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Education, theory and practice

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TOWARD A LEARNING SYSTEM
FOR MEDICAL EDUCATION

DISSERTATION
Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

by
Warren Ray Aiken, B.A., M.A.

*****

The Ohio State University
1970

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Each of us is in an ultimate sense the product of interaction with all the rest of us, whether directly or indirectly. Therefore, what seems to be our own inspiration and labor is, in actuality, the work of all. However, there are some who concern themselves more intimately at any set time with a particular endeavor. Those who entered into the corporate preparation of this paper include Edgar Dale, academic advisor and Wisdom's friend; James Bradford and Joseph O'Rourke, colleagues in research and practice; June Aiken, wife and counselor; Dean Clarence Cole, C. Roger Smith and the entire faculty of The Ohio State University College of Veterinary Medicine, fellow soldiers in the battle of Learning Synergistem development.
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"Reports of Research in Closed Circuit Television." A study report of experiments conducted under grant from the Ford Foundation, in AFROTC classes at The Pennsylvania State University. Published by The Air University, USAF, Maxwell AF Base, Alabama, 1956.


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"LASERS WE ARE." An article in the Association for Research and Enlightenment Journal, Virginia Beach, Virginia, May 1970.

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Studies in Educational Media. Dr. Robert W. Wagner

Studies in Curriculum and Instruction. Dr. Paul A. Klohr
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INTRODUCTION

The need for increased numbers of professional and technical personnel in the health fields is presently being emphasized. This emphasis is prompted by long overdue social and political awareness that all of a nation's citizens are entitled to equality in health care. It is also prompted by a threatened ecological system due to the generation of wastes by an increased population in an affluent nation.

Increasing sophistication of medical and paramedical science tends to multiply the academic, laboratory and clinical learning experiences requisite to preparing personnel, and thus to increasing the time required for mastery of the added areas. However, plans are underway to reduce the preparation period in order to more quickly gain a greater output of graduates from existing capacity. Quality in preparation for practice cannot be permitted to deteriorate.

Medical education and training programs have been responsive to this complicated challenge. Some of the most significant applications of learning methodology have taken place under the aegis of health professions' preparation programs. But the thrust toward excellence is in the main an individual affair: promising teaching and learning practices are fulfilled too seldom to match changing, growing needs. A systematic way to quickly extend the inspired work of the few to be applied by the many in a sustained consistent
effort is required. Through consistent and persistent application in the medical school environment of what we know how to do well in teaching and learning may we hope to develop and sustain needed programs.

This dissertation proposes an approach to development of a practical system for learning in medicine. A proposal for a systematic educational change and development toward evolutionizing the medical curriculum has been prepared by James L. Bradford. (1973)

An earlier study of veterinary medicine at Ohio State (Brumley and Charters, 1939) is referenced by Bradford as, "pointing to some of the same problems and solutions that are relevant today." Bradford also notes that, "Its failing seems to have been the lack of a systematic way to change in keeping with changing needs." What Bradford found pertinent to curriculum is equally applicable in the area of learning and instruction. However, since Bradford's paper deals extensively with the process of change, this aspect is omitted in this dissertation. The focus of attention is on the process of systematic consideration of the steps for implementing a curriculum for preparation in the health care professions.

At this point it is appropriate to present definitions of the major elements in an educational program (suprasystem) as well as a simple model (Figure 1) of the relationships between those elements as they will be developed in the two dissertations.

CURRICULUM DEVELOPMENT SYSTEM: A structured set of activities and events, guided by established criteria and designed 1) to select from the organized bodies of knowledge, skills and attitudes the
elements that best interpret those bodies for the student, and further 2) to structure those elements in patterns that will be meaningful for the student, resulting in a new or improved curriculum.

VALUES AS CRITERIA

CURRICULUM — — LEARNING — — CHANGED
DEVELOPMENT CURRICULUM SYSTEM SYSTEM STUDENTS
AVAILABLE, TEACHABLE HEALTH, SCIENCE KNOWLEDGE, SKILLS

FIGURE 1. AN EDUCATIONAL PROGRAM

CURRICULUM: A structured set of selected intended learning outcomes, designed to guide the planning, execution and evaluation of interactions between the learner and his environment.

INSTRUCTIONAL SYSTEM: A structured set of planning, implementation and evaluation activities and events guided by curriculum and intended to change learner behavior through meaningful interaction between him and his environment.

Two short quotations from the work of Mauritz Johnson may help clarify the distinction being made:

Curriculum prescribes (or at least anticipates) the results of instruction. It does not prescribe the means, i.e., the activities, materials or even the instructional content to be used in achieving the results.

Whether experiences are viewed subjectively in terms of the sensibility of the experiencing individual or objectively in terms of his actions in a particular setting, there is in either case no experience until an interaction between the individual and his environment actually occurs. Clearly such interaction characterizes instruction. (1968, pp. 129-130)
The first chapter of this paper, which analyzes the current context for change in medical education and synthesizes an approach (systematization) for meeting changing needs, shares common characteristics with Bradford's Chapter One, and was developed jointly. The necessity for a chapter having common elements arises from the integral relationship between curriculum and learning in the development of educational programs. Curriculum and learning will be treated separately as a matter of convenience after Chapter One, although the intention is not to excise curriculum neatly from the concepts of learning and of a total medical education program. It is hoped that the reader will take serious note of the major points of interaction between the two systems.

Chapter two presents a system concept of learning, and develops four functions which encompass the immediate business of learning: 1) translation or derivation of objectives from the learning outcomes of curriculum, 2) interaction for learning, 3) servicing the learning function, and 4) communications associated with the other functions. Chapter three analyzes learning for determining possible additional aspects that should be considered in developing a learning system, and chapter four assesses the system requirements of the servicing function. Chapter five records the beginning of learning system development at The Ohio State College of Veterinary Medicine, including a six-year plan for full implementation of the new curriculum and the learning system. Functional processes organization and administrative organization of the learning system as applied within the total integrated veterinary education program are presented. The study concludes with the import and emphases for general application of the model.
A brief historical overview of the development of medical education in the United States will serve to support our contention that many potentially useful concepts have been suggested and even tried but never broadly implemented for the general improvement of medical education. Such an overview will also provide an historical perspective for the dramatic developments of the 1950's and 60's. Those developments will later become the basis for the synthesis of an approach to solving the problem of systematic change in medical curriculum and instruction.

The First Century of Medical Education in the United States (1765-1893)

One might wonder at the slow start made by American medical education between 1765 and 1893 because the beginnings seemed most promising. Both William Shippen and John Morgan were scholars trained at Edinburgh, one of the finest medical schools of the time. When they founded the medical school at the College of Philadelphia (now the University of Pennsylvania) they expressed high ideals, some of which might have set new and unique directions for American medical education, but unfortunately the time was not right for their proposed changes.
Throughout this section on historical perspective we will quote notable leaders of American medical education to illustrate both their advanced ideas about education and the conservative forces that kept some principles almost unchanged for 200 years. The following passages are from an address by John Morgan to the Trustees of the College and the Citizens of Philadelphia in 1765:

The various branches which compose the science of medicine are Anatomy, Materia Medica [pharmacology], Botany, Chymistry, the Theory of Medicine [physiology and pathology], and the practice. (Wartman, 1961, p. 176)

The scientific discipline approach to the organization and teaching of medicine, as expressed here by Morgan, had its beginning in the first systematic codification of medical knowledge by Avicenna (980-1037) in his Canon. Underlying this approach was a strong feeling that medicine must be taught inductively; that only by first teaching the facts of anatomy could anatomical concepts be understood, and only in the context of anatomical facts and concepts could the student learn first the facts, then the principles of physiology, and so forth. Again Morgan:

A person may be a good practical Anatomist, and yet be ignorant of Physiology; but it is impossible to be a good Physiologist, without being an able Anatomist... As every disease we labour under is a disorder of the vital, animal or natural functions; a thorough acquaintance with these in their sound state is implied before we can pretend to understand their morbid affections, or how to remedy them. (Wartman, p. 173)

It is important to note that Dewey and many after him have taken exception to the theory-practice paradigm, and have suggested that in many learning situations practice-theory is more appropriate.
The failure arises in supposing that relationships can become perceptible without experience—without that conjoint trying and undergoing of which we have spoken. It is assumed that "mind" can grasp them if it will only give attention, and that this attention may be given at will irrespective of the situation. Hence the deluge of half-observations, of verbal ideas and unassimilated "knowledge" which afflicts the world. An ounce of experience is better than a ton of theory simply because it is only in experience that any theory has vital and verifiable significance.

(Dewey, 1916, p. 169)

We now recognize that a physician cannot learn in a few years of study, enough to carry him through a lifetime of productive practice, and if he could his knowledge would soon be obsolete. In 1765 Morgan suggested that:

A contracted view of Medicine confines a man... to a few partial indications in the cure of diseases... He repeats over and over his round of prescriptions... and, although he is continually embarrassed, has the vanity to believe that... he has within himself all the principles of medical knowledge. [This notion] flatters the imagination... and chains one down to a dangerous routine of practice, unworthy of the name of art.

(Wartman, p. 183)

The most celebrated academicians... strongly recommend "to let none of those discoveries escape us, which are daily brought to light by the labours of masters of the art." Without this care, say they, the most consummate practitioner, within the space of twenty years, will be ignorant of those truths which are then familiar to novices.

(Wartman, p. 188)

Some contemporary leaders in medical education are making efforts to prepare and present to the student the objectives of his studies. Others are beginning to propose programs in which the major responsibilities of the faculty member are to motivate him, guide his path through subject studies and inculcate those intangibles of ethics and professionalism that can be gained only by direct contact.
Morgan (1765):

The business of a Professor is to place before students in a full light, at their first entrance upon any study, the true object of that study, and to ascertain their proper pursuit. In performing this, he first explains to them the terms of art, and renders the language and ideas thereof familiar. He afterwards directs them to what is the most proper course of study, and to the best authors to be consulted on the subjects of which he treats. He points out the mistakes which any of them may have run into, and puts them up on their guard against such errors as are apt to mislead students. He supplies the defects of those authors, and mentions what new light the latest disquisitions and discoveries have thrown upon every subject. He confirms his steps, smooths the rugged path he has to tread, assists him in climbing the steep ascent, and, before dismissal, informs him how he is to conduct himself, in order to reach at length to the summit of his profession. Having a plan before him, a fixed end in view, and the means of attaining it within his reach, the student impelled with an irresistible ardor, presses forward, eager to reach the goal of knowledge and the height of all medical attainments; and since he is so well instructed in his career, has the apparent prospect of wished for success... (Wartman, p. 190-191)

The germ of significant reform seems to have permeated the first American medical school. However, in the one hundred or more years that followed Morgan's address, medical educators saw a continual deterioration in the art of medical teaching, and indeed in the profession itself. Many appealed for change, but little was done to turn the tide until "in 1877, William Pepper...reported the results of a well-documental survey of medical schools in the United States, Europe, Asia and South America" (Wartman, p. 193). Pepper reiterated the inductive discipline approach to curriculum organization, and listed five major reforms:

The first part of the course is devoted to chemistry, botany and such other branches of the natural sciences as are fundamental to the science
proper of medicine, after which anatomy and physiology... are taken up, to be followed by the study of pathology and of morbid anatomy, and later still, of the theory and practice of medicine, surgery and obstetrics, together with that of the chief specialities.

The needed reforms...are as follows:
1. The establishment of a preparatory examination.
2. The lengthening of the period of collegiate studies to at least three full years.
3. The careful grading of courses.
4. The introduction of ample practical instruction of each student both at the bedside and in laboratories.
5. The establishment of fixed salaries for the professors, so that they may no longer have any pecuniary interest in the size of their classes.
(Wartman, p. 199)

These recommendations came at a time when formal medical education was a minimal part of the student's training. In some places students served a year-long preceptorship before entering medical school. Having completed eighteen weeks of formal training, the remaining thirty-four weeks of the second year were again spent in the community as a preceptor. After the third year, which was identical to the second, an examination was given and the student became a physician.
(Carnegie Quarterly, 1970, p.3)

The Establishment of American Medical Tradition, (1893-1946)
The suggestions of Pepper and others were not broadly applied at any school, and for that reason perhaps more than any other, they had no far-reaching effects on medical education until the establishment of Johns Hopkins Medical School in 1893. At Johns Hopkins many reforms were designed into the program including three innovations not listed
by Pepper, which remain integral parts of medical education today:

1. Adoption of the English system of clinical clerkships.
2. Introduction of resident house officers in the hospital organization.
3. Selection of teaching faculty on the basis of their "productive capacity" (i.e. "their contributions, and in general their published contributions to their subjects.")
   (Wartman, p. 202)

The Johns Hopkins model was emulated by a number of medical schools across the country, but most important it set the stage for a national evaluation of medical schools and an irreversible stimulus for change: Abraham Flexner's, Medical Education in the United States and Canada (1910).

Flexner exposed a grossly inefficient system for physician training that stood in bold relief against the improvements at Johns Hopkins and a few other schools. Added to the experience of those programs, his report was stimulus enough to form a whole new pattern for medical education—a pattern that soon became so well established that it was not seriously challenged until the late forties, and has not been substantially altered in most medical schools today.

There is little question that Flexner's organizational approach was well accepted. However, a number of his comments in other areas either fell on deaf ears or more likely were lost in non-systematic flurries of change that left little time for more than the pedantic. He called for a drastic shift of the medical student from being an observer to being an active, involved participant—to learn by guided doing:

On the pedagogic side, modern medicine like all scientific teaching, is characterized by activity.
The student no longer merely watches, listens, memorizes; he does. His own activities in the laboratories and clinic are the main factors in his instruction and discipline. (Wartman, p. 213)

Laboratories are not now the main factor in at least the first two years of medical instruction. In fact, even today watching, listening and memorizing seem overwhelmingly predominant. For this reason, watching, listening and memorizing become the skills that the student is actually taught, quite different from Flexner's concern for development of intellectual abilities and habits for continuing self education:

The student must be taught the positive exercise of his faculties; and if so trained the medical school begins rather than completes his medical education. It cannot in any event transmit to him more than a fraction of the actual treasures of science; but it can at least put him in the way of steadily increasing his holdings. (Wartman, p. 216)

Although Flexner argued that the medical faculty should be active in the pursuit of scientific knowledge, he must have been most unhappy to see research become the almost exclusive yardstick of a faculty member's worth, for he also emphasized the need for "men of another type,—the non-productive, assimilative teacher of wide learning, continuous receptivity, critical sense and responsive interest." (Wartman, p. 218)

On the matter of integration of the sciences, Flexner expressed an important principle that many individuals have pursued, but that few schools have adopted even since Western Reserve's pioneering program in 1952. He said:

Medical education is a technical or professional discipline; it calls for the possession of certain portions of many sciences arranged and organized with
a distinct practical purpose in view. That is what makes it a "profession". Its point of view is not that of any one of the sciences as such. It is difficult to see how separate acquisitions in several fields can be organically combined...in the realization of a controlling purpose, unless this purpose is consciously present in the selection and manipulation of the material. (Wartman, pp. 220-221)

In 1925, (fifteen years later) Flexner compared the developing patterns of medical education in the United States with those in well-established European schools. In this report he supported the inductive approach to teaching medical science and gave heavy emphasis to the practical laboratory experience.

Medical education improved so dramatically during the first quarter of the twentieth century that few entertained further thoughts of change until the late forties. Tremendous increases in medical knowledge and changes in practice from the Second World War and post-war research stimulated some to sense the need for a new approach. But tradition had a firm hold, and a deep schism between clinical and basic science faculties militated against any cooperative effort toward a sweeping re-evaluation.

Born out of studies begun in 1946, and commencing with the implementation of a revolutionary change of curriculum at Case Western Reserve in 1952, a new period of evaluation and change in medical education was launched. But again change was slow. In the eighteen years since then a fairly small number of schools have made meaningful changes in curriculum or instruction, and many of those have been newly established schools with relatively little in the way of vested interests and tradition.
It is clear that in the past there has been no dearth of insight or creative suggestion for change, apparently following the historical pattern, new and increasingly potent forces for change are resulting in changes that some analysts believe are largely scattered, isolated, uncommunicated and ineffective. A new approach to the problem of change in medical education is indicated. The remainder of this chapter will be devoted to an analysis of medical education of the 50's and 60's and to a new approach to planning and change in medical education.

THE CONTEXT OF THIS STUDY OF MEDICAL EDUCATION (1946-)

We have identified what we consider the four major developments in the scientific world and in society in general that have been most instrumental in effecting profound changes in the role of medicine and medical education during the last two decades or more: The knowledge explosion, integration of the sciences, public demand, and social concern.

These developments have had ample exposure in the literature and will be considered only briefly here. Related to each of the major developments we suggest a number of trends in the practice of medicine, which have in turn suggested new curricular and instructional needs and attempts to meet those needs.

Following this section we will show that the developments, trends, needs, and attempts at their fulfillment suggest the need for a total, integrated education program made up of several functional categories as well as some organizational patterns through which change activities operate. This analysis is summarized in Figure 2.
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**FIGURE 2** Analysis of The Context of Medical Education 1946--
Knowledge Explosion

"If a fast reader were to begin now and read for twenty-four hours a day, it would take him more than one hundred years to read the biomedical literature for any month." (Humphrey, 1970). The explosion of information in all areas of science is indisputable, and is inextricably involved with the well-established trend toward increasingly specialized training for the individual. In medicine this has led to the near extinction of the general practitioner and to longer periods of specialty training in the form of internships and residencies. It has led not only to further divided specialities but also to the addition of new specialities, and the proliferation of allied professions.

The knowledge explosion and specialization in medical practice have led some medical educators to design curricula in two parts: a core of learning essential for every physician of whatever specialty, and a series of elective courses intended to allow some early specialization or an opportunity to choose a specialty after exposure to two or three alternatives.

Another approach to solving the information problem has been to teach concepts, principles, and modes of operation (processes) early in the curriculum and save examples details for later. This deductive approach is in sharp contrast to the more traditional inductive situation where a student is given all the facts and is expected to integrate them essentially on his own. The knowledge explosion has made this latter approach increasingly more difficult to use because of the seemingly insoluble question of which facts can
be omitted, without destroying pattern trends which inductively
lead to basic concepts.

"Learning to learn" has been another phrase stimulated by the
explosion of knowledge. In ten years half of the information a
medical student learns now may be useless or dangerously obsolete.
Therefore the student can no longer be a walking encyclopedia; he
must be a complexly cross-referenced indexing system, and must know
where to look for information and how to use outside sources quickly
and accurately. He must form habits of continuing education so that
his mental filing system is constantly up-dated.

In response to an increased awareness of the learner and the
learning process, several new instructional concepts have developed.
These concepts which have been tried in the context of expanding
medical knowledge, are: (1) learning for mastery (2) self-actuated
study and learning (3) a continuum of modular instructional units, and
(4) formal learning outside the institution.

A specialist is likely to be working near the frontiers of knowl-
dge in his special area; he therefore must be able to interpret
intricate relationships and to generate new knowledge, or see new rela-
tionships. Such capability comes from (1) a frame of reference (2)
concentration on problems in a specific context. Thus specialization
obliges the student to enter in great depth a particular aspect of the
general field. Access to the more sophisticated levels of knowledge
is through mastery of the concepts of underlying principles and details.
This comes partly by repeated application of basic and intermediate
science knowledge to more complex specialized problems, and partly by
study and restudy of all that can be known that is contributory to
the special area.

Specialization is by nature primarily an individually pursued
learning activity. It is critical for the specialist to be continually
updated; he must initiate inquiry, rather than depend wholly on formal
courses presenting others' findings. His quest also leads to study
wherever the potential for new knowledge exists; particularly in places
where new problems are likely to be found. Capabilities of this kind
require learning experiences outside the school itself.

Specialization and self-actuated learning become practical through
the integration of information into single concept modules that can be
easily arranged into a tailor-made continuum of study. The view of a
course of study as a continuum has long been voiced in precept, but the
prevalent example is a "loosely related series of isolated compart­
ments." (Cooper, 1969, p. 33) The modules facilitate a learning
experiences continuum in the way that elements and their isotopes
comprise the spectrum of matter.

Integration of the Sciences

Up to recent times, the corpus of laws of nature
was almost identical with theoretical physics. Few
attempts to state exact laws in non-physical fields
have gained universal recognition. However, the
impact and the development of the biological, behavioral
and social sciences seem to make necessary an expansion
of our conceptual schemes in order to allow for systems
of laws in fields where application of physics is not
sufficient or possible. (Bertalanffy, 1956, p. 18)

Bertalanffy points out that our main problem today is that of organized
complexity. He sees concepts like wholeness, self-regulation,
directiveness, control, differentiation, as indispensable for dealing with living organisms or social groups. He considers that the basic problem posed to modern science is a general theory of organization, and he suggests the interaction of biological, behavioral and social sciences as a basis for the derivation of such a theory.

Robert R. Wagner of Johns Hopkins University School of Medicine sees a revolution in biology that will profoundly affect medical education. Biology, in his opinion, has gone through a descriptive period, and an analytical period; beginning in the decade of the 1960's it is starting a new era marked by the thesis that all biological events can be explained logically and simply by fundamental laws governing spatial arrangements and interaction of molecules and their component parts. The examples he gives relate to genetics and protein synthesis, explained by information theory and feedback mechanisms as functions coded in DNA and RNA molecules. (Wagner, 1962)

We see an integrating trend in the practice of medicine that stems from ecumenicism in the sciences. Interdisciplinary cooperation has emerged, and with it the health team approach to providing health services. The team concept prompts increased role differentiation and specificity, but at the same time requires integrated efforts.

This is reflected in curriculum by attempts at integration of courses. In instruction, attempts at team teaching are made, necessitating increased faculty coordination and information exchange. Requirements for physical sciences, mathematics, cybernetics, psychometrics, sociometrics and applied sciences such as electronics are generated by the resultant need to communicate or translate among the
disciplines, and by the integral role played by these disciplines in medical science. The emphasis in medical courses has begun to shift toward function and away from morphology of organisms, because similarities of function have become more significant than differences in morphology.

Increased awareness of the learner and the learning process is leading to attempts to provide more realism in the learning environment and in learning experiences. Innovation and experiment are encouraged in instructional approaches in attempts to meet the rising expectations of students.

**Public Demand**

Whatever is made available to any members of a responsible society tends to be assumed as the right of every member of that society. One statistical example will show the magnitude and potential effect of the demand for medicine, the practice of medicine and medical education: three-hundred and thirty-seven member teaching hospitals of the AAMC report a 41% increase in clinical outpatient visits and 66% increase in emergency care from 1961-2 to 1967-8. (Parks, 1969, p. 5) Under conditions like these, it is most difficult to give the teaching of office practice and home care the attention appropriate to public demands.

Demand for medical services now exceeds the means of providing those services. Many disparities in kinds, quality and amounts of services are the result. Yet, as Dr. James Dennis, Dean of the School of Medicine, Oklahoma City, states:
Although the development of a critical mass of health care deficits did not occur suddenly, many in academic medicine seem to be unaware of, or insensitive to, the realities of the social pressures that have been generated by unmet needs...but there can be little doubt that the population expects the medical schools to fill its physician manpower needs...many of the pressures that now impinge upon us reflect the fact that the most important "patron" of medical education is no longer the philanthropist but the taxpayer...and he can make powerful demands that his health be protected and his life prolonged. (Dennis, 1969, pp. 18-19)

Health team manpower is approaching a critical shortage, and deficits can only be reduced by growing numbers of professional and allied health personnel coming out of the schools. Dr. Frank McKee, Director of the U. S. Public Health Service Division of Physician Manpower says, "Expert medical observers have estimated that our present needs are for a graduating class each year of 16,000 physicians." (Lysaught, 1969, p. 66) The class of 1968 was 7,966 for all U. S. medical schools, about half those needed according to Dr. McKee's estimate. Dr. P. R. Lee, in the Mayo Alumnus (1967), estimates that by 1975 we will require 3.4 to 3.6 million health workers. The Surgeon General has estimated that the current shortage is 50,000 physicians in the U. S. with the deficit in dentists, nurses and other health professionals just as serious. (Cooper, 1969, p. 32) Dr. John Cooper states that, "To meet this need, we must have a net increase of about 100,000 health workers a year—a growth rate 50 per cent higher than it was in the past decade." (1969, p. 33)

Thus it is no surprise that the AAMC and AMA jointly and strongly stated an endorsement of the position that all medical schools should now accept as a goal the expansion of their collective enrollments.
to a level that permits all qualified applicants to be admitted.

The crisis is not only one of numbers but is also the inadequate system through which health care is provided. Bergner and Yerby ask, "Which of our students are presently receiving didactic or practical instruction for the provision of comprehensive health care? Do they have any notion of working as part of the health care team? The failure of most of our medical, dental, nursing and other schools to move ahead in these areas may turn out to be more important than all the other factors in the health care equation." (1968, p. 545)

Public demands and manpower shortages are reflected in several attempts at a solution: Some schools have shortened the time from college entrance to medical school graduation. A cooperative effort was initiated between The Jefferson Medical College of Philadelphia and The Pennsylvania State University to enable highly qualified students to earn both the B.S. and M.D. degrees in five calendar years after high school. In National Board examinations and in performance at Jefferson, there were no observable differences between the accelerated and the non-accelerated groups. (Herbut, 1969)

There have been increases in enrollment. Entry twice yearly has been introduced in a few schools. Efforts at reducing attrition have saved some students. New schools have been organized and new facilities have been constructed.

Changes in curriculum and instruction are less obvious and not yet much implemented. A biomedical program which provides an intensive science-based education and an analytical approach to biology, has been established for the six-year B.S. and M.D. accelerated program of
Rensselaer Polytechnic Institute and Albany Medical College. The curriculum is designed to give the student superior preparation for a career in medical practice, research or academic medicine. Results have been reported as promising. (Kanter, 1969)

The university medical center is being set forth as facilitating acceleration. Acceleration as one way to individualize instruction is intended to attract the exceptional student who would otherwise be bored or who would avoid the long period of study before attaining professional status. (Parks, 1969)

Other instructional developments include increased use of television, programmed text and computer-mediated presentations. The emphasis is beginning to shift from a heavy orientation toward research in medicine toward improved teaching techniques. Teaching assistants are being sought. Self-actuated learning is being studied, and the practice and application of learning are being optimized. Resources for learning are being made more available to the teacher and the student through production and distribution services as well as assistance in planning and design of materials by media specialists and educational professionals.

Social Concern

There is a growing awareness on the part of medical students that portends changes in the delivery of health care. Until recently, students had a largely introverted concern for their own career in practice or research. Students today are becoming more concerned that a child born to poor parents has twice the risk of dying before its first birthday as a child from a non-poor family; that infant mortality
in rural communities in the South for Negroes is 3 to as much as 7
times as high as it is for the white population; that 50% of poor
children do not receive adequate immunization and 64% have never seen
a dentist. (Cooper, 1969, p. 32) Such social awareness will shift the
emphasis from "patient", "diagnosis" and "specialist" to "person",
"health" and "team".

The emphasis on the patient as a person draws a wide circle that
takes in the ecological and social welfare of that person. World food
problems and agricultural well-being, animal herd and pet health,
population and preventive medicine problems are all within this circle
of concern.

Social awareness is actively involving medical students in seeking
solutions. Robert Ebert, Dean of Harvard Medical School, predicts
these students will act as the "necessary prod to a conservative
profession and to a conservative educational process." (Cooper, 1969,
p. 34) Areas of immediate interest will be the assuming of responsi-
bility for the health of a cross-section of the people of the commun-
ity around the teaching hospital. A fine example is The Ohio State
University College of Dentistry, where a program of carrying the
dental services to the invalid and aged in the place of their confine-
ment is underway under the personal efforts of Dr. Wendell Lots.

Another area of interest will be the expansion of the out-patient
department to preventive medicine, reliable patient medical history,
equal treatment of private and charity patients, and the model teaching
of group office practices in keeping with trends. (Parks, 1969)
One emerging learning experience that has developed out of the "patient as a person" concept is first year medical student contact with patients and the responsibility for following the health needs of a family. For example, at Case Western Reserve:

Instead of waiting two years to encounter a live patient, in the first week of his first year the student now assumes limited responsibility for his own "family"—husband, pregnant wife, and young child—whom he sees for at least two years with a pediatrician. (Carnegie Quarterly, 1970, p. 5)

A major concern currently in the forefront of student interest is the unequal educational opportunities of minorities. Hutchins et al., identify the two largest minority groups in America today as women and Negroes. (Hutchins, 1967) The admissions process is the key decision point, and if society would be best served by including less qualified members of minorities, medical educational programs will be obliged to make special efforts to provide qualifying experiences to the disadvantaged.

There will be increasing interest in performing service in developing countries early in a medical career. To enable the young doctor to cope with the primitive facilities and the diseases endemic to a region, as well as the sociological barriers, education will be prompted by cooperative world health and U. S. legislated programs to place more emphasis on these aspects of health care preparation. (Merrill, 1967)

The foregoing problems provide curricular and instructional emphasis that must respond to social concerns, and the "whole patient in the environment" concept. One additional consideration is probably most significant: students view themselves as potential colleagues in
the practice of medicine. They expect to be treated as persons and as professional aspirants. Provision for their involvement in planning a program of medical education and their individual courses of study can no longer be overlooked. The students must not only be invited to participate with faculty and administration in the total process of education, but a formal structure must be set up to cause their responsible participation.

AN APPROACH TO PLANNING AND CHANGE IN MEDICAL EDUCATION

In the context of massive demands and external change, medical education must address the many pressures for internal change, and at the same time continually provide a functional program to educate physicians. This is perhaps why new schools have been the most innovative, but older schools must also make significant changes very shortly if the nation is to fill the health care gap.

Functions of a Total, Integrated Education Program

The means suggested here for medical schools to reach their overall goals through systematic implementation of the necessary operational and ideologic changes will be called a Total, Integrated Education Program (TIEP). A TIEP is total because it identifies and takes into account all functions necessary to meet desired goals. It provides the capability for recognition of and action on any problem relevant to its operation whether the appropriate solution lies in an established faculty rule or an honest, intuitive approximation. It incorporates rigid organizational patterns where they are appropriate and flexible.
non-organization where it thrives. TIEP is an integrative concept because all program elements are designed to interact meaningfully in the achievement of a common set of goals. Oneness is an essential quality of TIEP, but so is individuality, because education can happen only to individuals.

The most distinguishing characteristic of a TIEP, however, is its dynamism. Participants—students, faculty, administrators—contribute actively to its progress. They anticipate, prepare for, become involved in, critically evaluate, and change the program on a daily basis. As a result there is a constant state of orderly flux.

Several broad functions must be accounted for if the TIEP is to begin to answer the demand to provide more effective medical education for more students. Six functions are discussed below because they reflect the trends and needs that have arisen from the knowledge explosion, integration of the sciences, increasing public demand, and social concern. They are: the learning process, assessment, selection of learnings, teaching as communication, management and control, support, and program validation.

The Learning Process

The first function necessary within a TIEP is learning, and some commonly accepted understandings are necessary if there is to be agreement on what constitutes institutionalized learning. We will suggest four areas that must be considered when any institution attempts to understand learning: the nature of learning objectives; the context of the learning experience; the type of learning activities; and the ultimate outcomes of learning.
For the consideration of the nature of learning objectives, a slight modification of Bloom and Krathwohl's taxonomy is suggested. It may be useful to emphasize the distinction between facts or knowledge per se and intellectual abilities and skills, yielding the following gross outline:

I. Knowledge  
II. Intellectual Abilities and Skills  
III. Volition and Value Judgement  
IV. Motor Skills

The context of any learning experience is different for every student, because each brings a different array of experiences to the learning encounter. To be meaningful learning must relate to what the student already knows in a substantive (non-verbatim) fashion. (After Ausubel, 1968) This kind of learning can only take place if the learner has established a learning set (mind set) to learn. Not only must the student be mentally prepared for learning, but he must be taught in terms of previously learned concepts.

Meaningful learning might be considered as one end of a learning context continuum with memory learning on the other end. Memory learning takes place 1) when wholly arbitrary associations are made (e.g. associating a name with a structure), 2) when a student lacks prior knowledge necessary to make a learning task meaningful, or 3) when the learner decides merely to internalize the learning task verbatim despite previous knowledge with the potential to make the task meaningful. Although memory learning of the first type (naming) is sometimes necessary, most often learning experiences fall between the extremes of meaningfulness and memory for individual students. We will show how improved curriculum and instruction programs can make
learning more meaningful and thereby more effective by upgrading the learning context.

