledge of the defense mechanisms since their past backgrounds and experience in psychiatry differed.

On the pre-test, those students who had already had lecture material on the defense mechanisms were significantly better than those who had not, (Table 1).

Table 1

Values of t for Mean Differences, Pre-test

	Nebr.	Jr. Clerks	Eastern School	Ministers
Nebraska	----	6.0**	7.96**	.51
Jr. Clerks	----	----	.789	5.79**
Eastern School	----	----	----	9.15**
Ministers	----	----	----	----

** Significant at the .01 level

The differences between groups was less marked on the post-test with the junior clerks still scoring significantly higher than the Nebraska sophomores and the ministers, but the eastern university sophomores no longer scored significantly higher than the Nebraska sophomores, (Table 2).

Table 2

Values of t for Mean Differences, Post-test

	Nebr.	Jr. Clerks	Eastern School	Ministers
Nebraska	----	2.56**	.85	.525
Jr. Clerks	----	----	.36	6.74**
Eastern School	----	----	----	1.038
Ministers	----	----	----	----

** Significant at the .01 level

The time needed to complete the program varied widely, as is expected in self-instructional devices, but the times reported by the students were only estimates and were therefore not tested for significance, (Table 3). Four of the 56 ministers reported needing 3 hours or more to complete the program as contrasted with a maximum student time of 2 hours, 45 minutes reported by one student only.

The information collected in this study does not show that the programed material is necessarily an effective teaching device except

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It ... felt

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

In the nursing department, the supervisor felt that the minimum available training time makes it imperative that the trainer be effective as well as efficient. The time factor usually results in minimum, haphazard training by multiple trainers who are not the most effective. Indeed the trainer may be the newest or youngest member of the staff, with little or no training experience.

A laboratory supervisor looked at the other side of the coin. He felt that a trainer must know "how to train." He explained that what makes a technician competent does not necessarily make him a good trainer of others. Yet, in his own department new assistant techni-

Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
2. He has a minimum of 1 year job related experience.
3. He is actively performing at least some of the skills being performed by the person or persons he is responsible to train.
4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses

Medical Records:

1. Department Head (Med. Rec. Lib.)
2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head

Maintain a high level of performance

Evaluate trainee's performance periodically

Motivate trainee to maintain performance standards

Retrain as needed

The Course Content

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The trainer is taught to classify causes of poor performance into three groups.

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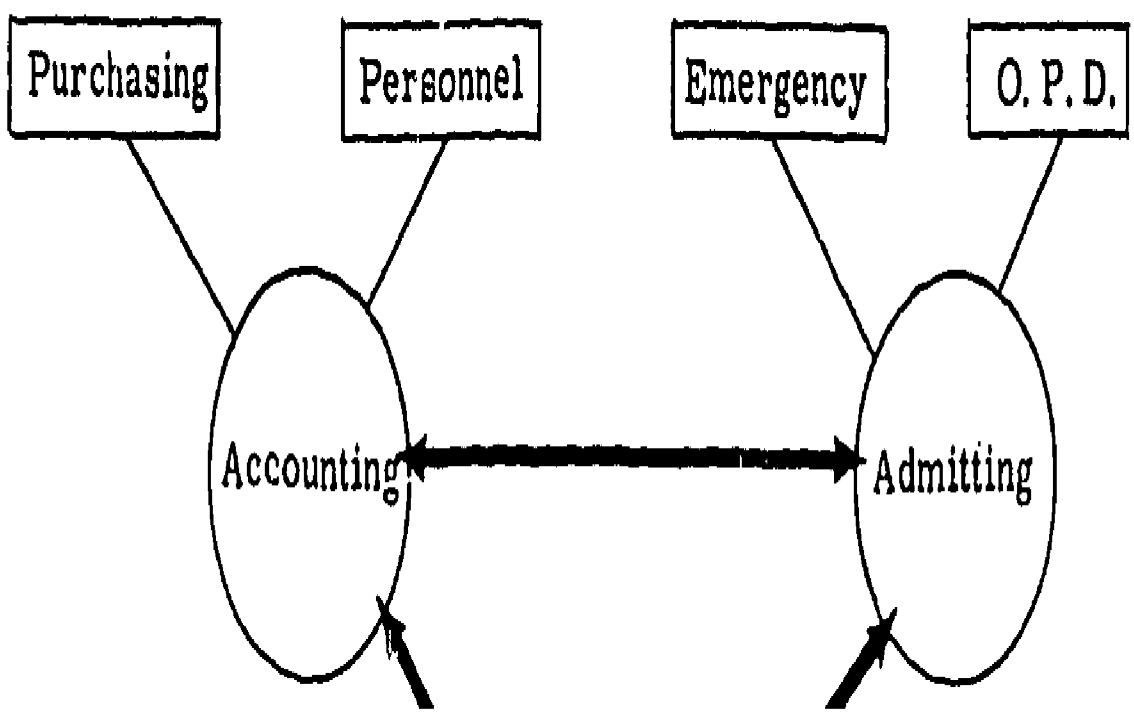

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Programmed Instruction to Train Hospital Employees How to Train Others

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4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

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2. Area Supervisors
3. Utility Men
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Maintain a high level of performance

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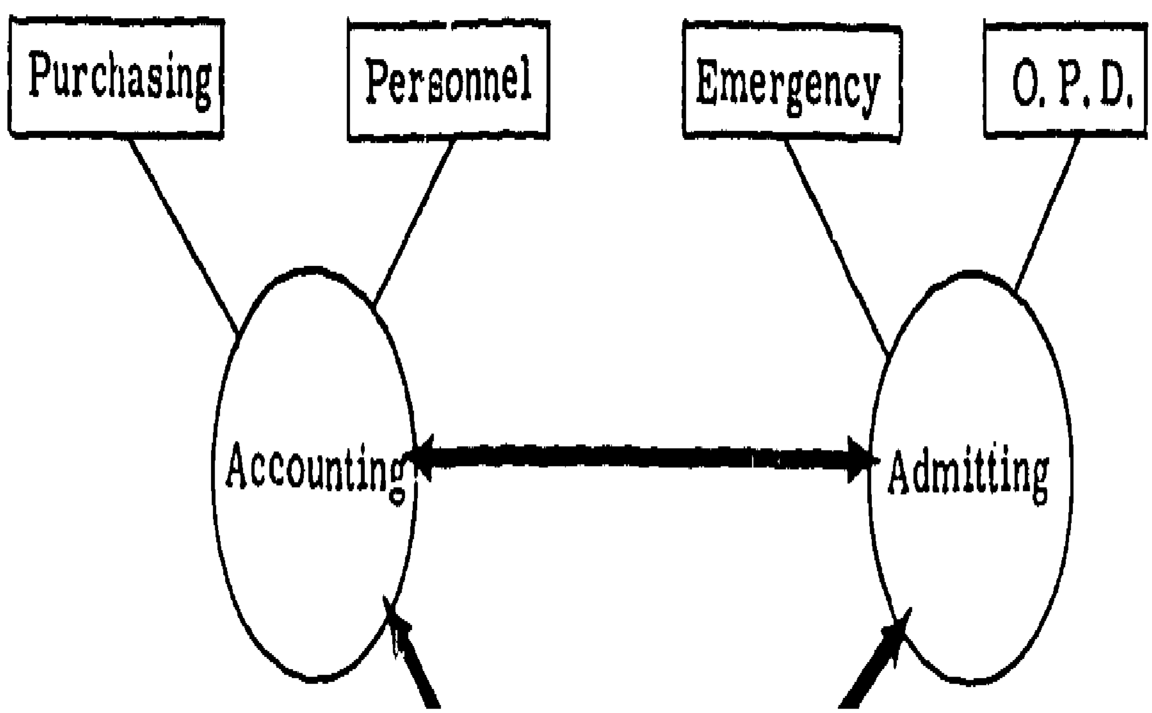

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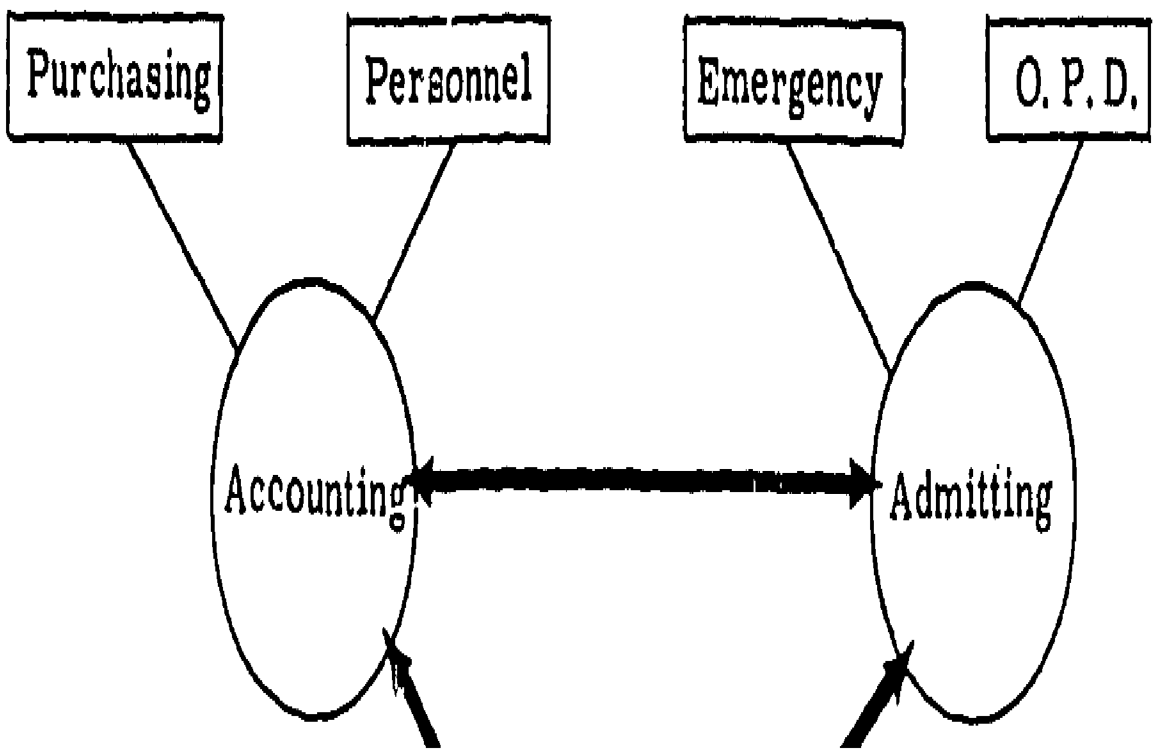

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as its use appeared to diminish the differences between groups which started with obviously different knowledge levels.

In addition to the information gained from the test scores, student comments noted on their response sheets showed up some of the strengths and many of the deficiencies of the program as it was written. Because of the preponderance of favorable comments from the students using the first version, a second edition revised on the basis of the field testing replaced the sophomore lecture on defense mechanisms the following year. Similarly, the psychiatrist at the eastern school asked to continue participating in the field testing in return for having the programed materials available to his students. His comments and observations were invaluable in the revision.

Table 3

Estimated Time for Completion of Programs

	Nebr.	Jr. Clerks	Eastern School	Ministers
Range (in minutes)	35-165	40-120	30-150	60-210
Mean (in minutes)	80	70	70	105
Median (in minutes)	75	75	65	100
Mode (in minutes)	75	120	60	70
No. reporting	43	32	87	36

As noted, revisions were made in the program on the basis of the 1965-1966 field testing and a second field test using both freshman and sophomore students from the eastern university and sophomores from Nebraska was carried out during the 1966-1967 school year. The information from this test is still being tabulated.

Summary

Four groups assumed to differ in their knowledge of psychiatric nomenclature were selected to field test a brief programed unit on the ego defense mechanisms. Preliminary testing indicated that three of the groups differed significantly before using the program. After the groups used the program, the *differences* between the performances of the groups was reduced. However, one group scored

significantly higher than two of the others both before and after the program.

Comment

Any attempt to measure the success of a teaching method should contain carefully constructed measuring instruments. Although field testing involves more than collecting scores on pre- and post-tests since the response errors and comments are sought as much as data which can be subjected to statistical analysis, it becomes immediately evident that there is a gross lack of adequate appraisal instruments either for testing before administering the program or for later testing of its effectiveness.

Except where it is possible to use sections of a widely given test such as the National Board examinations, standard tests are unavailable. Even the National Board examinations are not the perfect answer since regional variations in scores are evident. These regional differences may be due to dissimilarities in the quality of the students or may result from lack of uniformity of emphasis in various parts of the country. The National Board examinations, although carefully constructed, are not without ambiguous questions and contain some on which experts in the field might reasonably disagree. Emphasis may vary from year to year in the National Board specialty sections, especially in Psychiatry, which may one year be heavily weighted in mental retardation and another year in pharmacology, etc. For a programed text of limited scope, the National Board examinations may offer too few questions to be of value.

