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ABSTRACT

The project sought to adapt a maternity nursing course and a series of pharmacology lessons for use on a computer-based teaching system (PLATO, Programmed Logic for Automatic Teaching Operation) and to study the relationships of process variables to student achievement in a self-directed learning situation. A combination of tutorial-inquiry teaching strategy permitted the student nurses in the study to gather data, perform simulated experiments, and respond to questions as they interacted with the computer. The PLATO system and procedures used in the study (the 140 subjects, instructional content, lesson preparation, content evaluation, the instructional method, the teaching logic, and record keeping) are described. The results presented showed that, by objective measurement, students learned the same material presented in a classroom on PLATO as well or better in one-third to one-half the time. Student and instructor attitudes toward PLATO were found to be generally favorable. Also included is a 15-item reference list and the following appended material: comparison and evaluation data for lesson forms, learning for specific lessons, and student performance; forms for student and teacher evaluation of PLATO; lesson objectives and sample materials; and a materials evaluation form. (Author/MS)

CERL Report X-40 February, 1973

COMPUTER-BASED INSTRUCTION OF BASIC NURSING UTILIZING INQUIRY APPROACH

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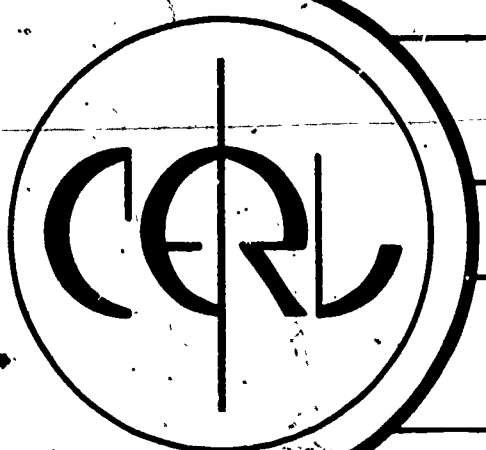

Computer-based Education Research Laboratory

University of Illinois Urbana Illinois

Final Report

NPG-188

Computer-based Instruction of Basic Nursing Utilizing Inquiry Approach

Maryann D. Bitzer, Project Director
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R. A. Avner

September 1, 1966 - August 31, 1970

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Acknowledgement

Acknowledgement is made especially to Mrs. Elisabeth Lyman for her part in programming the instructional strategy. This work is described in detail by Mrs. Lyman in "Instructions for Using the PLATO Logic, General.", CERL Report X-1, May, 1968.

Appreciation is expressed to Lezlie Fillman for her assistance in slide production and to the typists Ginny DeWar, Marsha Bringham and Marge Snyder. The contributions of time, material and encouragement of Sharon Harkness, Mary Hays Carney, Bonnie McManus and Sr. Julia Moriarty of Mercy Hospital School of Nursing are gratefully acknowledged. Thanks is also extended to the students for their patience and perseverance.

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Introduction

Based upon results of a pilot study done in 1963,[1] this project, begun in 1966, was to adapt nursing material for use on a computer-based teaching system and to study the relationships of process variables to student achievement in a self-directed learning situation. A course in maternity nursing and a series of lessons in pharmacology were written and adapted for use on PLATO, the computer-based education system at the University of Illinois. A combination of tutorial-inquiry teaching strategy permits the student to gather data, perform simulated experiments, and respond to questions. The computer furnishes the student with pictorial or graphic information and processes her responses, indicating the results immediately in a variety of ways. The maternity nursing course has been tested with nearly 200 students and has been integrated into the curriculum of a diploma school and an associate degree program. This course, along with the series of pharmacology lessons are still in use at the time of this writing.