Another learning continuum describes the type of activity in which the student participates. The extremes are discovery at one end and passive reception at the other. In a purely passive reception activity the student is presented the information to be learned in final form and asked to internalize it for replication at a later time. Discovery activity requires that the student discover the principal content:

The learner must rearrange information, integrate it with existing cognitive structure, and reorganize or transform the integrated combination in such a way as to generate a desired end-product or discover a missing means-end relationship. (Ausubel, p. 22)

Neither a pure passive reception exposure nor a pure discovery approach to knowledge acquisition is suggested as ideal; rather, careful consideration of learning goals and the ultimate use of learning are necessary, to decide on the extent of passive reception or discovery learning.

Physicist Phillip Morrison adds an interesting dimension to discovery:

Linguists say that one characteristic of knowing a language is productivity. Productivity does not mean the number of words uttered per day. Productivity for them means the ability to create and understand new sentences, sentences which combine already known elements in new ways. Nobody knows a language who cannot do that at some level. (1967, p. 21)

The inference for medicine is that medical students must know enough of medical language (facts, cognitive and motor skills, and
values) to enable them to achieve productivity, which is the ability to know and do new things by recombining known language elements.

Finally, the ultimate outcome of learning must be considered. In this respect we distinguish between training and education. Both predictable learning outcomes and unpredictable outcomes are sought in medical education. Training implies learning for the predictable and education implies learning for the unpredictable outcomes.

According to Plimpton:

Training is a preparation for only one thing, and once trained, one is finished and completed. Education is a preparation for many things; both those currently known and those to be discovered. It is never completed. (1963, p. 205)

Curricula for education are developed by selecting among and between the organized bodies of knowledge, skills and attitudes for the elements that analysis identifies as having the greatest interpretive value. The items selected depend on how fundamental and crucial they are to the organized body of content, how well they explain its structure, and how powerful they are in furthering its characteristic thought processes and modes of inquiry.

Assessment

A second function of a total, integrated education program has to do with assessment of the learning program. This process begins with the formulation of goals and objectives and involves the comparison of actual functions with intended functions.

All educational institutions have goals that guide their operation and provide the philosophical base from which they build. The general goals of medical schools are often based on the three traditional areas
of teaching, research and service, with more specific areas of operation and special emphases defined within each category.

We defined curriculum as a set of intended learning outcomes (p. 3). This is another level of criterion that expresses the kinds of activity that are expected of graduates of the curriculum in each of the major areas within the total domain of medical knowledge.

Further we have mentioned the importance of understanding the nature of learning objectives. That is, at each step of the way, how can we determine whether the student is making progress?

These three levels of goals or objectives—program goals, intended outcomes, and learning objectives—will all be shown to be necessary criteria for the ongoing assessment of the total integrated education program at various levels.

Because definitions of and understandings about learning objectives abound and rarely agree, a short explanation of the concept as we understand and use it is in order. Later discussions in this chapter depend upon this common ground.

Specific instructional or learning objectives are used to translate the medical education program into learning experiences. To provide the basis of mastery, specific objectives are stated in terms of behaviors that are measureable. They show what action is taken, the degree of performance necessary for successful completion, and the criterion conditions. (Mager, 1962). Goals do not have these characteristics, but give an overall description of the aims of a course or other large curriculum unit.
In speaking of overall goals and their translation into learning objectives, George Miller says,

A sober analysis of what goes on in medical schools, however, must suggest to the observer that not infrequently individual instructors either have no clearly defined objectives or that those they do have are unrelated to those of the department or school. (1961, p. 91)

If a program of excellence with learning for mastery is to be realized, something must be done so that all learning activities are organized and guided by real goals and measurable objectives stated in meaningful, understandable terms.

This study assumes that the facts of life in respect to learning objectives are: (1) they are seldom formulated in a formal way, or more often than not, remain vague ideas in the minds of teachers and students; (2) they may be established during development of a course of study, but are not communicated to teachers and learners with clarity and effectiveness; (3) evaluation of student mastery in the basic sciences is usually based on a sampling of content facts and principles recall, with few problem-solving or application type measures. For the clinical sciences, exposure and evaluation are presumed to take place for all essential experiences, yet it is reported that for such significant areas as radiology, formal learning experiences are not likely to exist. (Squire, 1969)

Therefore, it is proposed that documented statements of desired learning outcomes be published by a college of medicine, and that a regularized procedure be established for producing and reviewing such statements on a scheduled basis. This crucial mandate must be given
special priority and recognition. It will come closest to achieving its purpose where the mandate is imposed by the faculty on themselves.

As Dewey noted, "Education as such has no aims. Only persons, parents, teachers, etc. have aims, not an abstract idea like education." (1916, p. 107) It is postulated that any exercise establishing an objective for someone else has little effect if that someone doesn't subscribe to this objective. Moreover, unless the objective is clearly communicated, it will have an effect different from the original intent, though it is ostensibly achieved.

The documentation must contain provisions for diffusion to each student so that he has primary responsibility to achieve the objectives, hence the goals they implement, as well as to inquire concerning any aspect of an objective that is not clear. Such feedback must be built into a reporting scheme. Objectives are bound to have more potency if formulated in terms of the learner's contextual map and goals. The learner himself is thus eligible to play a role in formulating objectives in the beginning. In fact, a regularized procedure for preparing and maintaining, and promulgating statements of objectives requires student participation. To be effective both the faculty and students must be mutually involved in the terms and means of developing such a procedure.

Selection of Learnings

A third function of the total integrated education program arises from the fact that it is infeasible to teach all medical knowledge to every student. The TIEP must identify those learnings that will guide each student to the program objectives.
There has been considerable discussion in medicine and other areas about identifying the core content that every student must master before he goes on to practice or to become highly specialized. Selection of content areas and topics by the faculty is the operational crux of this approach, which is beset by the paradox that the faculty man who is apparently most qualified to identify essential elements of his field is usually least able to identify those that are non-essential.

Most of the popular and apparently successful science curriculum movements in public education have taken a somewhat different approach. They have assumed that it is most important for students to be able to approach and work with knowledge in the way a scientist might. This way of thinking about curriculum, often identified as the process approach, is differentiated from the content approach, and is associated with cognitive psychology, and the discovery emphasis of the passive reception-discovery learning continuum. It has been espoused in recent times by Dewey, Bruner, and many others. Perhaps one of the most eloquent statements on the subject is in Emile, by Jean Jacques Rousseau (1762):

Teach your scholar to observe the phenomena of nature; you will soon rouse his curiosity, but if you would have it grow, do not be in too great a hurry to satisfy this curiosity. Put the problems before him and let him solve them himself. Let him know nothing because you have told him, but because he has learnt it for himself. Let him not be taught science, let him discover it. If ever you substitute authority for reason he will cease to reason; he will be a mere plaything of other people's thoughts... Undoubtedly the notions of things thus acquired for oneself are clearer and much more convincing than those acquired from the teaching of others. We develop greater ingenuity in discovering relations, connecting ideas and inventing apparatus, than when we merely accept what is given us and allow our
minds to be enfeebled by indifference. (Rousseau, 1911, pp. 131-139) A cautionary note: Dewey, in answering criticism of progressive education that grew out of excesses in permissiveness and non-direction, outlined needs for teacher control in the discovery process. (Experience and Education, 1938)

"Learning to learn", a popular phrase mentioned earlier in relation to continuing education, by many accounts embodies the principles of discovery and problem solving. Bradford (1968) has suggested a "Cognitive Development" approach for medical education which is centered around the cognitive abilities and skills portion of Bloom's taxonomy, and which incorporates a learning system based on the student's solution of increasingly complex problems.

It is clear that careful consideration must be given to the nature of the experiences included in a four-year medical program. Further, consideration is due the question of who selects those experiences. Traditionally this has been the sole responsibility of the faculty. There are increasingly strong indications that at least two other groups within the medical school should have major roles in program definition.

Professional medical educators are essential in helping faculty members to interpret program requirements so that the learning experiences developed from those requirements do for the student what the faculty originally intended. Perhaps most important, the individual student must play an increasingly significant role in selection of his own learning experiences. This will happen through membership on college educational program committees, and more directly through each individual's selection from a range of alternative experiences—each designed for a different type of student to reach the same
Teaching As Communication

A fourth function to be accounted for by the total integrated education program is teaching as an intent to communicate. If teaching is not communication, it is not teaching. Edgar Dale characterizes teaching as sharing—a two-direction process—intercommunication. He says that it includes "the collision, the creative interaction of minds." (1967, p. 167) In such a "reciprocal liking and understanding arising from a community of interests" (1967, p. 167), the teacher makes things plain by "spreading them out," (1967, p. 168) so that learners "can see what needs to be done." The teacher "transforms by informing, to develop a zest for lifelong learning..." (1967, p. 170)

Teaching is viewed by the writer as an intent to communicate totally. It involves speaking and listening, writing and reading, observing and visualizing. These manners of dealing with real things, with their icons and their symbols, take place in special kinds of places, times and contexts termed the learning environment. The messages are specifically designed to inquire into the nature, meanings and processes of cognitive, affective or psychomotor aspects of the object of inquiry.

Health preparation provides a rich intercommunicative opportunity for teaching and learning. In the main, the concrete and the abstract can be in close juxtaposition. Although an extensive and complex set of symbols must be used, there are facilitating terms for their acquisition. The patient is a focal point for creative interaction,
and the interaction can be at any of several levels of complexity to fit the learner's readiness. This is the kind of complex context that learning requires—one involved with seeing, with hearing, with smelling and tasting, with feeling, with doing; but medicine also has elegant deductives that have power and value for some learners.

Management, Control and Support

Another function that must be accounted for is that of management, control and support. In order to offset the sense of powerlessness felt by administrators and planners faced with the need for radical change, sophisticated management tools have been developed. Some colleges of medicine have phased these tools into specific activities such as curriculum design, instructional media usage, student evaluation, facilities design, scheduling, budgeting, personnel management, inventory control and equipment maintenance.

Management systems analysis is an approach that permits order to be imposed on what actually may be random events. "It provides a framework that permits the judgment of experts in numerous fields to be utilized so as to yield results which transcend individual judgment. It enables persons to achieve solutions and raise probing questions in a universal language, i.e. systems analysis." (Hartley, 1969, p. 515)

The University of Toronto Medical School provides a good example of the use of a productive management information system. They were pushed to increase enrollment, to turn out allied health personnel, to change the curriculum, to enhance instruction. They were faced with short funds and rising costs. A team of 12 to 15 physicians, systems
analysts, computer programmers, mathematicians and economists asked, "what would happen if we adopted this alternative educational program, or this alternative measure to solve our problems?" (Wilson, 1969)

The team used a tool called simulation analysis, a computer-based approach. Models accurately describing the most basic aspects of health care and education were formulated, then projected for requirements that would be generated by given simulated constraints, inputs and outputs. Questions were then asked of the model to determine what would happen with such things as a minimum number of people, maximum salaries, minimum funds, maximum research or maximum graduate outputs, etc. University of Toronto's Dr. Richard Wilson says that this does not give all the answers, but does give an idea of where a given policy or practice is headed. Better decisions can be made on allocation of resources to attain educational objectives, and the effect of any plan becomes apparent in a computer readout in one day instead of a costly trial over years. New imaginative concepts can thus be tested for feasibility, revised and retested until a workable model is achieved.

Program support includes planning, programming and budgeting for all aspects of educational resource needs. The Planning, Programming, Budgeting System (PPBS) is one tool for development and presentation of relevant information on the costs and benefits of major alternative courses of action (Alioto and Jungherr, 1969) using data on teaching personnel, staff, teaching loads, patient loads, policies, plans, procedures and similar variables.

Whether they are a part of a sophisticated computerized system or just a few individuals dedicated to meeting faculty needs for
learning assistance, the support services rendered as part of the TIEP are perhaps the single most important function.

Program Validation

Educational program validation concludes the functions of a TIEP. Are the goals that have been established goals that actually meet changing needs of society and the individual? The state of health of the nation, and even the world, is the final test of validity of the TIEP. Surveys that indicate the relative progress being made on overcoming health care deficiencies are one means of feedback to determine program validity.

A second aspect of validity is the performance of interns and practitioners in being able to handle the health problems presented in daily practice. Records, examination and observation by health care professional experts are required for carrying out evaluation and making recommendations for change. Continuous monitoring of both the general capacity and specific ability to provide health care are called for. Means of disseminating and acting on such information are found at both institutional and governmental levels.

The Department of Health, Education and Welfare has some effect through grants that selectively increase outputs of personnel, and that encourage development of quality of programs. Only the institutions themselves through the design of their educational programs, can have a significant and long-lasting effect on the abilities of graduates to cope with existing and anticipated problems.
Organizations Contributory to TIEP

Organizational patterns are introduced here and discussed in greater detail later because of their potential to contribute to the successful functioning of a total, integrated education program in medicine.

Central to the integrative functioning of the TIEP is an OFFICE OF MEDICAL EDUCATION (OME). Such an office should serve the specialized educational needs of the whole college, coordinating educational program and materials design, implementation and evaluation, as well as providing professional expertise for college planning and for applied educational research projects.

The guiding principle of the OME must be to serve and anticipate student and faculty needs while imposing a minimum number of constraining, artificial requirements. In short, it must work to reduce the complications of an extremely complex educational situation by acting as soothsayer, errand boy, interpreter, judge, expeditor, banker, mechanic and psychiatrist for students, faculty, administrators, curriculum and learning.

Part of the office of medical education's function should further be identified as a LEARNING RESOURCE CENTER (LRC). Learning materials are conceived and educationally designed by college faculty and OME educators; they are then artistically designed, produced, catalogued, distributed and maintained by learning resource center staff. With increasing emphasis on multi-media materials, it is essential that there be close communication among all individuals in the process. For this reason educational staff members coordinate all aspects of materials preparation on a project basis.
The learning resource center combines into a single group the functions previously assigned to divisions of medical illustration, medical photography, medical television, laboratory supply, central duplicating, and the medical library. Aiken describes how such an arrangement makes possible the production of more effective materials, largely eliminates duplicate productive efforts, makes possible unified budgeting to meet specific needs and provides many other advantages.

Neither the TEACHING HOSPITAL, nor more broadly, the university medical center, are new organizational concepts, but some aspects of their function bear heavily on the success of a total, integrated medical education program. One of the most discussed functions is to make practical the growing concern for social problems by providing a dynamic interface with the community.

In the future the teaching hospitals, along with the related medical education institutions, must assume a much more responsible role in total planning for comprehensive health services in the areas in which they are located in full concert with other providers, consumers, and public officials in such a way as to assure the individual and his family of excellent comprehensive health care. This is essential to the educational function if the teaching hospital is to play its full role in preparing health professionals for the future. (Jones, 1969, p. 335)

The last sentence above implies two additional and related functions of the teaching hospital. First, health professionals must be prepared for the future. That is, they must be trained and educated to work as members of health care teams, they must learn what it means to practice community medicine, and so forth. Second, health professionals must be prepared for the future. University medical
centers can no longer prepare physicians, dentists, veterinarians, and a few allied professionals; they must prepare teams of health professionals of all types who are trained to function not as individuals but as a unit.

Another important function of the teaching hospital is communication with other hospitals and with members of the profession generally. The regional medical programs are an expression of this function as are computer instruction links and other similar activities. Teaching hospitals will play a significant though not exclusive role in inter-institutional programs for sharing, exchange and distribution of instructional materials, programs, facilities and expertise such as those currently under investigation by the Council for Institutional Cooperation (Big Ten), and the American Veterinary Medical Association.

Organizational patterns of the types outlined above have developed in non-systematic attempts to carry out the various functions of medical education programs. Here they will be considered as existing to carry out a total, integrated education program in a systematic way.

Chapter Conclusion

We have pointed to the major functions of a total integrated educational program (TIEP), and have suggested some aspects of the medical education environment that indicate the need for such a program. It is important to note that this first chapter as well as succeeding chapters have been developed from the perspective of the system approach to planning and change as it applies to the educational setting.
Maccia points to the crucial need for a system approach to educational problems when, after describing the highly interactive character of many educational functions, he states:

Such interaction makes for an organization of great complexity, one which does not lend itself readily to the characterization of variables one at a time. What is needed, therefore, is educational theory based upon an acceptance of complexity and interaction, and so involving characterizations which leave complexity and interaction intact. General Systems Theory presents such a point of view for educational theory. (1962, pp. 1-2)

Within the six TIEP functions there has been no attempt to identify every aspect that should be associated with curriculum development or learning system development. The details of curriculum development as a system have been presented by Bradford (September, 1970). The details of the learning system follow in chapters two through five. Two additional systems are suggested for the TIEP—support system and assessment or evaluation system. Some aspects of support and assessment will be noted as they relate to learning interaction and to servicing the learning function, but a more thorough analysis lies outside the scope intended for this dissertation.
CHAPTER TWO - PRESCRIPTION FOR A LEARNING SYSTEM

This chapter will translate the requirements for an orderly approach to the problems of learning into a theoretical model of a learning system or "synergystem". Intended functions are identified and analyzed for application in professional health care preparation.

The term synergystem is coined from the words synergism and system. System is defined here simply as a set of clearly interrelated parts, all directed in their functions toward a common purpose. Synergism means combined or cooperative action or working together. A definition of synergism is: "any body organ, medicine, etc. that cooperates with another or others to produce or enhance an effect." (Random House, 1967) Mutual will and inspiration or participation in the spirit of the endeavor is the meaning we intend. Synergystem, then, is a set of clearly interrelated parts— including people who share an inspiration— all working toward a common purpose.

CHARACTERISTICS OF A SYSTEM APPROACH

After course development has been carried to a point where a series of interrelated sciences or subject areas are involved, and where a number of learning methods are to be matched to students' learning styles or sets, a structured approach is indicated in order to deal with the hundreds of variables involved. The medical sciences are mainly interdisciplinary, optimally calling for a team teaching
approach. Objectives in both education and training are included. Several instructional media and facilities may be required, also adding to the variables. A non-structured approach is likely to be hit or miss in workability in achieving learning outcomes. Before a learning synergystem model can be formulated, however, an explanation of the system approach to be used to develop the system model is necessary. The next section provides principles common to the learning system and to the curriculum development system proposed by Bradford in collaboration with the writer.

The system approach has been characterized as a logical step-by-step approach to problem solving which we use continually, even though we perform many of the steps unconsciously (Lehmann, 1968, p. 144). As such it is cited to be no more than what we have always called the scientific method. However, Trzebiatowski (1969) points out that, despite a great deal of similarity in the process the two approaches have significantly different purposes and thus lead to different ends:

The system approach is interested in the arrangement of the components in a manner that tends to constrain action toward a specific end. The scientific method seeks understanding by measuring the correspondence between a set of observations and a set of concepts...

The key difference between the scientific method and the system method can be found in the final step of both methods; that is, in the scientific method the research findings lead, hopefully, to a greater and more comprehensive theory, and in the system method the research findings yield a direct and immediate plan of action. (pp. 3-4)

The system approach, then, is a way of formulating a plan of action for achieving a specified goal through a series of analysis and synthesis steps. Below are listed the most conspicuous aspects for
the system approach. (Lehmann, 1968, p. 21-22) These can be termed strategies for system development. The primary thrust, whether analysis or synthesis, is shown in parentheses.

1) Clear definition of system purpose, specific formulation of performance expectations and construction of criterion measures (analysis).

2) Description of characteristics of input (analysis).

3) Selection of alternatives - what has to be done and how, by whom or by what, when and where, to attain predetermined performance (analysis) - to build a system model (synthesis).

4) Evaluation of output of the system in operation in terms of the system purpose and operations criteria (analysis).

5) Adjustment of system to optimize output and operations (synthesis).

Systems Characteristics and a Learning System

In the domain of health care learning, we define our purpose in relation to the mandated curricular inputs that prescribe the outputs of our system. The learning system implements the primary purpose or reason for existence of the total integrated education program (TIEP), that is, a tyro health care practitioner as an output. The transformation of the above system strategies into a learning synergystem will require us to:

1) Formulate specific learning objectives (analysis).

2) Develop criterion measures to test achievement of objectives at completion of unit by the student (analysis).
3) Examine the entry characteristics and potential of the learner (analysis).

4) Generate sets of learning tasks to reach objectives (analysis). This includes facilitating objectives and tasks.

5) Develop performance measures that provide learners with knowledge of results during the learning process within each learning task (analysis).

6) Generate alternative learning experiences for students of various learning sets and styles to accomplish learning tasks (analysis-synthesis).

7) Prescribe specific sets of learning tasks for individual students, and recommend learning experiences calculated to correspond to learning style (synthesis). This includes the sequence or ordering of tasks, according to psychological principles, and prerequisites for learning each level.

8) Maintain learning environments appropriate to the learning experiences, to include the resources of information, equipment, facilities and people (analysis-synthesis).

9) Correlate the system components and processes, including the activities or roles of students, faculty and staff, toward unity of structure and operation (synthesis).

10) Operate the system and collect information on achievement of objectives by learners, and on how efficiently the system operates (analysis).

11) Regulate the system to attain optimum achievement and efficiency, and to respond to changes in conditions (synthesis).
12) Provide information feedback to curriculum development system, evaluation system and information system in the TIEP.

In concert with the spirit of a learning synergystem approach, actual analysis will be made at respective points of application in developing the system model. Need assessment is implicit in each of the enumerated steps and their implied strategies, therefore such assessment is conducted in the analysis.

The strategies, when grouped will be termed functions. Each function will be characterized by the dominant theme of the subfunctions that comprise it. Thus, further explanation of the system approach will be mainly in the context of the learning synergystem model proposed by this paper.

Elements and Role

The steps listed above constitute the process aspect of a learning system. The products of the learning system are students with the characteristics and capabilities defined by the learning outcomes. A third aspect of a learning system is its elements. The elements are those acts of men or machines that in combination, guided by the system process, result in the planned system product.

Elements may be of three types: (1) technical work acts, (2) communication acts, or (3) decision-making acts. (Jensen, 1969, p. 102) Elements are defined during system analysis, and are assigned specific functional relationships within the system. However, the functional relationship between elements does not usually correspond
to the set of acts assigned to a given man or machine in the system. Such a set is identified as a role.

ROLE AS A MEANS FOR INTEGRATION OF ACTION

Role, according to Jensen is "a set of behavioral acts that comprise an integral part of a long chain or sequence of differentiated actions that are taken to accomplish the immediate and long-range objectives of an educational system." (1969, p. 102) As noted above, acts may be one of three types. Technical work acts are those tasks that directly contribute to the product of the system. In learning, discussing an unclear point with a student, writing a text, projecting a film, and grading an exam, would all be technical work acts.

Communication acts are those that relay, "between roles, information about the status and progress of the work contributing to the end-product." (Jensen, 1969, p. 103) Posting exam grades, informing the department chairman of an equipment requirement, critiquing the diagnosis of an intern, and unconsciously setting an example, are all communications acts.

Decision-making acts solve problems that arise as a result of lack of coordination between technical work acts and communications acts. Coordination is routinely handled by established rules, which in effect are pre-made decisions. For example, if a bad example is regularly set for clinical students during ward rounds by a particular faculty member, there may be an unwritten rule that prompts his colleagues to talk to him about the problem in an attempt to resolve it quietly. If these attempts fail, a special decision may be required of the department chairman to solve the problem.
Roles and Systems

It quickly becomes obvious that there are many possible combinations of acts that might make up roles in a system as complex as a medical learning synergystem. Beyond role identification, Jensen suggests six additional tasks that are necessary to this aspect of the educational system: (pp. 105-108)

1. Formulation of a set of educational goals that are to be attained and the identification of the clientele that are to be served. This has been shown to be part of system analysis.

2. Building an inter-role structure that will be effective for mobilizing resources and for implementing the educational programs that will be utilized as a means to achieve the educational goals.

3. Building an organizational culture that will enable role incumbents (and/or machines) to clearly perceive the acceptable behavioral responses that should be made to different kinds of organizational situations.

4. Determining whether the inter-role actions generated by role incumbents produce the kinds of actions that lead to the accomplishment of the educational goals.

5. Utilization of human resources available to the organization.

6. Making adjustments in and periodic reorganizations of the goals, structure, culture, role interactions and personnel placements of an educational system.

Educational change agents are urged to study Jensen in detail. It is impossible to give more than a flavor of his work here.

We have looked at some basic concepts of the systems approach to solving educational problems and have perceived the learning synergystem from the perspective of role identification and interaction. Now we will relate these concepts as they might be related in a learning synergystem.
Role Formulation

Through system analysis we identify those functions that, taken together in a certain pattern, achieve the system goals. Functions (e.g., translation of each learning outcome into an individual learner set of learning tasks) are made up of a variety of tasks or acts that may be accomplished at different times and places (e.g., identifies subject content to be learned, identifies facilitating content, develops list of learning tasks, assays student inventory of acquired abilities, prepares individualized list of learning tasks, makes copies of lists, and distributes lists to appropriate points).

Each act may be performed by a different person, and by more than one person, and/or machine. Any given person or machine may perform many acts that contribute to a number of functions, and that collectively make up a role. The point is that functions, having been identified through system analysis as necessary to meet system goals, must be further analyzed into acts, and regrouped into roles to fit the organizational constraints of a man-machine organization. (Figure 3)

The theoretical learning system model to follow is in the form illustrated on the left in figure 3. Chapter three will present an analysis of learner-inputs, learning acts and instructional acts in health professions preparation. Chapter four will analyze acts in learning services and control functions. The fifth chapter will rework the model so that it will be more like the practical organization illustrated on the right in figure 3.
IDENTIFICATION OF THE INTENDED LEARNING SYSTEM FUNCTIONS

The intents of the functions of a system are "what the system is to be used for and why." (Hopkins, 1960, pp. 4-5) Hopkins implies the following guidelines: 1) the intents of functions should be pertinent to the system itself, and not to the personal motives of people connected with the system; 2) functions intents must be restudied by any system designer to be sure that the intended system functions are clearly understood, precisely defined and any conflicts resolved; 3) functions intents are not fixed, but may need to be modified as the design and development of a system proceeds.

Identification of functions intents aims at the analysis steps of need assessment, goal definition and constraints setting. When functional intents have been described and constrained, their combined spheres of operation will establish the boundaries of the system.
In pursuing the question, "What is the system supposed to do and why?" a practical, all-inclusive list of needs, uses, and purposes is generated. The intended functions of the system are then synthesized into revised, condensed statements that sum each set of related meanings. (Hopkins, 1960, p. 6) Sources of information can be a study of the existing system and similar systems, and the imagination and writings of those who have studied the needs and who have had experience with the functions. In the case of a learning system for professional health care education and training, a system as such has not yet been developed except vaguely or in part, yet a plethora of information is available from many programs and experienced sources. It is the intent of this dissertation to move toward a learning system by organizing and utilizing this abundance of information.

George Miller is representative of an exemplary source. He has outlined a variety of learning needs, uses and purposes. (Miller, 1962, pp. 80-94) The 1953 American Association of Medical Colleges statement of "objectives" is listed along with other statements of organizations and individuals, and discussed at length.

Edgar Dale is eminently qualified; he has drawn from a wide and long experience with learning and the learner, and has culled a special list of needs, uses and purposes for a systematic medical learning effort. (Dale, 1968.)

The annotated bibliography at the end of the chapter will indicate the type and extent of sources consulted by the author in order to synthesize the following condensation of those needs a professional health care learning system would fulfill, the uses to which it would
be put, and the purposes for which it should exist.

The author's condensed statements of the intended functions of a medical learning system are given below. The functions are groups of acts, which together produce an output of achieved learning objectives, in the form of health care practitioner capabilities, from the input of prerequisite capabilities of students. In the learning system, there are prescribable sets of acts that provide a systematic capability to:

a) translate learning outcomes (curriculum) into sets of objectives, and objectives into sets of learning tasks, and the construction of their associated instruments to measure prerequisites, learning progress and terminal proficiencies in the objectives.

b) generate and conduct a variety of interrelated diagnostic and interactive learning experiences, in the appropriate learning environment, each of which makes its unique contribution to the accomplishment of learning tasks.

c) guide and maintain learning support and management of the learner's environment, to effect a highly meaningful context for learning interactions, and to minimize non-productive time and efforts of the learner and others.

d) effect communications that permit the system to operate as a coordinated whole; for the system to operate in concert within the total integrated education program (TIEP) suprasystem; for the updating and improving of the system, including increased understanding of the learner and the learning process and
responding to evaluation; and for information feedback to curriculum development, student pre-study and selection, and system information, support and evaluation at TIEP level.

These functions will be identified as subsystems of a learning synergystem in chapter five, where they will be flow charted. Fundamental interrelationships of the above functions are implied by the diagram of the learning synergystem (figure 4).

<table>
<thead>
<tr>
<th>INPUTS (from TIEP)</th>
<th>LEARNING PROCESS</th>
<th>OUTPUTS (to TIEP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Learning Outcomes</td>
<td>Translating Learning outcomes into objectives and activities</td>
<td></td>
</tr>
<tr>
<td>Selected Pre-medical students</td>
<td>Students interact with learning resources to learn</td>
<td>Students ready for licensing exam</td>
</tr>
<tr>
<td>Information materials, personnel resources</td>
<td>Servicing the learning function</td>
<td>Licensed Practitioner</td>
</tr>
</tbody>
</table>

![Diagram](image)

Figure 4. Learning Synergystem

Curriculum development, described by Bradford (1970) is a function of the TIEP, and is the source of learning outcomes. The learning outcomes, however, are not directly useable in the interacting function, but must first be processed into learning objectives, learning tasks and achievement measures. This translation is considered
here as a separate function peripheral to the central function of learning interaction.

The TIEP identifies students for input to the function of interacting for learning who have certain prerequisite capabilities for pursuing the courses that make up their desired program of study. This is done partly by prescribed pre-medical studies and partly by screening for aptitudes, achievement and other criteria.

The TIEP also includes the means of certification of the student as professionally qualified as an output of the learning process.

From the TIEP comes the material resources, learning environment and personnel that serve the learning process. The function of servicing the interaction process is also diagramed as surrounding or supporting the central function. The communicating function is represented as internal to the educational process.

If the grouped functions were to be viewed as a living organism, communication would comprise the nerve, blood and connective tissues network that facilitates the functioning of the other organs and the entire organism. The communicating function enables the life processes to be carried on. In the diagram of functions interrelations, learning interaction is comparable to the life processes.

Communicating is required no less for the translating function, which can be equated with the central nervous system of an organism, and for the servicing function, which can be equated with the food and waste system of the organism. This analogy to a biologic system is made to imply the organic oneness of the four functions. The functions are carried on in close juxtaposition as they would be in a living
organism. In practice, the activities or acts that comprise the four functions of a learning system are carried on by roles that move across functional boundaries as the roles are performed by individuals. The roles are usually made up of acts that are carried on in more than one functional area. The acts can be organized as a discrete set for a function, and another discrete set for a role. A professor's role is likely to be comprised of acts in each of the four functions. A student's role is likewise intra-functional. This arrangement is a feature that permits a complex set of functions peculiar to learning to be considered as a synergystem for planning and operations.

The effect of each function on the design of the synergystem will now be considered, then we will return to the synergystem as a whole.

EFFECT OF THE FUNCTIONS ON LEARNING SYSTEM DESIGN

Translation

The process of formulating sets of objectives from the learning outcomes is an analysis of what the learner is to be able to do, as a result of learning activity. It is also how well the learner is to perform, and under what circumstances. Objectives, therefore, specify the observable behavior of the learner that result from his having learned. The statements of Mager, Tyler, Miller, Smith and Gagne concerning the preparation of learning objectives can be used to specify and to evaluate objectives that we prepare.

What the learner is to do should be in terms of observable action, should indicate the cues for that action and specify the persons or
things with which the learner will interact. For example, the learning outcome that is input to the learning synergystem from the curriculum development system was given as: "Having completed his study of the digestive system, the student will, given his role in a simulated health care team, make choices reflecting his positive position with respect to continued learning." We must then know the specific kinds of choices among what alternatives will reflect what nature of positive position, as opposed to negative or neutral position, upon what type of cue, and with type of role or object. An objective for such intended learning outcome might be stated as: "Playing the role of preventive medicine specialist in a health care team, a student will show that he practices updating his learning by recommending to the team leader, when consulted, an (immunological) technique recently perfected but not yet taught in class."