Ideally, the results of the pre-test should help the programer decide on the suitability of his program for the group with which he intends to use it and the post-test should guide his revision of items, sections and review frames. In practice, he must question the reliability of the test questions as thoroughly as he does the effectiveness of the program items. Since there are no standard appraisal instruments available, especially in the psychiatry field, he must either construct his own pre- and post-tests, subject to the same errors as the program itself, or he must prevail on others, no less biased, to write them. Anyone who attempts to construct fair examinations for students quickly becomes aware of the difficulties in writing tests which elicit more information than, "What am I thinking?", or a simple regurgitation of memorized "facts." As any teacher, the programer endeavors to determine the reasons for his students missing what he considers important questions on an examination. It may be difficult to decide which of several factors is responsible when over one-third of the students miss the same question.

The problems may lie in the test itself, in the order of presentation of the material, or in the style of presentation. Any single question may be poorly written, ambiguous, or too complex. It may contain elements of more than one correct answer. It may phrase a definition in terms slightly different from what the students have previously learned.

In the post-test particularly, the programer hopes to find the problems in the programed material itself and the questions should help discover which areas were inadequately treated when originally explored. But other inadequacies may be inherent in the program, such as too-frequent repetition of response, not forcing the student to think in the face of stimuli, or insufficient reinforcement in review frames. If many students fail to understand one section of the program, then it must be revised. The problem lies in pinpointing where the lack of understanding begins when the appraisal instruments are inadequate.

In his book, *A Guide to Programed Instruction*, Lysaught (1) indicates that evaluation is not an easy process and that the methods of field testing may sometimes lack sufficient controls to satisfy the careful researcher. Evaluation would be simplified if adequate appraisal instruments were available, but for the programer who confines his work to relatively limited areas, it seems unlikely that these instruments will be developed. Having written a programed unit, he must return to the beginning, defining the learners and outlining behavioral objectives. In constructing his pre- and post-test he must not only continue to keep the learners and objectives in mind, but finds he must also appraise his tests as carefully as his programed text.

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Teaching Controversial Materials by Means of Programmed Instruction

PRESTON LEA WILDS, M.D.* and
VIRGINIA ZACHERT, Ph.D.*

IN PREPARING programmed materials, how should one handle controversial material? The beginning program writer is often led astray by a commonly held misconception that linear programming styles, which usually limit themselves to teaching the "right" answers, are best suited for the handling of non-controversial subjects, and that branching formats are needed to handle controversy.

Actually, the use of programmed instruction to teach subjects involving controversy or debate follows the same principles as the use of programmed instruction to teach non-controversial subjects, and has little to do with distinctions between linear and branching programming formats. The programmer must decide first of all on his objectives. He must decide what outcome he desires in terms of student behavior. Once he has made this decision, the appropriate programming strategy is usually readily available.

Attitudes in Learning Controversial Material

I. Student Non-involvement

The student learns that the issue is controversial and can be safely ignored until others resolve it by further study or research. He feels no personal responsibility for further learning in this area so long as the issue remains controversial.

*From the Department of Obstetrics and Gynecology, Medical College of Georgia.
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II. Student Unilateral Involvement

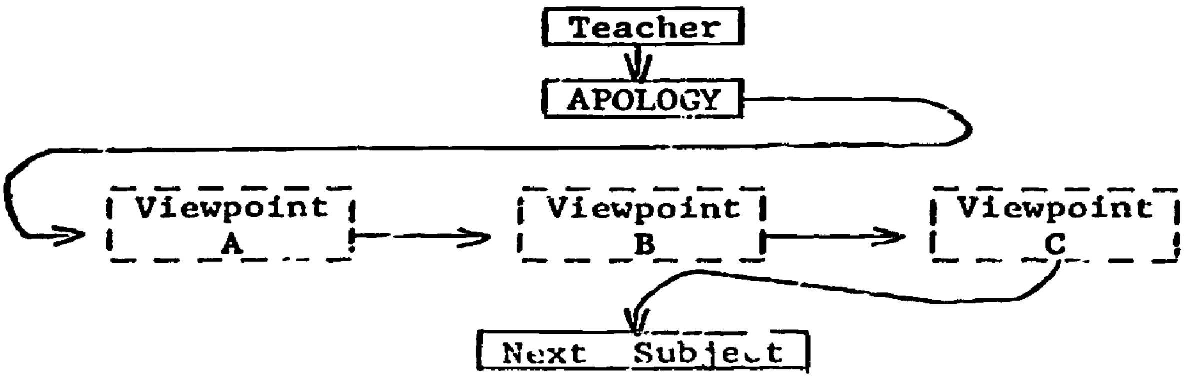

FIGURE 1. TEACHING NON-INVOLVEMENT (LINEAR)

A. The Teacher's Viewpoint
   1. The student learns only the teacher's viewpoint in the controversy but learns it with enough emotional learning involvement to defend it vigorously.
   2. The student learns the teacher's viewpoint in the controversy with enough emotional involvement to defend it vigorously and, in addition, learns enough of the opposing viewpoints to be able to attack them effectively.

B. The Learner's Viewpoint

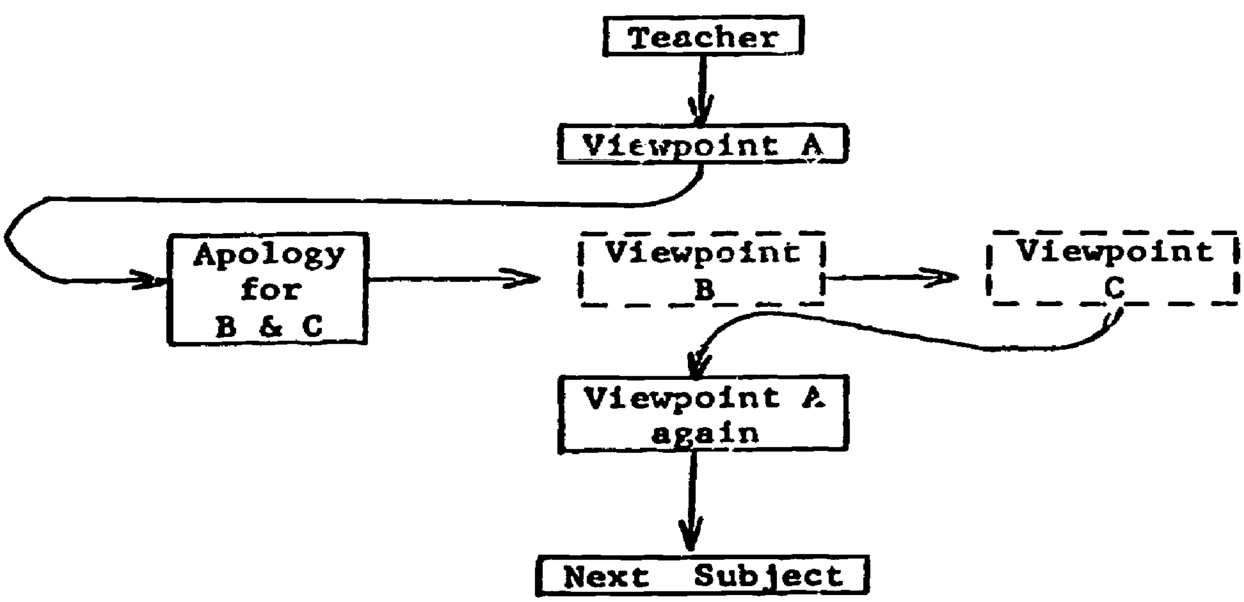

FIGURE 2. TEACHING UNILATERAL INVOLVEMENT (LINEAR)

The student selects his own viewpoint in the controversy and learns enough to defend it vigorously, ignoring the opposing views.

III. Student Multilateral Involvement
The student learns the different sides of the controversy with so much involvement that he seeks to resolve the controversy on his own initiative through further study, inquiry, or research.

Of the attitudes described above, each is appropriate in its place. Each can be achieved through the use of appropriate strategies. Many teachers, however, have difficulty achieving compatibility between their objectives and their teaching methods.

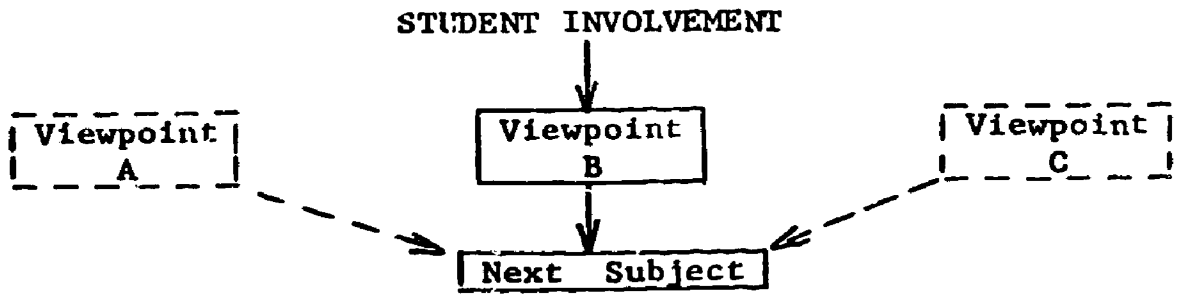

FIGURE 3. STUDENT'S UNILATERAL INVOLVEMENT (LINEAR)

Strategies for Teaching Controversial Materials

I. To Obtain Student's Non-involvement
The lecturer apologizes in advance. He informs the student that the issue is controversial, unsettled and must await the result of further research. When this is tried in a lecture, the students lay down their pencils till the lecturer gets back on solid ground.

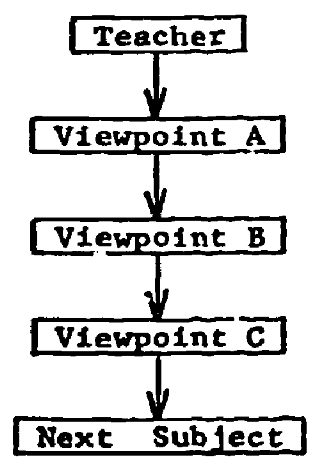

FIGURE 4. MULTILATERAL INVOLVEMENT TEACHER'S SEQUENCE (LINEAR)

II. To Obtain Student's Unilateral Involvement

A. The Teacher's Viewpoint:

He makes an appropriate sales pitch, using the soft sell as necessary. If he thinks that opposing viewpoints may carry some weight, he is sure to acknowledge them, as he amplifies their deficiencies.

B. The Learner's Viewpoint:

In conventional teaching situations, the student who masters this approach is simply following the example of his teacher and beating him at his own game with an opposing view. A one-sided programmed text can have the same effect as a one-sided teacher. They both tend to elicit strong opinions from some students, with a minimum enlightenment.

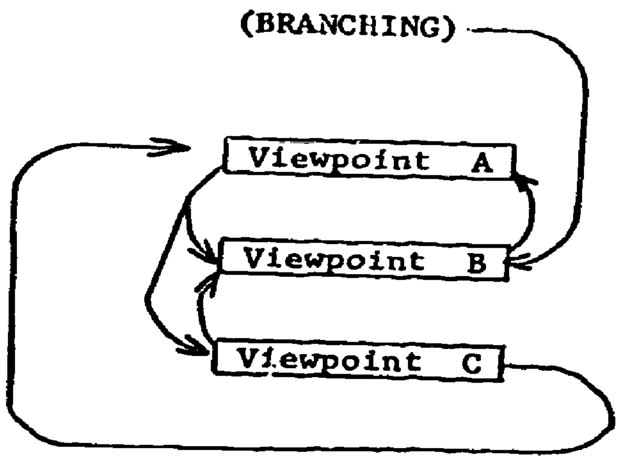

FIGURE 5. MULTILATERAL INVOLVEMENT STUDENT'S SEQUENCE (BRANCHING)

III. To Obtain Student's Multilateral Involvement

A. The Teacher's Sequence:

The teacher can present, in any sequence he chooses, each viewpoint of the controversy in an impartial manner, *giving each viewpoint his most persuasive sales pitch* possible. Neither before nor afterwards does he intimate that the issue is controversial. He simply presents all sides of the controversy as persuasively as possible and then moves on to the next topic. Depending on how well he has held his student's attention, the group will range from non-involvement through several different varieties of unilateral involvement to a few who, having paid careful attention to his entire presentation, are now multilaterally involved.

B. The Learner's Sequence:

The student works through and learns all aspects of the controversy in a sequence he chooses for himself. For the autonomous learner this is undoubtedly the best and most efficient way. Superior students have always learned by this method, in spite of the best efforts of teachers and programmers, and doubtless will continue to do so. Programmed materials, properly used, should enhance rather than limit the freedom of students to learn best in their own way.