Health care expansion programs, shortage of nurses, technological innovations and changes in roles and skills are but a few of a variety of challenges which confront us in nursing education today.[2] This project explored the use of computer-based education as a means of meeting some of these challenges. With technology advancing so rapidly, we think that it is most important to stress flexibility, creativity, and a problem-solving approach in our educational program in order to produce the type of nurses we need today. Therefore, in preparing the computer-based course material, we strove to provide a flexible teaching logic, one which would allow us to present material in a variety of ways;

ways which we thought would encourage an open-mindedness of approach, and help the student to develop or reinforce critical thinking skills. To make the student an active participant in the learning process, a method of presentation referred to as student-directed inquiry was used. In this teaching logic the computer presents the student with simulated patients and commonly encountered questions or problems and requires that she must find information which will enable her to solve the problems or answer the questions. The student is allowed to choose her own approach to a problem, specify which experiments she wants simulated, etc. By allowing the student's decisions and actions to control her progress, she is given maximum control over both the direction and rate of her learning.

There are many advantages to the use of a computer-based education system such as PLATO. Its unique features make it an ideal instructional device for training in general cognitive skills. The rapid response and internal branching capabilities of the system provide each student with immediate attention and individualized instruction. Although servicing many students simultaneously, the response to requests and feedback of results is so rapid that most students receive the impression that they have the computer's undivided attention. The use of internal branching allows the method of presentation or type of material to be altered on the basis of a student's response history as well as her last response and thus facilitates remedial instruction. In addition, the capability of simulating experiments which are otherwise time consuming, costly, or dangerous is extremely valuable. For example, in teaching nursing one can allow students to experiment freely with simulated patients.

Although some instructors find this very idea of experimentation alarming, this concern is unfounded. Allowing a student to determine her own approach to a problem situation, to err and resolve problems in her own way is a good method of teaching and does not create a "devil-may-care" or other undesirable type attitude in students which carries over into the actual clinical situation. Rather, the student learns a great deal by experimenting to find out "what happens if?", and in this manner finds the errors in her judgment or solutions to nursing care problems prior to the real-life situations. If inadvertent, her mistakes in judgment usually make a lasting impression, but fortunately, since simulated patients are easily revived, the mistake does not result in trauma, emotional or physical, to either student or patient. Evaluation, both of and by students, is essential to continued effective instruction. The complete record keeping capability of the system allows authors to obtain immediate information concerning student performance and student opinion. Student response data are invaluable in diagnosing and revising lesson material as well as locating individual student difficulties. Lessons are quickly and easily revised or updated. Another important advantage of CBE is that it makes more efficient use of both instructor and student time. Students can learn at their own pace; those requiring less time to complete the material are free to do independent study, devote more time to another course, or just have free time, whereas those students who need it can have additional instructional time without feeling that they are slowing down the class. The instructor, meanwhile, is freed from routine lectures and thus allowed more time to increase the depth of the learning experiences in the clinical situation

and in psychosocial aspects of nursing and leadership. She has more time to provide individual instruction, communicate with the student, answer questions, conduct discussions, organize, guide, and manage her educational experiences. Although we look upon computer-based education more to supplement the teacher rather than supplant her, there are many instances where the computer can and should replace the instructor, releasing her for those aspects of teaching where the human instructor is more efficient and effective than the computer. A computer-based education system can dispense information just as effectively, sometimes more so, than a human instructor. It is an excellent device for providing drill and practice and accomplishes tedious and time consuming tasks of testing, checking and grading with ease and rapidity. Its use should not be limited to these things however, because it can also be used effectively to teach concepts and problem solving. We have found two other advantages of CBE which are of particular importance to nursing education today. First, it lends stability to situations where there is a shortage or rapid turnover of faculty, and secondly, it allows larger numbers of students to be taught effectively without a comparable increase in faculty.

Description of Computer-based Education System: PLATO

PLATO, the computer-based teaching system located at the University of Illinois' Computer-based Education Research Laboratory was utilized for this project.

PLATO is an acronym which stands for Programmed Logic for Automatic Teaching Operation.[3] The model used, for the nursing education project PLATO III has seventy graphical-pictorial student terminals (twenty of which can be used at any one time) connected to a CDC 1604 computer. The channels of communications between the student and the computer are illustrated by a block diagram on Figure 1.

The electronic book and the electronic blackboard are the sources from which the computer selects the information presented to the student. The electronic book consists of 122 slides which are prestored as 35mm images in a computer-controlled electronic slide selector. Slides may contain illustrations, textual information, or questions. For the nursing material, we find that one and one half to two hours of instruction requires, on the average, 80 slides. The student is presented with the slide she requests in one millionth of a second. Although this slide selector is shared by all students, the students can view the same or different slides simultaneously (Figure 2).