How well the learner is expected to perform is in terms of accuracy or correctness, and in terms of a given rate, level or other quantification. The above example of a learning outcome implies that the learner will always show a positive position in respect to continued learning. Such expected condition may be unreasonable unless the objective is stated in a way that allows some alternatives.

The circumstances under which the learner is expected to perform pertains to the actual physical or mental situation. The learning outcome example does provide us the situation in the form of simulation for role playing. We have made it more specific by adding the particular nature of the learner's role, and specifying that he should be consulted as a cue to give information. (Volunteering the information may be a higher response level in the role being played.)
The first phase of the translation function is not completed until learning objectives have been prepared for all pertinent aspects of the learning outcome. There are usually several levels of mental work, physical ability or refinement of attitude that are to be achieved, and these should be listed separately if lumping them together in one statement would result in not clearly defining the several aspects of the objective to be realized in the outcome.

Some objectives may only be intended to facilitate learning of prerequisites for the principal objectives relating to the outcome. Such subordinate objectives should be stated to show that they lead to prerequisites and be grouped with other such objectives in apposition to the primary objective. Learning tasks and measurement translation will be made easier thereby. A taxonomy of objectives can serve to prompt the above considerations.

Learning Objectives Taxonomies in the Translating Function

Bloom's taxonomy of cognitive objectives ranges from the level of recalling specific terms up to the levels of analysis, synthesis and evaluation in intellectual abilities—the use or application of knowledge. (Bloom, 1956) Objectives must be specific as to each level if the learner is to have adequate guidance, and if his achievement is to be properly assessed. The example of an objective on the preceding page implies recall of facts, application of knowledge that has been integrated by the learner, synthesis of a proposal, and an evaluation using external criteria. However, the objective is aimed only incidentally at cognitive skills. Its main thrust is affective or value-laden, that is, concerning which the learner has personal convictions.
Psychomotor tasks are linked to knowledge by what a student is doing, and to attitude by why he is doing it. A taxonomy has not yet been finalized in psychomotor learning objectives, but Krathwohl has prepared one for the affective domain that ranges from a lowest level of merely giving attention to a thing or idea, up to internalization of a value concerning the thing or idea. (Krathwohl, p. 95) The value objective given as an example on page 57 aims at behavior characterized as consistent value-based action—at the top of the affective taxonomy.

**Will and Intuition in Objectives Taxonomies**

There are two additional aspects that do not appear to be adequately conceptualized in the cited taxonomies. The first may be termed volitional, or the part played by the will of the individual in the motivation of the learner. The second can be characterized as intuitional, at a hidden and perhaps, expanded dimension of the consciousness, or as psychic in nature.

Volitional abilities are as yet enigmatic to all except adepts in the use of auto-suggestion, misterned hypnosis, although all learning is in debt to the practice of suggestion. This principle will be discussed at length in chapter three on the learning process. Meanwhile, using the meaning given by Krathwohl as willingness (p. 179) and commitment (p. 182) we see that the cited example of an objective is ostensibly stated for affective learning. Volitional learning is implicit in that the learner at some prior point commits himself to the value precept in such degree that he wills to act it out. The qualification that I wish to make in regard to the affective values of willingness and commitment is that the learning takes place after a
release of the will. This will be developed further in chapter three. In my opinion, abilities of the intuitive, hidden dimensions of the mind of the learner are also worthy of learning objectives considerations. I have suggested an ordering of "tacit" levels for learning (Aiken, 1969), by which I infer that unconscious processes can be tapped for knowing, and imply that abilities in a hierarchy of categories can be acquired by the learner. The credibility of this domain is slowly being established, albeit reluctantly, after centuries of disrepute and misunderstanding. This is especially so in western academic circles, except among some minds such as the eminent nineteenth century psychiatrist Dr. Richard Maurice Bucke, whose unusual learning was not much shared with the people of his day. Dr. Bucke analyzed the phenomenon of "enlightenment". This and other learning concepts are explained in chapter three.

An objective for tacit levels of learning might be stated as,
"In the quest for an unknown solution to a problem in medicine, student will demonstrate ability to comprehend difficult concepts that pertain to the problem, and be able to keep his mind steadfastly on the problem for an extended period. Following this, he is able to free his mind from the frame of reference in which he has been thinking, and in which he is blocked in his thinking, and move to a different frame of reference to achieve an insightful discovery."

This type of tacit objective has clearly been achieved in many fields by many scientists and inventors, and it is learnable, as demonstrated by Kestin (1970). Such objective reaches beyond the evaluation defined by Bloom at the highest level of his taxonomy. (Bloom, 1956)
Additional development of this topic will be made in chapter three.

We have now looked at objectives formulation in the translation function. Although this is only the first phase of the total function, it is considered by learning system designers as the most significant in its effect on system design. The formulation of objectives is what the system approach must achieve to bring into being a bonafide learning system. The objectives tell what the learner must know and be able to do as a result of learning. Thus objectives imply the nature of the system input and output, as well as what changes the system must make. It is on effecting these changes that the functional design is based. The remaining phases of translating objectives into learning tasks and constructing tests, facilitate design, but are not as critical in their effect.

Translating Objectives Into Tasks

Formulating learning tasks is reducing an objective into a set of acts that can be undertaken by the learner in a step-by-step learning process to achieve the objective. Gagné defines the Task level as "...the smallest unit of performance which can be identified as having a distinct and independent purpose." (Gagné, 1965, p. 12)

Returning to our first hypothetical learning objective, that of continued learning it may likely have a lengthy set of tasks many of which would contribute to other objectives in the course of their being accomplished. Performing these tasks could be distributed over considerable time and undoubtedly many interactions would occur in their being carried out.
An example of learning task specification of our continued learning objective might be one in which we have the student:

(1) read article on (immunology) in latest journal and answer colleagues' questions in seminar on preventive medicine.

(2) attend a weekend symposium in (immunology), and prepare résumé for distribution to his colleagues.

It can be noted that each learning task is comprised of one or more learner-performed acts. The two learning tasks with their several acts, hopefully, will lead to the formulation of a new habit on the part of the learner, thus achieving the objective. Perhaps he already has acquired a habit of relying only on the information that is predigested and made available to him. Old habits that will prove unproductive in a swiftly-moving field like medicine must be changed. Only new habits can change old habits, typified as a "frozen, thaw, refreeze" process. It is therefore necessary to reach the objective of the new habit of continued learning by a set of learning tasks that develop the new habit.

The systems approach requires that we design a series of tasks that help the learner remove his existing action from a rut or groove, and set it on the desired track, and to do so in a way that does not build learner resistance. This requires consideration of the learner's individual characteristics at the beginning of learning when we identify the types of learning and quantification needed for overcoming one habit and establishing another.

What is the effect on the learning synergystem of specification of objectives into tasks? Now that we have translated our objectives
into learning tasks and acts, we are able to discern not only what changes in behavior must be made, but the steps by which the changes and augmentation will be made in student capabilities that are inputs, to achieve the desired student capabilities that are outputs of the system.

When we have looked at the acts of constructing criterion measures that will show us that the objectives have been achieved by the learner, and the acts of preparing the incremental learning progress measures that tell the student the extent to which he has acquired the knowledges, skills, values and volitions, we will have analyzed the first of our four intended functions, and systematically developed a requirement for the next of our intended functions, learning interaction.

Translating Objectives into Tests and Measures

To complete our analysis of the translation function we will first examine the nature and function of a criterion measure. Mager refers to the expected performance indicated by a learning objective as "terminal behavior", that is, performance capability at some expected level. The adequate statement of an objective identifies and defines the expected performance, thus the objective is actually a statement of the criterion (p. 13). Our continued learning objective was given as "Playing the role of preventive medicine in a health care team, a student will show that he practices updating his learning by recommending to the team leader, when consulted, an (immunological) technique recently perfected but not yet taught in class". The planned for behavior is, "recommends an untaught technique, when requested, while role playing". The criterion is, "practices updating his learning".
The behavior demonstrates that he meets the criterion.

The measurement in this case is the display of the planned-for behavior in a role-playing situation. Our ultimate objective is obviously that the behavior will transfer in a real situation, thus an unstated future condition is anticipated for Mager's "terminal behavior". The fulfillment of the final objective, therefore, is only partial as far as our measurement indicates. We could construct a paper-pencil instrument to measure achieved behavior, which would be even less realistic than the simulated situation. In either case, we are assuming that the learner's updating of his learning has become a characteristic behavior, when in fact he may be performing only for the simulated or academic situation. Correlations show that examinations and grades are not highly indicative of work performance levels.

Behavior under actual conditions of the practitioner would give a truer measure. Too often, in the interests of expediency for concerns other than learning, the paper-pencil, or at best the simulated situation, provides the basis of measurement. A specific assessment of whether objectives are being achieved, and whether they constituted an adequate set in the first place, is never made.

The constructing of testing instruments themselves is based on the above considerations. In respect to this process, Desmond L. Cook of the Educational Program Management Center of The Ohio State University has developed a system approach to achievement test construction (Figure 5). This approach aids the production of adequate testing instruments.
**Total System Function:** The principal function of the total system is to produce an instrument which will discriminate validly and reliably between student levels of achievement according to instructional objectives and content in a specified substantive area. Such instrument should be subject to the constraints of being used in a typical classroom situation.

<table>
<thead>
<tr>
<th>Input</th>
<th>Process/Sequence</th>
<th>Output</th>
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<tbody>
<tr>
<td>1. Subject area</td>
<td></td>
<td>1. Instrument</td>
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<tr>
<td>2. Instructional</td>
<td>General Phases</td>
<td>2. Grades</td>
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<td>objectives</td>
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<td>3. Time limits</td>
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<td>3. Test and</td>
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<tr>
<td>4. Principles</td>
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<td>item statistics</td>
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<td>5. Grade level</td>
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**Figure 5.** System Approach to Achievement Test Construction Total System Outline
Testing and System Change

The effect on the translation function, and in turn on the learning synergystem, of how behavior is measured, or what instruments are used, is exerted primarily through the objectives. It is likely that major changes in objectives will come only from a feedback from what goes on beyond the boundaries of the translation function. Thus the means and locus of measuring behavior will determine the kinds and magnitudes of changes in the objectives, hence changes in the design of the system. This is obviously a point of decision in the design of the learning synergystem: where do we test performance? If it is tested inside the learning system, any existing means of producing the behavior could stay in a status quo state for long periods, adapting mainly to internal changes to maintain homeostasis, like an animal in a germ-free environment. Testing conducted internally by the learning system itself does not oblige the system to answer to any outside force for change, therefore may not cause needed or desirable changes. Homeostasis is maintained by adjusting tests or "curving grades" to satisfy uncritical, "vested interest" testers. Objectives seemingly are reached and seemingly existing objectives are adequate to achieve the learning outcomes, when in fact deterioration can have set in.

If testing was on the outside of the learning system, at the level of the total integrated education program (TIEP) some occasional changes could be expected in the way things were done in learning. The force for change, being on the outside of the system would be less inclined to overlook shortcomings leading to deterioration. Perhaps this would, as a minimum, take the form of validation and refinement.
of learning objectives. The system would be obliged to adapt to changes in the TIEP if testing were also done at the TIEP level.

If the decision is to test at both the level of the learning system and in the outside world of the health care practitioner, the system would need to be very responsive to change, and would require design features different from those needed to maintain stability in a controlled environment.

For example, if the monitoring of outcomes on learning to learn disclosed that, at the 5-year point after graduation, only 40% of health care practitioners were using an immunological technique that had been found superior to the one in their repertoires at graduation, a system change would seem necessary in order to reach desired levels of performance in respect to continued learning.

The difficulty might not lie within the learning system itself, but could be at the level of the total integrated education program in not having made the proper inputs and support. It would thus be necessary that the learning system incorporate a monitoring feature to allow it to validate and control its own functions, to regulate and report internally its own operational acts, in order to avoid being put in the position of having to "react" to unjustified demands that could lead to a deterioration of function. Such a monitoring feature could be an input required of the TIEP's evaluation system. Having such unbiased monitoring feature would help to insure system operations integrity, and quality control of learning.

The point can be made that without a functional analysis and the considerations derived above, the implied decision to test at the levels of both the learning system and the TIEP may never have been made.
Thus the need for the monitoring feature provided by the evaluation system of the TIEP would not have been foreseen.

Initial consideration of the function of translation of learning outcomes into learning tasks and tests, in relation to design of the learning system, brings us logically to the second function, that of the interaction of learners with their environment. The learning environment includes the information resources of people and things and events. It is through interaction that the learning tasks will be done and learning occur. Describing the function of learning interaction as an influence on system design will consider the relationship learning activities to the learning tasks that were translated from learning objectives in the preceding section. The nature of interaction activities or experiences, the learner, prerequisite learning, individualized programs and transfer of learning will be looked at for possible effects.

**LEARNING INTERACTION AND SYSTEM DESIGN**

The condensed statement of the intended function was (p. 53):

In the learning system, there is a set of acts that provides a systematic capability to generate and conduct a variety of interrelated diagnostic and therapeutic learning experiences, including appropriate learning environment, each of which makes its unique contribution to the accomplishment of the learning tasks.

The inventory of learning tasks that comprise the output of the translation function and that become the input of the interaction function, must be transformed into learning activities or experiences. Whereas the learning tasks were the very small units of expected
performance, the learning experiences that correspond to them will be units made up of combinations of reading, listening, observing, writing, speaking, visualizing, doing, feeling and willing, respecting resources of symbols, icons, natural and man-made objects and people, singly or in combinations. Examples might be, "Student reads article in journal and answers colleagues questions in seminar on preventive medicine"; "Student attends a weekend symposium in immunology, and prepares a report for his fellow students".

Multitudes of variations possible in these units each results in exposures, percepts and concepts. It is the generation of concepts in the learner, including valuing and using, that will be termed learning here, and it is the means of exposure that will be termed interaction.

Nature of Interaction

Thus, learning interactions can mean the simplest to the most complex ways of exposing the learner to learning resources. But, interaction denotes a two-way action, therefore emphasis should be on a two-way exposure process. In cases where the interaction is not overt, we can consider it to be taking place inside the learner. That is, one perception of an object or symbol is internalized, then a second, a third and so on. These interact or are reorganized by the learner to form concepts.

The learner's train of thought will rarely be triggered or promulgated by the particular resource thing or event alone; response is more to those appercepts that have been internalized, than to externalized perceptions. Consider the richness, therefore possible
differences, between any two individuals, one a tyro doctor, the other a layman, in an encounter with a sick person, under identical circumstances.

These interactions likely will go on without our management of the learning situation.

Overt interaction can be directly with a human resource or with that resource in a mediated mode such as by computer assisted learning, where the professor has put his personality and/or strategies into a program for the student to interact with. Where a professor is mediated by television, the interaction can be similarly stored for repeated use, but is more at an overt level.

Therefore, for purposes of analysis here, learning interactions will be those exposures generated and managed by or for the learner that can result in meaningful experiences that accomplish learning tasks. The generation and management of the exposures, whether by the learner or others, will be considered to be the acts that comprise the learning interaction function. These acts can also be termed instructional.

**Interaction and Learner**

Instruction is construed as prescribing the means listed by curriculum theorist Mauritz Johnson as activities, materials and instructional content used to achieve the set of learning outcomes. Instruction is characterized as meaningful interaction between the learner and his environment. Such interaction is thus equated with learning experiences. This is considered in the context developed by John Dewey in *Experience and Education* (Dewey, 1938, pp. 42),
who said,

The word "interaction"... expresses the second chief principle for interpreting an experience in its educational function and force. It assigns equal rights to both factors in experience—objective and internal conditions. Any normal experience is an interplay of these two sets of conditions. Taken together, or in their interaction, they form what we call a situation.

Instruction is held to exist as a spectrum of acts that go from the extreme of teaching as expostulating facts and principles to learning as Dewey's "situation". Instruction and learning are simultaneously viewed as a continuum that began with creation of the individual learner, and extends indefinitely into the future, with change-causing interaction taking place NOW. This idea will be expanded in chapter three.

Learning, therefore, begins with independent mental activity by the learner, and from time to time involves pedagogical agents. Such agents are either freely chosen by the learner or come by mandate of society or "the system", and can act to assist or to interfere with learning. The instructor role will be more fully developed in chapter three.

Learning interaction is chosen as a term to emphasize the central position of the learner in the business of learning. The central and key role performed by the learner places the interacting function at the focal point of attention and action in the learning synergystem. It is learning, not instruction or teaching, that is the nucleus of the intended system. Therefore, the terms learning outcomes, learning objectives, learning interaction and a learning synergystem are intentionally chosen.
Learning is the key criterion that guides the design of the intended system. An instruction-focused, teacher-centered approach often has the following characteristic effects on what we may call non-systems: (1) student learns passively—teacher does most of the activity, (2) presentation of information is the principal mode of action, (3) recall of information is the principal performance required and measured, and (4) same program for all learners.

A learning synergystem should be characterized mainly by the learner having a large share of the responsibility for his own learning, including its objectives and the manner of their achievement, and how he is measured. It should be an individualized program as to style, rate and tasks of learning.

**Learner Prerequisites**

This brings us to the requirement to determine the individual learner's capabilities in terms of the inventory of tasks and an individual program of learning interactions. The data for this requirement can be derived in the learning system or supplied by the total integrated education program—the suprasystem. The determination can be made at either level. Another decision point has been reached.

The experience of medical programs, such as that at the College of Medicine, The Ohio State University, is that discriminatory testing as to learning styles is not yet adequately researched. Style, as it is used here, merely refers to students preference for conventional classroom lecture approach or for mainly self-study. At Ohio State, the student merely elects an option where more than one track through a program is provided. Seventy percent elected the self-study track
in a pilot study for the professional program leading to the M.D. degree. Guidance will likely soon appear from educational researchers and planners on what should be planned for student learning styles in respect to learning, as a result of this and similar studies. Preliminary results at Ohio State indicate self-study is just as effective, yet allows better use of time to meet individual student needs.

The rates of learning are variable, not only among individual learners, but for a given learner from day to day, and for different types of materials. The division into acts of the interaction function allows for different learning rates without actually knowing what they are, therefore this effectively yields one alternative for the system provisions. A second alternative is to measure students' rate as averages and group them for learning experiences. The latter alternative should be used only as an interim measure until learning experiences are available for implementing the former.

In respect to tasks, the student can be pretested for prerequisites for each task. Those tasks for which he is qualified to undertake study become a part of his program. Remedial acts are prescribed for where he does not have the prerequisites. The theoretical basis for this approach is discussed in chapter three. Those tasks in which the student is ostensibly already proficient are part of his program only in the sense that he is required to demonstrate proficiency at appropriate points. This diagnostic and remedial program is continuous and incremental by learning units, therefore it would logically be an integral part of the learning interaction function.
Thus the decision is facilitated by our systematic consideration; the total integrated program will supply such data as is obtainable and pertinent from premedical sources and from the student, and the learning system will monitor the student to gain learning interaction types of information. The diagnostic, prescriptive and remedial process will be carried on within the learning system. It is anticipated that most integrated programs will eventually do the routine aspects of this process by computer. (Caffrey, 1967, p. 166; Bushnell, 1967, p. 11-24, and 77-107) This is already beginning to have a profound effect on the design of the learning system. For example, at the Ohio State College of Medicine, a portion of the self-study track and continuing education is by computer-assisted learning. The writer is engaged in a pilot program at the Ohio State College of Veterinary Medicine in developing a computer-assisted diagnostic and remedial program in the prerequisites for veterinary pharmacology.

Learner Program

Individualized programs require a participation by the student in the selection of the learning tasks and options in associated interactions to construct his program. If we have the student participate in curriculum development at the level of the total integrated program, he would then be aware of the learning outcomes, and in a position to make informed decisions. Provisions for students to participate and to make learning task choices add a number of acts to be performed within the learning system. Most of these are student-performed acts that would be incorporated into the translation function.
The learning system would then need to accommodate individual programs by providing at least two or more learning paths or "tracks". Tracks would be designed for different learning styles or "sets" with emphasis on the reading mode in a tract, the listening mode in another, and perhaps the visual in a third, although it is likely that much visualization would be incorporated into any learning track in medicine. There is also the techniques area that requires much motor performance that must be rich in visual reference.

The primary problem of providing for individual tracks through a program or in multiple programs has been scheduling. Solution of scheduling problems lies partly in the changing of policy at the total program level to place less emphasis on larger group accommodation, and more on achieving an individual schedule. Solution is mainly in designing the learning system to permit the learner to engage in selected learning experiences at his discretion within feasible limits.

Design alternatives to oblige the learner in the degree indicated above include fully automated storage of learning units with on-call retrieval for use in many individual study and laboratory areas. This may soon be realizable for basic science aspects of professional health care preparation, but the clinical aspects, and patients, cannot yet be interacted with by a large number of students independently on a fully individualized basis. There is not sufficient opportunity, and provisions for such interaction have not yet been worked out.

Supervision and tutoring in direct personal interactions, with doctor-professors are required. This may eventually be possible by
computer-arranged rendezvous of small groups of like-minded students, the doctor-professor and the patient. The computer would consult its record of each student's readiness for types of experience, his schedule and other data, to bring him to particular interaction opportunities occurring at a number of patient facilities. This is normally prohibitive in the amount of coordination required when done by usual methods. Time is critical, as certain cases do not present themselves often or with much opportunity to plan and schedule.

A more feasible alternative for the immediate future is to structure the learning system to provide for the more critical individual experiences, but continue the majority of interactions in various size groups suited to the interaction mode. The major thrust for learning effectiveness could come by making each mode of interaction highly effective in its power to communicate, that is, maximize the interaction of individual learners in the large group in lectures and in the smaller groups in discussions.

Transfer of Learning

All interactions should be designed to maximize transfer of learning by making the interaction a duplicate of the future application situation, whether in the program or beyond graduation.

Another aspect of effective transfer is the opportunity to practice what is being learned. The learning system must provide for rehearsal of the recall of knowledge and the practice of skills to at least the point of overcoming awkwardness in their use. This will have considerable effect on system design, since the system must conduct the learner through much basic learning experience that is not
directly patient-connected, then must integrate basic experiences at the application level in a way that does not jeopardize student cared-for patients.

One example of the problem, and a solution, is in learning the use of anesthesia, where a man-made model of the patient provides the effects of the students treatment. Thus, he can learn the nuances of anesthesia without losing real patients, yet do his learning unsupervised by a professional anesthesiologist.

The above provides us with representative considerations on the effects that the function of learning interaction might have on system design. The anesthesia example spoke of a machine model of a patient, which implies a simulation device for learning. This effects a transition to the next function, the servicing of learning.

**LEARNING SERVICES FUNCTION AND SYSTEM DESIGN**

The function of learning services is to fulfill the purposes of facilitating learning. The acts comprising the services function provide resources needed in the translating and interacting functions—resources that lend clarity and force to learning as well as enable a basic interaction. Resources support should implement for maximum or optimum interaction in whatever ways the total integrated education program and student learning demand.

**Servicing the Learner**

The support required for a student to perform the learning tasks or set of acts as set forth earlier in the chapter will provide an entry to the resources problem. Two sets of acts were stated:
1) Student reads article in latest issue of journal, and answers colleagues questions in seminar on preventive medicine.

2) Student attends a weekend symposium in immunology, and prepares a résumé for distribution to his colleagues.

The first set of acts requires appropriate current journals, and an area or facility in which to hold a seminar. The current journals can be supplied by the student as a subscriber, or by a library. The area could be a spot on the lawn, living quarters or a room designed with provisions for audio and visual media, and acoustics control. There are many alternatives.

The second set of acts requires registration, possible travel arrangements, and at least some means of copying a report, or typing and copying. The registration, arrangements and copying could be done by the student or by secretarial staff.

Both of these compound acts require monetary resources as well as information, equipment, facility, materials and personnel resources. Some aspects require acts by others than the student, and coordination must be effected among these and in relation to the resources. Generally the more compound the act, the more resources types and amounts are needed; the greater the interrelation for communication and learning, the more specialized assistance is required.

Granted, servicing the above sets of learning acts may be a too-elementary requirement for introducing the function of servicing learning needs in terms of learning environment supply and management. Clearly the function has far-reaching ramifications, but the intent here is to emphasize the effect on design of a particular philosophy
of servicing learning. The simple example will do this more directly than one that begins with a requirement for an elaborate technology. Chapter four develops some of the more involved aspects of learning services.

The particular philosophy has been stated earlier as "bringing the resources to the learner." When this is combined with a philosophy of individualized learning, the statement is amended to "making the learning resources available to the student as he needs and wants them."

This can be placed in a feasible configuration by first describing the extreme case where the learner does not stir from his room for learning. The resources for interaction are all carried or piped in to the learner. For a major proportion of most basic medical science learning today, this is not an unreasonable servicing mode. Books, and lectures, which could be given via television, plus a microscope and slide sets, would not only be feasible, but a well-motivated student would not suffer by comparison with his fellow students in the classroom. Such practices as dissection in the discipline of anatomy would require a new approach if it remained in the basic sciences.

We can now back off from the extreme case, place the student in a "home base" study area in the "teaching institution", and extend basic sciences learning to include access to dissection and other laboratories. This will require a minimum of locomotion and non-productive time on the part of students. The Ohio State University College of Medicine is taking this approach.
This is accomplished primarily by applying the philosophy of making resources convenient for learning to facilities design. Various alternatives have been found workable, such as the multidisciplinary laboratory. (Fuhrman, 1968)

**Servicing and Learning System**

Our question is, "What is the effect of the learning services function, guided by such philosophy, on the design of a learning synergystem?" Looking back to our simple examples of learning support acts (p. 78), we can develop the following criteria for an open system to meet individual needs while carrying out the function, and for determining possible effects:

1) Student must perform some acts in the management of resources. The resources can be conveniently located and arranged for selection and use, but students will have to be able to exercise initiative in their use.

2) Students should not be at the mercy of the system when they are individually ready to perform particular learning acts. This presents a special case for any system meeting needs of a large number of students. Feedback of the information on the state of supply, condition, maintenance of equipment and related matters, must be continuous and immediate, and response equally so. Insuring availability and proper condition of resources are critical aspects of the supply-maintenance-response mode where students are involved directly in acts of manipulation and management of resources.
3) Orientation on procedures and techniques for resources use, must be provided not only for students but faculty and staff. This problem is one of diffusion, where there are always 10% who never "get the word." It is also one of skills, where some are not adept even in applying fundamentals such as reading and listening, let alone some of the more involved skills such as rehearsal of recall, and the application of facts and principles necessary in learning. A remedial program can be anticipated to bring people to a level of act performance required to make the system work effectively for all learners in all interactions.

4) The servicing system unless carefully managed can become the "tail wagging the dog". The acts comprising the support of learning should not result in creating a rigid structure unresponsive to change. This danger of overemphasis on the learning resources functional area generates highly specialized facilities, technical equipment schemes and extensive, involved learning materials and their production. By overemphasis, I mean placing priorities on such means of learning as audiotutorial programs to the denigration of already successful and exemplary learning means, though
they may be less in the limelight.

These criteria and other considerations discussed under the translating and interacting functions, have the effect of further emphasizing the organic wholeness needed in a learning system. Specifically, the servicing acts should be integrated in an inconspicuous and smoothly functioning effort to put learning always at the center of action. Who does this and how it is done will be discussed under roles in chapter four.

Chapter four surveys acts of learning services, and alternate considerations for their application. Chapter five concerns matters of organization for their function. We look now at the last of our functions, that of the set of acts of communication for carrying out the translating, interacting and learning services functions.

**DESIGN FOR COMMUNICATING IN A SYNERGYSTEM**

In the diagram of the Learning Synergystem (p. 54) the communicating function is not shown explicitly. Communication is inherent in the other functions in the way that connective, circulatory and nervous tissues are vital and integrated aspects of an organism.

If we use the analogy of the liver as a learning synergystem, the connective tissue serves to hold the other supply, storage, transforming and production, types of tissues together as an organized operating organ. The circulatory tissue not only brings the inputs to the liver, and delivers the output products and wastes, but transports and regulates interorgan flows and exchanges as well. The nervous tissue monitors the function of the organ not only internally but for integrating its condition and action with other organs and the
whole body.

The key point concerning the communicating function in the learning synergystem is that, like the above tissues it really has no functional boundaries. Its acts go on inside as well as among the other functions, and across the system boundary as well—even extending to the world beyond the Total Integrated Education Program.

Interfunctional communicating acts are carried on in the roles that perform the other acts of the translating, interacting and servicing functions. Intra-functional acts are performed mainly through these same roles. There are no roles that assemble communications acts as an exclusive endeavor, but nearly every role in a learning system, especially the roles of students and professors, can be expected to be made up mainly of communications acts.

For example, we might note that the very first act of a student is performed beyond the TIEP. He applies for admittance. This is primarily communication. The student is eventually enrolled. The selection process was based on spoken and written communications acts performed at the level of the TIEP. Finally, the student in the learning function, acquires information by which he forms concepts. A number of media carry many messages received by the student. The professor figures prominently in this communicative process as a sender. He also acts as a receiver of student inquiries to establish an interaction.

Such boundlessness of acts inherent in the communicating function, performed by inter- and multi-functional roles characteristic within a learning situation, permits great flexibility in the design
of a system, and for its response to changes, and keeps the system open. Flexibility is important to continued function, especially in the learning synergystem, because, like the liver, when communicating functions become dysfunctional, a hardening ensues, and the total program is ailing.

Particular aspects of communicating as they pertain to learning acts are discussed in chapter three, and in chapter four for those concerning learning services acts. Chapter five shows the organizational requirements for communications.

Chapter Summary and Conclusions

In this chapter, the systems approach was briefly described and interpreted for application to learning. The generalized functions of a learning synergystem were established, and a preliminary model diagramed. Effects of the functions of translating objectives, learning interaction, servicing learning and communicating, on the design of the system were analyzed, and their interrelationships were inferred.

The main considerations for the initial or critical step in generating a system, i.e., the planning that properly precedes the steps of system design, development and assembly operation and evaluation have been presented. These latter steps as they pertain to a specific program, that of Veterinary Medicine at The Ohio State University, will be outlined in chapter five, when the model is further developed and related to the TIEP as a suprasystem.
The conclusion reached by the foregoing analysis is that the systems approach can be applied with an expectation of benefits to health care learning—benefits that are worth the extensive analysis and synthesis that must go on to truly be a system approach to program development. It is also concluded that a learning synergystem is an acceptable concept for developing and implementing components and functions to promote learning in a total integrated educational program for the preparation of Doctors of Veterinary Medicine at The Ohio State University.
ANOTATED BIBLIOGRAPHY


Uses a system approach to present concept of the system for education and learning, and to provide guidelines in formulation of objectives, analyzing learning tasks, designing a learning system and implementing and evaluating the system. The subject is clearly presented with diagrams using reinforcing verbal illustrations for each step. Such concepts as system functions analysis, component analysis, synthesis of a model, strategies and their application to developing and testing a learning system are quickly developed with economic use of easily understood language. This is a "how to do it" source, with glossary and references particularly selected to develop a comprehensive systems understanding and a balanced perspective.


The foreword by the Council's president, Logan Wilson, says that this is a non-technical report for "generalists whose decisions influence the behavior of specialists." Ostensibly, it is about computers, but the matters treated in terms of the use of the computer should be in the system planner's background knowledge and his repertoire of strategies. Provides the broader basis in which an educational program and a learning system will be expected to operate, and the considerations critical to successful operations.


This is a branching programed text that has been found especially helpful to instructional planners at all levels. This is especially true for the system approach where the stating of objectives in behavioral terms must have first priority. This book is optimally sparing of the reader's time either as a first acquaintance with the process of objectives preparation or as a review-rehearsal of the principles and their applications. Directs the reader through description and values of objectives, what makes an objective meaningful to planner and learner, analysis of expected learner behavior, qualifying and quantifying the intended behavior, stating the criterion and a self-test. The book's author says that his purpose is "limited to helping you
specify and communicate those educational intents you have selected."