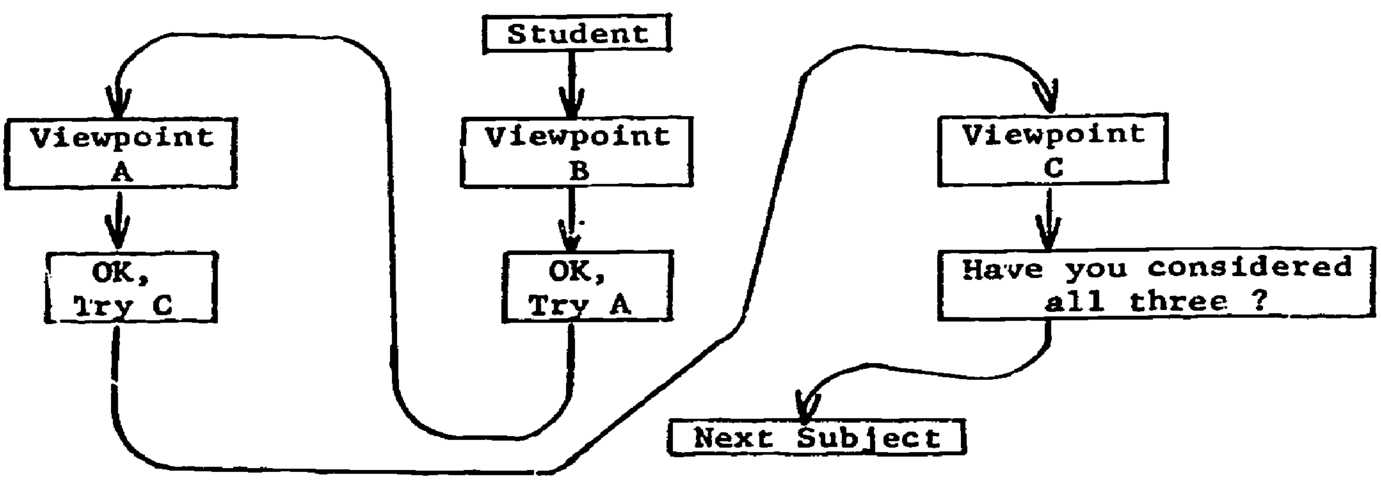

FIGURE 6. TEACHING MULTILATERAL INVOLVEMENT TO STUDENT WITH UNILATERAL BIAS (BRANCHING ⟶ LINEAR)

Summary

Appropriate handling of controversial material in programmed instruction formats, as well as in other types of teaching, requires that the programmer decide in advance what outcome he desires in terms of student behavior. The desired degree of student involvement can be classified as follows:

1. Student non-involvement
2. Student unilateral involvement
3. Student multilateral involvement

Once the desired outcome has been determined, the controversial material should be developed to meet the behavioral objectives determined by the programmer.

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Formulating Instructional Strategies: A Program on the Management of Mental Health Problems as a Case Study

GEORGE L. GROPPER*

THE PROCEDURES that educators follow in devising instructional experiences for the learner, whether in the school classroom or in the training classroom have in recent years been dubbed a "technology." A recitation of the procedures involved in that technology (e.g., specifying objectives, tryout and revision, etc.) often sounds like a well rehearsed litany. But one of the key procedures has nothing like technological certainty and is without doubt the step least understood and most neglected. It is the "formulation of instructional strategies."

An instructional strategy needs to be formulated to determine the kind of learning experience that will most efficiently and effectively lead to satisfactory terminal performance. Instructional strategies thus concern themselves with ways of taking the learner from an initial to a terminal capability. This requires the specification of the kind of responses to be practiced, the stimulus contexts in which they are practiced, and the kind of stimuli that are used to insure that they can be correctly practiced. Typical decisions that are made include: whether to use visual or verbal materials; whether to require recognition or production responses; whether to have one type of response early in learning and another type later; whether it is sufficient to require the learner to state verbally what procedures he would follow or to require him to practice the procedures themselves; whether to

*Director, Instructional [illegible] Program, American Institutes for Research, Pittsburgh, Pa.
(1)The training program was developed under the auspices of United Mental Health Services of Allegheny County, Inc.

practice describing situations to which he would react or to practice reacting to those situations, etc. These decisions are highly complex and the bases for making them are not well established.

This presentation attempts to share with you the *rationale* for some of the strategy decisions we made in the development of an actual training program. (1) The program has been designed for teachers in the elementary grades and is intended to enhance their skills in managing the social and emotional problems that occur in the classroom. Three broad objectives were set forth for the training program: (a) to enable teachers to identify behavior that constitutes a problem, and based on an assessment of how serious the problem is, to decide whether to attempt to manage it in the classroom or whether to refer a child with the problem for professional help; (b) to train teachers in management techniques based on behavioral principles (e.g., contingency management) so that they can deal with problems that are "manageable," and (c) to help teachers to gain insight into their own attitudes toward children with behavior problems.

By means of illustrative strategy decisions made concerning each of the major goals of the training program, the presentation that follows elaborates on some of the many considerations involved in the complex business that is strategy formulation. It should be granted at the outset, of course, that more than one kind of learning experience can lead to the same kind of outcome. In advance of comparative results testifying as to the wisdom of the several possible kinds of learning experience, all that can be done is to provide a defensible rationale for the particular kind of instructional strategy chosen. This paper thus shares with the interested reader one set of rationales to be considered as a *case study* rather than as a universal prescription.

Before an instructional strategy could be developed for each of the three major goals of the training program, the following types of identifications had to be made:

—a behavioral description of the specific criterion behaviors expected of teachers;
—the types of skills underlying those behaviors;
—an estimation of the current skill level of the population to be trained;
—the types of learning involved in acquiring a higher skill level;
—the psychological processes underlying the types of learning (e.g., discriminations, generalizations, and chains).

Based on such considerations, differing strategies were formulated for each of the three major training areas. Some of these considerations will be touched on in the sections that follow.

Classifying Problem Behavior

On the basis of a Critical Incident investigation which was conducted by means of interviews with 100 third-grade Pittsburgh teachers, social and emotional problems frequently occurring in the classroom were identified. The following thirteen major behavior categories were identified:

1. Attention to Classroom Activities
2. Physical Activity
3. Reaction to Tension
4. Appropriateness of Behavior
5. Meeting Work Requirements
6. Interest in Work
7. Getting Along with Others
8. Consideration for Group Needs
9. Response to Teacher Requirements or Instructions
10. Degree of Independence
11. Regard for School Rules and Conventions
12. Regard for General Rules and Conventions
13. Integrity

All children, whether normal or maladjusted, display problems in each of these areas. The teacher has to learn to distinguish between problem characteristics that are typical of normal children and the problem characteristics that are only found in disturbed children. For example, lack of attention to classroom activities may range from the inattentiveness that a normal child exhibits (when he is simply bored), to the more serious withdrawal that a disturbed child exhibits. Or problems may crop up ranging from the restlessness that normal children engage in (after prolonged periods of work) to the hyperactivity that disturbed children typically exhibit.

These, then, are the types of social and emotional problems a teacher is likely to encounter in the classroom. What is she expected to do about them? The first part of the training program sets this behavioral goal for her:

—to decide whether an observed child behavior is a problem; and if it is a problem

—to classify its seriousness: (a) is the problem natural for the age,

Programmed Instruction to Train Hospital Employees How to Train Others

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It [illegible] felt

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

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Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
2. He has a minimum of 1 year job related experience.
3. He is actively performing at least some of the skills being performed by the person or persons he is responsible to train.
4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses

Medical Records:

1. Department Head (Med. Rec. Lib.)
2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head

Maintain a high level of performance
- Evaluate trainee's performance periodically
- Motivate trainee to maintain performance standards
- Retrain as needed

The Course Content

The next step was to determine what specific concepts would be taught and how they would be presented. On the basis of the field study, we established the following criteria to help us determine the content of the course: 1) The basic training principles to be taught must be based on modern industrial training psychology. They must

reactions are appropriate to the information transmitted. The trainer can then change his own behavior in accordance with the trainee's responses. But, conversely, the student, who is hesitantly performing, needs to know whether or not his actions are appropriate before he's secure enough to go on, or can adjust his performance. This is the aspect of feedback which we decided to stress. To apply this principle we specify a clear-cut procedure. The trainer should *tell* him whether he's right or wrong. When he's wrong, point out his mistake and *correct* him; when he's right, point out he's right and *support* him; occasionally praise his appropriate behavior.

Withdrawing support gradually implies letting the trainee work

greater impact by teaching "How to Train" before "Preparation for Training."

We selected three sub-terminal behaviors we wanted to bring about in a trainer who must be able to make appropriate preparations for training: he must be able to determine training needs, plan the order of training and prepare his trainee for training.

The program prescribes a clear-cut procedure for determining the indoctrination training needs of a new employee. Preparation for refresher training applies the same basic rules, but the resultant training needs are usually fewer. First, the trainer must state the overall training goal. Generally, the goal is determined by the trainee's job

A periodic review is the recommended mode of evaluation and we felt that simple guidelines would help the student internalize a workable evaluation procedure. He is taught *what* to check, *when* to check and *how* to check.

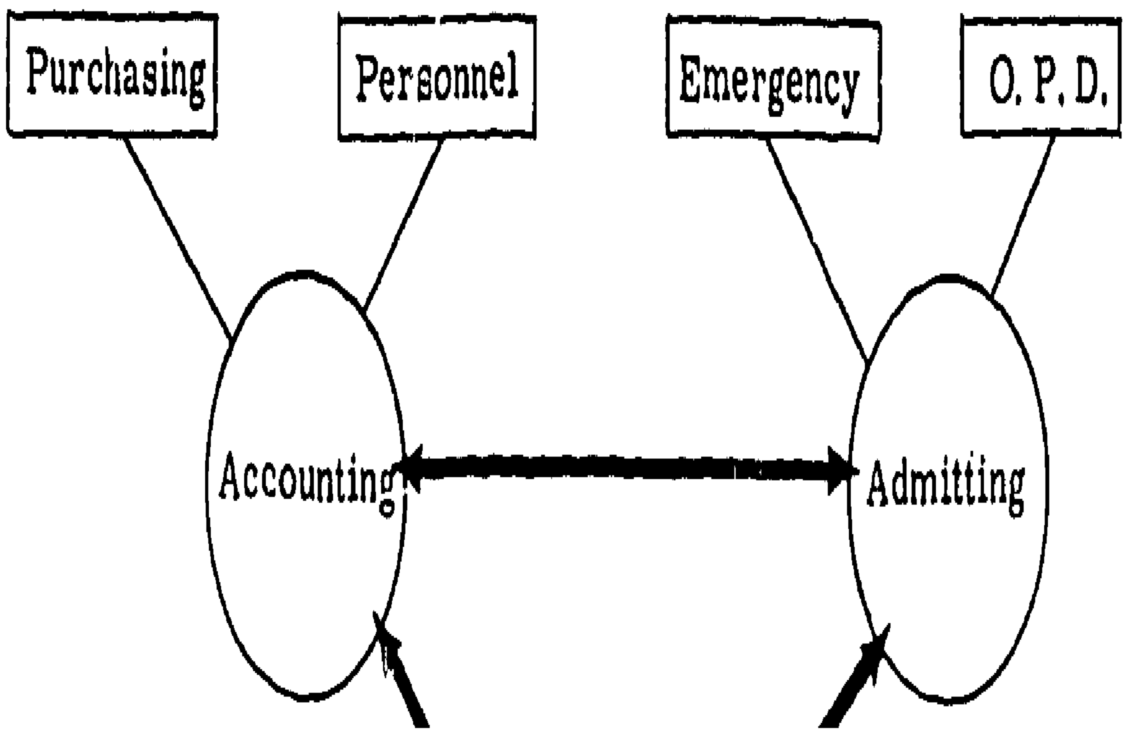
Using the job breakdown form, the trainer learns to check most often on those tasks or functions which are most important. Generally speaking, the most important tasks would be the ones that affect the patient's welfare most directly. He is taught to check on a regular basis, that is daily, weekly, monthly, etc. Whether he should check more often or less often depends on how reliable the trainee is and how recently he has learned the tasks. The trainer must then find

take action to improve performance.

The trainer is taught to classify causes of poor performance into three groups.

1. The trainee may be *unaware* of what is acceptable performance. Clearly, improving the trainee's performance would involve telling him what's expected.
2. The trainee may be *unwilling* to meet acceptable performance because of personal or interpersonal problems. This can be considered a problem of motivation and would be too difficult to handle in this program. The program only recommends that the trainer attempt to motivate his trainee by explaining the need or

SCHEMA OF FUNCTIONAL RELATIONSHIPS



nursing department and other supporting departments such as dietary, technical medical services, housekeeping, medical records, and social service. A few examples were taken from the top of the chart indicating that the strongest relationships are with departments other than nursing. A final analysis shows that examples were selected from 14 different departments.