The electronic blackboard consists of a storage tube for each student station. These tubes are also under computer control, and diagrams, symbols, or words are plotted on them, point-by-point, for each student. Up to 700 alphanumeric characters can be written each second.

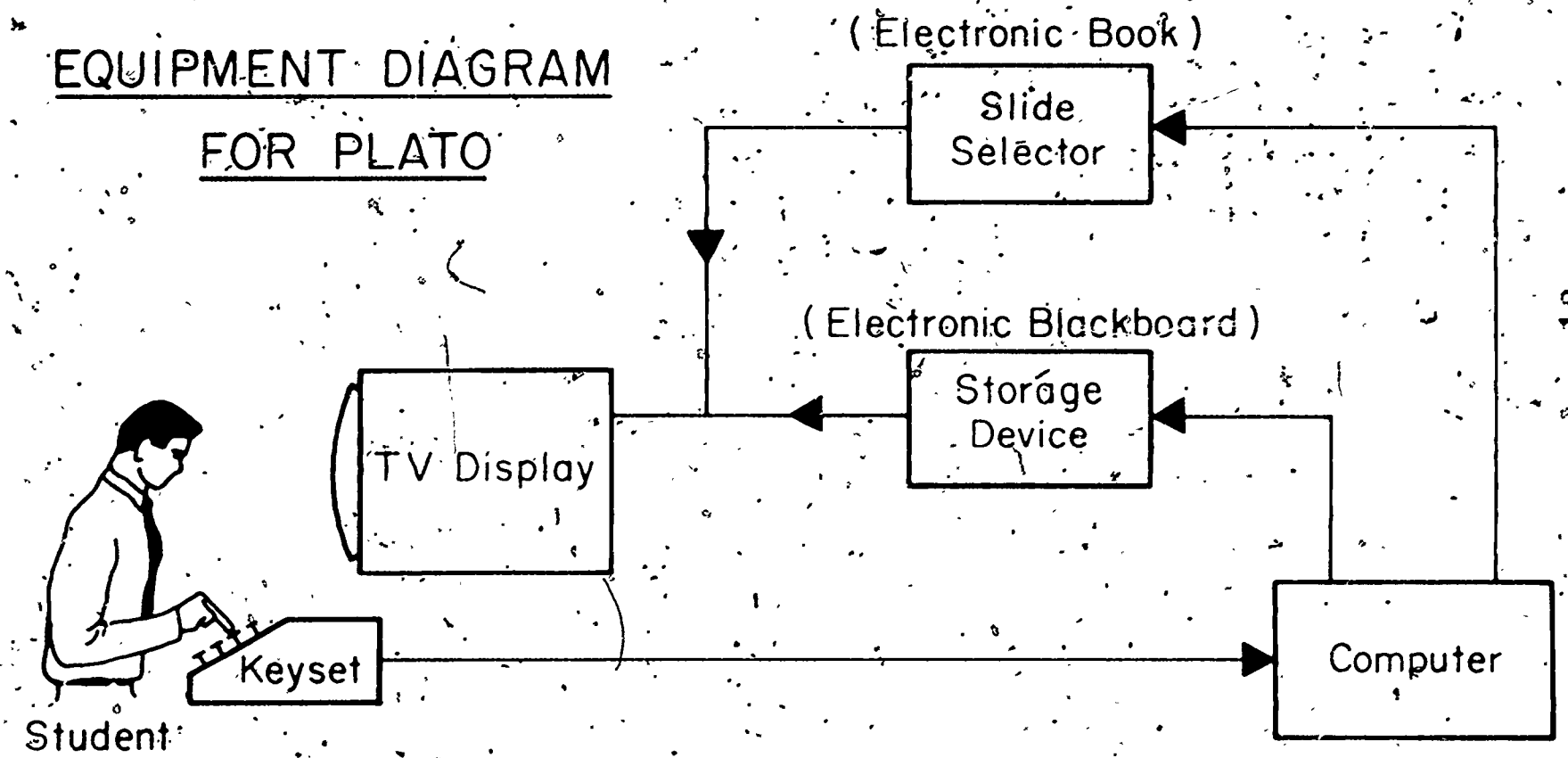


Figure 1. PLATO Schematic-Single Student

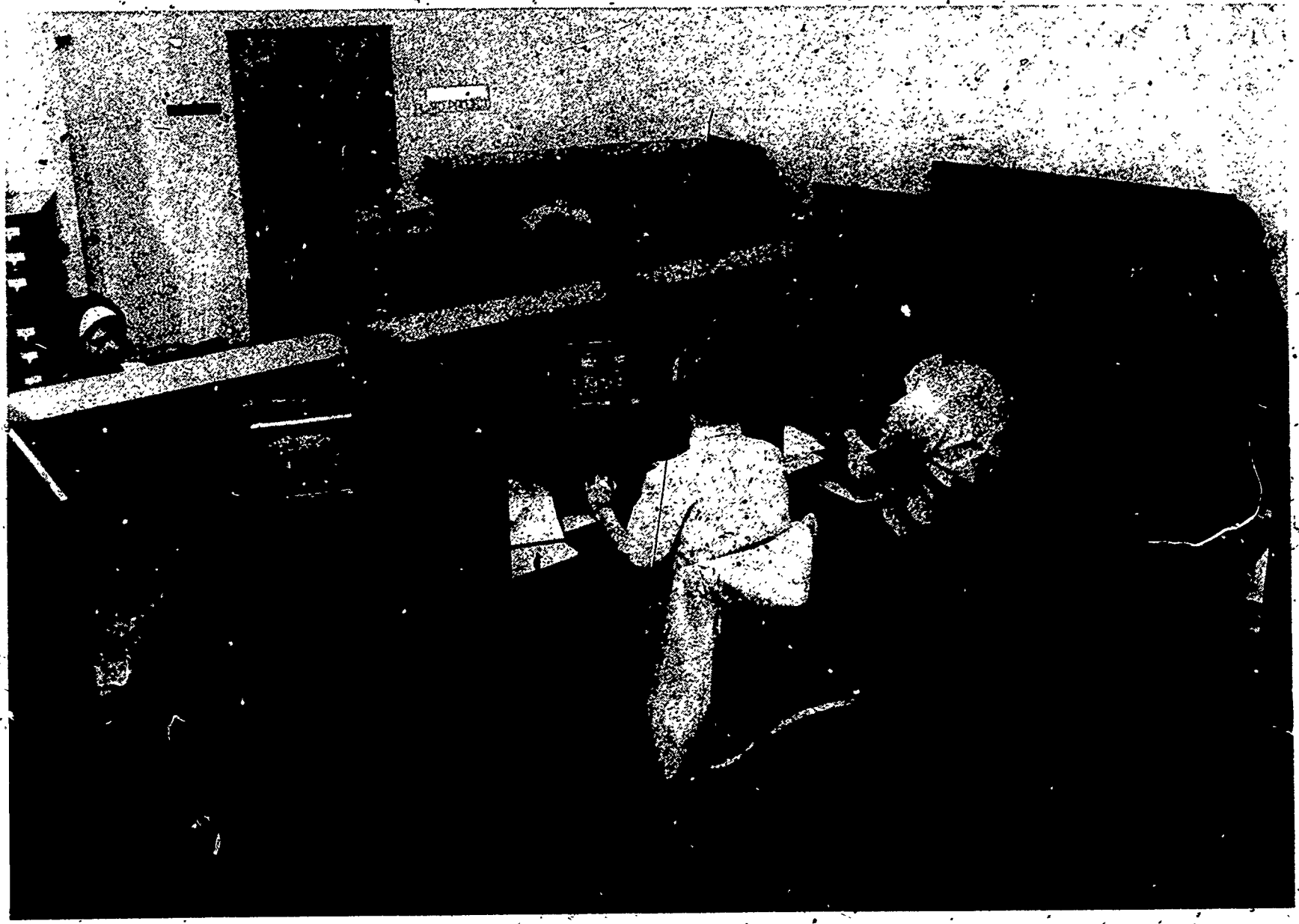
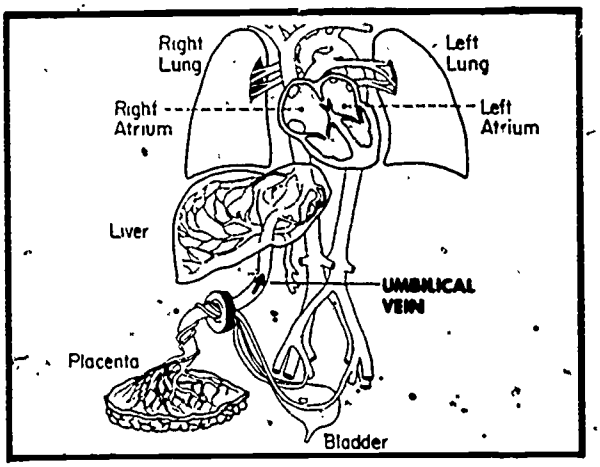