Provides a specific look at the medical student, his learning problems, medical teachers and teaching problems, the tools of instruction, especially objectives of medical education, and evaluation of learning. The book is referenced here particularly for its insights on the learning system inputs of students and expected learning outcomes. Several sources of objectives are given, including the joint AMA and AAMC list. The remaining topics are also pertinent for consideration in learning systems planning and development.


Describes, with actual programs as examples, the use of the systems approach in decision-making. Applies this to education at higher policy-making levels, then at the level of the school itself. Discusses the merits of several models such as Berkeley, and strategies such as PERT, as applied in specific, publicized instances. Describes coming use of computers in learning, counseling and managing the learner. Provides a good background in selected case histories of the systems approach in education, such as Case-Western Reserve and Garber High School. Relates the Delphi Method to Education.


A concise step-by-step analysis and synthesis of the functions in a learning system for the training aspects of an educational program. Provides the patterns for rehearsal or practice of skills and knowledge.

Develops sources of objectives in a careful analysis, a two-dimensional matrix for stating objectives, selection and ordering of learning experiences, and the evaluation of learning outcomes. Acts as a detailed guide for exhaustive consideration of the acts and functions that should be carried on at the suprasystem level of the education program.


These two reprints provide insights needed for communications planning of a health care learning system. The majority of the remaining articles on each of media are all pertinent to system planning at a more detailed level.
Attempts to develop a learning system disclose that a pattern of things, events and conditions, which results in a learner acquiring new capabilities, termed learning, is also characteristic of what goes on under the heading of teaching. What lies within the teaching-learning spectrum? What must a design for a learning system consider in order to be an effective tool for handling teaching-learning problems?

Approach to the Problem

This chapter deals with basic ideas of instruction and learning, and the learner, using both old and new data, some of it controversial. Hopefully, it will add enlightening dimensions to the apparent polarity of teacher-instruction and student self-instruction, and identify productive learning processes for inclusion in the learning synergystem. These processes constitute the acts or tasks that are performed by students, professors and others to make up the learning interaction function. Consideration will be given to these questions:

(1) How should intended learning outcomes and their prerequisite knowledges and skills be communicated to the learner?

(2) What kinds of learning activity or interactions with what environment should be sponsored for the learner?
The answers to these questions should help to identify individually performed acts, learning activities, and the criteria for building a subsystem for productive learning interaction.

These primary questions have some antecedent queries that will be considered in order to develop a basis for looking at the primary questions: (a) what is basic in learning? (b) what is the nature of an environment conducive to learning? (c) what will promote effective use of learning in continued learning and in problem solving? Answers to these questions will help to formulate criteria for productive learning processes, and establish the teaching and learning acts performed by professors and students.

It is emphasized that considerations will be mainly in the context of health education. The search for additional dimensions will be through a focus on fresh concepts or on new ways of viewing older concepts. There have been inspired suggestions in respect to the learner and learning from sources not only in, but outside education. There have also been inspired suggestions not only in, but outside the broader arena of academia as well. Looking ahead to possible future developments in attempts to provide for more consistent improvement in medical education, the potentials for changes that lie in such suggestions ought not to be ignored.

It is not enough that we look only to the expected or usual provisions to carry on the learning process. Some allowance must be made for the unusual that seems always to emerge or intrude, calling for an "outrageous" hypothesis. Workable mechanisms must channel not only those suggestions that lie mainly within the domain of professional
medicine and education, but also those present and future concepts that seem strange but that may develop as significant. The mechanisms should systematically apply both today's and tomorrow's medical instructional knowhow.

Therefore, the reader evaluator is requested to take up his grain of salt when interacting with concepts given here, and suffer the writer to develop some unusual points in the disputation, if only in the interest of looking at some outer limits. The well-tried areas should be considered as being already acceptable for inclusion in a workable solution. Albert Einstein (1946, p. 2) said that "common sense was a layer of prejudice laid down prior to age eighteen."* The thought occurs that a study of learning should consider uncommon-sense ideas also. Some unusual ideas for learning will be introduced.

The description of the learning interaction function in chapter two outlined the need to expose the learner to learning resources in order to interact for learning. Criteria for generative and management acts were prescribed. The product of chapter three will be representative interaction modes that generate and manage the kinds of acts germane to professional health care preparation. The modes will be organized into a learning interaction subsystem in chapter five. Role definition will continue in this chapter and be completed in chapter five.

* This was said in developing the meaning of relativity. Dr. Einstein commented that students were predisposed by virtue of learning a singular set of rules about the universe, to disbelieve ideas that seemed to run counter to their beliefs. He stressed the value of "uncommon-sense."
We shall now consider the first of our two basic questions: how do we communicate intended learning outcomes and prerequisite learning? The use of learning objectives and the importance of example are introduced.

OBJECTIVES AND REALISM

The function of the statement of learning objectives as "doing something to something" is seen as suggestive to the student who has established longer range goals, which is obviously true for the health professions student. The function of the objective is therefore considered critical in respect to the learner knowing exactly what he is expected to learn, to know when he is actually learning it, and to be able to recognize when the learning has taken place.

Successful students are able to imply objectives when objectives are not made explicit, provided the content or experience is adequately organized and presented so that the implicit objective can be discerned. If a student is to learn to learn, he must have some experience in developing valid objectives to reach learning outcomes. Clear statements of skill, knowledge and attitudes that are to be measurably demonstrated or applied by the learner constitute an organizing means, a communication time saver, and the stimulus to effective teaching and learning. Having reduced the nebulous and global to a related series of measureable specifics, the business of learning what needs to be learned can be undertaken expeditiously. Also, it can be ascertained when the learning task is acceptably completed, without prolonging or repeating the learning exercise.
The function of clear statements of "doings to whats" also serves the interests of realism in learning activities. Making the intended "doing" obvious, tends to point up the need and appropriateness of carrying on teaching and learning activities in a real or professional work situation. If the real situation is not feasible, then a reasonable facsimile in the form of simulation is prompted by the objective. In any event, applications of underlying facts and principles in problem-solving situations are implied by a clearly stated objective that gives: what is done to what, in what measure, in what situation.

Realism is highly suggestive for learning. The learner's filing and retrieval system is provided, through realistic practice, with the most likely cues for later response during encounters in professional activities.

The explicit objective can thus be seen as aiding in the determination of what learning experiences should be provided, therefore the planning function is also well-served.

Precept and Example

A second and important consideration for our realistic communication to the learner is that of providing a living example. Much attention is paid to the use of precept in the educational process, but too little to the effect and potential of example. Much learning occurs as a direct result of the examples provided to the student by professionals, laymen, teachers and others. However, the lessons actually learned may be unplanned for and unexpected. The preceptor may not realize the power of his example. This will be discussed
later in this chapter under Learning to Learn from Precept and Example.

We go now to the first of our antecedent questions: what is basic in learning? The following ideas will be discussed: (1) learning is information processing, (2) learning is creativity, (3) learner has extra dimensions.

LEARNING AS INFORMATION PROCESSING

In consideration of what is basic in the learning process, Gagné has lately provided a new avenue for approaching learning and instruction. A direct quote from his May 1970 article in the Phi Delta Kappan will effect liftoff. He says: (1970, p. 468)

"As a field of endeavor, research on how human beings learn and remember is in a state of great ferment today. Many changes have taken place, and are still taking place, in the conception of what human learning is and how it occurs. Perhaps the most general description that can be made of these changes is that investigators are shifting from what may be called a connectionist view of learning to an information processing view. From an older view which held that learning is a matter of establishing connections between stimuli and responses, we are moving rapidly to acceptance of a view that stimuli are processed in quite a number of different ways by the human central nervous system, and that understanding learning is a matter of figuring out how these various processes operate. Connecting one neural event with another may still be the most basic component of these processes, but their varied nature makes connection itself too simple a model for learning and remembering."

Practice or repetition is a long-accepted implication of the "connectionist" conception of learning, viz that learning is always basically the same process, whatever is to be learned. The curve of
forgetting for cognitive categories of the taxonomy of educational objectives, appears to support such contention. In this context, the teacher does two things: (1) arranges for contiguity between the stimulus and response pairs; (2) provides for sufficient practice to strengthen the learned connections and to aid recall.

Skinner's innovation of the connectionist learning mode (for animals) is characterized as operant conditioning. (Medrick, 1964, p. 43-46) Although it is conceded that some behavioral elements of a learning sequence are internalized by operant conditioning, the reservation is made that the cognitive levels with which we are dealing, in learning for the health field, are not equatable with the kinds of learning that Skinner generalized about. It is my own opinion that operant conditioning goes on at levels below that of man's mental uniqueness. I believe that man is more than a learning animal. Further, I hold that it is in the realm of higher mental learning that significant gains in learning by interaction are possible, although these levels may need to be reached by some measure of operant conditioning. (Medrick, 1964, p. 27-67) Studies of habit reversal and probability learning in the lower animals by Bitterman and others suggest that "...brain structures evolved in higher animals do not serve merely to replicate old functions and modes of intellectual adjustment, but to mediate new ones—a contradiction of Thorndike's hypothesis. More important, the intellectual uniqueness of man, denied by Darwin, is thus made probable." (Sc. Amer., Jan. 1965, p. 62)

Memory and learning are different processes. Karl Pribam shows that lesions produced in certain cortical areas of the brain have
been shown to "impede learning some five-fold, but leave intact solutions to problems." (Hilgard, 1964, p. 87) New problem solutions are difficult to learn, but when confronted with old problems animals are able to proceed normally. Learning occurs as a result of exercising the function of retrieval of what is stored. Storage is facilitated by inputs that have some commonality with previous inputs. Some individuals have persistent image storage abilities termed eidetic imaging, which permits precision recall after as much as 24 hours. This means recall of exact shape, size and details.

Linguistic memory is different from pictorial memory in respect to recall. (Sc. Amer., May 1970, p. 104) Haber found that words associated with pictures allow more complete recall of pictures. Recognition recall of pictures is essentially perfect; they are stored in labels that do not need rehearsal of recall for recognition. But pictures cannot be recalled in words since they were not stored in words. A dramatic increase in descriptive (not recognition) recall of pictures is promised by attaching words to pictures.

The writer's personal experience in this process indicates that it requires techniques that are not ordinarily much practiced by learners. Such techniques include simply reciting the details of the picture in words while looking at the picture. Recitation of the relationships of the details, and rehearsal by visualizing and describing from memory, can effectively attach word descriptions to recognition recall of pictures.

Gagné cites research and develops the "information processing" concept of learning. Inputs are stored for a short term of 30 seconds
or so, during which time they are organized and rehearsed ready for transfer to long-term storage unless interfered with by other inputs. Coding prior to long-term store transforms the inputs in some way to make it easier to remember them. (Gagné, 1968, p. 89)

The implications of the information processing conception of learning and remembering, in Gagné's opinion, are: (1) a hierarchy of prerequisite subordinate intellectual skills will permit learning without repetition, (2) each learner approaches each new learning task with a different collection of prerequisites, thus diagnostic testing for, and learning of, missing prerequisites needs to precede new tasks, (3) learner's strategies of retrieval must be exercised by periodic spaced reviews, (4) learner needs strategies of coding such as Ausubel's "advanced organizers" (Ausubel, 1968, p. 134) and "anchoring ideas", (p. 137) (5) retrieval strategies such as "networks of superordinate categories" (p. 53) are needed.

As a consequence, instruction "becomes a matter of stimulating the use of capabilities the learner already has at his disposal, and making sure he has the requisite capabilities for the present learning task, as well as for many more to come." (Gagné, 1970, p. 472)

The implication for communication in the information processing approach to learning is seen in Edgar Dale's conception of the COIK fallacy: "Clear Only If Known." (Dale, 1957, p. 11-16). The requisite capabilities act to make known a contextual map, and the new learning task is, by analogy, a clear overlay on that map. Thus, what the learner possesses in prerequisite information makes the "new" information clear—he is able to find his way.
LEARNING AS CREATIVITY

The writer notes Gagné's dissatisfaction with the too-simple stimulus-response connection concept of learning, and accepts the advantages offered by the information processing view. However, this is still far short of a "rending of the veil" concept, which is the evolutionary dynamic to be sought for man as a learner. It is assumed by the writer that Galileo voiced a valid concept in, "You cannot teach a man anything; you can only help him to find it within himself." (Kestin, 1970, p. 250)

Pleasure Feeling As Motivation

Perhaps paramount in discovering or unlocking the "truth within" as expressed above, and by Browning in "Paracelsus", is the hedonic effect or ecstatic feeling generated in the learner when he is "on the right track" in his quest for knowing. I adapted this idea from William Gordon's development of creative thought processes. (Gordon, 1951, p. 134) The pleasureable feeling seems to be generated by mental activity itself. It has been demonstrated that this feeling has a powerful motivating effect. Experiments with rats having electrodes to stimulate the "pleasure center" in their brains show that pleasure stimulation as a reward is of much higher order than food. A rat will die of starvation before crossing an electrically charged screen, but the charged screen does not deter the same rat seeking stimulation of the pleasure center. (Sc. Amer., Jan. 1963)

In a human, Gordon proposes that the pleasureable feeling comes from preconscious recognition that insights are on the threshold of emerging to the conscious.
I propose that a feeling of excitement and pleasure accompanies the step-by-step development of a concept. If the learner is able and permitted to make his own bridging steps by subjective or intuitive knowing and integration, and thus to generate his own insights, he will be like a hound on the trail of a rabbit.

Bisociation

J. Kestin supports this view in his development of novelist Arthur Koestler's principle of "bisociation", the association and fusion of two frames of reference to produce a new and permanent intellectual synthesis. (Kestin, 1970, p. 250) Release from a roadblock that has developed in searching for an answer in the first frame of reference, by suddenly being shifted to a second frame of reference tangential to the first, which results in "seeing the point", evokes a feeling of catharsis--the "Aha!" of experience.

Learning theorist Goodwin Watson says that "sudden insight" or "cognitive reorganization" can come when the following conditions have been achieved (Watson, 1964, pp. 82-87)

(a) sufficient background and preparation
(b) attention given to relationships operative in whole situation
(c) perceptual structure allows key elements to be shifted into new patterns
(d) task is meaningful, and within range of ability

We can equate preparation in condition (a) with the degree of concentration on a problem that the participant may be considered to be "completely absorbed in the search for answers." We are implying
along with Kestin, that conditions (b) and (c) are inherent, and not necessarily formally learned. Motivation is likely to be directly proportional to meaningfulness of task as a condition in (d), and it is proposed that level of ability is an unknown inherent quality except as actually demonstrated in specific applications.

I hypothesize that the inherent dynamics and qualities are at least partially a consequence of learning efforts in the broader spectrum of previous experiences in other lifetimes, as well as the present one, for the individual learner. Psychologist Carl G. Jung attributed this to the "collective unconscious." (Jung, 1936) It is also sometimes spoken of as "racial memories." However, it is firsthand learning experience in more than one lifetime that is hypothesized here. This facilitates explanation of high potential for creative abilities, including learning, possessed by individuals, that have not been overtly acquired in the present lifetime. Thoreau said it something like this, "We do not come into the world without some spending money." (reference not known) I hasten to add—that we may have ourselves earned. This hypothesis will be rationalized later in the chapter.

Kestin, like Koestler, uses the joke, pun and epigram to illustrate the collision and fusion of two apparently disjoint matrixes. He quotes a Koestler example: "Philosophy is the systematic abuse of terminology (first matrix) specially invented for the purpose" (second matrix). Here the clash of matrixes is mild and we react with a smile, as we derive an esthetic satisfaction in seeing the point. Kestin is convincing in his argument, "that the creative act of learning is the
result of the very same mental process as is used in making the most momentous discovery. The difference is only in degree—not in kind." (1970, p. 251)

The implication for instruction of this powerful motivational dynamic, is that, in presenting to each learner an optimal program of experiences, the learner's pleasure center is stimulated, and he is self-driven in his further quest, until like Archimedes, he conceives an idea and shouts, "I have found (it)", then rejoices. If on one extreme, instruction fails to provide the prerequisites, or on the other extreme, saturates and inundates the learner, especially in the form of compulsory exposure, it is likely that the learner may effectively be denied his "Eurekas" on his individual pathway to learning. Motive power for learning will be switched off. Kestin quoted Plato as saying that, "knowledge acquired under compulsion has no hold on the mind." The Learning Synergystem will be planned so as to discourage attempts to impose knowledge on the learner.

EXTRA DIMENSIONS OF THE LEARNER

In consideration of the second antecedent question of "what is the nature of the learner?" this study elects "to make the familiar strange and the strange familiar." (Gordon, 1961, p. 11) This is done in the hope of prompting concepts that can have a productive impact on learning in the health professions.

It is observed that the learner occupies the role of principal operator in learning. Therefore, consideration of instructional processes must make obeisance to the learner's uniqueness. Health education has yet to apply with full effect what might be gained
from viewing each learner as a self-made result of his own long-term learning endeavor as implied by a number of lives preceding the present one. The medical learner's uniqueness in respect to the level to which he has acquired basic science knowledge prerequisite to medical studies, and the degree to which he has learned to be taught are held to be obvious. He has successfully run the gauntlet culminating in his selection into medical school, which attests to that uniqueness. We will now consider his capacity for medical learning in respect to (1) a very broad opportunity for acquiring aptitudes and interests favoring learning in the field of health, and (2) his reorientation toward learning to learn.

Recall and Suggestion

First, it has long been known that age regression under suggestion enables recall of minute details from past experiences.* Medical hypnosis research indicates that the mind's storage system is normally 100% operative, and the retrieval system is no less effective. Patients can also recall what the doctor said and did although under deep anesthesia. (Wolberg, 1964) The lack of recall under usual circumstances, then, must rest in the blocks that exist between mind and will—blocks that can be overcome consciously for some types of recall by simply making a demand on the mind's file, then relaxing until the material is released.

*The International Journal of Clinical and Experimental Hypnosis gives accounts of cases that substantiate this claim. The patient is given suggestions to regress to earlier years of his life and then to give verifiable details of occurrences that he is not otherwise able to recall.
Here are some cases of the principle at work: a sentence is read or heard; each key word has more than one meaning, but there is usually only one meaning in the context of the sentence. At the end of the hearing or reading, the contextual meaning is known, therefore the specific meanings of the words have been selected and integrated. In the case of a joke that rides on a twist in the contextual or specific meaning of a sentence or words, this spontaneous contextualizing process is even more profound. These cases are almost instantaneous in their demand and release of what the mind has stored.

The medical learner is adept verbally, mostly by reading and listening, and easily learns in these modes. It may be possible to greatly increase his recall by programmed suggestion and rehearsal of recall to exploit this capacity.

In other cases, a problem of recall is posed, but the data are not immediately at the preconscious level. In a few moments or longer, the data "comes to mind." There is also "sleeping on the problem." In these cases, the answers may not be thought to be a part of the respondent's data bank, but he anticipates they will be "worked out" for him at the integrating level of the mind while the conscious mind rests from the problem. The writer's personal observation at The Ohio State University indicates that most medical learners have relatively little difficulty with this process, and it should be possible to enhance this ability greatly by practice and suggestion.

(USAF Instructor Journal, 1967, p. 55)
There are several modes of practicing the recall of information that are in concert with the will-bypassing or suggestion process. One of these is conversation or discussion, where other persons or learners act in a way that makes demands on the learner to recall information. Recall is then made seemingly without conscious effort most of the time, at least where discussion follows soon after exposure to new material. Another mode is that of being placed in a trying situation where recall of data is needed to alleviate stress. A case in point would be a quiz at the end of the lesson. The use of suggestion in itself offers potential for recall, but more important, it can also operate in respect to a much larger context that will now be developed.

Direct Experience Beyond One Lifetime

The tabula rasa concept has long been discredited, but the opportunities for learning in the womb do not allow for unusual propensities, so genetics is saddled with the burden of explaining an Einstein or a Beethoven. The experiments with the flatworm purport to show that actual learning can be passed on by any part of the worm, which then regenerates into a new individual (Sc. Amer., Feb. 1963, p. 54). But, if unusual propensity for mathematics, music or language arises, where there is no genealogy to supply the original learning, what then? It would seem that the flatworm experiments confirm that prior learning is necessary.

So where did such complex learning take place, and how could the genetic structure be programmed with a thing as explicit, as say, the Davidic Sanskrit language? In a case on record, (Time, Sept. 1969, p. 54)
a six-year-old boy in Israel began talking in an unknown language. It was finally discovered that it was so obscure as to be known only by a certain professor at the distant university. This cannot be explained as an ESP phenomenon, since the boy's message was not a repetition of the thoughts of the professor or of writings in this area. It seems far-fetched to credit this case to "genetics."

A less dramatic example is implied by West's quote from Herbert Spencer (West, 1966, p. 771)

That neither in boyhood did I receive a single lesson in English, and that I have remained entirely without formal knowledge of syntax down to the present hour are facts which should be known, since their implications are at variance with assumptions universally accepted.

Spencer seems to be saying that he didn't learn syntax, yet knows it well. I contend that he came into this lifetime with a propensity for the English language.

If we were to hypothesize that the learner exists as an entity in a continuum that not only succeeds a given life expression on earth, but that precedes that specific lifetime, the above phenomenon could be explained easily as recalled experience and prior learning. As yet undefined dynamics might allow an entity to somehow provide this learning to the brain of the body that he would soon occupy, that is, to endow it with appropriate memory, aptitudes, likes and dislikes, tendencies, interests, and more, thus to establish a pattern for fulfillment in the lifetime ahead. Previously acquired knowledges and skills would soon be reacquired through minimal exposure in experiences, into which "inherited" inclinations and capacities would likely lead the entity.
As analyzed by Richard Bucke, M.D., some unusual individuals such as Buddha, Jesus, Paul, Plotinus, Francis Bacon, Walt Whitman, Edward Carpenter, and many others were "illumined" (Bucke, 1901, pp. 3 and 9-11). They were suddenly "intellectually enlightened" to a new plane of existence, from self-consciousness to a consciousness of the life and order of the universe. Bucke attributes this to an evolution of the human mind always underway. I see it as forever available to any learner who is seeking to know, and who disciplines himself properly, as explained by Kestin and by Gordon, for creative mental activity.

The position might be implied, then: what considerations for learning could be applied with fuller effect under an assumption that the individual brings forward from a vast background, a unique learning set, and a memory trace of medically related knowledge? How can such predispositions be put to work in accomplishing learning tasks? An attempt will be made to answer this question later in the chapter, but an initial implication is that the learner has primary responsibility for his own learning.

RESPONSIBILITY OF THE LEARNER FOR HIS OWN LEARNING

William James proposed that it is not from the means, but rather from the extremes that we are likely to derive new insights. (James, 1956, p. 5-6) This does not imply that the vast "middle ground" of the spectrum of any activity or experience should be excluded; indeed, the middle ground makes a vital contribution to understanding. It does mean that although the very ends of the spectrum are too often ignored since they are significantly different from the generally
accepted standard, it is by the very reason of their difference that they may tell us something more about the nature of the whole spectrum.

The case in example is learning and teaching. Teaching has traditionally been given the prominent place in education, yet Francis Bacon mentions 15 ways in which "the mind is formed" but does not mention teaching. (West, 1966, p. 766) Kelly West, M.D., Professor of Continuing Education at the University of Oklahoma Medical Center, eloquently expresses the view that students could possibly "gain more from watching us (teachers) learn than from watching us teach."

There is now a shift toward the view that the most important function of the medical school is to transfer the burden of education to the student himself. George Miller, et al, have made a most perceptive and comprehensive analysis of teaching and learning in medical school, and adequately presented the middle ground, and they emphasize learning rather than teaching. Kestin, in looking at this problem, says: (1970, p. 255)

When we think about the problems of higher education, we are too often carried away by the frequent use of the active verb "to teach." With very few exceptions, students are not "taught" by their professors in any direct sense. Teaching is not the transfer of knowledge from the brain of the instructor to a number of brains which belong to the students. A higher education must be acquired by learning. Achievement in learning is the result of an intensive, solitary struggle of each individual with himself.

Therefore, we now examine ideas related to the learner's responsibility for learning: suggestive influences, feedback, and uncertainty.
Learning To Learn As An Effect of Suggestive Influences

In completing discussion of the antecedent questions, a paradigm that sums the learning process is proposed by the writer. It is stated as "I believe; I know; I become." Edgar Dale sees this as "the scalpel in hand" theory of learning. The scalpel symbolizes for the student that he is going to embark on a learning adventure. When the scalpel is actually being used (or some equally visible sign of medicine), under the control of the student, he knows that the adventure has begun. The embryo doctor thus starts his metamorphosis that, through practice, will bring him doctorhood.

Robert Glaser, M.D., in a reappraisal of the "Stanford Plan", in respect to "heightened expectancy" said (Glaser, 1969, p. 82),

Educational research faces grave methodological obstacles in its efforts to demonstrate the superiority of any one approach to medical education. All studies agree, however, on the importance of enthusiastic expectancy and participation as a major ingredient of educational success.

Observation and analysis of learning suggest three simple steps that repeat cyclically to enhance the learner's capability to generate concepts. The first step is "I want to learn. I seek to learn. I expect to learn." This can be simplified to "I believe". (adapted from Elman, 1964)

The second step is contingent on the first, and is "I know I will learn if I do thus and so." Knowing follows belief when a given belief is demonstrated to the self. This calls for giving it a try.

The final step is consistent and persistent practice in doing or applying the process or behavior intended to be learned. The learner
internalizes the learning or becomes the product of that learning. Feedback of results leads to reinforcement of expectation, and the cycle repeats. Repeating the cycle, and moving from concrete to abstract, to new concrete, to more abstract, through several related conceptualizations, can result in complex concepts being built by most learners.

It should be noted that learning expectation can be for a little or a lot, for none or all. It must be kept in mind that whatever results the learner achieves will always reinforce similar continued expectation of any learner, except when the feedback is modified or the cycle is interrupted. Thus each learner through a formative period is either learning to learn effectively or ineffectively, or he is actually learning to not learn.

Dale, in an editorial note on this dissertation, raises the question, "Could little differences in the results of methods mean that none of them really changed the attitude of the student toward himself as a learner?" Studies reported in the literature on the clinical use of suggestion indicate that this could be answered affirmatively. One study, for example, found that wording and tone of instructions, motivational instructions and suggestions of what the subject was capable of doing, were critical in their influence as a causal variable (in hypnosis) Int'l. J. of Clin. & Exp. Hyp., 1967, p. 111)

The steps I believe, I know, I become, lead to a single concept: suggestions to the mind of the learner that learning will result from learning experiences, fosters learning for most (maybe all) learners.
The more that the primary suggestion is reinforced by continued secondary suggestion in any form during any of the three steps, the more learning and the habit of learning will be effected.

Suggestive reinforcement in wanting to learn is emotional in nature; a building of desire and intent to learn. This in the final analysis is the perogative of the learner, at least at the professional level. On the other hand, in knowing that learning will take place, suggestive reinforcement comes from the effect of past successes in that learning actually did take place as a result of wanting, knowing and practicing. Suggestive reinforcement in the action or practice step is in the form of the feedback that learning is taking place. It is the recognition that a change in behavior is occurring.

Suggestion works equally as well for interfering with learning or blocking it. If the potential learner is in an environment that continuously and primarily suggests that he will be at a disadvantage to want to learn, that he will be unsuccessful, then an aversion to learning will be learned. One aspect of this threatened disadvantage is testing and grades.

Learning and Feedback

The power of the feedback effect of watching and knowing the results being obtained by action or practice is illustrated by data recounted by Dr. Kenneth Gaarder, research psychiatrist with the National Institute of Health. On February 20, 1970, he presented a lecture at The Ohio State University, on "External Feedback as a Method of Controlling Physiological Variables; A Potential New Therapeutic Technique." The use of an electroencephalographic tracing or
other instrumentation enables the learner to see or hear when he has reached the peak of a particular state of consciousness or other physiological condition. With such feedback, according to Dr. Gaarder, the learner can acquire control of his brain rhythms or other involuntary processes such as heart action. He can then learn to influence the occurrence of a behavior or response which heretofore was an unconscious reflex.

"For example, when the heart rate goes up, the metabolism goes up. If we wish to teach a person how to increase metabolism we monitor the heart rate, and have him learn to establish the states that cause the heart rate, therefore the metabolism to increase." (Gaarder, 1970)

Applying this principle to learning, we could monitor the learner for the most stimulating effect or state for the highest or most effective learning rate, and have the learner recognize and learn how to achieve this state. The learner could then enter this state much as do the yogins who can control their autonomic physiology, and the learner would be ready for learning with greatly increased facility.

The implications for voluntarily entering states of consciousness or physiological states for learning purposes are uniquely significant. Techniques known and used only by very few adepts in the past are now available to many laymen. Such techniques enabled rapid filing of information and its complete recall. Now, with an instrumented process, many may be able to be adept in filing information for superior retrieval.

The process of selectivity that attends students entering the health professions ensures that the individual has already demonstrated
considerable success in the learning process, whatever mode or style was used. The primary factor in selection is academic success. For this reason the full application of the paradigm set forth above can only enhance health student learning efforts. Evaluation as to academic success will remain primary during their medical education, and they have already amply shown that they have learned well how to be taught and to learn kinds of things similar to medical sciences.

Uncertainty and Learning

Reflective thinking, or the effort by the learner to more fully understand a concept upon discovering that he does not know all the answers to a question or problem, is a primary requisite to competency in learning. The learner must become aware that his understanding is still incomplete; he must develop the ability to be uncertain when it is not appropriate to be certain. He must learn to approach each concept, new or old with the attitude, "What are the possibilities?" (Sieber, 1970)

His model of an example to follow must be seen as employing uncertainty. Also, since success is linked to an anxiety-free state (no fear of failure), the use of testing devices must be for learning, not for grades, if reflective thinking is to be generated, and uncertainty adopted as a mode.

Although the learner has a responsibility to hear a precept and to follow an example, we place the burden of the next idea for learning mainly on the teacher.
Learning to Learn from Precept and Example

As a teacher I might adopt the following: "Whatever precepts I shall give, I will endeavor to be a living example of that precept. If I say that a thorough history-taking is prerequisite to arriving at a proper diagnosis, I hope to be observed always being thorough in taking a patient's history. In fact, if I am observed always doing a thing in a certain way, it is likely that you the student will conceive the precept of my doing without my even stating it. Thus my example is of greater importance by far than my statement of a precept.

I can exert exampleship in another way: I can guide you in a model practice and can consistently and persistently require your performance to reflect the criteria that we together have set for you (and me) in respect to that model."

The above is an attempt to convey the importance of setting an example for the learner under preceptorship.

Preceptorship is practiced effectively in clinical departments. Here the academic physician, e.g., the surgeon, can not only provide the rules; he is seen in action by the student. The student patterns his own thought processes in the image of the surgeon's. However, Robert R. Wagner of Johns Hopkins University School of Medicine says, "Everybody knows what a surgeon is or does, at least most of the time. In this day and age it is much more difficult to define the role of his colleagues in microbiology, pharmacology and especially anatomy. What they do is all too often only casually related to what they teach."

(Wagner, 1962, p. 1)
The lack of relationship between what an anatomist, per se, does with anatomy in respect to the practice of medicine is not clearly discernible to the student by example. The student sees the practice of anatomy, but does not see the practice of medicine.

If the student could see his anatomy preceptor setting an example in learning and using anatomy in the many relevant applications to clinical situations such as in radiology, surgery or palpation in the physical examination, and see this during his initial study of anatomy the study of anatomy would not likely be so irrelevant in the student's view, as has been traditional with beginning students.

It is proposed that much is to be gained by establishing the learning situation in such configuration that the learner can observe the learning process of his preceptor and fellow students, and be aware of his own status and progress in how well he is learning to learn. Students who have learned by being taught, and who have been subjected mainly to the precept without the example in respect to learning itself, will require reorientation. Most students now want to be taught; they will likely find it difficult to shift their orientation to learning to learn. An artful contriving of the learning situation to permit the student to see his professor less as a preceptor and more of a fellow learner should be very helpful.

To become a healer—to do healing—one must see it demonstrated and then do it. The practice of medicine must be seen as starting when the student begins medical school. Practice precedes theory, not the other way round. John Dewey put it this way: (Dewey, 1916, p. 169)
"An ounce of practice is better than a ton of theory simply because it is only as an experience that any theory has vital and verifiable significance—a theory apart from an experience cannot be definitely grasped even as a theory."