Language and Vocabulary

Another objective was to communicate easily, yet keep the reader involved. The choice of language used and the selection of the vocabulary were left to the discretion of the programmer. Analysis of a randomly chosen sample of 100 consecutive words indicates a Flesch

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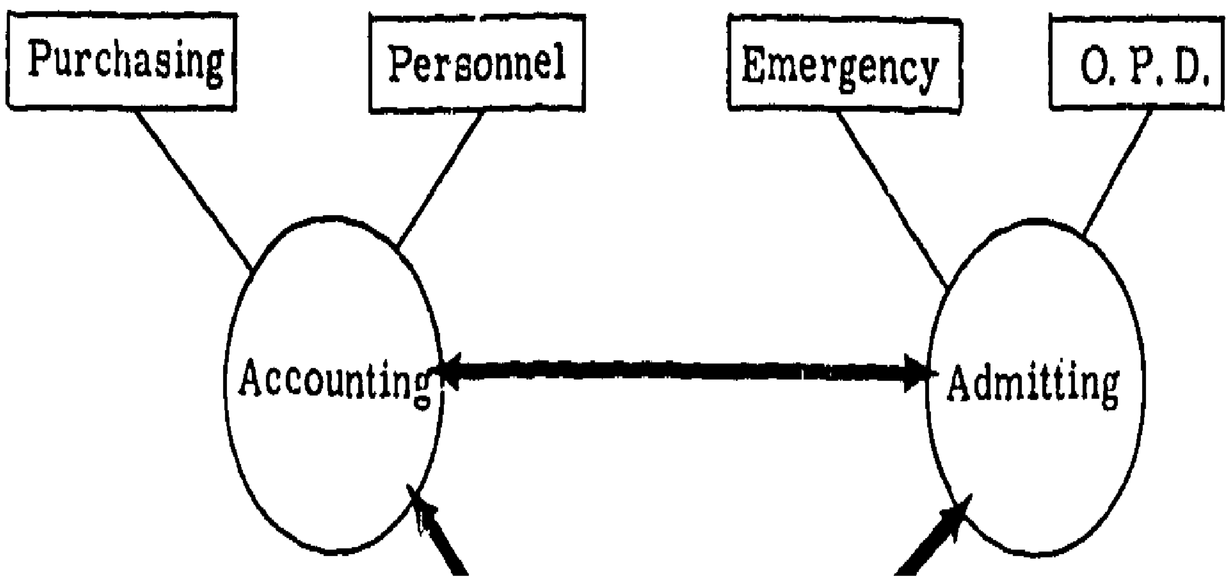

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part of growing up (NORMAL level); (b) or does it represent some form of maladjustment still capable of classroom management (PROBLEM level); (c) or is it so serious as to require outside referral (REFERABLE level).

To aid teachers in making decisions as to the severity or seriousness of a given problem behavior, a set of multiple criteria was developed. These include such variables as:

—Intensity (how disruptive of a child's other activities is the problem behavior);
—Appropriateness (is it a reasonable response for the situation);
—Duration;
—Frequency;
—Recovery Time (how quickly forgotten is an episode);
—Specificity/Generality (in how many types of situations does the problem behavior occur);
—Manageability;
—Assessability of Circumstances (how easily can precipitating situations be identified);
—Deviation from Maturity Level of Class;
—Contagion (how much of the rest of the class is affected by the behavior);
—Number of Problems Exhibited;
—Contact with Reality.

Judgments can be made as to the seriousness of a problem based on the levels for each criterion that a problem behavior satisfies.

The first section of the training program thus is designed to familiarize teachers with the thirteen types of problems they are likely to encounter in the classroom. It is also designed to teach them to apply the above criteria to problems they will encounter in their actual work. Their decision as to whether the problem behavior observed is at the NORMAL level or at the PROBLEM level (and to be managed in the classroom) or whether it is at the REFERABLE level (and by definition to be referred to competent professionals) would depend on their ability to apply decision criteria to actual behavior. Given these requirements, *what kind of learning experience* need be devised?

The first set of skills to be taught consists of "recognizing behaviors as problems" and then classifying them at an appropriate seriousness level. Both skills are taught at the same time but the instructional strategy differs for each. To enable teachers to recognize that thirteen types of behaviors constitute "problems" often encountered in the classroom appears to require nothing more complex, it would appear, than giving them practice in observing such behavior (whether described verbally in print, or presented realistically on video tape). For this purpose, the teacher is exposed to verbally described examples of each type of problem behavior. Because the teacher will ultimately have to recognize problem behavior in the flesh and not in print, transfer from the learning situation to the classroom must be facilitated; that is, the type of recognition practice selected must make it likely that the teacher will recognize problem behavior when they encounter it in the classroom. Accordingly, television tapes were prepared in which multiple examples of each problem type are presented in realistic fashion. Thus, the teacher can practice recognizing problems in as nearly similar a way as she is likely to encounter them in the classroom. The chances of successful transfer to the classroom are thereby increased. This then was the primary rationale for using the television medium.

The *multiple* examples presented both in print and on tape also exposed the viewer to the range of manifestations given problems might have—allowing for generalization across sometimes seemingly disparate behaviors that nevertheless represent the same type of problem. Neither program, however, required the teacher to list or produce the names of the problem types, that is to say, they would never be asked "List the types of problems you are likely to encounter in the classroom." Rather, programs merely required the teacher observing an instance of behavior to *recognize* whether or not the behavior constituted a problem.

The verbal program had an additional goal. It was designed to aid the learner to discriminate or distinguish between the three seriousness levels cited earlier, namely Normal, Problem, and Referable. Since the criteria on which such discriminations are based are primarily conceptual, a verbal treatment was considered appropriate. But, in addition, since a teacher would, in the classroom, be expected to *encounter* behavior at the various seriousness levels and make judgments as to what those levels might be, the television tape, in addition to exposing the viewer to the different types of problems, also presented these problems at various levels of seriousness. Thus, teachers are given practice in discriminating between seriousness levels on the basis of the examples presented in print and on tape. Examples have been prepared for both the visual and verbal programs with the criteria applicable to each behavior problem built into them. Thus, if "contagion" is an appropriate criterion for a particular problem type, the example of the problem would have a "contagion" element built into it.

Accompanying both visual and verbal programs are *job aids* listing, defining, and exemplifying criteria on which seriousness are to be judged. The job aids are to be made available to teachers following training, so that they can gain adequate practice using them. For this reason, no attempt was made to require the learner to *produce* or define the criteria from memory during the training program. The practice drill that was provided concerned itself simply with *matching* behavior observed on tape or in print with descriptions in the job aid. Descriptions of problems are provided at the various seriousness levels. By making a match between an example in a learning exercise and an example in the job aid, the learner can decide on the seriousness level of a given problem. With sufficient practice of this kind, it should be possible to make accurate classifications later on in an actual classroom.

Of particular interest here is the absence of any attempt to require the learner to define or list criteria as might be done in many programmed texts. In this program her only task is to *apply* the criteria. The decision to require only application of the criteria was based on the recognition that the concepts underlying the criteria are already understood. Had they not been understood, a conventional program requiring practice in defining them would have been prepared. Since the underlying concepts were already understood, practice is afforded only in *applying* them to actual examples. What the teacher has to learn is what combination of criteria (concepts) results in what seriousness-level classification. The job aid is designed to facilitate this requisite practice in applying the "seriousness" criteria.

The instructional strategy developed for recognizing and classifying problem behavior can be summarized as follows: it was assumed that, since the teacher would merely be required to recognize or identify a particular behavior as a problem, simple, but repetitive exposure to examples of the problem types and the subsequent availability of jobs listing them would suffice. The bulk of the practice a learner engaged in was thus not concerned with the production of responses indicating that X was a problem. Rather, when observing a problem it was concerned with making judgments as to its level of seriousness. But here, too, job aids were available for use in making these judgments. The job aids provide examples to assist the learner in identifying the seriousness level of the problem he is concerned with. Sample problems at each level are used to facilitate the learner's task of classifying a problem behavior at a given level of seriousness.

Managing Problem Behavior

The behavioral objectives for the management section of the program include:

- recognizing types of problems as requiring a particular type of management strategy;
- implementing the management strategy appropriately;
- recognizing student behavior indicating that the management strategy is, in fact, appropriately implemented.

To attain these objectives a programmed text and a programmed visual presentation were prepared. In the programmed text, learners identify verbally described problems and describe the management strategy they would use. In the programmed video presentation, they identify visually presented problems and write out what they would do or say to manage them. Thus, as was provided in the section on problem classification, both procedures give learners practice in the actual behaviors they are expected to exhibit. But, unlike the "classification" training strategy, the strategy for training management techniques calls for drill in *defining* concepts and *stating* principles. Why the difference?

The concepts taught in the "classification" section of the training program primarily involve the *criteria* used to judge the seriousness of problems. The various criteria (frequency, duration, manageability, contagion, etc.) represent concepts teachers already understand. Furthermore, the behavior expected of the teacher consists simply in the *recognition* of one of three levels each criterion might satisfy. Given these two conditions it was not unreasonable to expect that a job aid offering examples serving as representative yardsticks would accomplish the required training goal. The requirements of the management section of the training program could not so easily be met.

The concepts and principles to be learned in the management section (e.g., reinforcement, extinction, punishment, shaping, etc.) were not already understood. Moreover, the teacher is expected to more than simply recognize whether a given situation requires a particular type of management approach. The behavior expected of her was the full implementation of all the complex procedures involved in each management strategy. Thus, it was assumed that being able to carry out the detailed and involved steps correctly in the great range of situations she would encounter, required that the teacher gain a generalized understanding of *how* and *when* to take them. For this purpose, the conventional programmed text was judged appropriate.

The program is designed to teach the learner to distinguish both problems of omission (e.g., failure to volunteer, to mingle, to pay attention) and problems of commission (hyperacitvity, fighting, dependency, lying, etc.). It also recommends management strategies for each of these two major types of problems. For problems of *omission* it teaches when and how to implement each of these four management procedures:

—reinforcement for spontaneous instance of desired behavior when it occurs;
—reinforcing successively closer approximations until the desired behavior is finally shaped;
—using eliciting techniques to provide occasions so reinforcement can be applied;
—self-control (self-eliciting) techniques for students willing to improve.

For problems of *commission* it teaches when and how to implement each of these five management procedures:

—extinguishing misbehavior by withholding teacher attention;
—extinguishing misbehavior by withholding peer attention;
—precluding opportunities for misbehavior by altering the stimulus situation;
—self-control (seif-precluding)
—punishing serious or dangerous behavior.

Appropriately applying any one of the nine management techniques requires the teacher to recognize situations calling for them and the ability to carry out a variety of complex steps. Illustrative examples in a job aid was not felt to be sufficient for this purpose. A programmed text on the other hand did provide the opportunity to teach the variety of discriminations and generalizations involved in the complex chains that make up the procedures called for by the management strategies being taught.

Gaining Insight Into Attitudes Toward Problem Behavior

Brief mention should be made about efforts in the third training area which, admittedly, is the most troublesome to handle. Since teacher attitudes can often *cause* as well as influence how well problems are managed, it was felt that the training program must deal in some way with them.

In the three to six hours that is available for dealing with attitudes, it is *questionable* whether measurable or lasting changes could be made. A goal that was deemed more likely to be attainable, was that of providing teachers with a "trouble shooting" routine by means of which they could *identify* what their attitudes were. Attitude change following such identification is possible, but not a stated goal of the program. The possibility of such change is made more probable in that the "trouble shooting" routines are available for continued application later on in the classroom.

The routines are called trouble shooting in the sense that electronics personnel trouble shoot or diagnose problems in equipment. It provides a way of *identifying* problems. In this section of the program, programmed questions about the behavior of other teachers presented on video tape and *questionnaires* concerning a teacher's own behavior systematically call attention to the types of teacher reactions to problem behavior. Attributes of teacher reactions are thus identified, so that teachers can determine whether they behave in the same way, or in different ways, toward children with and without problems. The concepts (i.e., the attributes of behavior) appearing in the questions are already understood (e.g., fairness, severity of punishment, looking for other problems, etc.). The purpose of the methods chosen is, therefore, not to define the concepts but rather to get the questions answered. Thus, questionnaires and not programmed texts were developed.

Conclusion

Although other forms of learning (e.g., identification, procedural learning) occur in each of the three sections of the training program, emphasis has been placed on concept learning. Some form of concept learning is involved in all three sections. A discussion of each instance has therefore provided an opportunity to describe a different strategy decision for basically the same kind of learning. The contrasts can be highly instructive in a discussion of strategy formulation.

Attributes of problem behavior provided the basis for classifying the seriousness of a problem. A job aid was used to teach them. Attributes of problem behavior determine the management techniques needed to deal with them. A programmed text was used to teach them. Attributes of teacher behavior indicate the "biased" reaction of teacher responses to problems. A questionnaire was used to identify them. Thus, it is apparent that systematic decisions were made to teach attributes (i.e., concepts) in three different ways and rationales for each decision were given.