Figure 2. Students Working at Terminals.

and the entire blackboard can be erased in one fifth of a second. This rapid write-erase capability, much faster than the average reading speed, is extremely important. It is obvious that an output which is slower than the average reading speed of the subjects results in bored students who are forced to pace themselves below optimal rates (some teletype-writers fall into this category). In the nursing project, we found that the students became so accustomed to this rapid response (it is possible that an unforeseen side effect of the computer course was an increase in reading speed), that any incident which resulted in a slow-down of output elicited immediate vocal complaints from the students.

A unique feature of the PLATO system is the superimposition of images from the blackboard and electronic slide selector on the student's TV display. This graphic-pictorial capability of the system allowed us to superimpose computer generated graphics and slide images, i.e., Figure 3 shows a) computer-drawn arrows and labels superimposed on a slide image containing a diagram of the circulatory system, b) computer plotted ovum at various stages of development superimposed on an appropriate slide image c) student responses (computer drawn) superimposed so that they appear in appropriate blanks on a slide image and d) one of a variety of messages superimposed over single slide image of a developing fetus.

Other devices such as film projectors, audio, physiological recording devices, and experimental apparatus may also be placed under computer control. Communication between terminals is also possible, with students at terminals interacting through the computer.



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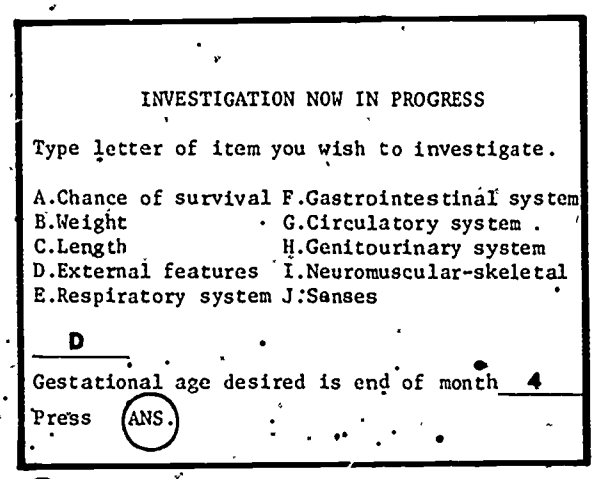

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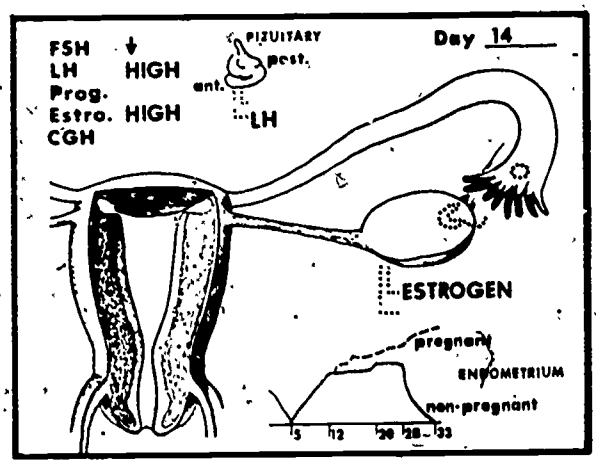