At this point in the discussion, we have come to the end of our first basic question of how do we communicate learning outcomes to the learner, and the antecedent questions prerequisite to the second main question concerning learning interaction. We have emphasized the central role of the learner in the learning process, and learning interaction as the mode for learning.

We move now to the second basic question: what kinds of learning activity or interactions with what environment are likely to be productive?

Answers will be sought by first examining, then attempting to reconcile or bring together teaching and learning into a single process.

TEACHER DOMINATION IN THE LEARNING EXPERIENCE

Skinner says (Skinner, 1968, p. 5-7),

Teaching is the expediting of learning; a person who is taught learns more quickly than one who is not. Teaching is most important, of course, when the behavior would not otherwise arise. (Everything which is now taught must have been learned at least once by someone who was not being taught, but thanks to education, we no longer need to wait for these rare events.)

Skinner's thesis is that teaching is simply the arrangement of contingencies of reinforcement for shaping behavior.

Pask says,

Teaching is exercising control of the instructional environment by arranging scope, sequence, materials, evaluation and content for students." (Pask, 1969, p. 28)
Gage, in focusing on the teacher's function of engendering comprehension in the academic disciplines says, (Gage, 1964, p. 412)

...only rarely, it seems to me, have we been concerned with the actual intellectual content, the cognitive organization, and the logical validity of what teachers say to their pupils and of what the pupils say to their teacher and to one another. When we examine a textbook, of course, these aspects of its content and organization come to the fore. We pay close attention to the logic of its arguments and the aptness and compelling power of the data and examples that the authors adduce. I am saying that we ought to look in the same way at what teachers do in the classroom.

Ausubel, et al, in looking at acquisition of cognitive abilities, cites research showing that learning of facts by students is significantly related to the clarity and expressiveness of teachers. (Ausubel, 1967, p. 51) This was presumed to be due to clearness of idea in presentation and providing of feedback. Consistent with this is Knoell's finding (1953) that ideational fluency (the ability to clearly explain in simple terms) correlated significantly with ratings of teacher effectiveness. Ausubel listed requirements as,

...meaningful and adequately organized grasp of subject by teacher: comprehensiveness, cogency, stability, lucidity, precession of concepts, integration of relationships between component aspects of field, awareness of significant theoretical issues of underlying philosophical assumptions, appreciation of methodological and epistemological problems.

Accepting the foregoing as implying that the teacher can perform important functions requisite to learning, what are the general modes used to accomplish these functions?

Lecturing. It is a fact of pedagogical life that the lecture is used extensively, and will no doubt continue to be used in the foreseeable future.
What then are the problems concerning the lecture and its use?

Flexner said,

The (didactic) lecture, hugging as closely as may be the solid ground of experienced fact, may therefore from time to time be employed to summarize, amplify and systematize. But however used—whether to classify firsthand knowledge or to fill a gap—the didactic lecture would appear pedagogically sound only at a relatively late stage of the student's discipline. It has no right to forestall experience, filling the student with ill-comprehended notions of what he is going sometime to perceive.

Abell, senior staff biologist, Commission on Undergraduate Education in the Biological Sciences, recently reiterated Flexner's idea by observing that we should "be pushing on from the initial question about how to lecture to the really crucial ones of why and when." He asks, (Abell, 1969)

Where, in fact, are we going to put the demonstration of a 'scholarly mind at work' that the very notable Report on Undergraduate Instruction from the University of Toronto describes as the most essential beginning and most satisfying end of a sophisticated educational experience? Where do the initial steps come in conveying an understanding of the processes of scientific thought and an appreciation of what Bronowski calls 'style in science?'

The Toronto report, cited by Abell, (University of Toronto, Presidential Advisory Committee on Undergraduate Instruction in Arts and Sciences, 1967) gives six obvious functions of the lecture: (1) provides personalized overview of a subject; (2) conveys professor's enthusiasm for subject; (3) shows how to tackle problems of analysis, experimentation and interpretation; (4) demonstrates scholarly mind at work while grappling with problems; (5) conveys insights and contributions unique to professor; (6) transmits information necessary to understanding a subject.
Abell is convinced that ways must be found to "lecture without really lecturing." Some of those he suggests in relation to the above are: (1) explaining a sequence of investigations in a carefully delimited area; (2) glimpses of great men as to scientific approach or personal insights; (3) dialogue, interview, debate; (4) the challenge (role playing) to find errors and weaknesses in an argument; (5) non-medical educator's look at medical education; (6) programmed with student feedback; (7) concentrated visual and multisensory experiences. (Abell, 1970)

Note-Taking. Another aspect that promises productive gain for lecturing is that of note-taking. Taking notes may constitute the single most distracting element to the student's concept building in the development of topics by the teacher. This distraction can be effectively alleviated by an outline handout that requires a minimum of notation by the student, yet allows (1) objectives, desired learning outcomes, structure of subject; (2) recording of all key points or criterion statements; (3) drawings, graphs, diagrams; (4) references for review and enrichment.

In order to prepare such an outline, most lecturers will need education specialist assistance in lesson planning and handout design. A means for systematically dealing with this problem promises assurance of its being done with reasonable results.

Learning Facilitator—A New Role

Perry Rosove sees the traditional role of the teacher as having changed in the direction of increased specialization in subject fields.
By using a process he calls "contextual mapping" he extrapolates to a generic role concept of the teacher as a generalist. This emerging role "combines four basic functions which today are distributed among four different roles. The functions include a) counseling students, b) engineering of learning activities and materials in system concepts, c) instruction and d) research." (Rosove, 1968, p. 48–56) Rosove substitutes the term "learning facilitator" as descriptive of the new role.

The learning facilitator as an educational and career counselor will call on an information system to provide relevant data from a variety of data banks or central information storage and retrieval points, including the traditional library as well as specialized consortia of medical and other information. In the evolving concepts of a real time multi-purpose facility, and a continuous vertical learning organization, as constituting the learning environment, guidance becomes a dominant element of teaching. As an engineer, the facilitator will design, develop, test, evaluate and redesign more efficient information systems for learners. The facilitator, using a real time approach made possible by the introduction of sophisticated instructional media into the educational environment, will be responsible for research on the process of learning in an adaptive system. Rosove says, (1968, p. 56)

When the teacher gives up dispensing facts as his basic function and becomes, instead, a director of learning processes and a designer of systems which facilitate learning, his status will probably rise accordingly. If he becomes a director of research and an educational systems engineer, he is no longer a "cog in a machine". He becomes, rather, a true professional. The new and widely
ranging responsibilities he may assume necessarily enlarge the scope of his authority. And as his authority rises, the authority of the traditional administrator over the learning process should decline. In a sense each learning facilitator becomes his own administrator.... Individualized instruction from both the learning facilitator's and the student's viewpoints implies a decentralization of authority which mitigates, to some extent the negative aspects of bureaucracy.

Rosove concludes that work and education are part of the same process. The writer extends this idea to placing the processes of medical practice or work and medical education together in the same real time environment in such manner that they will complement and reinforce one another. This should help to block the perpetuation of teaching for the sake of teaching, and place the emphasis on learning.

Teaching is so overrated and over-practiced in medical education that it will seem heretical, in the least, to seriously consider its transformation into such role as "learning facilitator." This may constitute a practical limit to be overcome by the glacial process of diffusion. Dr. West, medical professor at Johns Hopkins, noted that "Non-teaching is an art." (West, 1966, p. 766)

Development of the non-teaching art will require a major shift in emphasis from teaching to learning; from students only participating in teacher-led activity to students involved in interacting with teachers, other learners and self; from teacher domination of learning experiences to student domination. A student is said to "participate" when he asks the teacher questions; this is only acting. He really interacts for learning when he begins asking himself questions. This is a key aspect as expressed by Robinson in his development of the
A powerful and certain process whereby humans learn is simply that of formulating questions and eliciting answers. The power and certainty increase as we move from the level of the ready-made question that is "asked" by the learner and the ready-made answer that is provided, up to the level where the learner faces question-provoking problems, and must work through to insights coming from his inner-self. Viewed in this way, the modes of learning exist like a spectrum from training to education.* Like the electromagnetic spectrum, the power needed to generate the higher frequencies of interaction increases exponentially.

Edgar Dale says that the role of the teacher among students that ask themselves questions is not to answer, but to help students learn how to find answers: a secondary step in learning to learn. Dale then quotes Thornton Wilder, "There is no true education save in answer to urgent questioning. Unease and deprivation awaken the young mind to inquiry." (Dale, December, 1968)

* Phil C. Lange's graphic representation of this paradigm. (Dale, 1969, p. 646)
Our task, then, is to structure learning experiences to foster students' urgent questioning. How do we systematically effect unease and deprivation in health professions preparation? Answering this question shifts us more to emphasis on the student in the learning situation, yet actually gives the professor a more significant role to play.

STUDENT DOMINATION IN THE LEARNING EXPERIENCE

Development of the art of maintaining the student in a situational learning environment that stimulates and provokes him to urgent questioning will require a shift from teaching to learning, from merely acting to interacting, from teacher-domination of learning to student-dominated activity. It will be the professor who must take the lead in this shift of emphasis. He is the one who will be the director-manager. He will also need to do his part in designing and engineering the implementation to make the shift a reality.

The obvious strategy is to keep the student in need of having to make decisions and solve problems where he must acquire knowledge and skills to achieve satisfaction. Acquiring satisfaction at each hierarchical level should perpetuate the need for new decisions and further problem-solving. Earlier, Gagné was quoted as saying that the learner should be stimulated to use the capabilities he already has at his disposal, making sure he has the requisite capabilities for the present and future learning tasks. (Gagné, 1970, p. 47)

The situational environment should continually serve the student health care practitioner in the same way that an automobile serves a beginning driver. The automobile responds to the acts of the driver,
and its response constitutes the immediate feedback as to the con-
sequences of each driver act. Of course, the driver must become
increasingly aware not only of the immediate effect of his acts, but
the longer-range effects, and must learn how to compensate and to
plan ahead. There is always room for some kind of improvement, some
new facts from research that should be incorporated in the habit pattern,
new conditions under which driving (or medical practice) must occur,
and new requirements that the function must fulfill to be professionally
viable. It should be noted that mistakes are a means to learning if
there is a meaningful way for the learner to use his mistakes as
directing him toward a proper path of action through a sequence or an
application of a procedure.

As in driving, the need for continued learning in the delivery
of health care services calls for something more than just what the
learner discovers on his own, but the interaction, commitments and
learning must remain the learner's responsibility. It is in the areas
of discovery and coaching, that acts other than the health care
learner's own must be provided for by the learning system. Here, the
great teacher finds every interaction with the student an opportunity
to keep the student in a "partial vacuum", in which the student is
periodically "satisfied", but continuously maintained in the position
and attitude of having to know more and to know more about how to use
what he has.

Teacher's Role in Interaction

The writer believes that student interaction with a professional
practitioner—professor will always be the better way for the majority
of students. It is not a problem of substituting for the professor, but rather the problem of increasing interaction on the part of the student. The very fact that we learn best what we teach should be a demonstration that the professor's interaction with the knowhow of health care is not in question. We want to make each activity as profitable in interaction for the student as it now is for the professor.

An early vital aspect of this type of interaction situation is providing opportunities to observe the professor-practitioner performing as a model in the roles eventually to be played by students. It is this "access to excellence" (Dale, May 1940), that makes up the key set of acts in this learning mode. An excellent motion picture director must on some occasions leave his seat and demonstrate the details of a scene. He can't always "talk" actors through the scene, especially if they have had no prior models and are inexperienced. This is equally true for physician and student physicians.

Fellow Student As Teacher

Student teaching student should also be considered, but there are some obvious shortcomings. The student who is being "taught" is in no better position for learning than when the teacher teaches. The mode of student teaching student must also be shifted to student learning by interacting with student, each student gaining optimal benefits. Real or simulated situations in health care delivery, with students acting in specialist and general practitioner roles in a health care team, with the professor in the wings as an overseer is possibly a better mode for learning. Students would also assist in the design
and the planning for the kinds of situations that call for decision-making and problem-solving. If the student is to learn as "teacher", it will be advantageous to do so in this broader context, and not to the disadvantage of fellow students.

**Aspects of Experience**

Experience is the best teacher if that experience is excellent and has been preceded by correct precepts excellently exampled. Practical behavior patterns of clinical diagnostic skills, skillful surgery and post-operative care are usually acquired in the post-school situations in which they operate. Most of this learning is done without verbal instruction. Medical professor Asahel Woodruff says, "When a person is having his first significant experience with any fact or truth, it should not be a second-hand experience such as lecture, or any other form of verbal teaching. It should be a direct "seeing" of the actual referent itself." (Woodruff, 1968.)

Such first hand experience may not always be best, however. It is a traumatic experience to witness certain diseased states, for example, and the second hand experience of a verbal description might better prepare the student to view the condition with a degree of detachment, and increase the possibility of learning what is intended.

Woodruff identifies five principal components in a theater of action that results from viewing the role of human learning and media in a larger context. These are: (1) a person; (2) the person's environment; (3) the interaction between the person and his environment which is composed of objects and the events in which they engage;
(4) the consequences which result from the events and interactions;
(5) the person's perception of and reaction to the consequences, particularly those that impinge directly upon him. This fifth component can be "the recognition of a satisfying state of affairs and perseveration along the same line of behavior (homeostasis) or the recognition of a nonsatisfying or annoying state of affairs and a change in the person (adaptation or learning). (Woodruff, 1968.)

Homeostasis is equated with habits. If a change is to be effected or learning to take place, a new habit must replace an old habit. Dewey defined habit in terms of experience modifying the one who undergoes it and therefore the quality of subsequent experience, including the objective experience in which learning experiences are had. This constitutes the "continuity of experience" principle for interpreting experience in its educational function or force.

In a second principle, Dewey assigned equal rights to both factors of experience: objective and internal conditions, and argued that any normal experience is an interplay of these two sets of conditions. Their interaction constitutes a situation. Continuity and interaction "intercept and unite." They are "the longitudinal and lateral aspects of experience." (Dewey, 1938, p. 35-42, my underlining)

NEW MODEL OF THE LEARNER

Based on the writer's discussion of the nature of the learner and the considerations set forth above, a new model of the learner in the learning situation is now hypothesized. The learner can be shown as a system in his own right, that operates in and out of the learning system. The learner-as-a-system can be viewed as open to a
universe of consciousness. His physical body and brain are only the materialized machine or animal component. (Ouspensky, 1959, p. 10)
This materialized component 1) acts in a sensory mode to screen and inhibit inputs, reactions and interactions; 2) provides an interface with the universe of consciousness and with the world and its learning situation; 3) acts as a manipulator of the objects and as a system construct in the learning situation, projecting a personality and playing a particular role at any given time. Viewed in this way, the learner becomes not only the processor-manipulator, but the vehicle by means of which the processing is made mobile, and by which in a spatial and temporal sense, experience can be stored and carried from one learning situation to another. The model is sketched in Figure 6.

**Figure 6. Extra-Mundane Model of the Learner** (adapted from Puryear, 1965)
Stored experience reaches back in time and space, and the process of extrapolation, as in weather forecasting, can reach forward in precognition of what objects and events are required to bring the particular learning experiences needed at each step of the way. It would be unwise to construct a closed model that did not accommodate such exigencies, for by so doing we would have precluded the concept of free will. The open model frees our imagination to wander in any realm of environment, seen and unseen, existing, no longer existing and to-be-existent. As a component of that environment, the would-be teacher becomes a fellow-learner. Dewey quotes Tennyson's Ulysses (1938, p. 42): "All experience is an arch where thro' Gleams that untraveled world, whose margin fades for ever and for ever when I move."

**Implication of the Model of the Learner For Learning in Medicine**

Every object and event in an environment viewed in terms of the extra-mundane model becomes symbolizable. The very purpose of the externalized world is for being internalized in terms of symbols which can be coded, stored and retrieved or processed for integration with other symbolized experiences. This then, equates with Gagné's stimulation of the learner's use of capabilities already at his disposal, and with the learner's need for a singular set of prerequisite experiences in a particular sequence.

To conclude our considerations of learner domination of the learning experience we should look briefly at the selected specifics of lecture, discussion, laboratory and clinic encounters for learning.
The student's role under conditions that inferred the model is to seize upon whatever is encountered as (1) a way in which he can experience for learning at this moment; (2) as a less satisfactory but temporary way in which he should take a constructive part in improving. Thus, the burden is on the learner to learn, even under the most adverse conditions, and he must help to insure that the worst is made better.

For example, in a lecture, the student must improve his capability to listen and to interact with the sources of information to make it a genuine learning experience. This will not be done simply by taking notes, but involves processing the information into an adequate filing system in its total context including such things as the professor's non-verbal language. If the student spends his time recording on paper, expecting to internalize later, he misses a wealth of what really could have been gained. (We should add the word of caution that it is also possible for the lecturer to inadvertently communicate what is not to be learned.)

This is no less true of discussion, laboratory and clinic opportunities for experience. In discussion, the learner must conduct himself in such a way that he can try out his recall and application of concepts in a verbal way. This necessitates his sending and receiving valid messages in both non-verbal and verbal ways in concert with others who must be given "equal time", and evaluating others' as well as his own concepts. In the laboratory, it takes the form of the learner generating his own questions to be answered by his own activity. This is also the mode for clinical experience, but the interaction is now
with an actual patient, human or otherwise, including discussion
with the client-patient and fellow members of a health care delivery
team.

Implication of the New Model of the Learner for Teaching

The professor's role in all of this has already been discussed. He
must be a fellow-learner, but we expect him to be able to anticipate
the way ahead, and as a more experienced fellow-learner, to lead
so the students can follow. He can guide them around obstructions
and help them make the correct turns where the sign posts are confusing.
Dewey shows the difficulty of this role by cautioning that the pro­
fessor's maturity of experience should be made available for guiding,
but should not be taken as a license to "disguised imposition."
Rather it should be for shaping experiences that lead to growth of
learners. (Dewey, 1938, p. 19)

The author quotes Kestin in order to express a singular set of
acts that should be included in the teachers role (p. 254).

The task of a creative teacher is to
promote creative learning, consciously to
create a favorable ground on which bisocia-
tions can flourish. His routine task is
to establish the required matrices of
reasoning. The routine task of learning
is to assimilate these matrices, to learn
to apply intelligently known routines of
problem-solving. The creative task of
teaching is to lead up to the confrontation,
to make students ripe for the creative act
of learning, for the satisfying yet illusive
flash of cognition.

The answer to our second basic question of what kinds of learning
activity or interactions, with what environment, are likely to be pro-
ductive, is simply those interactions that fulfill responsibilities
of the real life and work situation, or that can be clearly related by the student to such responsibilities. The student thereby gains the satisfaction so important in continuing with learning toward eventual goals. Thus, the activities that must be translated into learner-actuated functions, and be carried out in a systematic way to insure learner achievement of the intended outcomes are:

(1) clear and forceful communication of the enabling precepts through the medium of living examples. The living examples are health care professionals. They work at delivery of health care. This is done in the usual types of settings for delivery services, and not limited to the one most convenient to learning;

(2) adequate opportunities for health care delivery practice under guidance and performance evaluation of the professional, including interacting with patient, decision-making and problem-solving.

We have fulfilled the criteria set by Ralph Tyler for learning interaction experience selection: (1) opportunity for activity and content, (2) student to obtain satisfaction, (3) prerequisites to be in student's repertoire, (4) variety and creativeness to capitalize on individual interests, and (5) expect different outcomes and several outcomes (plan for reaching more than one objective such as cognitive and affective, i.e. "structures" by which any learning can take place). (Tyler, 1965, p. 42-44)

Chapter Summary and Conclusions

We looked at some usual and unusual dimensions of the learner and learning, and formulated a new extra-dimensional model of the learner in the learning environment. We noted the implications of such a model
in respect to the learner and the learning situation. We asked, "Who is involved in learning and how are they involved?" The acts of the interaction function were thus assigned to roles to be performed, and some directions established for carrying out the roles.

A conclusion can be drawn that the extra dimensions of the learner can be, and probably should be, accounted for in the learning synergystem. Accounting for this extradimensional aspect may be necessary to gain a fully functional synergystem, and thus an increased potential for interaction by the learner.

A second conclusion is that the placing of emphasis on learning, and placing the responsibility for learning on the student will make the role of the professor-as-doctor example more critical, and will promulgate the emergence of the learning facilitator role.

It can be inferred from the total discussion that it is essential to the well-being of the learning system that it remain open to change. The effects of providing for the extra-dimensions of the learner and for promulgating the emergence of the learning facilitator role in system design are expected to be significant in maintaining openness. This will also be one criterion in developing the learning services subsystem which follows in chapter four.
CHAPTER IV - SYNTHESIS OF LEARNING SERVICES

It was implied in chapter three that the function of interacting for learning can be performed almost entirely through acts on the part of the learner. The role of the professor as a learning facilitator was developed as having potential of great value in the interacting function. The acts identified and assigned to the role to be performed by the professor were shown as critical in learning to fulfill certain requirements for all learners and additional requirements for some learners.

In any case, from the beginning of the process of translating the curriculum into learning tasks and tests, there are acts that need to be performed to support role performance primarily of the student, and secondarily of the professor, as the learning interaction function is carried out. The nature of this need as it is to be fulfilled in a learning synergystem was outlined in chapter 2, and representative acts were identified.

This chapter will consider the types of acts performed in the servicing of learning, and assign them to roles. The organizational considerations for performing the roles and fulfilling the servicing function are reserved for chapter five.

In analyzing the nature of the learning services problem, the question is too often, how many audiovisual services, of what types,
or how much servicing can and should be done? The question that should be answered is, "What will best develop, promote or lead to the intended interaction for learning in this particular instance?" Answers to this question can establish a valid context for the servicing function in which the learning media should be considered in a proper and systematic way.

LEARNING INTERACTION AND MEDIA: A MATRIX APPROACH

To answer our question in a meaningful way, using a system strategy, we must analyze the intended interactions in terms of the learning experiences desired, and the tasks and acts necessary to have such experiences. For example, if experiencing the consequences of taking the positive value position that he should continue to learn, even though not under the compulsion of an academic program, is desired for the learner, we ought to first make him aware of his need by involving him in a problem that has such consequences. Therefore, we design that type of problem situation.

The student's involvement in the problem is an event that includes associated objects and people, which forms a symbol set that he is to store and integrate into his contextual filing system for later use.

Developing the Context for Learning

This event leads, in turn, to our consideration of the learning experiences that cause involvement, or that bring interaction. Edgar Dale has developed a hierarchy of experience categories he terms the "cone of experience." (Dale, 1969, p. 107) Refer to figure 7 to review the levels of experience from the real life situation to the
verbal type of vicarious experience.

To involve the student in the problem of learning to learn, in chapter two, we specified simulation by role playing, casting the student as a preventive medicine specialist—a member of a health care team. This provides a sense of reality. To wait for an actual situation to happen, hoping the student would be involved coincidentally for the desired learning, is expecting the unlikely. Therefore, the contrived situation is used. We could, in an initial experience, "plant" an upperclassman to give an exemplary demonstration. The contrived experience can be more or less controlled to achieve our ends.

In the above discussion, we have been translating an objective into a learning task.

We now come to the end of the translating function, and to the beginning of the services function. We are also in the process of designing the learning interaction situation, and are ready to consider what sensory inputs will occur and what media might be employed to the advantage of the learner.

The introduction of the students to the problem and to their roles may take the form of a narrative handout, live actors, television or a cinema skit, a filmstrip or slides and audiotape, or just a dialogue on audiotape. Whatever we select will become a responsibility of the servicing function.

Again, in the interests of reality, but with an eye to simplicity, we arbitrarily choose the audio tape dialogue as the medium for getting the students into the problem situation. This decision is a cue for the servicing function to plan the required support.
Verbal Symbols
Visual Symbols
Recordings, Radio, Still Pictures
Motion Pictures
Educational Television
Exhibits
Study Trips
Demonstrations
Dramatized Experiences
Contrived Experiences
Direct Purposeful Experiences

Figure 7. Edgar Dale's Cone of Experience (Dale, 1969, p. 107)
Returning to the learning situation, there is an interaction strategy to figure out, a script to write, a rehearsal and a recording to schedule, and to dialogue with at least two voices. There is equipment involved for production, and again each time a playback for learning is made. There is scheduling of the simulation interaction situation in an appropriate setting, and for students who must be selected as ready by prerequisite learning for this particular learning experience. There is storage and retrieval of the audiotape for use and reuse. There is arrangement for feedback and evaluation. The above list of acts imply the kind of activities that must go on to perform the learning services function. We will just consider the problem of what are appropriate media for learning interactions. The selection of audiotape was arbitrary. What are the alternatives?

Media Selection Problems. The selection of television, in lieu of the audiotape mode, would permit a visual as well as an aural mode, and if properly done would increase reality. The equipment considerations might prohibit this mode, but if not, complexity has been added to the services function. The "get ready" time, to produce a television recording, is increased and additional special facilities, equipment and additional technical services personnel are required. We should reflect that almost the same results may be achieved by a simple typed handout containing the lines to be read by each student to enter his role and establish the problem situation. In fact, this is recommended by the writer as the initial mode for this type problem. The introductory sequence can thus be economically produced and
validated before going to a more expensive permanent mode. More important, the results of the learning experience itself can be determined, and thus validated. It is only necessary that the script or narrative convey the problem concept clearly and unequivocally to each interacting student.

In the interest of novelty and variety, we may want more than one mode available for use. More elaborate modes are justifiable where they can provide such novelty and realism and where they can be used over and over again by many students. For example, the use of television for this type learning activity may not be sufficient reason for having television facilities and equipment, but once these are already available for other more critical purposes, or justifiable due to an aggregate of uses, television use in this case may be warranted. This principle is also applicable to other modes and associated media.

System Approach to Media Selection. We have been considering the problem of learning design and media selection. The approach used can be described as intuitive, although since we implied that we looked at more than one factor in making a choice, the approach may have been thought of as "practical" or "functional". When we moved away from an arbitrary selection and considered other factors, we began to weigh and consider, but much of our consideration was based on value judgments, and not on a systematic comparison of factors and modes. There was no need to become entangled in the relative merits of one mode versus another, as to learning effectiveness, because the learning situation did not critically hinge on the mode and media match. However, there may be many occasions when it would be advantageous to consider a more
systematic approach to this problem.

Tosti and Ball have suggested a behavioral approach. (Figure 8) They engineer the mode of presentation according to stimulus encoding and duration, response demand and frequency, and management categories and frequency of change of presentation. (Tosti, 1969, p. 14)

Let us examine the single aspect of "management for attainment" more closely. Does it meet the criterion of "more systematic" for making media selections in medical education? Tosti and Ball list four "strategic subclasses" to deal with the student whose response to a presentation does not result in attainment of the learning objective:

1) redundancy; i.e., repeat presentation until student does reach objective.
2) multi-form; i.e., select a parallel but different form.
3) multilevel; i.e., select a lower level (more expanded) form.
4) error-diagnostic; i.e., select actions designed to correct specific errors.

Choice among four alternatives not only allows for systematically dealing with non-attainment, but prompts us to analyze what has been the shortcoming, thus to consider it systematically. Looking at the other aspects of the matrix, each of the forms of presentation has been designed in terms of stimulus encoding and response demand, therefore a variety of presentation modes is available.

Simplification of the Matrix. The writer wishes to employ the above described matrix, but argues that the model presented by Tosti and Ball has its application primarily in forms of "presentation" which tends to emphasize information passing rather than interaction for
Figure 8. Tosti and Ball's Dimensions of Presentation (Tosti, 1969, p. 14)
learning. Applying the matrix in terms of learning interaction by professional medical students can result in the desired shift in emphasis away from information presentation.

There is also a need to effect simplification; the matrix may be too complex to be practical for repeated, extensive use among variables that may not be all that significant in learning rates and sets for very mature medical learners. Simplifying can be done by reducing the dimensions of the matrix or by reducing the number of elements in each dimension. A set of rules for expeditious use of the matrix can make it practical. This is what is now intended in what follows.

The author's initial configuration of his modification is given in figure 9. This model is intended only for application in professional medical education. The use of the matrix is in combination with Edgar Dale's cone of experience to generate or create associations and to prompt consideration of both the alternatives and the factors involved in the use of media.

In the revised model, stimulus has been more broadly connoted to be a confrontation experience in which students make contact with concepts. The concepts are experienced in the structure and function of a happening or a problem situation, as well as by appropriate means of communication. The message remains visible or audible as long as needed.
Encoding of Concepts

CONFRONTATION: situational environmental symbolization communicational symbolization

Interaction Demand

INTERACTION: cognitive - intuitive (internal) affective - volitional (internal) psychomotor - verbal (communicative)

Management Purpose

MANAGEMENT: attainment (multilevel, error-diagnostic) prescriptive (selection by prerequisites) system support (scheduling, time, economy)

Figure 9. Matrix For Matching Learning Interactions and Media
Response has been changed to a more involved behavior termed interaction. By using the three continua: cognitive-intuitive, affective-volitional, and psychomotor-verbal (communicative), a useful taxonomy related to both meaningful response and learning is generated. Frequency of a specific interaction or change of the taxonomy add many-dimensional possibilities.

Only three of Tosti and Ball's management purposes are retained, and these are limited by their respective descriptors. Only two of the four strategic subclasses (explained on page 139) are retained as applicable to extensive medical education use.

Application of Matrix. Example uses of the matrix in matching learning interactions and the media to be employed will help to explain terms selected in the modified matrix. In our example of introducing students to interaction for learning the positive value position respecting continuing education learning, we first select from the cone of experience (figure 7) the level of experience best suited to the learner's actual application of the anticipated value position. This appears to be a simulation by sociodrama since we want the kind of experience closest to that likely to be encountered in actual situations, and we also wish to be practical in engineering the learning situation. Next, we look at "confrontation" and see two possibilities under encoding. Obviously, we intend to use both types of symbolization; we want the situation to act as a carrier of meaning and we also intend to use verbal communications. Thus, we will have to combine the spoken and/or written form with the situational form if it is to be a persistent confrontation, i.e., if the students are to refer to any aspects
of the problem at a later time, then we should use the written form as being both persistent and immediately accessible. (Our drama does not require such reference, therefore a written script is not mandatory: only the key "lines" of each actor need to be provided to the respective actors) For example, the cue line to be spoken by the first student might be, "How could this disease have been prevented--are there any recent developments applicable to this condition?" The stage is now set for the preventive medicine "specialist" student to contribute from his medical journal reading concerning a new immunological technique. Thus, only the introduction to a problem by a short statement and a "line" delivered by one student can serve to elicit possible responses by other students, and establish the interaction.

Next, we look at what we demand as an interaction by the student. We want him to recall information of a specific nature (immunological technique) when confronted with a situational need, and to communicate verbally. He will be expected to do this once (sparse) in this situation, but will likely use a series of communications to convey the full meaning, import, and application of his contribution. He will feel pleasure at being able to contribute and this will confirm his value position. Thus, we combine all three pairs of demands, two covert and the third overt. The overt response is primarily speaking or verbal.

Our management of this interaction is for attainment by a single episode. If we fail, we are not likely to be successful by repeating or going to a simpler level, but we could have prepared the student by providing a set of prerequisites, and scheduling him through confrontations and interactions to qualify for the experience: a change of
management to prescriptive. Our management of system support for the learning interaction or experience itself, is also based on one or more factors, and also prompts us to consider alternatives.

A second example will serve as a contrast to further clarify use of the matrix. We wish a student to learn the procedure for taking a patient's history and conducting a physical examination, including laboratory tests. He is only to be introduced to the procedure in the first learning objective. There are 120 students that are to have the experience in a two-week period, and we want it to be realistic, yet self-actuated because it is not possible to bring 120 beginning students into the clinical situation. The cone of experience suggests simulation by programmed interaction. We always try to move toward the base of the cone for realism, for beginning experiences.

We decide to encode the confrontation and manage error-diagnostic attainment by having the students individually interact with a computer program. We use a hypothetical patient to establish situational symbolization, and display this by a cathode ray tube (CRT) printout of answers to questions selected by the student from groupings on transparencies shown on a random-access projector. The student responds through the telewriter by selecting questions and procedures in a sequence. The program feeds back the accuracy of choices and manages the student through a general procedure that permits some leeway in details.