This presentation is offered as a case study in the complex business that is strategy formulation. No brief is made for the correctness of the decisions taken or the soundness of rationales presented to support them. What can be argued is that any trainer or educator is *required* to go through a similar process if he is to justify the programs he creates. Merely putting a programmed text together because programming is "in" does not mean that training objectives will be optimally met. There are programs and there are programs. Merely using television because the equipment is available—or giving a lecture because that's the way it's always been done—is not an acceptable rationale. We need more justification than that. We need to acquire much greater sophistication than we now possess in formulating instructional strategies for the educational programs we produce. Our technology needs refinement.

Part VII

Programmer Training and Development

One of the long-standing questions concerning the development of self-instructional programs is, "How do we develop the people to write the program?" As a special portion of the Third Rochester Conference, the instructional staff of the University discussed their work in programmer training, an activity which dates back to January of 1961 marking Rochester as the first institution to offer regular academic courses in programming materials for auto-instruction. Because the Conference meetings were held in a workshop format, we have reproduced one paper that was published shortly before the sessions, and have written a second, Lysaught and Pierleoni, specially for this volume. The context of the meetings covered generally all those areas discussed in the two papers.

Research on Programmer Training: What Has Been Done; What Needs Doing*

JEROME P. LYSAUGHT, Ed.D.**

OPERATIONAL USE of programmed instruction has now passed its ninth anniversary. Despite the steady growth in experience with programs and in related research concerning programmed instruction, there have been all too few attempts at synthesis of the various areas that comprise the domain of self-instruction. As a result, repetitious studies have frequently been reported; and, conversely, unsubstantiated generalizations have sometimes been accepted. In an effort to demarcate and analyze one area that exists within the domain, this paper will review the research that has been done on the subject of programmer training, suggest current beliefs that seem tenable, and report either work that is in progress or work that needs to be done in order to round out the knowledge needed for future decisions.

As a framework for approaching this subject, let me raise six rhetorical questions that represent the concerns many of us have over the training of programmers. Following each question, some discussion will be presented, and future needs will be suggested. Out of this effort, other, and better, questions may be raised in the minds of our readers; and we would appreciate any feedback, whether it be additional questions to be explored, relevant research that has not been mentioned, or comments and criticisms that come to mind.

1. Why is there any need to train programmers at all?

While this may seem a rather naive question, it is sometimes fruitful

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**Associate Professor of Education and Research Associate in Medical Education, The University of Rochester.

to see whether an area of research activity is worth the effort expended at all. For example, if there were sufficient numbers of programs and programmers available, or if adequate numbers were being provided by incidental instruction, there would be no need for training them at all and, therefore, little practicality in research directed at variables related to that training.

Little in the way of systematic research has been done in relation to this question. Most efforts seem to accept as a given premise that there are shortages of both programs and programmers, and that the solution is to train more people. Commonsense-wise, this seems to be a comfortable position, but there is little in the way of hard data to bolster an argument on either side.

In terms of the sheer availability of programs, for example, there has certainly been a dramatic increase. In 1962, the Center for Programmed Instruction reported the existence of 122 programs. In a single year, this figure climbed to 352 programs. In 1966, the last year of the CPI survey, only 291 programs were recorded. Carl Hendershot of Delta College, producer of the most complete bibliography of programmed courses in this country, estimates that his current revision includes approximately 2500 programs. What proper conclusion should be drawn from these figures is a matter of conjecture, but there has been growth in the number of self-instructional sequences.

Similarly, the number of institutions offering courses in programming and the number of individuals completing these courses have risen sharply. While there were some beginnings in developing programmers as early as 1958, it is generally agreed that the first formal collegiate course in programming took place at The University of Rochester in January of 1961. Since that time, Rochester has "graduated" approximately 550 individuals from the basic course. The Center for Programmed Learning for Business at The University of Michigan, with more frequent course offerings, has trained perhaps twice as many persons. The United States Air Force has trained hundreds of individuals over the years, as have other military services, academic institutions, and private organizations. There really is no way of arriving at a figure for the number of educational programmers trained in this country; but the number undoubtedly exceeds by several times the number of individuals actually working, full or part time, as programmers.

Everyday experience indicates that the present number of programs is insufficient to meet the needs of many learners, nor are there enough available programmers to fill the positions offered by companies seeking to hire them. Weekly correspondence received at The Rochester Clearinghouse on Self-Instruction in Health Care Facilities indicates a shortage of both instructional materials and personnel trained in producing them.

It is only fair to point out the evidence on the quality of existing programs is somewhat ambivalent—so the fact that a program has been published and is available is no guarantee of its meeting the needs of an organization interested in teaching the subject matter treated by the program. We have on the one hand, see Figure 1, the analysis of Hartley (1966) suggesting that early programs are overwhelmingly as effective, or more effective, than traditional forms of instruction.

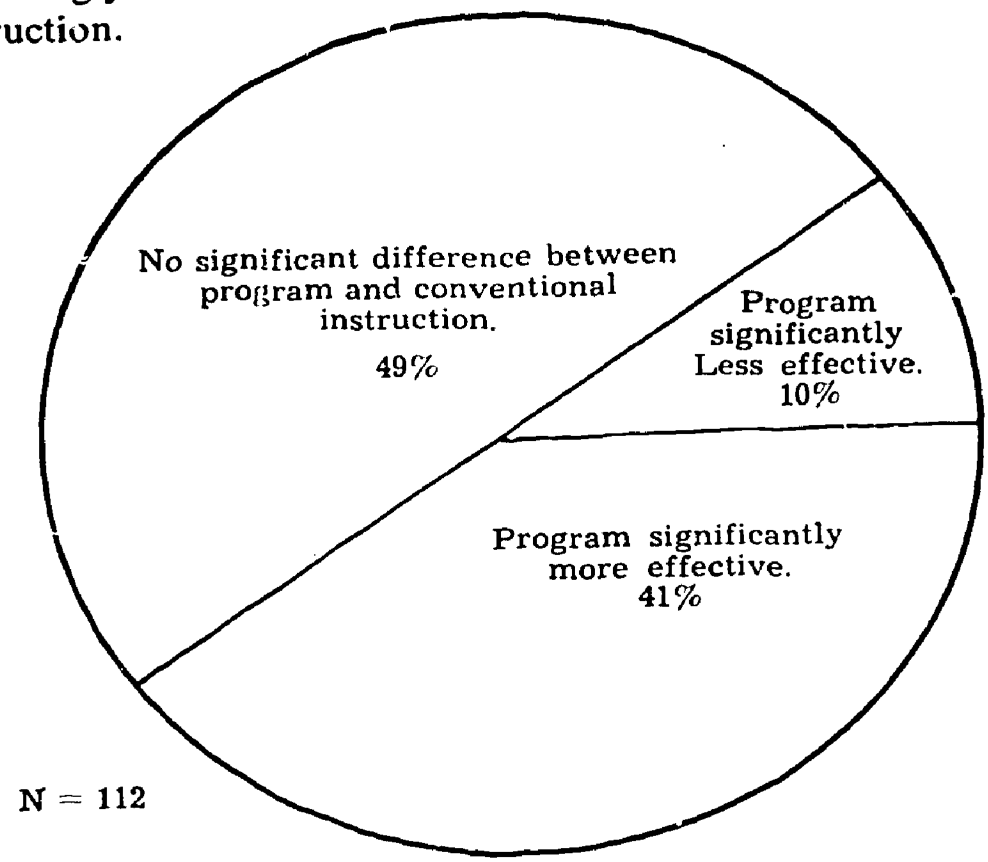

Figure 1. Comparison of programmed and conventional instruction on general effectiveness (Achievement and Efficiency).

In contrast, Komoski (1966) suggests that a majority of the commercially published programs have serious developmental shortcomings, markedly in the case of field testing, see Figure 2.

Only a minority of those programs surveyed met any minimum standard of field testing, revision, and evaluation prior to their being offered to the public. Such a situation seems *prima facie* evidence that programs are needed; and, corollary to this, that trained individuals must be prepared to produce them.

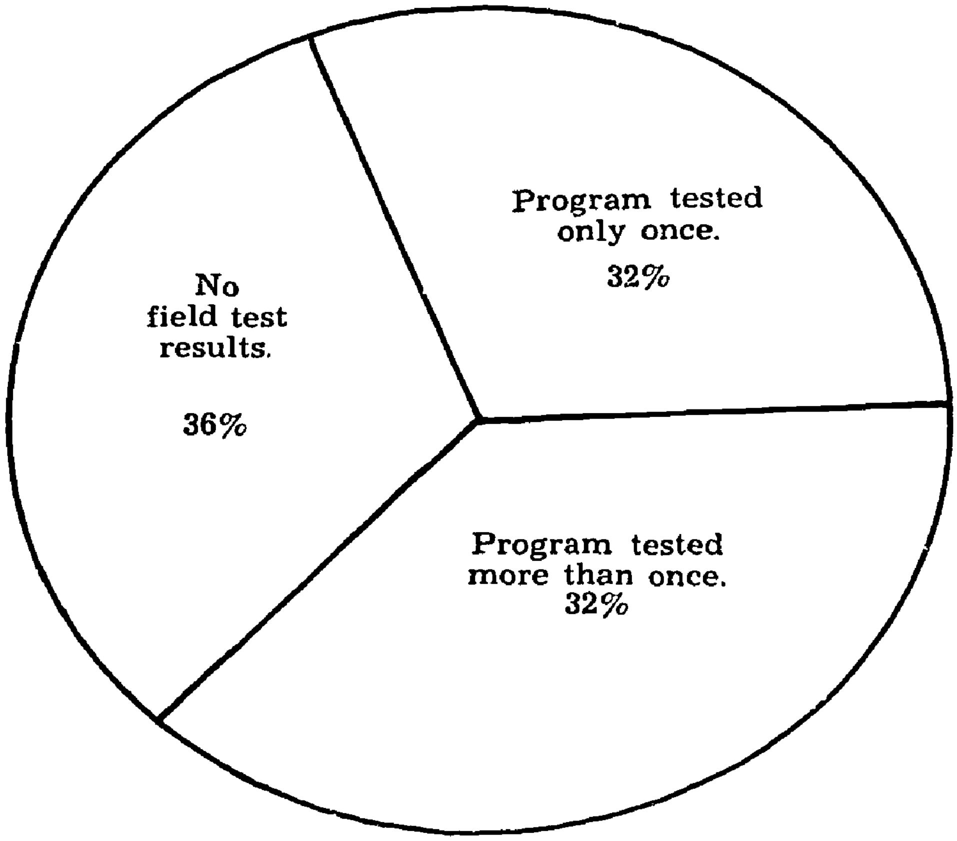

Figure 2. Reported testing experience of 291 self-instructional programs currently marketed in the United States.

2. What kind of studies are required to help us better understand what is needed with regard to providing programs and programmers?

First of all, simple descriptive reports and surveys would add to our baseline data on how many programs exist, what areas they include, and what their objectives are. Similarly, information should be collected in the numbers of programmers trained, their availability, and the demand for their services. One particular task, however, would seem to be most needed: this is to develop a curriculum guide in the various disciplines indicating what programs exist at the various levels, and what portions of the curriculum are covered by each existing program. Such guides would encourage teacher use of programs—and would enable publishers to better direct their efforts to avoid hopeless duplication of some areas and seek out manuscripts for areas that currently are not covered by any self-instructional sequence?

3. What are the methods by which people are trained as programmers?

A rapid glance at the listings of media institutes or the announcements of programming courses in the now defunct *Programmed Instruction* newsletter shows the geometric increase in the number of institutions that offer training courses in programming. In the last issue of this journal, Tracy (1967) summarized the commercial offerings that are easily available; no summary has yet been done this year for academic courses sponsored by colleges and universities.

In all these offerings, however, it is not easy to find detail. There is one report on the programming workshop at the University of Rochester (Lysaught, 1965) which lists its objectives, illustrates several of the activities, and offers a copy of the daily schedule of the course. In the same publication, there is a somewhat similar report (Rummler, 1965) on the University of Michigan course in programming. Beyond these two cases, a survey of the literature finds little else in the way of tangible information on the content of programmer training workshops.

It would be a benefit to a great number of people if a survey and data guide were prepared on what kinds of training are taking place, what the objectives of instruction are, and what specific activities are included within the curriculum. For example, both Rochester and Michigan stress actual involvement in programming sequences to stated objectives; certain institutions in the past have seemingly gone in the direction of more orientation and less programming experience. We need, however, a good descriptive research study to determine the parameters that are involved and what the next steps should be.

4. What are the trainees reactions to programming courses?

One of the implied objectives of any programming course is to meet the individual needs of the participants in terms of preparing them to go back to their organization as programmers. It would seem important, then, to develop base-line data on how the various programming courses seem to meet the needs of the participants, and how the various details of the course seem related to the behavioral outcomes planned for the experience.