Our first consideration in developing the interaction situation is what to do with the student who has no experience on which to begin to see a pattern or sequence, to be able to interact with the computer—
assisted learning (CAL) program. Prescriptive management prompts prerequisite experience, but this cannot be provided in direct experiences in the allotted time. So we go to a television tape recording of an interview and examination of a patient by a doctor. This may take only 12 to 20 minutes and can be given to all inexperienced students simultaneously. The television skit requires only observation and cognitive interaction response by the student. He is then ready to interact with the computer program. In both cases we encode in language already in the student's vocabulary or that can be comprehended from context. In the case of the prerequisite experience we did not require a persistent display, accessible for reference, so could use a moving image, hence television. This could also be done by cinema. On the other hand, CRT and transparency displays allow us a more persistent image for the student to use as long as he requires them for cognitive and psychomotor responses. The program is also designed so that the student is to respond frequently.

Our examples have assumed the existence of original sources of information and learning materials from which our programs are prepared. The resources of learning information are now considered. The philosophy that is to guide the servicing function in the learning synergystem is that of bringing the resources to the learner. The alternative developed in chapter two favors the "home base" concept for the learner, bringing resources to the student to provide for an interaction in a real time, real life learning environment.
SCOPe OF LEARNING RESOURCES AND LEARNING SERVICES FUNCTION

Two general categories are usually found in the organization of medical learning experiences: core and electives. Core is further divided into basic sciences and clinical sciences. Electives are usually advanced or specialized sciences and clinics. We will consider learning resources in respect to sciences or disciplines, and clinics.

All objects and events in the learner's environment can be symbolized, and since symbolizing is a required process for the kinds of learning being dealt with, resources constitute the objects and events that are to be symbolized. If we consider the concepts that all learners bring to the learning situation, which concepts are involved in interaction with the objects and events in the learning environment, then we should sum all experiences and ideas as resources. Since experiences and ideas reside with human beings, we will simply consider them as human resources, including professors and students, and any others from time to time.

The types of resources labeled objects include any natural or man-made entities, including man himself as an object, and icons or signs and symbols themselves. Those labeled events are characterized by actions that can be observed or participated in by learners. Events include the visible and audible processes related to perceiving and conceptualizing, where combinations of symbols themselves become a new, more generalized symbol. Therefore, we have the possibility of resources that already exist in a potential learning environment, those that exist because of action in the environment and those that can
be brought to the environment. They can be brought to the learning environment both internally in people and externally, whether as actually physically present or present through a form of mediation (e.g. the professor mediated by a CAL program). In effect, we have deliberately included everything. Can and should a learning system be able to provide from such a spectrum? If the guideline of “best enabling the learning interaction” is valid, the answer is that we might reasonably expect it to do so in some feasible way.

**Special Medical Resources**

In medical learning, there are some kinds of resources that are unique. At the basic science level, specimens representative of normal, abnormal and diseased states are required. It is not always feasible to interact with some specimens in the living state, and some are dangerous to work with whether alive or dead. Also, special instruments such as electron microscopes or tools are required, and specially equipped areas and special conditions that are peculiar to medicine such as germ free environments, are necessary. If the learning situation is to result in real experiences, the learning environment must contain these instruments and present these conditions for a proper interaction.

The considerations for such resources are not different for learning than they are for the practitioner in any significant degree. Where the laboratory or clinical situations are simulated, learning transfer is most likely where the simulation resembles most nearly the eventual application. This is the primary reason for such debates as the one concerning the value of dissection in the discipline of anatomy.
Laurenson has prepared a study-aid that directs students through the events of dissection while pointing out the essential clinical facts. (Laurenson, 1968) When dissection is viewed as the learning of techniques leading to surgical skills, it can be questioned as not even remotely resembling the conditions of surgery. However, if it is pursued as an experience for learning how to locate, expose and trace various body components in a cadaver, the learning may more likely transfer, even for application in surgery.

Implication For Learning Services

The implication of the above for learning resources services is that the best approach may be to enter the actual health care delivery environment and its conditions of practice, modifying them as required to facilitate learning. Under this guideline, the major consideration for the services function becomes the individual consideration of students that will maximize interaction. The principal acts include formulation of guidance for design of facilities and the scheduling of individuals to correlate with learning activities.

There is a multitude of aspects to consider when developing such an environment. Three main ones from the learning standpoint include interaction and media, facilities and media, facilities and interaction. There are also matters of personnel, finances or budgetary considerations, supply and maintenance, administration and control, and others. Some of these have already been briefly discussed. Chapter five will make a proposal for facility consideration that meets needs and observes the criteria given above, namely (1) resources brought to learner in
an actual health care delivery environment and (2) correlating learning activities with individual student schedules.

The Department of Audiovisual Instruction or the Association for Education Communications and Technology and National Education Association in collaboration with the Center for Architectural Research, Rensselaer Polytechnic Institute, has published three reports to guide the facility and media design process. This is described in the annotated bibliography at the end of this chapter, and is recommended along with other annotations for further study of this problem.

Another aspect of realism in the learning situation in medicine, is that of the professor-as-resource who must engage in (1) learning for updating his own medical competencies, (2) practice for maintaining his own proficiencies and to provide students with actual cases by the professor serving a clientele, (3) research to contribute to the advancement of the medical art, and (4) publication. Emphasis on each of these areas varies from professor to professor and time to time, but there is a tendency for these things to take precedence over the planning of his role in the learning situation, including the updating of institutional and self capabilities to maximize learning. His essential contributions to the implementation of any revisions of the total integrated education program and learning translation, interaction and servicing functions, sometimes come last in priority.

The implication for learning services of the above emphases by the professional practitioner in preference to teaching, lies in the lack of implementation of our learning system or aspects thereof. Promising educational changes are not diffused in their major and minor premises
and the techniques may not be learned. Change is a traumatic experi-
ience at best, but it is especially difficult when attention is only
partial and efforts are elsewhere than on an innovation or new program.
James Bradford treats the problem of change and diffusion in his con-
comitant dissertation, therefore it will not be developed here.
However, one point should be emphasized.

Elements of a plan must be mandated and communicated with clarity
and force. They must be repeated over an extended period, especially
to those of the faculty that are "gatekeepers". Otherwise, a system
will not get underway or, if it does, will not operate as it was
intended. Its function will be adulterated by unplanned acts or omission
of planned acts. This points to the need for learning services per-
sonnel, the generalists in education and communications, and the
media, and tests and measurements specialists.

SPECIALIZED EDUCATIONAL ASSISTANCE

The need for special assistance can be provided by temporary
consultants and by permanent staff members. Traditionally, the
learning services function in medicine has been limited to the medical
illustrator and the medical photographer, technicians who turn out
visual materials as requested by the doctor—professors in support of
their teaching, research, professional meetings and their publications.
Lately, other areas are being added by some schools, including televi-
sion and computer-assisted learning. The latter is only under initial
development and testing in pilot programs such as those at The Ohio
State University.
The above traditional approach to learning services has several shortcomings: (1) much of the learning materials produced are useful only if the professor is knowledgeable in preparing such materials, and communicates his educational intent to the illustrator or photographer; (2) materials of value to learning are not used to best advantage, nor is there much crossfertilization of exemplary methods except as may be diffused by "gatekeepers" and students.

A second area of concern that calls for specialist educational assistance is the evaluation of the need for requirements for learning facilities and equipment which has been generated by a proposed program or required in existing programs. This includes standards of quality of suitability criteria, procurement, installation, operations and maintenance, supply and inventory. Where there is no coordinated consideration of these aspects of learning services, the professor or department chairman and deans must then either become knowledgeable concerning such standards, on their already tight schedule, or remain at the mercy of vendors. Accumulated unfavorable experience of the past has tended to restrict the use of audio and visual equipment to the overhead projector, the 35 mm and filmstrip projector and the motion picture projector. Some professors avoid films unless they can call on a central instructional materials center or laboratory to satisfy their needs. A fivefold increase in the use of films occurred when a complete and responsive service was put into effect at the College of Veterinary Medicine of The Ohio State University.

Well designed, adequately maintained and operated equipment leads to increased effective use. The need to make a learning activity more
interesting and clearer or more forceful in its communicative power is recognized by professors, therefore they will elect to do so where it is feasible. Learning services performed by educational and communications generalists and media specialists aid in making it feasible. Further, teaching personnel must be trained to use the equipment so they are not timid about using it with a class. More important is the service provided in hunting for quality materials and assisting in their procurement, storing and distribution.

Perhaps most important of all is assisting the professor in identifying the audiovisual materials needed to augment an intended learning interaction. Where production is necessary, it is usually essential that assistance be provided in preparing and processing materials. This can take the form of transcription and editing of audiotaped notes, script writing, printing of handouts, and coordinating materials production generally.

The generalist in education should be available from the inception of learning outcomes, all the way through functions of translating outcomes into objectives and tasks and interaction for learning. This is critical in the systems approach, because the statement of objectives, tasks and tests, and the designing of learning interactions are the keys to generating a system, and become principal acts in the generalist's role. Secondary acts include directing specialists in producing materials for learning, establishing criteria and procedures for application and production of films, television recordings and other materials. The design of audiotutorial materials and computer-assisted learning programs are more recent requirements in medical education.
Integration of audio and visual materials for interactions, especially in simulation and problem-solving or any complex learning activities, are the obligation of the generalist. Primary and secondary acts were initially identified in chapter two, and further developed in chapter three. Description of the acts will continue later in this chapter, and organized into roles in chapter five.

The effort required to transform predictable learning into individualized learning materials is a herculean undertaking for someone already engaged in other pursuits. With expert help it can be accomplished. Otherwise, it is likely to remain a plan, never getting off the ground.

Testing Services. The design, grading and analysis of instruments for measuring learning is an important area in which the help of a specialist in tests is needed. The efforts of an education generalist are also required in the overall design of the strategy and integration of competency measures into learning experiences and materials.

A test is designed to fulfill one or more of the following: achievement, diagnosis, motivation, learning and prediction of future success. A test should not be made for the expressed purpose of obtaining grades. Grades are a by-product of the purposes given above. Design is influenced by both purpose and the underlying philosophy of the curriculum. If the student is to learn for mastery in contrast to being measured against his peers, the measuring instrument must be clearly definitive of what the student must be able to do and how well. This provides a real challenge to the test-designer. Teacher-made tests are not likely to go much beyond requiring cognitive recall.
where the teacher has not given special attention to the testing process and test instruments.

In addition to design, which includes formatting for machine grading, there is item analysis and interpretation to the faculty to assess the difficulty, reliability and student comprehension, or the readability of their tests.

There is also the contribution that must be made to student self-assessment of his accomplishment of learning tasks, and the self-testing that must be built into learning materials. The test specialist also assists the professor with materials preparation and the pre-testing that determines whether prerequisites have been attained by students.

**System Evaluation.** The learning system itself requires internal evaluation for proper operation and control. Regulation is made possible by feedback of accumulated information from each critical point in the several flows of work proceeding within the system. Types of regulatory information include duration and frequency of use of materials, time required to make them available to individuals, student evaluation of their use and value in learning, faculty and staff rates of production, etc.

The output of the system, its consumption of resources and re-evaluation, come under the purview of an evaluation system at the total program level. Data gathering and reporting that is needed from within the learning system must be provided by the learning system. This is combined with data generated by the evaluation system for feedback to the curriculum development system, learning system and support system.
We will conclude this section by noting the need for a learning resources catalogue to keep students and professors informed and aware of the types of materials on hand and the types of available services. The issuing of special topic memoranda can also serve for advising and updating in relation to modern techniques and information on what others are planning or doing.

We turn now to the problems in design and production of materials for medical learning. Emphasis will be on materials that program learning activity that provides students with meaningful experiences for achieving learning objectives.

**DESIGN AND PRODUCTION OF PROGRAMMED MATERIALS FOR LEARNING INTERACTION**

Emphasis on learning materials that are "programmed" is useful in the sense that efforts to produce the formats carrying the content and contextual messages to be learned, are never really random. Whether in the textbook, in the lecturer's notes or merely in his mind, as well as highly structured, the "materials" are generally or specifically programmed. They have a logical, psychological or chronological sequence that proceeds in the form of unit built on unit, unit attached to unit, whole part whole, and simple to complex, to build concepts and simultaneously provide a contextual map.

The development of this idea is the purpose of this chapter topic. Three aspects will be discussed: (1) learning must be validated for a programmed approach; (2) there are specific design criteria that assure the likelihood of validated learning experiences; (3) the criteria can be applied to effect self-instruction activities and direct experiences.
Learning Validation

Edgar Dale gives us a general guideline for programming (1970, p. 4)

The essence of planned or programmed instruction is to provide a logical sequence of experiences which results in the mastery of the intended learning. The program need not follow a set, stereotyped form; it should be judged largely on its power to provide the greatest amount and quality of stated learning in the shortest time.

Dale sees improved communications through the art of designing the materials of learning as a means of reducing the teacher's re-explaining the already inadequate explanations in textbooks and lectures. Improved communication of concepts and contextual mapping is the purpose of programming. The method of validation is to find out whether the instructional program works by examining the empirical results of the program in terms of the stated learning objectives. What are the observed changes in behavior? Do students using the program learn? If not, how should it be revised for effective instruction?

The mediation for programmed learning includes professors, books, computer programs, television programs, or any other that are found in learning situations. The difference is not in the media, nor so much in the usual "program" of the learning approach, but lies in the key fact of the validation of results. If the intended learning does not become the learning achieved, at least for nearly all students, it isn't programmed learning. Thus we can view a learning program as structured activity that results in desired experiences and validated outcomes. In a way, we have only said that any planned activity is programmed learning, and this could be the case if learning actually
takes place. The difference is that in the programming approach we make sure learning takes place. In unprogrammed instruction we only hope that our later tests will show that it did.

Once we have validated the learning, using a close facsimile of the intended learning experiences and materials, we can put the finishing touches on them and mass produce them for continued use. The materials or media must be planned in the learning design as the expected means of communication, since a change in media can result in a change in the clarity and force of the communication, hence a change in the results.

**Design Criteria.** Herbert Thelen says that programmed learning ought to provide for the following (Thelen, 1963, p. 189-196):

(paraphrased)

(1) Rewards available only during or after learning effort, and be commensurable with effort. Program be purposive, have possibilities of risk (frustration).

(2) Visible progress toward a goal. "Wrong" responses that eliminate unproductive pathways or help define what needs to be done next are highly useful. (Mistakes are allowed). Programming will use large number of bases of judgment: relevant - irrelevant, consistent - inconsistent, central - peripheral, certain - doubtful, et al.

(3) The educational criterion to be used is progress toward reaching a conclusion, toward formulating a hypothesis, toward summarizing an argument, or toward accomplishing other meaningful intellectual tasks.

(4) The program must develop the seeing of relationships within a pattern of elements, with the whole pattern visible as it is built up.
of a sequence of small operations. However, a specific sequence is not ordered except where it might be critical. The program should be designed to allow the student to select among alternate paths to suit his learning set.

(5) Teacher role is that of customizing a set of experiences for the student on the basis of programmed task-problems that emerge out of preceding problem work. (Mechanics of materials preparation should be such that students can devise some of their own.) Materials are not to be completely self-contained. Students are to interact solitarily, then within a group, or with the teacher.

(6) Alternatives among routes and universals will allow for individual differences.

(7) and (8) Concept of activity is meaningless unless linked to concept of purpose. Responses must be germane to student's mode of inquiry, or essential to a pattern. Student must discover a pattern among elements and formulate some kind of testimony of experiences. The student returns to missed elements to obtain satisfaction.

(9) Ideas and discoveries by students are an emergent aspect. These underlying apprehensions, in conflict, produce the sense of a problem, and provide readiness for new learning.

(10) Feedback comes as perception of consequences of behavior, and allows confirming the pattern among elements on which interpretations are made.

The effect of the above on programmed materials is to produce guides for inquiry activities. Such programmed guides would be resources that could be used selectively as needed. The guides would require
many responses and allow many choices for a single problem. The search for a pattern would get structured feedback; interpretations would get feedback from a tutor or a discussion session. The materials provide for student discovery and dialogue in a sequence that promotes learning. The program requires the individual or the members of a group collectively to act to shape the environment, then experience the consequence of that shaping.

An example is a computer-assisted learning program that presents the alternatives for treating a patient, plus access to all the needed information to treat the patient for recovery. If the student shapes his environment in one way, that environment responds with recovery; if he shapes it incorrectly by omission or commission, the response is "Doctor, your patient died!"

Robert G. Smith gives us further suggestions concerning feedback to the learner of the knowledge of results (Smith, 1966, p. 14-15): (paraphrased)

1) Method should correct or eliminate student guesses that conflict with knowledge of results.

2) Knowledge of results should lag performance by a period determined by student's need to experiment.

3) Knowledge of results should show the direction of student's response in relation to correct response (Thelen's second point stated procedurally)

4) Activity of the student during his waits for knowledge of results and where feedback must be occasional, must be managed.
Smith also gives two suggestions helpful to learning procedural types of things: 1) student verbalizes each input as he practices; this equates with verbalization in association with pictures for later recall, as noted in chapter three. Mental practice may be nearly as good as actual practice, and can be done when actual practice is not feasible. (Smith, 1966, p. 17)

Criteria Applied. Applications of the above will now be outlined by examples. In the first example, instruction sheets or posted directions give places, times, resources and rules of conduct, etc. to guide the student in self-instructed laboratory tests procedures. One item in the resource list is a text that gives detailed instructions; another is a narrated film in a cartridge showing a detailed demonstration. There is a set of slides with audio tape textual materials. There is a television recording of the application and evaluation of the lab tests. A schedule shows that a lecture will be given at a particular time. A professor is shown as present at a certain time for consultation, and there are teaching assistants present. The schedule also calls for discussion groups at appropriate times. This can be described as a self-tutored approach to learning. Where instructions are given by an audio tape, and much of the instruction is by taped lecture, the term used is audio-tutorial. This approach was developed by S. N. Postlethwait at Purdue University. There is a difference in the mediated Thelen approach described in preceding pages and the Postlethwait approach. Thelen's ten provisions give the student more freedom to choose and discover, whereas the audio-tutorial is much more directive and the student path is designed to be the same
for each student. The potential for original interaction is high with the activity program and low for the audio-tutorial. The steps in developing activity self-tutoring units used by the writer will be flow charted in chapter five.

The learning situation designer should attempt to achieve a learning situation as high in relating opportunities as possible. A low relating activity for a student who is learning diagnosis of heart action and efficiency would be: looks at diagrams of normal heart and abnormal heart; memorizes labelled parts from chart in classroom in anatomy; studies normal and abnormal development of heart using slide sections in embryology laboratory.

A high relating learning opportunity would be: hears sounds of normal heart; then some specific major dysfunction; consults diagrams of normal and abnormal heart; sees model animation or film of heart action while hearing sounds; listens to sounds with stethoscope, and makes diagnosis. If confirmed, goes to more subtle case of same dysfunction. If in error, is directed to correcting information, then a second case with similar gross dysfunction.

Programming optimally requires learning strategies that lead the student to voluntarily expose himself to the needed learning situation, and to interact in such manner and degree that the learning is maximized for him. Once the strategies are worked out, the job of preparing the actual program materials can begin. The strategies actually imply the uses and types of media in most cases. Strategies that require interaction with a professor or tutor on a person-to-person basis can be entered into a computer. If such is the case, the
preparation of materials becomes more complex and time-consuming, involving specialized personnel, at the present state of development. When computer-assisted learning programs are able to accept a professor's own language and strategy directly, the preparation will be greatly simplified.

As it now is, "acts" include not only translating the interaction into verbal and visual means, but coding into a format that allows the computer to store and retrieve the specialized sequences needed for interaction and feedback in response to the learner. The program also must be able to manage any aural or visual supplemental or implementing materials via automated or student operated devices. The reader is referred to the annotated bibliography at the end of the chapter to explore the design and production problem and the learning services acts involved. They are only implied by the treatment given here.

John Dewey said that, "All language, all symbols, are implements of an indirect experience; ...the scope of personal, vitally direct experience is very limited." (Dewey, 1916, p.29) Programmed activity can lead to direct experience when its strategies are based on the student having the prerequisites so as to be ready for entering into a situation for learning directly. This is to be sought for, and students should not only be assisted in gaining learning from direct encounters, but also to know they are learning. Most of us have lost the promise of early efforts in subtle or subliminal kinds of learning because we were unaware of changes taking place, therefore never pursued them or persevered to gain the promise. Instrumentation, as
noted in chapter three, is now reinforcing subtle learnings, by making them visible, audible or tactile, or by other awareness mechanisms. For example, the use of the oscilloscope to make the alpha brain wave a visual cue for entering an altered state of consciousness.

At the practical level of medical learning the best example of direct experience is the student being given responsibility for delivering those health care services that he is already capable of delivering from the first day on. This is not without some risk, but if the mistakes are computed in advance, and the program designed to avoid responsibilities, therefore acts and encounters, where students' mistakes would be serious, the benefit can be made to completely justify the risk. If a student is to learn to be a doctor and a student of medicine, he needs to act like a doctor-student from the beginning, and this must be reinforced by his being treated as an associate on the health care delivery team. This is the most important learning programming strategy, and the health care environment, especially the patient, is the most significant resource and medium of learning. The student is also the ultimate programmer of his own learning.

Chapter Summary and Conclusions

We have tried to give some dimensions to the learning services function by answering the question of what will best bring about interaction for learning in medicine. The problem of media was developed in terms of the immersion of the student in experiences, bringing resources to bear on the creation of the learning environment and to create interaction situations. A media matrix was adapted to aid the
process of designing interaction in terms of realistic levels of experience and managed attainment of objectives by situational-environmental and communicational symbolizations. The scope of learning resources was developed to point to learning services acts generated by special requirements in medical education and the trend toward individualization. The problems in design and production of materials were outlined by considering programmed learning as a process requiring special support. Programmed multi-path learning activity was favored over the more restrictive single-path approach. The roles of those who perform the multitude of acts that result in the function of servicing learning interaction were concurrently developed or implied.

Preliminary conclusions in consideration of what is involved in carrying out the servicing function are:

1) It is unlikely that a medical education program can make major changes toward individualization of learning except through the assistance of educational generalists and media specialists. There is just too much learning program development work to be done and the doctor-professors are already so immersed in the business of medicine, that learning enterprises are prone to become secondary with them. Insistent followup on the part of the assisting staff is required to fulfill development goals.

2) Exposing the student to increased interaction in the real health delivery environment is a complex process requiring special incremental preparation. This involves much planning, preparation and management, especially of learning resources including the student.
3) Medical education can and should apply the broader spectrum of media to individualize learning and add force and clarity to communications acts. Application must be of highly professional calibre to be well-accepted.

4) Special consideration must be given to organization and facilities designed for joint learning and health care delivery, if gains are to be consolidated on an institutional scale.

Consists of three reports: 1) guide for policy makers, 2) guide for design professions, 3) a technical guide. The term *media* is used in the sense that it connotes anything which is intermediary in getting across an idea and anything that is intermediary in bringing a teacher to a student. The title denotes emphasis on the newer media such as television, and the ways it is to be used such as for individualizing of learning. Alternatives are suggested within each report, and considerations for planning for media in facilities are nearly all-inclusive. Format facilitates reference.


Organized into three parts: "Theory and Practice of Audiovisual Teaching;" "Media and Materials of Audiovisual Teaching;" and "Systems and Technology in Teaching." Emphasizes the use of audiovisual materials as an integrated, functioning part of a systematic program of instruction. Develops the acts involved in the role of teacher as "...manager, organizer, motivator and evaluator of learning experiences." The implications of choices among a rich variety of media are clarified. Up-to-date reference material is abundant in annotated reading lists at the end of each chapter; specialized interests can be explored in depth.


Surveys requirements for media generalists and specialists, and physical facilities for educational media. Gives criteria and procedures for administering materials, equipment, production services, budgeting and improving utilization. Chapters on textbooks, television and programmed learning administration. Discusses media services at levels from single school to state departments of education. Includes research and system approach. Emphasizes orientation and role relationships.

Surveys needs, development and functions of teaching laboratories. Provides criteria for determining suitability of multidisciplinary laboratories for various disciplines and types of teaching. Chapter on planning the teaching laboratory for a medical school. Photographs of alternatives.

U.S. Naval Training Device Center. Instructional Television Research Reports. Human Engineering Report 20-TV-4: June, 19

Provides 12 steps and the criteria by which systematic judgment can be made as to whether television should be used as a component of a learning system. This is an applicable approach for assessing any of the media. The examples could guide construction of steps and criteria for other instructional media for learning systems.


Organized into sections on Communications and Media Overview, Audio Tape, Computer, Film, Programmed Instruction, Radio, Television, Miscellaneous and Multi-Media. A bibliography of additional articles is available on request of Bibliography No. AVE-1. Significant aspects of each domain are represented and insightful ways to use the media are given, many with examples and illustrations. The authors include most of the recognized leaders in the communications and media fields. A source book and background readings.

Miller, George E. et al. Teaching and Learning in Medical School. Previously annotated in chapter three of this dissertation. See especially chapter 10 "Materials of Instruction".


Gives the history and describes the restructuring of the beginning college course in Biology at Purdue University, and provides an example of a week's unit of study. Describes the physical facilities using photographs as well as narrative. Presents the audio-tutorial system and its application to the restructured course, and gives experience on operational aspects. Extends method to primary school instruction. Provides guidelines for utilizing this approach and additional helps in seven appendices.

Provides thorough coverage of color television techniques as well as television in general, and specifics. Adaptations for small studios and large commercial studios. Covers equipment, lenses, audio, lighting, scenery and properties, graphics, special effects, film and video tape recording, performing and acting, makeup and clothing, studio and control center, producing and directing, remote telecasts and personnel.


A complete treatment including script preparation, planning, budgeting, equipment and film choice, shooting, lighting, sound recording, artwork and animation, editing sound track, prints and film library. Detailed guidance.
CHAPTER V - LEARNING SYNERGYSYSTEM AND VETERINARY MEDICINE

This chapter is intended as a description of the beginning and the progress to date of the education program and learning system now underway at The Ohio State University College of Veterinary Medicine.

The Total, Integrated Veterinary Education Program (TIVEP) is presented, including its curricular organization, and the plan for its implementation and evaluation. This is followed by an outline of the interrelationships of the Learning Synergystem with the TIVEP, and the evolving organization for the implementation of the Learning Synergystem. Brief descriptions of essential elements are given, and procedures for the early incremental implementation of the system are considered.

THE TOTAL INTEGRATED VETERINARY EDUCATION PROGRAM

A fortuitous opportunity for a systems approach to medical education program development was presented during 1968. At this time, Dr. Clarence Cole, Dean of The Ohio State University College of Veterinary Medicine, established the requirement to increase the annual student enrollment of 85 to 240 by 1974. Upon the anticipated completion of a new veterinary hospital in 1972, the enrollment is expected to be 160. The Dean also named a committee to develop recommendations that would draft (1) a major innovation of the curriculum to use the organ systems and disease approach, in lieu of the disciplines approach, and (2) implementation of the first year of the new curriculum with an initial modest increase in student enrollment as early as possible.
Upon completion of the work of the committee, which was expedited by a workshop for the entire faculty in September 1968, Dean Cole gained a faculty vote to implement the first year of the new curriculum, and for an enrollment increase from the existing 84 students to 96 students for the 1969-70 school year.

This opportunity for program development was facilitated by the formation of an office of veterinary medical education staffed by graduate students in education communications. The writer is a member of this team. Preliminary requirements and design of the approach were drafted in the summer of 1969. A comprehensive total veterinary educational development was subsequently defined and documented in the form of a grant request prepared for submission to the National Institute of Health in November 1969.

The proposal contained selected learning interaction experiences and learning resources functions, including elements of a learning resource center, to be planned, developed and implemented within the learning system component of the total veterinary program.

A boost toward expanded learning resource center, and learning materials design roles, was made when Dean Cole assigned control of 1969-1970 learning resources budget dollars from college teaching departments to the Office of Veterinary Medical Education. Thus the faculty could request these funds to implement their respective elements of the total program, but were under an obligation to work with the education office to determine the learning effectiveness of their intended resource applications, and their integration into the overall education plan. The 1970-1971 budget and the proposed 1971-1972
budget for the learning resource center are included as Appendix C. Development continues at an accelerated rate toward the capability for individualized and self-actuated learning, through the efforts of the faculty and the office of veterinary education staff.

The current development effort is established with the University in the Six-Year Plan, ending in 1976-77. An extract of the plan is included in Appendix C. Such effort includes learning system aspects which are reported on here, and the evolutionary development of the curriculum, reported by the aforementioned Ph.D. dissertation by James L. Bradford. Bradford gives a more complete history and description of the development of the program in chapter four of his paper. The reader is directed to that source for further pertinent information.

A continuous annotated case record and report system of the program of development was established in the office of education beginning with initial planning activities in 1969. In addition, inquiry made of the several developmental projects being carried out at other medical and veterinary colleges, such as Case-Western Reserve School of Medicine (Ham, 1961) and Duke University College of Medicine, has been continued by direct communication as to innovation, progress and evaluation, and made part of the file. From these sources, a cross-check on planning steps, plans developed, early trial ventures in learning interaction and learning resources support activities, plus evaluation and initial reactions to such ventures and programs was made. Field trips have been made to the University of Purdue and to Michigan State University to study self-instruction programs in veterinary medicine.
Inasmuch as the curriculum which is to be the output of the curriculum development system, is also the directing and guiding input to the learning synergystem, it should be available to the reader of this dissertation. The descriptive explanation of the curriculum that was mailed to students in July 1970, is included as Appendix A: NEW VETERINARY MEDICAL CURRICULUM.

This report was prepared as the front portion of the formal document which contained all course data, including elective courses, that was submitted to the University Council on Academic Affairs in June 1970, and approved by them. Tentative approval had been given to the adoption of a preliminary Year One program, a year earlier, by the University Council for Academic Affairs, in order to allow the implementation of the first year of the total program. As a result of the experience gained during the school year 1969-70, major and extensive modifications were hammered out for the second generation of the plan. One-hundred-twenty students were selected for the class that entered in October 1970. The revised second year of the new curriculum was also initiated at this time.

It is planned that modification will be a continuous feature of the program. Robert Glaser says (1969, p. 175)

Most educational innovations underway at the present time are not characterized by a systematic development and evaluation that can lead to continuous improvement. An ordered sequence of evaluation, correction, evaluation again, and further improvement is fundamental to the development of high quality.

It is in expectation of systematic development and evaluation, and an ordered sequence of evaluation and correction that the new veterinary medical curriculum is being prepared and implemented.
The central system by which the goals of the curriculum are to be achieved is the learning synergystem. Preliminary consideration of the system approach to learning in medicine was outlined in chapter two, and a model of a learning synergystem proposed. (Figure 4)

At this point the model is to be applied to implement the new veterinary medical curriculum. To summarize the functions and to further clarify the acts and their interrelationships, flow charts are presented. (Figures 10, 11 and 12) These charts organize the functions of learning outcomes translation, learning interaction, and servicing of learning, into subsystems as they are presently being carried out within the College of Veterinary Medicine at The Ohio State University.

Only the inputs, principal steps and sub-products, and the outputs are given to illustrate the overall aspects of each functional subsystem. Communications acts are implicit in nearly every step, therefore a separate communication subsystem has not been charted.

The first step in translating is given as "derive all learnable aspects of each outcome." This means simply to break each broad learning outcome into meaningful separate concepts or skills that can be expected to be learned. There should be numerous elements for each broad outcome.

In step two, each concept or skill should be viewed in respect to the guiding statements of philosophy such as "learning to learn will be emphasized in the education program." If any particular concept or skill is in conflict with the philosophy, the conflict should be resolved, or the concept or skill be rejected, or modified. This process
can serve the purpose of causing critical analysis of what is relevant in achieving an outcome and what is supportive of generalized purposes. The objectives and criterion items can then be stated, the learning tasks and activities set up and tried out for their validation.

**THE TRANSLATING SUBSYSTEM**

![Flow Chart of Translating Learning Outcomes into Activities for Teaching and Learning in Veterinary Medicine at Ohio State University.](chart)

Validated learning activities are set forth by a syllabus to bring students and others into the types of interaction shown. Scheduling and environment are sometimes fixed, and sometimes variable, according to the situational requirement. Where a student is free to elect his learn-
learning mode, say self-tutoring, he may schedule himself, and the resources are accessible on a more or less continuous basis.

THE LEARNING INTERACTION SUBSYSTEM

pre-vet students

(validated experiences) (syllabus)

(student self-tests, practices recall)

(student formulates and asks questions)

(professor monitors and guides)

(professor asks and answers questions)

(student interacts with computer program)

(professor monitors CAL and interacts)

(professor monitors, guides, tests and interacts)

students ready for qualifying examinations for practitioner

Figure 11. Flow Chart of Representative Elements and Processes of Interactions for Learning Veterinary Medicine at The Ohio State University

Until very substantial numbers of structured and validated activities are available, students will be limited to study of textual materials as the primary self-teaching means, although each of the interaction modes is used. The interaction subsystem flow chart implies much
choice and flexibility in learning modes. This condition will be realized fully only when activities have been structured for all modal possibilities in all content aspects.

Figure 12. Flow Chart of Making Learning Resources and Support Available to Learners and Teachers in Veterinary Medicine at The Ohio State University.

Servicing requirements are satisfied by delivering resources to the learning interaction subsystem, and by maintaining the learning environment. The scheduling of activities is performed as a service.
rather than an administrative task because sequencing of activities to insure the learning of prerequisites rightfully comes under learning system control. Sequencing is shown as a decision in the servicing subsystem, but it can also be an output of the translating subsystem where sequencing is critical for a validated learning unit series.

ORGANIZING FOR IMPLEMENTING THE LEARNING SYNERGYSYSTEM

Arriving at the point where organization should be considered, we are reminded by Edwin Novak, professor of educational research and information systems at The Ohio State University, that, (Novak, 1970)

A learning system refers to a group or assemblage of interrelated and sometimes separate elements or components which operate as an organized whole to accomplish a particular learning goal and set of learning objectives.

We have looked at an array of elements and components such as learners, professors, content, methods, devices, materials, and others in chapter two. We looked at these components in terms of their incorporation within functions made up of acts, and suggested the ordering of these acts into roles. A diagram was used to show the way roles are delineated in an organization. (Figure 3)

We have now organized the functions that directly concern learning into subsystems of a Learning Synergysystem by flow-charting the functions. From the subsystem flowcharts, we can proceed directly to the expression of the functions and their interrelationships in terms of organizational entities that perform the roles, and show their lines of responsibility, authority and support. (Figure 13)
Figure 13. Organization Chart for the Learning Synergystem
The Associate Director for Learning Resources plans, develops, and coordinates the system as described above, to include the learning resource center (LRC). He:

1) works closely with his staff and individual faculty members to design and develop effective and efficient learning experiences, under constraints of program design.

2) directs learning materials procurement and development programs; develops procedures for storage, retrieval, and dissemination of both equipment and materials to students and faculty; and coordinates multi-library learning resource services.

3) coordinates programming of learning units into learning modules and integrates modules into the overall learning system, including applications for use in the classroom and carrels, hospital and laboratory, field and home study.

An illustrated description of the LRC and its components is provided in Appendix B: Learning Resource Center Brochure. This was developed to inform prospective donors of the nature of the intended learning activities and the special considerations that are needed to realize the eventual goals of individualized learning.

During 1970-71, the function of the learning synergystem in the total, integrated veterinary education program is to complete internal operating definitions and procedures, to test learning interactions, and to develop methods and materials most effective for application to an organ systems diseases approach to learning veterinary medicine. The following goals are being sought during 1970-71 and throughout the duration of the project:
(1) Implement and evaluate sets of core learning experiences that may better enable each individual student to master knowledge, values and skills in his preparation to be a scientific and effective practitioner of veterinary medicine.

(2) Design, develop, test, and produce a spectrum of veterinary medicine learning materials, treating scope and depth of learning resources under these titles: Multiple Options To Individual Learning Experiences (MOTILE); Special Collections of Resources (SCOR); Guided Learning Interaction Modes (GLIM); Computer Assisted Learning (CAL) and Television Assisted Learning (TAL).

(3) Establish control and interface elements of the learning system that will bring students, learning experiences, and resources together in optimum ways for most effective and efficient mastery of the science and techniques of veterinary medicine.

MOTILE. Under existing programs of instruction, every student is exposed to the same materials presented in the same sequence by the same media for similar duration. The concept of MOTILE is to provide each student greater opportunity to tailor his own learning experiences, enabling him to learn in the way and at the rate most appropriate for him. Increased flexibility will be realized by increasing the means of exposure of presentation of subject content, by permitting the sequence and duration to be altered, by providing for student self-management and coordination of learning and establishing self-evaluation measures, all in modular form for each unit of instruction. MOTILE provides a
shopping list of optional materials available in several formats or what Edgar Dale terms a "cafeteria of learning experiences". Cross-references that permit audio and visual presentation modes to be used together, a ready storage and retrieval means, schedules, and evaluation criteria and measures are packaged for the student. Formats include programmed learning, simulations, multimedia presentations, 35 mm 2x2 transparencies in sets, tissue microscope slide sets, lectures on audio tape, single-concept 8 mm and 16 mm films, videotapes, and computer-aided learning programs. The student is able to select from these as well as the existing program of lectures, demonstrations, and laboratories to learn a given concept. A second student can learn the same concept with different materials. Learning units will have instructional activities guides that tell the student what options are available, and how he may profitably proceed in study of the unit.

The strategy for developing MOTILE modules is planned as follows:

1) Identify and list texts, lectures, laboratory exercises, existing films, slides, and other presentation modes and materials already available to student.

2) Assemble subject content and learning experiences data from audio-taped records, conferences with information sources and survey of literature and texts.

3) Prepare (write and illustrate as necessary), validate and reproduce such additional learning materials as student textual or reference information handouts, study topical references and bibliographies, pretests and quizzes.

4) Develop such additional learning materials options as audio tapes, single concept films, 35 mm slide series, programmed learning activities and materials, and videotapes.
5) Incorporate learning by television, computer assisted learning, learning interactions and simulation experiences into MOTILE modules as they are developed and validated by separate programs.

6) Develop student performance criteria and devise evaluation instruments (both student self-administered and College-administered).

7) Establish procedures for management of learning materials including reproduction, storage, scheduling, distribution, dissemination, inventory, maintenance, to provide for optimum use.

8) Coordinate Evaluation System feedback and Learning Synergy system revisions.

SCOR. During the first year of the revised curriculum, a continuous survey will be made to determine (1) what visuals are used, (2) what visuals are desired that are unavailable, (3) what modifications are needed for learning. SCOR will extend to audio tapes, programmed learning materials, radiographs, videotapes, 8 mm and 16 mm films, models and others, during years subsequent to 1970-71, as significant production is planned in each audiovisual area.

GLIM is intended to promote increased opportunities for personal learning interactions between student and fellow students, faculty, staff and others in a veterinary medicine environment, and to develop ways of applying interpersonal communication situations for more effective learning. At present, the main interactions are principally the student in a large group facing the lecturing or demonstrating professor. Some student-to-student interaction occurs spontaneously as an adjunct to other activities, but no planned or scheduled opportunities are provided.

GLIM will structure and program learning situations designed to bring student peers, lower and upper classmen, and graduate students
together for designated learning purposes. The student-professor interaction mode will be enhanced by increased opportunities for small group and one-to-one confrontation.

Student interactions with staff members, administrators, technicians, and with D.V.M. practitioners will be carefully planned. The student will be able to manage some of his own interactions by selection of those modes and materials which he finds best suited for his individual learning.

**CAL** as implemented in 1970-71 in the instructional system will test four modes now being designed using a computer author and student type terminal, and professional assistance supplied by the University:

1. Multi-level problems in the procedures of diagnosis and treatment of animal patients.

2. Special subject learning approaches or strategies (e.g., a model of cardiac function)

3. Student self-evaluation and study of basic concepts in pharmacology using computer presented diagnostic pre-testing and a study guidance program.

4. Development of a simulation facility, with emphasis on student-to-student interactions in problem-solving and using multi-media presentation. Learning strategies developed under CAL pilot programs will be departures from the tutorial and didactic modes currently encountered.

**TAL** was implemented late in 1969-70, with a low-cost, yet good quality black and white portable 2-camera system. Three monitors were purchased, and others were temporarily available through the Teaching Aids Department of The Ohio State University. A 1-inch video tape recorder and special effects generator were also part of the system. The recorder is convertible to color by the addition of a pre-wired component.
This system enables the faculty to become familiar with production requirements, such as planning and writing, camera angles and lighting, and audio quality. Faculty members can learn what is possible with TAL, and begin to think in terms of its potential for student learning. Color will eventually be required in an extensive medical TAL program, but there are many potential programs that can clearly convey their message with the black and white medium.

One example is a series of programs produced on bone fracture repair. The close-up detail of tool use and techniques in applying the several fasteners and stiffeners to renew the integrity of the bones, were a convincing demonstration of TAL. Over 90 students were able to see the demonstration just as they could expect to see it as they did the work themselves. This is not possible under usual demonstration conditions. Further, the tape is replayable after each learning trial for individuals to check every detail in their own procedure and technique.

A commercial studio quality color capability is planned for incorporation in the new veterinary hospital. In the interim, the existing system will be used not only for acquiring the experience necessary to plan and operate TAL, but for actual production of as many types of programs as feasible.

In addition to special emphasis on the foregoing innovative types of learning resources, all conventional learning situations will be analyzed for application of the programmed learning interactions principle, and materials will be developed to aid or augment regular presentation. Subjects such as radiology are currently being prepared
for individual student study carrel presentation, as are programs
teaching the analysis of heart sounds and interpreting electro-
cardiograms. Units in preventive medicine are already being validated
as to their learning effectiveness. Steps in the development of
these units are flow-charted in figure 14.

METHODOLOGY AND IMPLEMENTATION. The elements described above are pre-
pared for selected units of instruction, validated with regard to
their learning effectiveness and placed in operation. Educational
specialists, in coordination with teaching teams and college depart-
ments, carry out the engineering and operations requirements for each
implementation. They also bear the main work load.

The spectrum of learning experiences options is being implemented
on a broad front where empirical results prove the effectiveness of
given learning modes. Undergraduate and graduate students of veter-
inary medicine are employed to perform routine tasks associated with
development efforts. (e.g. collecting and organizing content data for
CAL, TAL and autotutorial programs) Educational and technical consul-
tants will be hired to meet special guidance needs, (e.g. learning
program planning and evaluation; facilities and equipment planning.)

The presentation of learning materials, matched to learning exper-
ences, is in four general modes:

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non-conventional materials in veterinary medicine are those that are not
presently found in general use for large groups in lecture and demonstra-
tion (96 to 120 students), discussion and laboratory, and clinical
instruction (30 to 60 students).

The conventional non-individualized mode has received most preparation attention in the past. A shift toward the remaining three modes with primary emphasis on individualized modes is being made under this proposal.

EVALUATION. Overall effectiveness of the learning synergystem elements in the first year will be analyzed by using validated instruments to measure learning of curriculum units, and the use of questionnaires and interviews to determine student and faculty reactions. Most or all of the following additional considerations will be given to each mode and unit:

1) Degree of student and/or faculty use.
2) Cost of materials production in relation to hours of instruction, priority of objectives, type of packaging, and alternative types of materials.
3) Learning time required for a given learning mode as opposed to alternative modes.
4) Correlation of student performance in various learning modes with tested personality traits.
5) Nature of problems faced in administering the program.

SELECTIVE IMPLEMENTATION OF LEARNING SYNERGYSTEM ELEMENTS

Earlier in the chapter we looked at the Total Integrated Veterinary Education Program (TIVEP) as it has been planned and implemented thus far. We saw that incremental, that is, year by year development of the TIVEP has been, more or less mandated by a commitment to increase
enrollments, rather than the usual system approach of installing a pilot project by which to evaluate and modify for full application.

There was little learning materials development time available to the professors engaged in teaching, practice, and research. With only a part-time staff of graduate student education generalists and media specialists, and a lack of lead time in which to design and prepare optional learning experiences and associated materials for the newly organized learning objectives, made it necessary in 1969-1970 to continue with previous learning strategies, methods and resources, for the most part. These included the lecture-demonstration to the full class of 96 students and laboratories for 48 student-size groups. The TIVEP added discussion opportunities for group size of 32 students.

Only the first year of the curriculum was implemented, therefore many faculty were involved with both the previous discipline-oriented curriculum and the reorganized common medical principle and organ systems curriculum. The staff of the OVME was obliged to plan and begin services for the new as well as apply as much as possible of their slowly expanding services to the three years of the old program. The result was that the first year of the new program was not made viable in respect to most aspects of the intended individualized learning and interaction opportunities. For example, many of the scheduled discussions actually became lectures, although there were several outstanding exemplary interactions at the 32 student-size groups.

Discussion Groups. Highly favorable student comment on hour-by-hour learning activities was reported weekly to the teaching team leaders and members to reinforce the continuation and growth of the
discussion type and calibre of interaction. One interesting observation, made possible by formal feedback was the case of a professor who planned and used a modified Socratic method of questioning to have students explore the common principles of pathology. In the beginning most students noted that they would rather have the professor get on with a straight information passing and topic development effort. Before the sessions were over, a large majority had begun to realize that they were developing new attitudes and learning new approaches needed in mastering pathology. The students were obviously not prepared for this kind of interaction at the beginning of their course, and had to learn to cope with it.

One of the settings engineered to enable a group of 32 students to interact, where normal and pathological tissues needed to be examined close up, was what the writer terms "a stairwell symposium". The professor had a small table on which he could display the tissue specimens removed in an earlier necropsy. The table was placed in the well at the bottom of a stairway that bordered on three sides of the well, and the students stood on the stairs leaning over the rail. All 32 were within smelling distance. The writer recorded a number of these question and answer sessions in order to develop a standard strategy and inputs for later use in tutorial programs, including computer-assisted learning. The professor probed the students knowledge to explore the pathological condition of the tissue with much interaction.

Attempts during discussions to have students ask the questions to develop the topic with the professor serving as a responding resource
generally met with failure. Students seemed unable to fall back on a "twenty questions" strategy to probe, therefore the professor usually had to resort to the technique of raising academic questions or directing questions to students to answer.

The writer noted many instances following a class or laboratory presentation, where individual students were able to utilize the professor quite effectively for clarification of points, however. It was also noted that most professors tend to give much more information than the student asks for. This reduces the amount of interaction markedly.

**Patient Contact.** Implementing the concept of early student contact with the patient also produced favorable reactions from students. Some occasions were provided by taking discussion-sized groups of students to the clinical areas. These were not so successful because the clinical environment does not permit adequate observation and interaction by the larger-sized groups required by availability of teaching professors and the configuration of facilities. The more successful interactions were made possible by bringing particular patients to a discussion area where they could be seen by all and an extended interaction made possible. Certain professors were adept at planning and conducting these sessions. They were able to handle the patient, the audiovisual illustrations, and verbal interaction processes with finesse. Others were inadequate in one or more of these respects, and their effectiveness in interacting with students was only partial.

**Autotutorial Units.** An autotutorial program was designed to guide professors and the Learning Resource Center staff in their efforts
to develop learning units that were self-instructional, and that stressed interaction. The first two of six units that will comprise the program have been validated, and are being produced for distribution to the faculty for their self-instruction in the authoring of autotutorial materials. Figure 14 is a flow chart of the in-service autotutorial program.

Professor Enhancement.

In respect to the diffusion of exemplary techniques, team teaching has produced some emulation of other’s teaching among professors. However, one professor cannot usually copy successfully what another professor is very good in doing unless he adapts it to his own capabilities and style. Inservice orientation and planning can overcome gross deficiencies, but the final success of any given professor vis-à-vis interaction with students for learning is a very personal thing. The writer recommends that those things done well by a given individual be enhanced, and the inadequate areas be augmented. For example, if a professor makes excellent drawings, his product should be a substantial part of his teaching. Since the blackboard is a principal tool, make its use and viewing more dynamic by use of whiteboard and watercolor markers. If the voice is not strong, it must be amplified. A wireless microphone is essential to freedom of movement in laboratory and clinical situations, and for some lecture-demonstrations.

Development Rationale. What has been implied by the discussion above is that the learning synergystem is currently being implemented on an opportunistic basis. The factors include (1) student’s record of expression in relation to needs, wants, suggestions and praise or
Figure 14. Flow Chart of Steps for Developing Autotutorial Units in Veterinary Medicine (Prepared in collaboration with Joseph P. O'Rourke, 1970.)
condemnation, which are carefully evaluated; (2) professor awareness and willingness to overcome, develop and be assisted; (3) administrative, planning and services staff response in promptness and quality; (4) a planned step-by-step concentration of attention to selected areas to implement the sub-functions of the system, in a way that they make needed improvements now, yet integrate with other elements being implemented and to be implemented.

Each piece of work is done according to a set of criteria to guide productive and operating effort to a level of quality and quantity of the eventual capability of the fully-implemented learning synergystem, and in respect to the goals of the TIVEP. For example, in the SCOR plan, 35 mm 2x2 transparencies made in the past are evaluated and rejected or filed according to the establishing procedure, as time permits. All new work is done strictly in accordance with quality standards and procedures. As screening and productive efforts continue, they thus are made to yield the sets of learning materials that fit learning interaction designs, and also to serve as resources for distribution beyond the College.

The GLIM plan calls for student interacting with student. This is already taking place on a limited unstructured basis. So the first step to enhance this is to provide regular and increased opportunities for such interaction, such as places to eat for the "brown baggers" and those that use vending machines. Social activities, and even living in the same rooms and dormitories, are planned to increase interactions. This can be brought about partially by designing the learning facilities so that students have a home base study and learning
area that is close to learning resources including professors and even patients. They must also be close to laboratory areas and other interaction areas. Current plans for the College of Veterinary Medicine include a facility for basic medical sciences where the spatial relationships are considered as shown in Figure 15.

The second level of implementation that is being readied is having two students pursue the same interaction with the computer, rather than undertake the program individually. Other formalized student interactions include small group viewing of single concept films and video tapes. These experiences are now scheduled at odd hours but upon full implementation of the TIVEP, will be provided regular time in the schedule.

Meanwhile the students can begin to benefit from the interaction and simultaneously become oriented in learning to learn on a personal responsibility basis. The point should be emphasized that, if this latter outcome is made an objective, it must be the activity that is scheduled, not the student. However, the overall schedule must insure that students all have equal opportunity to avail themselves of the activity.

Conclusion. Application of the system approach to learning in veterinary medicine at The Ohio State University is as yet only partial, with attention being given to the implementation of single aspects of programs on an opportunistic basis. The existence of the overall design that is described in preceding pages permits each such single aspect to be prepared for integration into the eventual system as it comes into being.
Continuing insistence on development of learning objectives and valid criterion measures, the validation of learning materials and experiences, the use of quality standards and effective operating procedures, and continuing evaluation, is expected to culminate in a viable learning system.

Functional overlap of learning interactions (1) can be facilitated by learning environment design that brings physical facilities areas into juxtaposition or overlap (2).

Figure 15. Interactions and Spaces Relationships Planning for New Basic Sciences Facility in Veterinary Medicine at The Ohio State University.
CHAPTER SIX - IMPORT AND EMPHASES

We learn only what we apply. What precepts developed in the study have been applied? Where were we at the beginning of the project and where are we now?

**Preliminary Assessment of Effects of Program.** During the initial planning of an approach to a new veterinary medical education program, teaching was given much attention, just as it had been under the then-existing program. Under continued diffusion by the office of veterinary medical education, of the importance of learning as the dynamic for focus of attention, emphasis began to center on the learner: how much did he need to know at each step? What was the best sequence for introduction of concepts? What concepts needed to be taught concurrently? Each of these questions was answered by taking into consideration the entering capabilities of the learner, and the integration of concepts for ease of comprehension, and potential for immediate application of learning for reinforcement and transfer.

The learning process, rather than the teaching process, in other words, was the prime factor in the formulation of an approach to veterinary medical education.

The continued presence of education generalists with an eye for the learning resources requirements being generated by the plans laid by the Curriculum Coordinating Committee, under the chairmanship of Dr. C. Roger Smith (Bradford, 1970, p. 243) are evaluated and fed back
to the committee. Also, where the potential of proven methods and resources can benefit the plan, they are proposed.

This has the effect of establishing general goals to eventually be reached in respect to individualization of learning, increased realism in learning and anticipated extension of learning materials development and application. Faculty expectation in these aspects are continually reinforced by the persistent efforts of the education office staff to work with faculty members in the design and production of learning activities and materials toward these goals.

A number of self-instructing units have been prepared and validated for use. Teaching films and 2x2 slide sets have been produced and others procured for student self-tutoring activity. Computer-assisted learning and television lessons are available. Each of these units was selected to fulfill pre-stated learning objectives of the total integrated veterinary education program. Previously, explicit objectives were conspicuous by their absence.

The application of the system approach to the total veterinary education program has demonstrated the power of goal definition, and an orderly approach to a complex problem. Steps of analysis and synthesis that aided planning and development of the new curriculum, and the six year plan for resources to effect realization of the goals, are now generally accepted by participants as the way to evolutionize the educational program.

The main thrust of learning program development and implementation thus far has been that of consistently doing well what can be done well without undue technical considerations. Building confidence of
the faculty in the learning resource center staff to assist with learning materials design and production problems, has received utmost attention. A key aspect of this is immediate and effective response in solving problems and in serving every request that promotes the learner's welfare. This literally means going cheerfully the second mile to see that each learning activity is rightly served. This has been done consistently in fact, and has been the main reason, judged by professor and student comment, for a satisfying measure of success in the evolutionizing process.

Regarding specific application in respect to the learning syner-gystem proposed in this dissertation, the principal effects are yet to come. These will follow the refinement of objectives and their fuller translation into learning experiences for students in the interaction sense. Early evaluation and feedback indicates a very positive value position of faculty and students on the merits of the new program. Achievement of learning objectives and the degree of transfer of learning remain to be determined as we move into the second year of the program. Revisions brought about by appraisal of the findings for the first year will be validated under fire by the much larger entering class.

A published report of progress to date is planned for release in the first quarter of the calendar year 1971. A second report is planned for 1973. These reports will cover all significant aspects of the total integrated veterinary education program. The learning syner-gystem will be featured in the second report.
Restatement of the Problem and the Proposal. The problem we face, as stated in the introduction to this dissertation, is that of providing medical education of ever-increasing sophistication, through a variety of more realistic learning experiences, to large numbers of students, in less time than at present. We proposed that a systematic way to extend excellence in teaching and learning more consistently and persistently, was required.

Two aspects of the medical education program problem were identified as (1) curriculum (developed by Bradford, 1970) and (2) instruction (developed by the writer). A system approach was chosen for development of these aspects to meet changing needs in today's world.

The historical overview in chapter one attempted to establish the premise that exemplary changes have taken place in medical education in the past, but they were isolated, or were slow in being diffused, or passed from the scene with their instigators and practitioners. Our analysis of the context of medical education from 1946, through the present into the future, was based on major changes in the scientific world and society that gave rise to trends in medicine, therefore to needs in learning and curriculum. These needs were grouped under functions suggesting a system approach for their fulfillment, and organizational patterns for system operation were suggested.

A learning system for medical education was developed in chapter two and elements of that system were further identified in chapters three and four. Chapter five gave the initial considerations and experiences in applying the model to professional preparation of students in veterinary medicine at The Ohio State University.
The first part of this chapter assessed initial progress of the program and forecast a formal report on the implementation of the learning synergystem and its effects. This section will attempt to postulate the potential for broader application of the model to medical education generally, thus providing a possible answer to the problem undertaken by this dissertation.

Extending the Application of the Learning Synergystem. The content and application of learning in veterinary medicine and in human medicine are substantially the same. The principle difference lies in the number of species which must be dealt with in veterinary medicine, otherwise fundamental knowledge and skills are essentially identical, and are applied in comparable fashion. As time passes, each new medical discovery actually brings these fields closer together. Therefore, the learning system being developed and implemented in the College of Veterinary Medicine at The Ohio State University is acceptable for adoption in principle at any school of medicine.

The student enrollment has been increased on the basis of the revised program. It is planned for this number to double as the learning system is developed more fully and facilities are completed. This is to be done without any significant increases in the faculty and staff, yet the professional education of individual students is to be more pertinent to an anticipated variety of specialized need for practitioners. Whatever is judged as critical to the success of the program will be germane, at least in major respects, to other veterinary and human medical education efforts.
The ultimate applications implied by success of this type of individualized, largely self-tutored learning program, include (1) variable length programs for different rates of learning among students; (2) commonality of essential portions of a program with increased opportunity for pursuit of specialty beginning earlier, and concurrently with the core portion of the program; (3) entry into program when student is ready by virtue of possessing the prerequisite skills and knowledge, and at anytime not confined to entry with a large class; (4) mastering of selected portions of core program prior to entry; (5) increased mastery of essential skill-knowledge requirements for practicing the profession; (6) continued learning established in the graduate as a pattern of professional life; (7) continued interaction for assistance and consultation set as a way of operations professionally.

The learner oriented system approach described by the study likewise has implications for all professional learning programs and situations. The concept of providing multiple opportunities for interaction by individual learners is broadly applicable, as is the use of self-tutoring modules or subject content units that program the learners' activities. Whatever is learned through the continuing implementation of the learning system in veterinary preparation, should be of immediate value to a college of education for teacher preparation, to a school of law or social service, and others.

For example, preparing teachers for college level instructional duties is now mainly trial and error. The learning system approach proposed here would establish a program of objectives, criterion
measures and learning interaction activities, to develop the prospective professor in each needed capability to be a learning facilitator.

Any professional school can profit greatly from the learning system's attention to feedback of what is effective in learning and what is not. The validation of learning units, and the assessment of student progress are both required elements in any business-like approach to learning, and these are built in to the learning system as a matter of initial planning. The very role that professional students play in the evaluation of the program is also not only provided for by design, but in actual operation as well.

A professional school must minimize guesswork. The learning system sets up the means to count misses as well as hits, and to analyze the situation for determining required corrective action. It establishes mechanisms to help students to ask for help in learning. More significant to effective learning is the value of the proposed system in fixing the conditions for learning in the same way that the curriculum fixes certain outcomes, yet allows alternate routes to realize those outcomes. Routes are established; they are not merely permitted to happen if they will, and they are not dictated as the way to go.

Of special interest to the professional school is the extra-dimensional model of the learner that is hypothesized by this study. Opportunity for multi-variate learning experiences has the promise of uniquely developing each sophisticated learner to fuller potential. The model of the learner is demanding reason for systematically providing as many realistic learning experiences as feasible, with a number of alternates in modes or styles to pursue the activities leading to the
experiences. The goal is an autonomous learner for life, not an automated trainee, and every professional student is entitled to a splendid program that he can help to tailor to his own path of inquiry and re-discovery of his capacity to serve his fellowmen.
PRINCIPLES AND OBJECTIVES OF NEW CURRICULUM

Recognizing the vital need for more veterinarians to serve society in the many fields of practice, and further motivated by the tremendous increases in biomedical knowledge and the resulting requirement for more effective and efficient instruction, the faculty of the College of Veterinary Medicine initiated a highly innovative professional curriculum with the first-year class of 1969-70. The curriculum was given faculty approval after exhaustive study by faculty in consultation with educational experts. The result is a curriculum designed to assure each student the basic knowledge, skills and attitudes requisite to entering the profession of veterinary medicine, as well as some training in a speciality area of his choice.

Five general GUIDELINES directed the development of the new program:

1. The ultimate goal of the curriculum is to develop self-reliant individuals who are capable of identifying and solving problems in veterinary medicine.

2. The most important persons in the College are the students. Their discoveries about veterinary medicine determine the success of the College.

3. The focus of the curriculum is on animal disease, the way it differs from the normal state, its diagnosis, treatment and prevention.

4. The curriculum is designed to conserve faculty and student time, and to allow maximum flexibility to meet individual needs and interests.
5. The curriculum must be constantly evaluated and revised. Evolutionary change is dictated by continued dynamic change in all areas of biomedicine.

Three ORGANIZATIONAL PRINCIPLES were cited by the faculty as central to definition of the new curriculum:

1. A curriculum consisting of a blend of core and elective portions was decided upon to provide each student with a strong grounding in the fundamentals of veterinary medicine as well as an opportunity to begin development in a specialty area of choice.

2. Organ Systems are the foci around which core content is organized. The veterinarian never sees an isolated organ system and because many basic medical principles are common to all organ systems, parts of the core bring together common principles and emphasize the whole animal. The first two quarters of the curriculum are devoted to Common Medical Principles courses. Throughout the remainder of the curriculum, whole animal implications are stressed by organ system teams, and student clinical experiences are emphasized.

3. Team Teaching meets the need for interdepartmental cooperation in teaching organ systems. Faculty teams that teach in the curriculum also had major responsibility for shaping it into its present form. Team leaders together with a representative of the Student Curriculum Advisory Committee and educational specialists comprise the Council on Education. This group oversees and directs ongoing educational change.

Several EDUCATIONAL PRINCIPLES were also adopted by the faculty to complete their conceptualization of the curriculum:
1. **It is essential to have clear objectives**, and to communicate these to the student at the beginning of any learning experience.

2. **The most useful knowledge for the student is generative knowledge**: The most important experiences in the curriculum are those that stimulate the student to discover new knowledge.

3. **Principles, skills and attitudes rather than facts should be the focus of learning; facts are necessary to support the other learning domains.**

4. **Concepts should be progressively developed in breadth and depth throughout the curriculum; literal repetition should be avoided.**

**DESCRIPTION OF VETERINARY MEDICAL CURRICULUM**

Because veterinary medical services are delivered by general veterinary practitioners and specialists in many areas - for example, the farm animal practitioner, the bovine practitioner, the veterinary research scientists, the public health veterinarian, the equine practitioner, the pet animal practitioner, the veterinary radiologists, the veterinary surgeon, the veterinary ophthalmologist, the laboratory animal practitioner, and others - it was decided that the curriculum should be more flexible. This is accomplished via core and elective portions of the curriculum.

Basic veterinary medical knowledge is the central theme in the Core. The Core encompasses all that each student must master while earning the D.V.M. degree. It requires approximately 67 percent of 12 academic quarters. One aim in cutting down the content of required courses by integration and avoiding unnecessary duplication was to provide the time for students to obtain full benefit from attending a university.
Students will be encouraged to mix with other students and faculties in other colleges in order to become familiar with developments in animal science, biological science, bioengineering and other related medical and environmental sciences.

The Core program is largely presented on an organ system basis. It begins, however, with a portion called Common Medical Principles (CMP). The common medical principles include that scientific knowledge and those intellectual and technical skills necessary for a student to launch an intensive study of animal disease on an organ system basis. Following CMP is the study of animal diseases through programs identified as 1) the cardiovascular system, 2) the respiratory system, 3) the urinary system, 4) the nervous system, 5) the endocrine system, 6) the reproductive system, 7) the integumentary system, 8) the musculoskeletal system, 9) the hemic-lymphatic system and 10) the digestive system. Each of the ten organ systems is interdisciplinary and focuses upon the particular anatomic, physiologic, pharmacologic, pathologic, microbiologic, parasitologic, and clinical science necessary for the students' understanding of normal and abnormal structure, function and chemistry as it relates to basic treatment and prevention of diseases of that system. In addition to the common medical principles and organ system approach to animal diseases, the Core curriculum includes in the third year, clinical experiences in various areas of the veterinary hospital, together with integrated laboratories conducted by the organ system teams. The fourth year is designed for students to explore their individual interests in more detail as they prepare for a career in one of the various aspects of veterinary medicine.
Our faculty recognize that knowledge personally acquired by individual effort has the greatest value and the most permanence. Throughout his career, the veterinarian teaches himself. Within college, the things learned best are self taught. As the College faculty and students develop more learning materials and procedures individual learning in the laboratories, library and hospital will become the principal way of life of the veterinary student. Student participation in the continued development of the educational program is encouraged, solicited and vital to a program of study as dynamic as modern veterinary medical science.