A review of the literature indicates that the only published reports deal with the University of Rochester program. Professors Riggsby

Table 1

Concerning the following kinds of learning, do you think the course concentrated on:

Factor	Student Response (%)*		
	Too Little	About Right	Too Much
Theoretical Information	5	91	4
Practical Information	2	91	7
Actual Programming	6	88	7
Required Readings	4	88	8
Optional Readings	6	82	12
Sample Programs	10	82	9
Participant's Own Program	7	89	4

*Slight discrepancies due to rounding errors

and Boyce of Troy State College have done similar work with reactionnaires, but reported their work informally. Thus, we can only speculate on the commentary of the last 272 individuals who have completed a single form of workshop experience, but the results in this case are encouraging. The participants were almost unanimous in feeling that they had gotten what they wanted out of the course, that their objectives had been reached, that they would take the course again if they had the decision to make again, and that they would recommend it to other teachers and instructors. In Table 1 there is a summary of their reactions to specific dimensions and content of the programming course.

While these data indicate that we can achieve high consensus among students in pursuing one set of objectives, there should be comparative research studies involving students in other programming courses to determine what their reactions might be. In short, we need some norming of reactions so that we can tell what significance is contained in information like that presented in the table.

5. What kinds of programs result from these training courses?

One of the key results that we should be looking for in terms of programmer training is whether, in fact, the participants are producing programmed sequences by the end of their training. There are a number of statements to the effect that specific instructional methods resulted in desired program outcomes (Brink, 1963; Rummler, 1965), but again there is very little in the way of reported data.

In the course of developing information for a series of studies on programmer selection, the staff at the University of Rochester has done detailed examination of over 550 student-prepared programs and evaluated them in terms of both internal and external criteria (for the methodology, Lysaught, 1963). While this approach to analysis is subject to some criticism (Rothkopf, 1963) a number of procedural safeguards were employed to ensure that programs were classified on the basis of independent and consistent judgment, and that there were consensual factors that contributed to the specific classification of the material. Figure 3 displays a schematic diagram of the results we found.

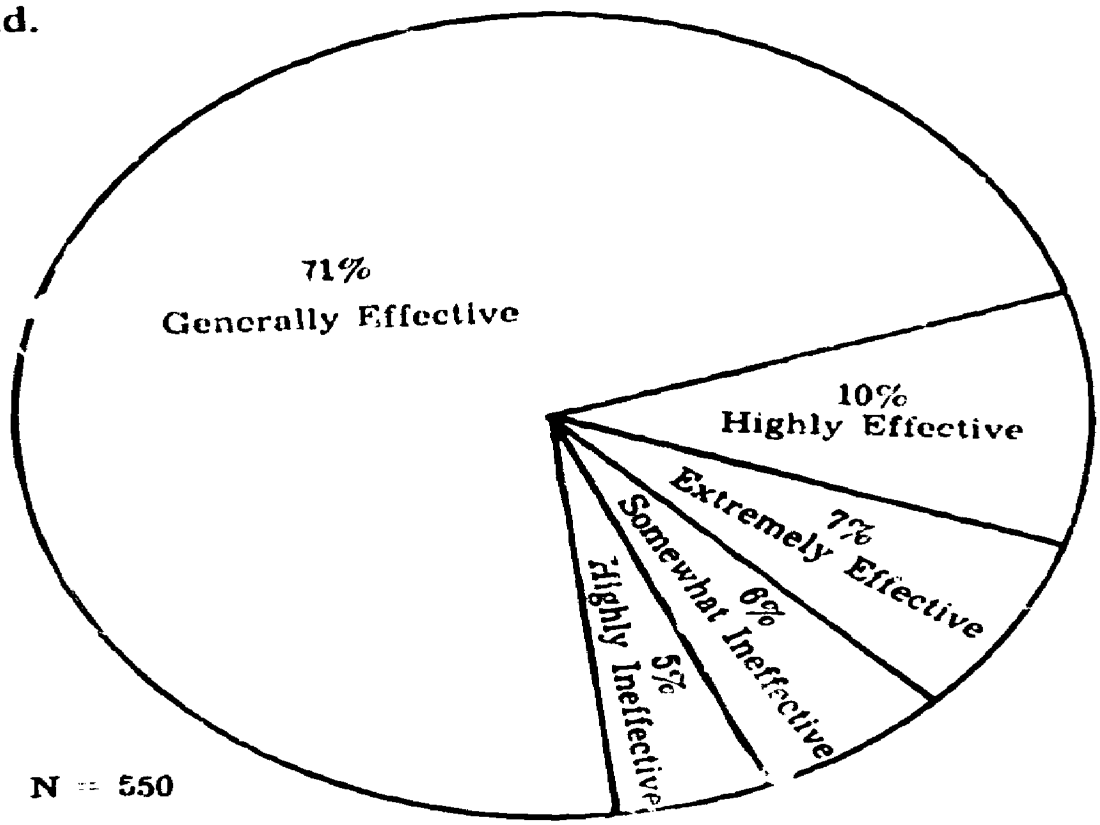

Figure 3. Cumulative results of programmer training at the University of Rochester.

There is obviously a need for more substantial information on the program quality that results from courses in programming. One such effort is underway. With the support of a grant from the U. S. Office of Education, the University of Rochester will study the programs of approximately 75 teacher-programmers at the conclusion of their workshop experience, field test the materials and derive modified gain scores for each of them. This will establish some definitive information. The limitation, of course, to this study is its lack of generalizability to other courses and other students; but it should provide a stimulus to other organizations, academic and commercial, to subject their own program teaching efforts to similar objective study.

6. What are the other effects of training in programming?

While there have been a number of observational commentaries on the effects of programmer training for improving classroom instruction generally (with the implication that a teacher trained in programming will be a better teacher whether he stays a programmer or not), there are only two studies that our literature search unearthed that bear directly on the matter. Wisenthal (1965) found in a study of student teachers that prior training in programming correlated with better teaching performance in the classroom and that students in the programming course who had developed superior sequences showed the best skill in classroom teaching. Despite certain methodological shortcomings, this study indicates a promising area for exploration.

With the support of a grant from the U. S. Office of Education, the University of Rochester programming group did a follow-up survey on the first 215 individuals that had "graduated" from the programming workshop and compared them with control groups of teachers who had received information on programmed learning but had no involvement in the development of sequences.

The results of this study subsequently have been reported (Lysaught, 1967) and may be summarized as follows:

1. Classroom teachers who have been trained in the programming process make significantly greater use of programmed instructional materials than do teachers who have received only cognitive and descriptive information about programs and programming. (Significance is below the 0.01 level of confidence.)
2. Classroom teachers who have been trained in the programming process make significantly greater use of programmed instructional material for both class and individual instruction

than do teachers who have received descriptive [illegible]ation about programs. (Significance is below the 0.001 [illegible] confidence.)

3. Classroom teachers who have been trained in the programming process make significantly higher use of self-constructed programs than their peers who have received descriptive information about programming. (Significance is below the 0.001 level of confidence.)

4. While classroom teachers who have been trained in programming make greater use of both commercial and other teacher-prepared programs than do their peers who have not been specifically trained, the difference is not statistically significant, though it approaches it at the 0.05 level of confidence.

5. Classroom teachers who have been trained in the programming process engage in significantly more professional activities outside the classroom that are related to in-service training and public information about programmed instruction. (Significance is below the 0.01 level of confidence.)

6. Classroom teachers who have been trained in the programming process have significantly more favorable attitudes towards programmed instruction than do teachers who have received only cognitive and descriptive information about programs and programming. (Significance is below the 0.01 level of confidence.)

At the present time, a research group at Temple University is preparing to explore the question of how programming skill affects classroom teaching performance, and their results should shed light on the generalizability of the Wisenthal and Lysaught findings.

In this area, then, although much remains to be done, there is more obvious work being done in planning and execution of research.

7. What are the possibilities for predicting programmer success?

An important question to consider in terms of choosing a person to be trained in programming is the probability of his [illegible]. In many cases, perhaps, an individual [illegible] wish the experience solely for his own professional satisfaction, [illegible] at least a [illegible] stances, however, an institution sends an indivi[illegible] training with the hope that he will return equipped to perform with some effectiveness as an instructional programmer.

Early survey work was done by Polin, Morse, and Zenger (1962) to determine criteria applied in selection for such training. A replication of their survey with programmer-trainees (Lysaught, 1964) provided some comparison and contrast to their findings. In 1963, a pilot study

Table 2

Factors Significantly Discriminating Between Highly and Least Successful Auto-Instructional Programmers

Factor	As Determined By
Intelligence Quotient	Otis Quick-Scoring Test
Critical Thinking Ability	Watson-Glaser Test
Theoretical Values	Allport-Vernon-Lindzey
Religious Values	Allport-Vernon-Lindzey
Self-Confidence	Bernreuter Personality

(Brink) at General Telephone of California isolated factors of mental and verbal ability that seemed to have significance in their internal selection of individuals for training.

Based largely on the work of these early analysts, a controlled study was conducted at the University of Rochester (Lysaught, 1963) and five indicators were found to be of actual statistical significance while fourteen others had to be rejected as insufficient indicators on the basis of the findings. Table 2 summarizes the five factors that seemed truly to discriminate between highly successful and least successful programmers.

A simple reversal study was conducted (Lysaught and Pierleoni, 1966) to test the hypotheses of the earlier research. On a limited pilot basis, three individuals who ranked high on all of the five factors were compared with three individuals who ranked low on the same factors. Their programs were administered to random groups of learners who met the definitions of the intended student population, and modified gain scores were used as the criterion of success. Table 3 summarizes the results found.

Striking differences emerge from this comparison. Obviously the sample is too small for generalization, but we plan to follow up on

Table 3

Results of Program and Test Administration for the Predicted Least and Predicted Most Successful Programmers

Program	Mean Scores Pre-Test	Post-Test	Gain Score	Modified Gain Score
Predicted Least Successful				
No. 1	2.3	4.0	1.7	9.5%
No. 2	6.1	12.2	6.1	43.1%
No. 3	11.5	14.6	3.1	36.5%
Predicted Most Successful				
No. 4	4.1	18.3	14.2	89.3%
No. 5	9.6	17.2	7.6	73.0%
No. 6	15.8	19.2	3.4	80.9%

this lead with the support of a grant recently obtained from the U. S. Office of Education. Similar studies, employing reversal techniques to test the validity of predictive measures, should be conducted with the graduates of other programming courses in order to provide documentary evidence on the effects of varying instructional approaches.

Summary

In this paper, we have attempted to provide a concise report on the research done to date dealing with the development of programmers—and to suggest in each of six critical areas what might be done as next steps toward the collection of information that would permit improved future efforts.

It is obvious from this rapid overview that little systematic research has been done in any portion of the field, and that in most cases we are seriously lacking even the most fundamental base-line data that are required to propose more serious, controlled research efforts. In only two areas, those dealing with the transfer of programmer training to the classroom and the prediction of programmer success, have there been a number of small studies that permit some reasonable form of comparison and questioning. In all other areas, we are working with only sketchy data—and apparently with a large amount of faith or affirmation.

It would seem as a beginning that an organization such as the National Society for Programmed Instruction should sponsor the acquisition and systematic ordering of information on programmer training, available courses and approaches, etc. This could be followed by the encouragement of surveys and observational studies to determine what the reactions of the trainees are to varying instructional sequences, what products are developed in terms of programs, and what other effects can be correlated to the specific training in self-instructional techniques.

Once these efforts have been started, we will have much greater opportunities for determining the relative effectiveness of the sequences produced and perhaps could arrive at conclusive suggestions on the selection of programmer-trainees.

If this survey of research to date reveals far more that is required than has been accomplished, it is only because this is so. It is sheerly personal opinion, but I suspect that a close examination of most other areas of programmed instruction would reveal similar patterns between what has been done and what needs doing. Perhaps only in the single area of uncontrolled, one-shot comparative studies that show the effectiveness of a single program have we had a surfeit of reporting. In many other areas, glib generalizations too easily obtain, and more systematic research and conclusions are lacking. The fault isn't in our stars, at all; it's in us, and it seems that we now should be making some more evident efforts to accumulate reliable information on the learning methods that we have extolled for their measurable, testable qualities.

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The Training of Programmers for the Health Professions

JEROME P. LYSAUGHT, Ed.D.*
and
ROBERT G. PIERLEONI, M.A.*

OUR OBJECTIVE in this paper is to summarize our experiences in training programmers to develop self-instructional sequences for the several fields of the health professions. Basic to our work in this area, is our belief that medical and para-medical programmers should be trained no differently from those in other subject matter specialties—at least through the initial stages of program writing.

While programming materials does include such independent variables as skill in writing, style and force of expression, and depth of content knowledge (in this respect, it is no different from textbook writing), there is nevertheless a recognizable process involved in the development of a good program, and this involves teachable, learnable skills. These skills can be expressed in a series of steps (1), and may be listed in terms of behavioral objectives for the basic programming course, as shown in Figure 1.

Figure 1

Instructional Objectives for the Basic Course in Programming Materials for Self-Instruction

1. Each learner will demonstrate a knowledge of the basic understandings and origins of programmed instruction by:
   a. Tracing the historical development of programmed instruction.
   b. Explaining the basic formulation of reinforcement theory as it applies to programming.

*College of Education and School of Medicine and Dentistry, The University of Rochester.

c. Demonstrating a knowledge and understanding of specified major research studies.

d. Listing and commenting upon the characteristics of programmed materials.

e. Discussing the characteristics and utilization of teaching machines with programmed materials.

2. Each learner will construct four short sequences of programmed material in varying paradigms according to objectives provided by the instructional staff.

3. Each learner will select an appropriate unit of material from his own subject-matter and grade-level field for programming.

4. Each learner will define those students for whom the material is to be prepared in terms of ability, achievement, and background.

5. Each learner will construct a set of behavioral objectives that specify what his students will do as a result of completing the self-instructional program.

6. Each learner will choose an appropriate paradigm for constructing a sequence in light of his students and his objectives.

7. Each learner will order and construct a programmed sequence for his selected unit using developed techniques and approaches.

8. Each learner will conduct initial field tests of his instructional sequence and make initial revisions in light of the responses made by the students.

The last seven objectives all require an explicit "product" which can be analyzed and evaluated; the first objective is measured in terms of a carefully validated and reliable paper and pencil examination. The really important point, however, is that the neophyte programmer actually gets a good deal of experience in doing, rather than talking about or considering.

At the end of the 15 session course, the participants have a self-made teaching program of approximately one hour's duration that has been developmentally tested and edited so that it can profitably be used in their own teaching when they go back to their institutions. Perhaps it may be of some value to discuss briefly who these participants are, what they have produced, and some observations on their applications of their materials.

The Health Programmers

Since 1961, our programmed instruction unit at The University of Rochester has been involved in the training of some 165 individuals from the health fields as programmers. Of this number, 15 have been from medicine, 110 from nursing, and 40 from the para-medical specialties. The latter grouping include medical technologists, hospital and nursing administrators, public health personnel, and students. The preponderance of nurses is due in large part to three special programming workshops that have been held for nurse educators under the auspices and support of the Public Health Service.

In order to relate these figures to some base, we could say that health personnel have constituted approximately 21 per cent of the total enrollment in the basic programming workshops to date and that 14 per cent of the participants have been nurses. Perhaps a more meaningful point in relation to this group of programmers, however, is that one out of five, almost exactly 20 per cent, have continued or returned for the advanced workshop in programming materials for self-instruction. As a point of fact, almost 75 per cent of the medical educators who attended the basic workshop went on to the advanced. The smallest percentage of returnees is within the nursing ranks—understandably so since there were so many in the basic course comparatively and the entrance to the advanced workshop is strictly limited in numbers.

While we have no strict analysis in hand concerning the institutional relationships of these individuals, it would seem that most of the physicians came from schools of medicine, and that the greatest percentage of nurses came from diploma schools of nursing, followed by individuals from collegiate schools of nursing.

Programs That Were Produced

The 14 medical educators represented a wide spectrum of clinical specialties—as a matter of fact, there is a pronounced skew in our distribution since we have had only one or two pre-clinical instructors in the programming workshops. Similarly, the nurses and para-medical personnel represented a wide spectrum of interests, and included persons in more representative numbers from the basic sciences.

In order to give a brief but panoramic view of some of the programs that have been constructed in the short period of the workshops, let us list some representative sequences:

A. Medical Education
   1. Electro-Convulsive Therapy
   2. Endocrine Changes in Menstruation
   3. Atrophy: Manifestations and Causes
   4. Resuscitation
   5. Defenses Against Anxiety
   6. Radiologic Treatment of Cancer
B. Dental Education
   1. Dental Examinations and Classifications
   2. The Detection and Correction of Food Impaction
   3. An Introduction to Ritter Dental Units
   4. Patient Anxiety and Pain
C. Nursing Education
   1. Medical Terminology
   2. Care of the Tracheostomy Patient
   3. How to Give a Hypodermic Injection
   4. The Actions and Uses of Salicylates
   5. The Tuberculin Test
   6. Calculation of Drug Dosages
D. Para-Medical Education
   1. Clinical Hematology Determinations
   2. Classification of Congenital Limb Deficiencies
   3. Analysis of Urine
   4. Nursing Service—Use of Nonprofessional Personnel
   5. Chemical Agents in Food-Borne Disease
   6. The Stomach and Small Intestine

Effectiveness of Trainee Programs

As can be seen from the final objective specified in Figure 1, the participants in the programming workshop carry their project only to the point of initial testing and revision by the end of the basic experience. We have received a host of letters from these individuals telling us that the revised sequences actually did perform effectively with their own students, and, most importantly, that the individual intended to develop additional units over time in his own teaching area.

In these cases, we are not concerned with the strict, controlled evaluation of the program under conditions that might be more demanding than necessary. The teachers have been introduced to basic forms of evaluation, including the modified gain score, and they can do a very reasonable job of assessing the instructional worth of their program. Indeed, it is this logical importance of the teaching sequence that may be at least as important as the statistical measure of significance under controlled situations.

It might be useful, however, to summarize briefly two projects, one in medicine and one in nursing, that stemmed directly from the programming workshops because the results found in their study should roughly parallel our expectations for other teacher-made programs.

Medical Education. Beginning with the earliest experience in the programming courses in 1961, an extensive project was begun in the clinical teaching of cancer by means of programs. Two of the programmed units which have been completed and developmentally tested are: Polyps of the Colon and Rectum, and Cancer of the Colon and Rectum. In the course of writing, field testing, and revising, both programs have gone through two rewritings.

Just to illustrate how effective these units were at the point comparable to the level of development at the conclusion of the workshop, the students taking the first developmental test edition of the Polyps program achieved an average modified gain score of 50 per cent. Students taking the other program on Cancer achieved a modified gain score of 67 per cent. Since a rule of thumb suggests that 50 or more per cent in M.G.S. is satisfactory instruction, we can see that both of these programs could have been made operational at the end of initial testing—and that with further refinement and rewriting could be made even more effective.

Nursing Education. In a similar kind of development, programmed units in cancer nursing were begun roughly in the same period of time. One was an Introduction to Radiation Therapy; the second was An Introduction to Cancer Nursing. While no calculation was made in terms of modified gain scores, a comparison between achievement scores of students taught by the program and those taught by conventional lecture showed significantly higher scores for the former.

The author of the programmed units stated, "Our experience with the use of two programmed units in a college nursing program has been very positive. The programs taught effectively, the material was appropriate to the students, and the students found the method acceptable.

Reactions to Programs and Workshops

As suggested in the report on the nursing programs, we have generally found a favorable reaction among program users to the material. This has occasioned student requests for other programs from the Rochester Clearinghouse, and has encouraged other faculty members to become involved in the programming of short instructional sequence for use in their teaching.

We have been concerned also about the attitude of the workshop participants, particularly whether they feel the course objectives and content have been well-designed for their purposes. For all of the courses since 1961, we have collected anonymous evaluations returns that encourage the students to criticize, comment, and suggest improvements in format and approach. Because of the anonymity, we cannot specify the reactions of many doctors and nurses and other health groupings, but we do have data from four groups of trainees, all of whom are health professionals. Three of the group consist of the nurses in the workshops supported by the Public Health Service; the fourth group included personnel from the United States Army Medical Service. Table 1 displays the reactions of some 110 individuals over a three year period.

Table 1

Reactions to the Basic Programming Workshop Among Nursing and Paramedical Students

Question	Percentage of Affirmative Responses		
	1965	1966	1967
1. Did you get from this course that which you came to obtain?	100%	95%	100%
2. Would you take this course if you had it to do over?	100%	100%	97%
3. Would you recommend this course to others?	100%	100%	100%

Individual trainees frequently mentioned their feeling of gaining practical experience in classroom management, and pragmatic aid in programming over and above the discussions of theory that usually abound in "education" classes. Many cited the value of the workshop in helping them to improve their teaching generally through better understanding of the learning process.

Most of the respondents felt confident in selecting and utilizing programmed materials—as well as constructing short units of self-instruction. Negative comments were generally restricted to the demanding pace of the course, and to a small minority of problems related to selecting a manageable unit of material to program over the duration of the course.

Implications of the Workshops

Two generalizations clearly emerge from our experience in using programs for health education and in training individual health educators to construct self-instructional materials:

1. The commercial development of health programs, while increasing, will be insufficient to meet demands for teaching materials in the near future, and very likely for several years to come.
2. The training of medical and para-medical educators as programmers for their own instructional materials is both feasible, and productive of high quality results.

We are not trying to imply that programming is a simple task or that the training of health educators in this process is any sort of panacea. The development of a program is a demanding and lengthy task. But health educators do produce good, effective, and efficient sequences. Indeed, the best hope of commercial development may well lie in the subsidization and encouragement of teacher-made programs since the general experience in research to date has shown that medical programs are perhaps the most effective single group of individualized instructional materials.

For several reasons, then, we encourage medical and health educators to take the time to become at least minimally engaged in program writing. We feel this is best achieved by participation in a programming course where construction of materials is stressed and required, and where the participants leave with a "product" to be used with their own students in their own teaching.

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gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

In the nursing department, the supervisor felt that the minimum available training time makes it imperative that the trainer be effective as well as efficient. The time factor usually results in minimum, haphazard training by multiple trainers who are not the most effective. Indeed the trainer may be the newest or youngest member of the staff, with little or no training experience.

A laboratory supervisor looked at the other side of the coin. He felt that a trainer must know "how to train." He explained that what makes a technician competent does not necessarily make him a good trainer of others. Yet, in his own department new assistant techni

Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
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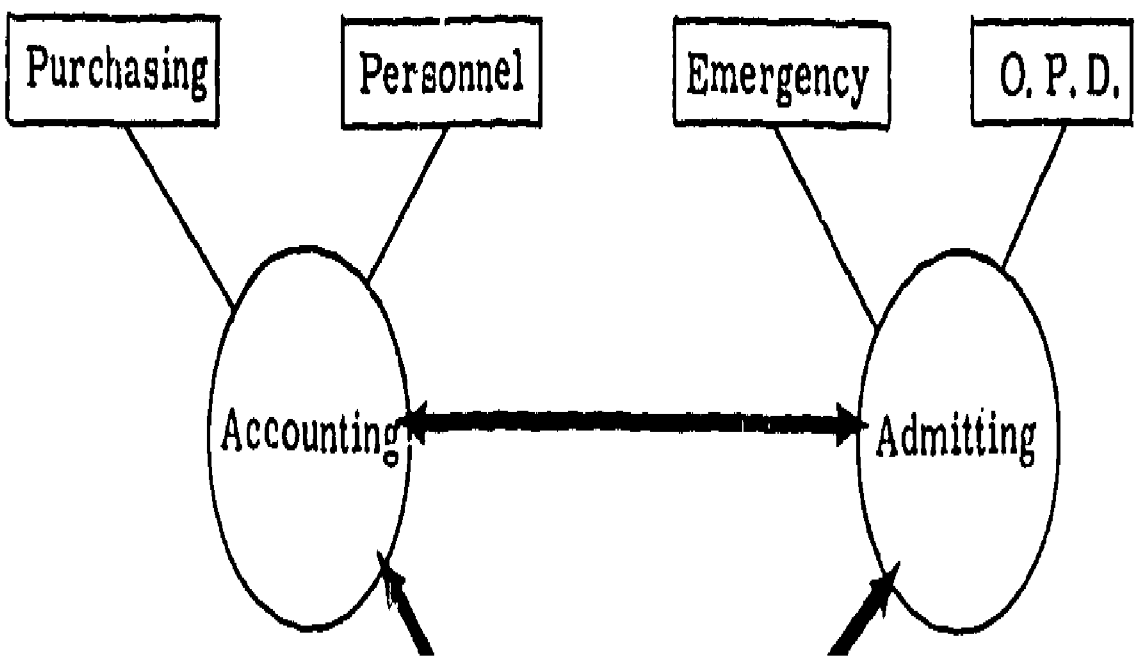