### CURRICULUM IN VETERINARY MEDICINE

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CMP V - Comparative Biology of Disease | 11           |
| Veterinary Medicine (College of) 551  
CMP VI - Basic Elements of Veterinary Medical Practice and Hospital Orientation | 3/21         |

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The Cardiovascular System | 6            |
| Veterinary Medicine (College of) 601  
The Respiratory System | 6            |
| Veterinary Medicine (College of) 602  
The Urinary System | 6            |
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The Nervous System | 12           |
| Veterinary Medicine (College of) 604  
The Endocrine System | 5            |
| Veterinary Medicine (College of) 562  
CMP VI - Basic Elements of Veterinary Medical Practice and Hospital Orientation | 2            |
| Elective | 3/22         |
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#### FOURTH YEAR

During the three quarters of the fourth year, students are expected to elect two quarters of clinical or applied elective packages (600 or 700 course numbers) which total a minimum of 30 credit hours. An additional 31 credit hours of elective courses are required for graduation. As many as 25 of these electives may be taken during the first nine quarters of study. It is expected that each student will select an additional 12-15 elective credit hours during the fourth year. The elective program for the fourth year will be determined in consultation...
The total required credit hours for graduation with the degree Doctor of Veterinary Medicine will remain unchanged (228 credit hours).

**DESCRIPTION OF REQUIRED CORE COURSES**

**COMMON MEDICAL PRINCIPLE COURSES**

**COURSE NOS:** Veterinary Medicine (College of) 510, 520, 521, 530, 531, 540, 550, 560-564.

**NAME:** Common Veterinary Medical Principles I - VI

**DESCRIPTION:** The practice of veterinary medicine is dependent upon advances in science. Every method of prevention, diagnosis and treatment of disease is the outgrowth of scientific research. The Common Medical Principles section of the curriculum familiarizes the student with the language, work, concepts and skills of basic comparative medical science. The subjects of anatomy, physiology, pathology, microbiology, parasitology and biochemistry are integrated into a broad interdisciplinary introduction to veterinary medicine. The program emphasizes those common elements indispensable for study of animal diseases on an organ system basis. There exists a vast scope of knowledge in the sciences relevant to the practice of veterinary medicine. The application of wise discrimination has resulted in the presentation of only a minor fraction of all that is known.

The Common Medical Principles section is subdivided into 6 units. The titles of components of Common
Medical Principles are: CMP I - Animals and Their Environment, CMP II - Comparative Topographic Anatomy, CMP III - Comparative Structure and Function of Tissues, CMP IV - Comparative Cellular Biology, CMP V - Comparative Biology of Animal Disease and CMP VI - Basic Elements of Veterinary Medical Practice and Hospital Orientation.

CMP I - (Veterinary Medicine - College of - 510) Animals and Their Environment includes acconsideration of 1) the composition of the whole animal body and sizes of the main body compartments from a medical viewpoint, 2) the external and internal environments and the concepts of homeostasis, biological variation and measurement and 3) animal behavior. The whole organism is considered as an indivisible anatomic and functional unit.

CMP II - (Veterinary Medicine - College of - 520, 521) Comparative Topographic Anatomy deals with the form, relationship and mechanical functioning of component parts of the body. The course incorporates a study of living as well as embalmed animal bodies and employs techniques of the surgeon, radiologist and internist for the acquisition of useful anatomical concepts and ideas. Anatomical science is viewed as a dynamic, significant and constantly useful source of knowledge pertinent to modern veterinary medicine.
CMP III - (Veterinary Medicine - College of - 530, 531)
Comparative Structure and Function of Tissues deals with early development and its control and the structure of four functionally distinct tissues. It is interdisciplinary in nature combining embryology, histology, endocrinology and physiology.

CMP IV - (Veterinary Medicine - College of - 540)
Comparative Cellular Biology deals with interrelationships between function, and structure at the cellular level. Hydrogen ion control, enzymes, energetics and regulations of metabolism and growth are placed in perspective for students of comparative medical science. Subjects treated summarily will be expanded and intensified at other appropriate loci in the curriculum.

CMP V - (Veterinary Medicine - College of - 550)
Comparative Biology of Animal Disease is an integrated presentation of general pharmacology, pathology, pathophysiology, parasitology and microbiology. It aims to establish concepts necessary for understanding the interactions between disease producing agents, body systems, tissue cells and subcellular units and drugs which modify tissue response and/or body history of disease producing agents.

CMP VI - (Veterinary Medicine - College of - 560-564)
Basic Elements of Veterinary Medical Practice and Hospital Orientation. An introduction to the importance of medical histories, physical examination, and handling
of small and large animals in disease recognition is offered. In addition, methodology of special laboratory procedures are introduced to assist in arriving at a specific diagnosis. Therapy both medical and surgical is discussed. This includes operating room technique, and pre and post-operative patient care. Student participation in laboratory and clinical exercises is included. The diagnostic process and therapeutic procedure as applied to animal patients are the central theme of the learning program.

ORGAN SYSTEM COURSES

COURSE NO: Veterinary Medicine (College of) 600
NAME: The Cardiovascular System
DESCRIPTION: General considerations of the importance of the CV System to body function and a comparison of disease states in man and animals will be followed by specific anatomic and physiologic details of the heart and vascular system. This information will precede considerations of arrhythmias, reactions of the heart to abnormal flow, syndromes of circulatory failure, and congenital heart disease. Pathologic states affecting the various portions of the heart and the blood and lymphatic vessels will be presented from the standpoint of etiologic agents, physiologic alterations, diagnostic methods and therapeutic approaches.

COURSE NO: Veterinary Medicine (College of) 601
NAME: The Respiratory System
The significance of respiration to body function and the comparative importance of diseases of the respiratory system will precede a detailed anatomic and physiologic consideration of the respiratory passages and lungs. The study of pathological changes in respiratory disease will include a detailed consideration of causes of disease (including hereditary and congenital, parasitic, allergic, poisonous, physical, circulatory, metabolic and nutritional, neoplastic and infectious) and will be integrated with discussions of the diagnosis and therapy of respiratory disease.

Veterinary Medicine (College of) 602

The Urinary System

Structure and function of the kidney and urinary passages will precede a general discussion of the role of the kidney in regulating homeostasis. Etiologic agents producing disease states and a detailed discussion of structural changes produced by these agents will be followed by the chemical changes which result in altered homeostasis and the diagnostic methods employed in diseases of the urinary system. The treatment of disease and the alteration in homeostasis will be given special attention and clinical patients will be used to exemplify the importance of kidney disease and proper renal function.

Veterinary Medicine (College of) 603

The Nervous System
DESCRIPTION: The development, structure and function of the central and peripheral nervous system and of the organs of special sense will be presented and followed by the reactions of these organs to injury. Neurologic alterations will be evaluated by neurologic examination, radiography, myelography, ventriculography and electroencephalography. Etiologic agents causing important diseases of the nervous system together with the pathogenesis, pathophysiology, diagnosis, prevention and treatment of these diseases will be discussed and illustrated. Examples of neurologic disease in clinical patients will be used for clinical discussion periods.

COURSE NO: Veterinary Medicine (College of) 604

NAME: The Endocrine System

DESCRIPTION: General concepts of endocrinology and an introduction to endocrine and metabolic diseases will precede the presentation of structure and function of the endocrine organs and neuroendocrine system. The important disease problems which involve the endocrine system of domestic and laboratory animals will be discussed from etiologic, pathogenic, pathophysiologic and therapeutic aspects. The concept of stress and the pharmacodynamics of hormone therapy will be discussed. Each endocrine organ (hypophysis, adrenal, thyroid, parathyroid, pancreas and pineal) will be considered in detail from the standpoint of specific disease problems and how
these perturbations interrupt normal homeostatic mechanisms.

COURSE NO: Veterinary Medicine (College of) 605

NAME: The Reproductive System

DESCRIPTION: Sequenced immediately following the endocrine system (Veterinary Medicine - College of - 604) hormone regulation within the body will be completed by studying the structure and function of the ovaries and testicles together with the associated sex organs. The obstetrical portion of this system will be concerned with conception, embryology, variations in placentae, gestation periods and maternal behavior in the various species as well as inherited defects in the different species. The gynecologic considerations will consist of diseases of the two sexes which prevent oogenesis, spermatogenesis, conception, embryogenesis or birth of the fetus. Etiologic, pathogenic, pathophysiologic, therapeutic and preventive aspects of these disease will be presented. Clinical patients and herd problems will be used to illustrate the disease conditions.

COURSE NO: Veterinary Medicine (College of) 606

NAME: The Integumentary System

DESCRIPTION: The structure and function of skin, primarily as it relates to protection, will be presented. The important diseases of skin and adnexae, particularly the infectious and parasitic diseases and the manifestations of hormonal imbalance will be presented in detail from the
etiologic, pathogenic, pathophysiologic and therapeutic aspects. Species variations in susceptibility to disease producing agents will be discussed. Clinical patients will be used in laboratories to illustrate the disease states.

COURSE NO: Veterinary Medicine (College of) 607
NAME: The Musculoskeletal System
DESCRIPTION: The structural and functional interrelationships of muscles and bones as they pertain to support, protection and locomotion will be presented. Congenital and acquired diseases from the standpoint of etiologic, pathogenic, pathophysiologic, diagnostic and therapeutic approaches will be discussed. Special attention will be directed to traumatic diseases of the skeleton, relying heavily on radiographic interpretation and therapeutic approaches. Clinical patients will be used to illustrate the disease conditions affecting these two tissues.

COURSE NO: Veterinary Medicine (College of) 608
NAME: The Hemic-Lymphatic System
DESCRIPTION: The structure and function of hemic and lymphatic tissues will be followed by a consideration of hemopoiesis and lymphopoiesis. The diseases which alter both formation and function of these tissues together with reaction of these tissues to disease states affecting primarily other organ systems will be presented from the etiologic, pathogenic, pathophysiologic,
diagnostic and therapeutic approach to diseases of the hemic-lymphatic system. Special attention will be directed toward immunologic diseases.

COURSES NO: Veterinary Medicine (College of) 609, 610
NAME: The Digestive System
DESCRIPTION: The major emphasis of the program is a thorough consideration of selected principles of comparative gastroenterology. Appropriate interdisciplinary study of relevant physiology, pathology, pharmacology, microbiology, parasitology, medicine, surgery and preventive medicine is applied. In general, the diseases are divided according to the principal way they are managed clinically, i.e. as surgical, medical or those which are treated mainly as preventive diseases.

MISCELLANEOUS REQUIRED CORE COURSES

COURSE NO: Veterinary Medicine (College of) 640
NAME: Organ System Laboratories
DESCRIPTION: An opportunity is available in the second quarter of the third year for the ten organ system teams to re-emphasize some of the more important diseases pertaining to their system, with clinical cases material, correlating the information pertinent to their system with alterations which affect the other organ systems. It will provide the teams with an opportunity to put their organ system in perspective with the body as a whole. There will be a total of one 2-hour laboratory per student for each team during the quarter.
COURSE NO: Veterinary Preventive Medicine 609
NAME: Preventive Medicine and Public Health
DESCRIPTION: Regulations concerning food handling based on scientific principles and requirements for compliance with regulations by food processing plants and food establishments will be presented. The epidemiologic approach to animal health problems will be emphasized including government regulations, control programs and eradication procedures.

COURSE NO: Veterinary Clinical Sciences 601, 602, 603
NAME: Clinical Conference
DESCRIPTION: A three-quarter sequence, two hours each week, when organ system teams or clinical disciplines will be responsible for sponsoring a comprehensive conference utilizing both faculty and students to further illustrate the importance of considering the entire organism when diagnosing or treating disease conditions. These times are provided to present the best of selected clinical case material to the entire third year veterinary class, other veterinary students and faculty in order that they might benefit from the in-depth discussion of the patient which should include consideration of all organ systems as well as species variations.

COURSE NO: Veterinary Clinical Sciences 610, 620, 630
NAME: Core Clinical Experience
DESCRIPTION: Third year veterinary students will receive clinical instruction in different areas of the veterinary
hospital as part of the Core Curriculum. These areas are divided by species and discipline, rather than organ system. It is understood that the areas may be divided into organ system approaches to medicine or surgery as specialty programs evolve. The students will devote approximately one month, in one block of time, in each of the following nine areas:

1) Small animal receiving and outpatient clinical experience
2) Small animal medicine
3) Small animal surgery
4) Radiology
5) Large animal surgery
6) Large animal medicine
7) Ambulatory clinical experience
8) Preventive medicine and public health
9) Applied pathology

COURSE NO: Veterinary Clinical Sciences 650, 651
NAME: Surgical Laboratory
DESCRIPTION: Application of the principles and techniques of anesthesia and aseptic surgery will be emphasized in a sequence of surgical exercises over two non-consecutive quarters. The use of prepared specimens and representative species of animals will provide a variety of surgical experiences for each surgical team. The student will have opportunity to develop technique and judgment in surgery and patient management which will prepare
him for more active participation in clinical surgery.

SENIOR CLINIC - ELECTIVE PROGRAM

The fourth year in the veterinary medical curriculum has been designed to maximize opportunity for students to concentrate on primary areas of interest. A faculty advisor compatible with the students' principal areas of interest will be assigned by the College Office of Academic Affairs. Together, student and advisor, will select an appropriate elective program for the year.

The elective programs are coherent programs of study designed to best prepare a student for beginning a career in general veterinary medical practice, veterinary public health, or comparative medical science. The electives are grouped into quarterly packages which reflect the nature of the specialty area, the specific needs of the student, and which together insure a meaningful study of animal patients. After declaring a major, each student will spend at least two quarters of the senior year in a program of appropriate packaged electives. Students electing a given major will be pursuing common courses of study in the veterinary hospital, although an appropriate amount of the time may be spent in other college approved courses related to the major program.

One quarter will be available for students, in consultation with their advisor, to pursue studies in any department in the university.
PHASING OF THE NEW VETERINARY MEDICAL CURRICULUM

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<tr>
<td>CMP I</td>
<td>Nervous</td>
<td>Clinics</td>
<td>1/2 Clinical or</td>
</tr>
<tr>
<td>CMP II</td>
<td>Endo.</td>
<td>Clinic Conf.</td>
<td>Applied</td>
</tr>
<tr>
<td>CMP III</td>
<td>CMP VI</td>
<td>Surg. Labs.</td>
<td>Electives</td>
</tr>
<tr>
<td>CMP IV</td>
<td>Elective</td>
<td>P. Med.</td>
<td>1/2 Other</td>
</tr>
<tr>
<td>CMP VI</td>
<td></td>
<td>Elective</td>
<td>Electives</td>
</tr>
<tr>
<td>CMP II</td>
<td>Reprod.</td>
<td>Clinics</td>
<td>1/2 Clinical or</td>
</tr>
<tr>
<td>CMP III</td>
<td>Integ.</td>
<td>Clinic Conf.</td>
<td>Applied</td>
</tr>
<tr>
<td>CMP V</td>
<td>CMP VI</td>
<td>System Labs.</td>
<td>Electives</td>
</tr>
<tr>
<td>CMP VI</td>
<td>Elective</td>
<td>Digest.</td>
<td>1/2 Other</td>
</tr>
<tr>
<td>Cardio.</td>
<td>Musculoskel.</td>
<td>Clinics</td>
<td>Elective</td>
</tr>
<tr>
<td>Respir.</td>
<td>Hemic-Lymph</td>
<td>Clinic Conf.</td>
<td>Elective</td>
</tr>
<tr>
<td>Urinary</td>
<td>CMP VI</td>
<td>Surg. Labs.</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td>Digest.</td>
<td>Elective</td>
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</tbody>
</table>

DISTRIBUTION OF CORE AND ELECTIVE TIME

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>QTR. 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective 35%</td>
<td>Elective 37%</td>
<td>Elective 33%</td>
<td></td>
</tr>
<tr>
<td>Core 65%</td>
<td>Core 63%</td>
<td>Core 67%</td>
<td></td>
</tr>
<tr>
<td>QTR. 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective 22%</td>
<td>Elective 32%</td>
<td>Elective 35%</td>
<td>Clinical or Applied</td>
</tr>
<tr>
<td>Core 78%</td>
<td>Core 68%</td>
<td>Core 65%</td>
<td>Electives 50%</td>
</tr>
<tr>
<td>QTR. 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective 47%</td>
<td>Elective 35%</td>
<td>Elective 33%</td>
<td>Other Electives 50%</td>
</tr>
<tr>
<td>Core 53%</td>
<td>Core 65%</td>
<td>Core 67%</td>
<td></td>
</tr>
</tbody>
</table>

The required core curriculum includes:

Common Medical Principles (CMP), Organ Systems, Preventive Medicine, Core Clinical Experience, Surgical Laboratories, Systems Laboratories.

In addition to core courses, 61 hours of elective courses are required.
The purpose of this paper is to present the urgent need for outside financial assistance by the College of Veterinary Medicine for the development of a College Learning Resource Center.
The construction of a new nine million dollar Veterinary Hospital for the Ohio State University College of Veterinary Medicine is scheduled for completion in 1972. In addition to modern medical facilities for conducting veterinary clinical instruction, the new facility includes specially designed rooms and work areas for the development of a highly versatile Learning Resource Center. Provisions have been made for 1) medical photography, illustration and closed circuit television production, 2) an autodidactic laboratory and 3) an audiovisual classroom. These will operate in coordination with 4) the Veterinary Medicine Library to complete the Learning Resource Center.

The Learning Resource Center is conceived as the ultimate in assistance to the learner for learning and to the teacher for teaching. The primary purposes of the Learning Resource Center are to produce learning materials and to provide functionally designed space and facilities in which students use materials to effectively reach learning goals. Unfortunately, appropriated funds are not available to the College of Veterinary Medicine to adequately equip and fully develop the Learning Resource Center. Outside financial assistance is urgently needed to procure special equipment for the Autodidactic Laboratory and the Audiovisual Hall.

The four major components of the Learning Resource Center are described on the following pages to show the functions and relationships of each within the Learning Resource Center.
Photography, Illustration and Television Production

The college presently has an active program of medical illustration with two full time illustrators to produce a wide variety of learning materials for use on slides, in films, in television, and in special demonstrations. This need is expected to grow considerably as there is more and more demand for individualized study materials.

A well-equipped photography operation also supports learning materials production with two full-time medical photographers and a clerk for indexing, storage and retrieval. Still and motion picture photography facilities are equipped to record medical phenomena from time lapse photomicrography of cell growth to herd behavior. Expanded illustration and photography capabilities will be supplemented in the new hospital by an extensive program of live and taped television, which will make possible instantaneous distribution of important learning events to all areas of the hospital.
The second aspect of the Learning Resource Center that will help answer the problem of individual attention for the large group situation is systematic coordination of large, medium and small group instruction in the Autodidactic Laboratory. Students will be able to review large group presentations via audio and video tape, and they will have assignments for individual and small group study that will examine those aspects of the subject which could not be efficiently treated in the large group.

**The Autodidactic Laboratory**

The Autodidactic Laboratory will be a dynamic library of audio, visual, and audiovisual materials. It is designed to accommodate 281 veterinary students in individual and small-group study. Four basic categories of learning environment will be provided: 1) learning carrels; 2) computer simulation areas; 3) television viewing areas; and 4) conference-office areas.
Conference-Office Areas

Three areas will be used as "home base" for teaching assistants who will always be available in the autodidactic laboratory. These areas will have a small desk and reference shelf and a small conference table to accommodate eight students. In addition, each area will have a computer terminal for use of small groups of students, or for the use of teaching assistants and faculty to author materials.
Learning Carrels

Learning materials designed to allow the individual student to learn at the rate he can best learn will be developed for use with four different equipment configurations in carrels. Audio tape controls in each carrel will allow the student to select a particular audio program, which will then be duplicated at high speed onto his remote tape deck. Each student will have full control of the deck assigned to his carrel so he will be able to go back for review or skip a section he already knows. This audio source will often be the professor guiding the student through a lesson just as though he were being tutored. The four types of carrels are distinguished by the additional learning equipment in each one: 1) 35mm slide projector 2) 8mm film projector 3) multi-purpose (slide and film) 4) computer terminal.

Carrels with audio and 35mm slide capabilities will be used for learning experiences which involve slides coordinated with tape or with a written outline. Other materials such as microscope slides, models, bones, and x-rays may be used in these carrels. With these materials a student might review previously learned material, learn material to which he had never been exposed, or review and reinforce learning that had been presented earlier in lecture, lab or seminar.

Carrels with audio and 8mm film capability will function in much the same way as those with 35mm slide capabilities. Film cartridges will be checked out at a central area by the student and taken to any carrel designated for film use (as will slide trays and other materials). Again, an audio tape may direct the student’s learning, and he may work with written materials, models, and other aids as part of the total learning experience.
Multi-purpose carrels will include equipment for all of the functions discussed above. These carrels will be used when a single learning program requires audio, slides, film and x-rays. Because good individual learning experiences seldom extend more than 40 minutes, and because there is a limit to the density of material that can be presented during that time, it is expected that there will be relatively few programs involving all of the above media. For this reason relatively few multi-purpose carrels are proposed.
Two areas are designated for computer simulation. Each will accommodate as many as five students at one time in highly interactive, realistic experiences which will closely approximate the experience of practitioners. Students will assume different roles in solving diagnostic and therapeutic problems designed to test their ability to apply knowledge at various levels of complexity. The computer will be programmed to manage these learning experiences and to react realistically to the students' inputs, but not to control the situation toward any predetermined result. That is, if a student favors a decision that would prove fatal to the patient, he will be allowed to make that decision and to experience the consequences.
**Television Viewing Areas**

Ten areas will be designed for groups of eight students and one instructor to view and discuss closed circuit television presentations. These areas will have two-way voice communication with the television control area so that a video tape can be requested at any time for distribution to one or more viewing areas. Twenty-three inch color monitors will provide ideal viewing conditions for the limited number of students, and moveable tablet-arm chairs will provide the capability for an instantaneous seminar before or after a presentation.
The Audiovisual Hall or classroom is a facility which will provide effective learning experiences for as many as 256 students simultaneously. It will include integral seating units to accommodate student microscopes and to provide adequate work surface. Demonstrations of medical practices and procedures will be done on stage and displayed to students using a color television projector. Remote control of studio, house lighting, slides and film will also be available to the professor.

The Audiovisual Hall

Research has shown that no one group size is ideal for all learning situations. Often initial exposure to concepts and skills, as well as demonstration of laboratory and clinical phenomena can be done most efficiently in very large groups. The major objection to traditional large-group teaching is the fact that attention cannot be given to the individual learner. The Learning Resource Center deals with this problem in two ways. First, a Student Response System is part of the Audiovisual Hall. This system provides five response buttons at each student position. The instructor may ask a question any time in the course of a lecture or demonstration to see how well the students are following. Each student indicates his response by pressing a button, and the instructor immediately sees how many students give each response. He can then modify the direction of his presentation as indicated by the responses. In addition, the response system will give the instructor a detailed account of each student's answers for day-to-day analysis of his progress.
The Veterinary Medicine Library will continue to be an important facility for student interaction with learning resources. The library seats 150 students and has a collection of over 20,000 volumes. Specially equipped learning carrels are presently being used for radiographic anatomy, interpretation of heart sounds and other selected subjects. Although much of the programmed audiovisual learning will be done in the Autodidactic Laboratory when it is completed, the library will continue to be the major source of printed references, and a major substation for autodidactic learning.
APPENDIX C

LEARNING RESOURCE CENTER BUDGET 1970-1971

AND EXTRACT FROM SIX-YEAR PLAN 1971-1972

237
LEARNING RESOURCE CENTER BUDGET 1970-1971

This budget is based on experience data from 1969-70, on projected needs, and on anticipated available funds to total $32,000.

<table>
<thead>
<tr>
<th>X 100 Consumables</th>
<th>TOTALS</th>
<th>QUARTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Illustration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X 110 (General)</td>
<td>800</td>
<td>320</td>
</tr>
<tr>
<td>X 111 (John Doe)</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Photography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X 120 (General)</td>
<td>8,900</td>
<td>3,800</td>
</tr>
<tr>
<td>X 121 (John Doe)</td>
<td>500</td>
<td>250</td>
</tr>
<tr>
<td>Television</td>
<td></td>
<td></td>
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<tr>
<td>X 130</td>
<td>2,000</td>
<td>800</td>
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<tr>
<td>Support Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X 140 (General)</td>
<td>600</td>
<td>240</td>
</tr>
<tr>
<td>X 141 (John Doe)</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>X 200 Equipment</td>
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<td></td>
</tr>
<tr>
<td>X 210 Illustration</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>X 220 Photography</td>
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<tr>
<td>X 230 Television</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>X 240 Support Services</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$8,300</td>
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</table>

Equipment will be purchased item by item as required for the educational program.

<table>
<thead>
<tr>
<th>X 300 Out-of-College Services</th>
<th>TOTALS</th>
<th>QUARTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illustration X 310</td>
<td>400</td>
<td>80</td>
</tr>
<tr>
<td>Photography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X 320 (General)</td>
<td>2,800</td>
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<td>X 321 (McAlister Blanket)</td>
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<td>X 322 (Malloy Blanket)</td>
<td>500</td>
<td>250</td>
</tr>
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<td>X 323 (Eonocolor Blanket)</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>X 324 (Chambers Blanket)</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>Television X 330</td>
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<tr>
<td>Support Services X 340</td>
<td>2,110</td>
<td>830</td>
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<tr>
<td>X 341 (Vehicle)</td>
<td>990</td>
<td>180</td>
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<tr>
<td>Travel X 400</td>
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</tr>
</tbody>
</table>

Grand Total $32,000
Explanation of 1970-71 LRC Budget Sheet

**Consumable** budgets must be used for supplies that are used in the operation of LRC service areas.

**Equipment** budgets must be used for items submitted, or approved by Aiken and Bradford.

**Out-of-College Services** budgets must be used for laboratory, duplicating, repair or other types of services rendered by non-college organizations. Specifically, photography blanket orders are for processing or other lab services rather than supplies.

**Special Considerations:**

*X320 General Photo Out-of-College services*—This category is for purchase of commercially produced films and for film lab charges that are not covered by one of the blankets (X321, 322, 323, 324)

*X340 General Support Services Out-of-College services*—This category is for special requirements brought to our attention by faculty during the year, and for rental fees incurred from TAL.

*X400 Travel*—All travel requests will be screened carefully on an individual basis by Smith and Bradford.

All requests may be cleared through the OWM with Aiken or Bradford. Funds are scarce this year and it is possible that priorities may force changes in the proposed quarterly allocations during the year.
Learning Resource Center

The Learning Resource Center (L.R.C.) program consists of the preparation, indexing, storage, retrieval and maintenance of all audiovisual materials and equipment used by all departments in the College of Veterinary Medicine. At present the program is divided into four sections and locations. Medical photography is located in the Veterinary Clinic; medical illustration is located in Goss Laboratory; very modest television and general support sections are housed in Sisson Hall. Upon completion of the new Veterinary Hospital in the spring of 1972, medical photography and medical illustration will be combined and supplemented by an extensive program of live and recorded television which will make possible instantaneous distribution of important learning events to all areas of the college.

Support services will expand by demand with implementation of each year of the new curriculum, and the requirements for using audiovisual equipment for both teacher-directed and student-actuated learning increase.

Medical illustration presently has two medical illustrators and one graphic artist. The existing workload is such that the present staff is working at maximum capacity. As faculty increases, workload will increase. Motion pictures for teaching veterinary medicine not only require static medical illustration, but all animation sequences must also be prepared by medical illustrators, and the graphic artist is required for charts, titles, and graphs. Audiotutorial programs, television production and computer-assisted learning require medical
illustrations and graphics. Working space will not become available for further substantive increases until 1972. Capability for medical models is planned for development by 1972-73.

Medical photography is subject to the same conditions as illustration. Existing staff, working to capacity, include two medical photographers, a technician and a clerk-typist. Again, lack of working space prevents much expansion until 1972. Demand for photomicrography is now at a level that acquiring equipment capability is being projected for 1971-72. Capabilities for 1972-73 include equipment generated by the new hospital, plus photomicrography, radiograph scanning photography and in-house color printing. Beyond are anticipated requirements for animation and other motion picture production capabilities.

Medical television capability is being developed cautiously. Present use of black and white, good quality, yet inexpensive recording and monitoring of laboratory or lecture demonstrations, editing and playback is now at maximum capacity, with several areas and applications having to be neglected. Operational capacity is presently being provided by personnel of the OVME, plus the audiovisual coordinator and his assistant in support services. There is a pressing need for color television for: 1) transmission from cameras in the new veterinary hospital, Goss Laboratory and Sisson Hall to a central recording and distribution point, thence to reception at learning stations, 2) film and slide projection, switching and special effects, 3) recording and playback of storable programs.

Color television with quality definition is planned for acquisition in three phases. Phase I will proceed beyond present black
and white capability, to include a mobile color system for origination, recording and viewing in Goss Laboratory, Sisson Hall and the temporary veterinary clinic in 1971-72.

The new veterinary hospital installation is to provide for studio program production recording on two-inch tape and playback, live and recorded transmission among facilities and to classrooms and student carrels, to be achieved in Phases II and III. Phase II will be the basic installation, in 1972-73 which will develop a limited operational capability of the general system, including one-half of the student viewing stations. Phase III in 1973 and beyond will provide for full operational capability with completion of student viewing stations and expansion of origination, transmission and receiving.

Support services provide technical and administrative services required in support of educational equipment and facilities in the College. Present services include 1) planning and implementing new audiovisual equipment systems, 2) transporting audiovisual equipment and materials intra-college and intra-university, 3) maintaining and provisioning audiovisual equipment, 4) operating special purpose equipment, 5) conducting inservice orientation on new audiovisual systems, 6) laminate engraving, 7) temporary, experimental construction, modification and installation of study carrels and associated equipment, 8) mimeographing, 9) film rental and procurement and maintenance, 10) audiotape reproduction and maintenance. Staff includes an audiovisual coordinator and one technical assistant, plus two work-study students. A van is rented to provide for equipment and materials haulage and distribution.
Increasing demands for services are expected to make an additional work-study student and a clerk-typist necessary by 1971-72.
A. Learning Resource Center Personnel

1. Medical Illustration
   - Chief Medical Illustrator: 100 hours, $10,200, $10,200, $0
   - Medical Illustrator: 100 hours, $9,000, $9,000, $0
   - Graphic Artist: 100 hours, $8,000, $0, $0

2. Medical Photography
   - Chief Medical Photographer: 100 hours, $9,000, $9,000, $0
   - Medical Photographer: 100 hours, $7,800, $7,200, $600
   - Photographic Technician: 100 hours, $6,800, $6,800, $0
   - Clerk-Typist: 100 hours, $5,200, $5,200, $0

3. Medical Television
   - Audiovisual Coordinator: 50 hours, $3,400, $3,400, $0
   - Audiovisual Technical Assistant: 50 hours, $3,200, $0, $0

4. Support Services
   - Audiovisual Coordinator: 50 hours, $3,400, $3,400, $0
   - Audiovisual Technical Assistant: 50 hours, $3,200, $0, $0
   - Student Work-Study (3): 20 hours, $500, $0, $1,500
   - Clerk-Typist: 100 hours, $5,200, $5,200, $0

   Personnel Total: $16,500

B. Equipment

1. Medical Illustration: $5,145
2. Medical Photography: $59,800
3. Medical TV: $114,825
4. Support Services: $10,085
5. Autodidactic Lab. AV-Hall: $510,917

   Equipment Total: $700,772

C. Alteration and Renovations

   None anticipated

D. Space Requirements

   Working space needed for operation of central duplicating equipment.
E. Operating

1. Consumables
   a. Medical Illustration 2,000. 1,000. 1,000.
   b. Medical Photography 12,000. 9,000. 3,000.
   c. Medical TV 9,000. 5,000. 4,000.
   d. Support Services 1,500. 1,000. 500.

   Category Total 8,500.

2. Services
   a. Medical Illustration 400. 100. 300.
   b. Medical Photography 6,000. 4,000. 2,000.
   c. Medical TV 1,500. 1,000. 500.
   d. Support Services 1,600. 100. 1,500.

   Category Total 4,300.

F. Travel

Funds in this category are for travel of professional staff to broaden their capabilities for serving the many specialized needs of the medical faculty.

1. Medical Illustration (2) 400. 200. 200.
3. Medical TV (1) 200. 200. 0.
4. Support Services (1) 200. 100. 100.

   Category Total 900.

   Operating Total 13,700.

   Learning Resource Total 730,972.
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