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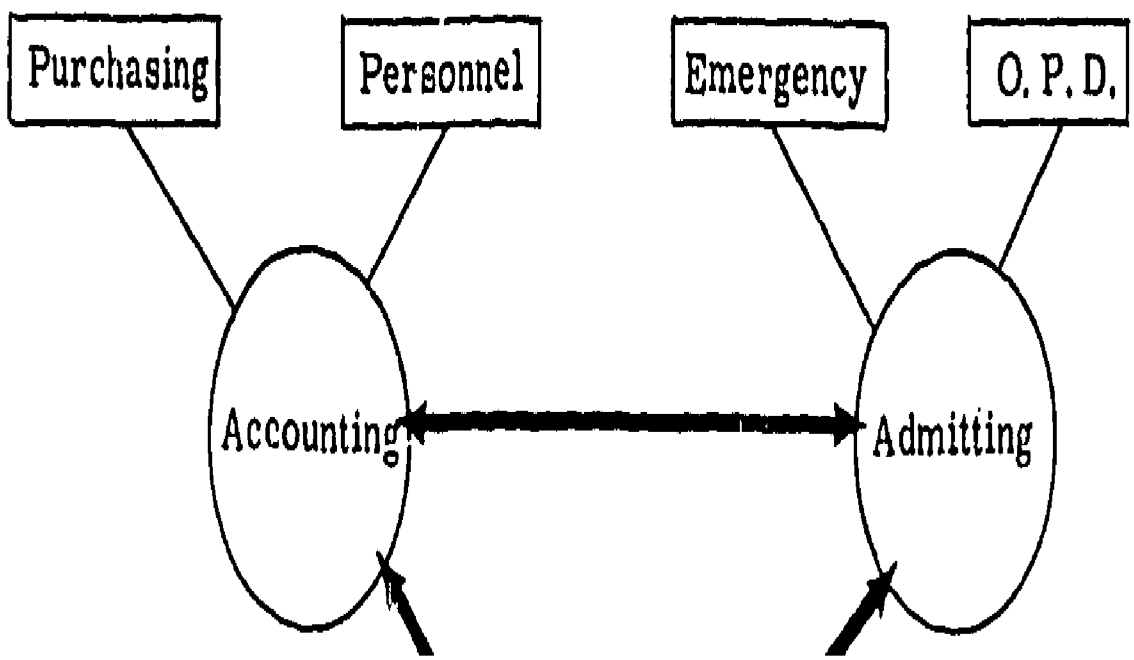

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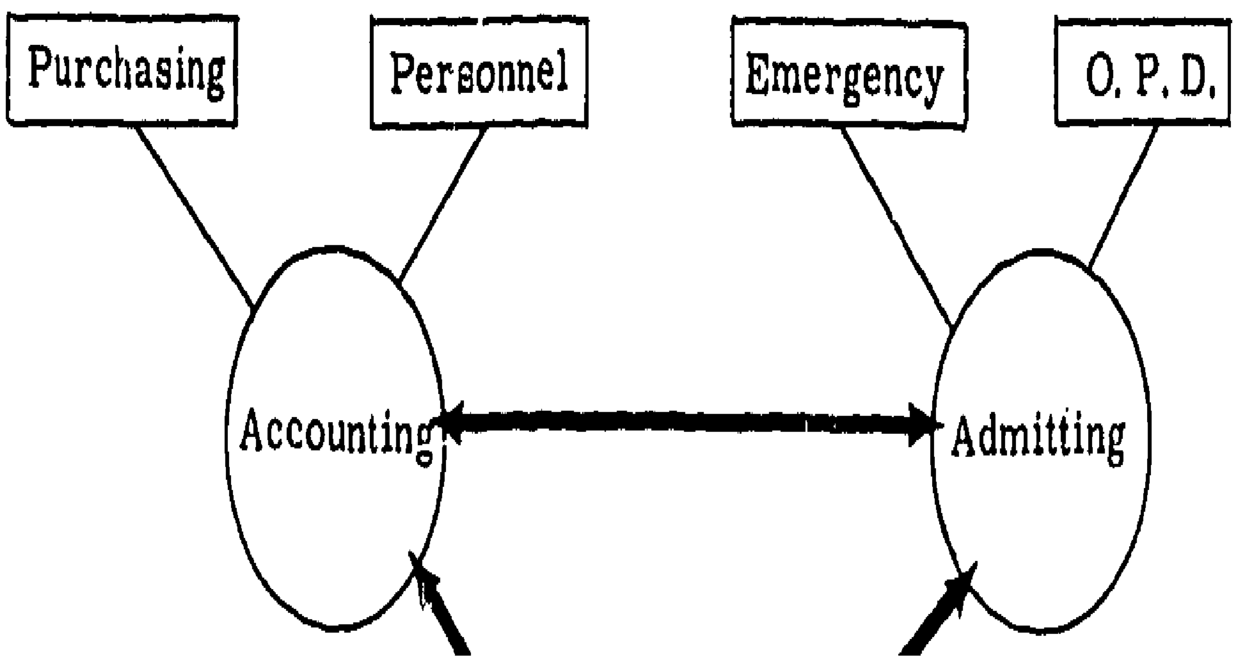

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Linear programs for medical students and technologists, consisting of six units: acidosis and alkalosis, diagnostic aids in thyroid disorders, instrumentation, evaluation of laboratory data, potassium metabolism, and basic statistics.

Preparation of Patients for Aeromedical Evacuation. Texas: Sheppard AFB, Medical Service School, February, 1967.
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Cumulative Index

Citations are indicated by figures in parentheses which refer to the FIRST, SECOND and THIRD PROCEEDINGS.
Specific page numbers follow the volume references.
For example: the listing (3) 65-66, refers to THIS VOLUME, pages 65 thru 66.

Programmed Instruction to Train Hospital Employees How to Train Others

gathered through personal interviews with hospital administrators, assistant administrators, directors of nursing service, training directors, and many supervisory personnel from administrative, technical, and professional departments. Basically we asked two questions which we felt would help determine the potential target population on the basis of two factors, urgency and numbers. 1) Which departments do you think have the most *critical* need for qualified trainers? And 2) in which departments would the greatest number of employees benefit from improved trainers?

Most of the supervisors we spoke to agreed that better quality trainers would benefit the greatest number of employees in the housekeeping department, dietary and nursing departments. It was felt

ate his trainee regularly and after each training phase determine what and when new tasks should be taught.

In the nursing department, the supervisor felt that the minimum available training time makes it imperative that the trainer be effective as well as efficient. The time factor usually results in minimum, haphazard training by multiple trainers who are not the most effective. Indeed the trainer may be the newest or youngest member of the staff, with little or no training experience.

A laboratory supervisor looked at the other side of the coin. He felt that a trainer must know "how to train." He explained that what makes a technician competent does not necessarily make him a good trainer of others. Yet, in his own department new assistant techni-

Our analysis revealed the following general description of the target student:

1. He is a high school graduate. (He may have additional training in such specialized areas as secretarial, laboratory technology, nursing, dietetics, social work, bookkeeping, etc.)
2. He has a minimum of 1 year job related experience.
3. He is actively performing at least some of the skills being performed by the person or persons he is responsible to train.
4. He supervises the activities of at least one person, at least part of the time.
5. He is often second in command within his own unit. (This may not be true in the smaller hospitals.)

Housekeeping:

1. Department Head
2. Area Supervisors
3. Utility Men
4. Floor Maids

Nursing:

1. Director of Nurses
2. Supervisors
3. Charge Nurses

Medical Records:

1. Department Head (Med. Rec. Lib.)
2. Ass't to the Department Head
3. Special Medical Secretarys
4. Special Clerks

Social Service:

1. Department Head

Maintain a high level of performance
- Evaluate trainee's performance periodically
- Motivate trainee to maintain performance standards
- Retrain as needed

The Course Content

The next step was to determine what specific concepts would be taught and how they would be presented. On the basis of the field study, we established the following criteria to help us determine the content of the course: 1) The basic training principles to be taught must be based on modern industrial training psychology. They must

reactions are appropriate to the information transmitted. The trainer can then change his own behavior in accordance with the trainee's responses. But, conversely, the student, who is hesitantly performing, needs to know whether or not his actions are appropriate before he's secure enough to go on, or can adjust his performance. This is the aspect of feedback which we decided to stress. To apply this principle we specify a clear-cut procedure. The trainer should *tell* him whether he's right or wrong. When he's wrong, point out his mistake and *correct* him; when he's right, point out he's right and *support* him; occasionally praise his appropriate behavior.

Withdrawing support gradually implies letting the trainee work

greater impact by teaching "How to Train" before "Preparation for Training."

We selected three sub-terminal behaviors we wanted to bring about in a trainer who must be able to make appropriate preparations for training: he must be able to determine training needs, plan the order of training and prepare his trainee for training.

The program prescribes a clear-cut procedure for determining the indoctrination training needs of a new employee. Preparation for refresher training applies the same basic rules, but the resultant training needs are usually fewer. First, the trainer must state the overall training goal. Generally, the goal is determined by the trainee's job

A periodic review is the recommended mode of evaluation and we felt that simple guidelines would help the student internalize a workable evaluation procedure. He is taught *what* to check, *when* to check and *how* to check.

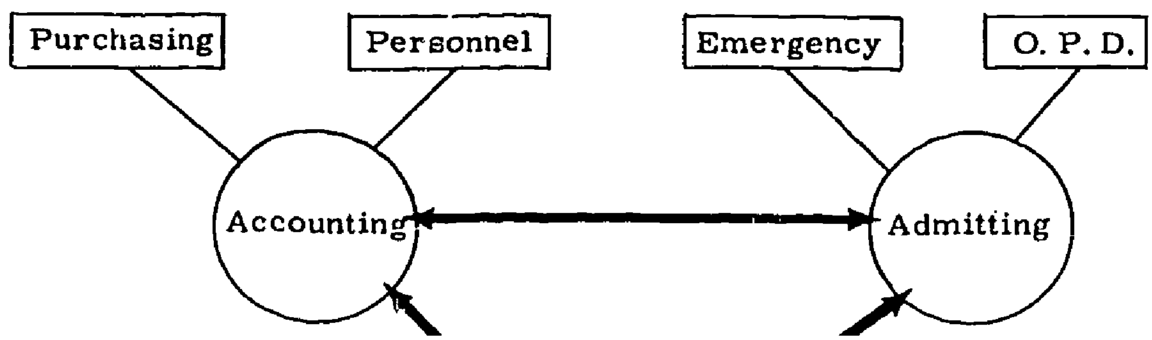
Using the job breakdown form, the trainer learns to check most often on those tasks or functions which are most important. Generally speaking, the most important tasks would be the ones that affect the patient's welfare most directly. He is taught to check on a regular basis, that is daily, weekly, monthly, etc. Whether he should check more often or less often depends on how reliable the trainee is and how recently he has learned the tasks. The trainer must then find

take action to improve performance.

The trainer is taught to classify causes of poor performance into three groups.

1. The trainee may be *unaware* of what is acceptable performance. Clearly, improving the trainee's performance would involve telling him what's expected.
2. The trainee may be *unwilling* to meet acceptable performance because of personal or interpersonal problems. This can be considered a problem of motivation and would be too difficult to handle in this program. The program only recommends that the trainer attempt to motivate his trainee by explaining the need or

SCHEMA OF FUNCTIONAL RELATIONSHIPS



nursing department and other supporting departments such as dietary, technical medical services, housekeeping, medical records, and social service. A few examples were taken from the top of the chart indicating that the strongest relationships are with departments other than nursing. A final analysis shows that examples were selected from 14 different departments.

Language and Vocabulary

Another objective was to communicate easily, yet keep the reader involved. The choice of language used and the selection of the vocabulary were left to the discretion of the programmer. Analysis of a randomly chosen sample of 100 consecutive words indicates a Flesch

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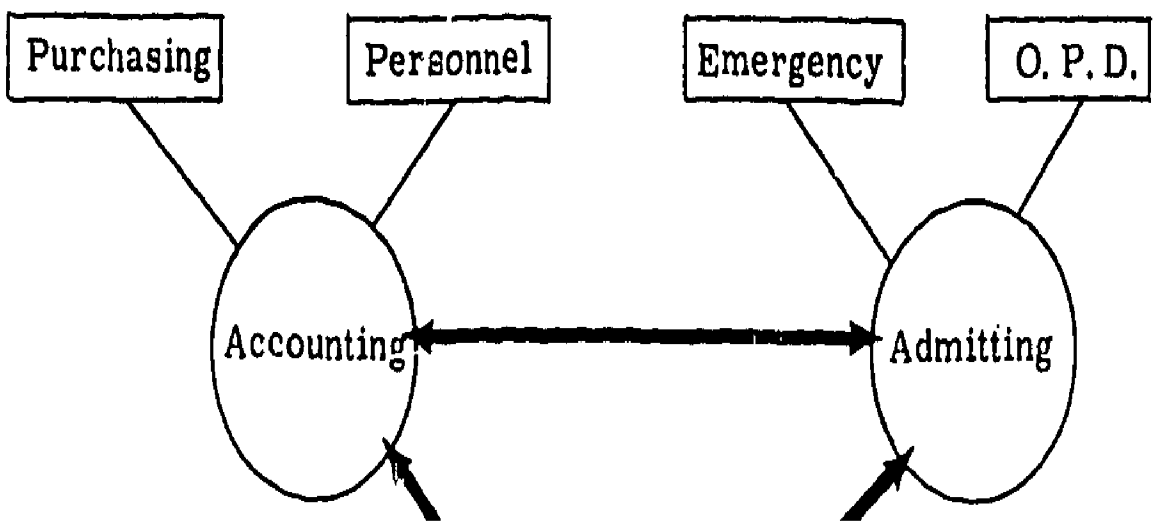

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