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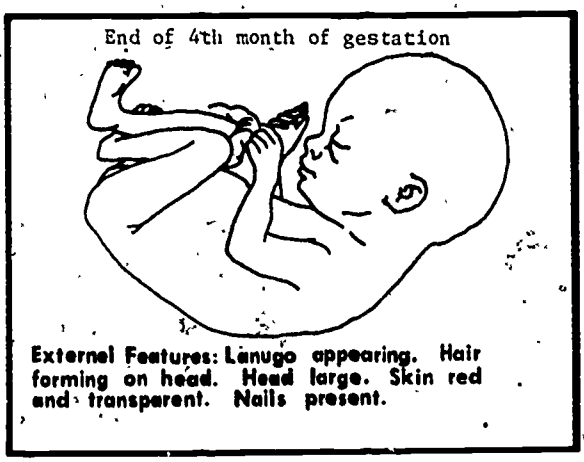

D

Figure 3.

Superimposition of Computer-generated Graphics and Slide Images

For the nursing material, the computer presents the student with simulated patients, problem situations, and questions, and provides, via the graphic and pictorial display, the information necessary to solve the problems or answer the questions. This information is prestored in, or calculated by the computer and given to the student in response to her inquiries. The student, by means of her computer-connected terminal, simulates experiments, gathers data, and answers the questions. (Figures 4 and 5 are illustrations of keyboards used for nursing courses.)

Purposes of Study

The goals of the project were: 1) To write and adapt basic nursing course content for use on a computer-based teaching system; 2) to incorporate the inquiry teaching method into the course content prepared for use on the computer based teaching system; 3) to develop and program a generalized inquiry teaching logic for PLATO, the computer-controlled teaching system located at the University of Illinois; 4) to determine if the basic nursing course content could be taught effectively by a computer-based teaching system; 5) to determine if the course prepared for use on a computer-based teaching system could be readily integrated into the curriculum by the regular teaching staff; 6) to investigate the relationship between the student's problem-solving ability and course material based upon learning by inquiry; 7) to investigate the relationships between process variables to achievement in a self-directed learning situation.

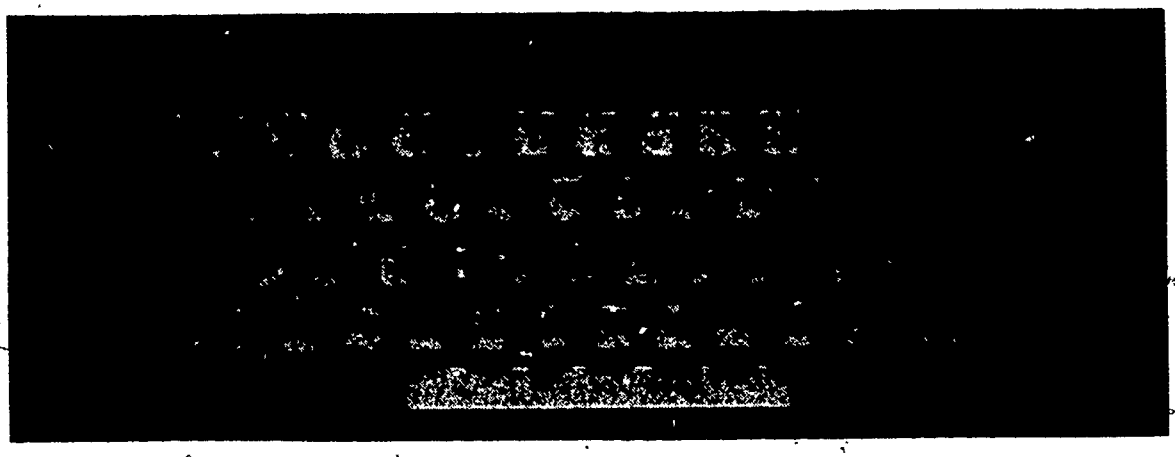

Figure 4
Keyboard used for Maternity Nursing Course
(General Logic)

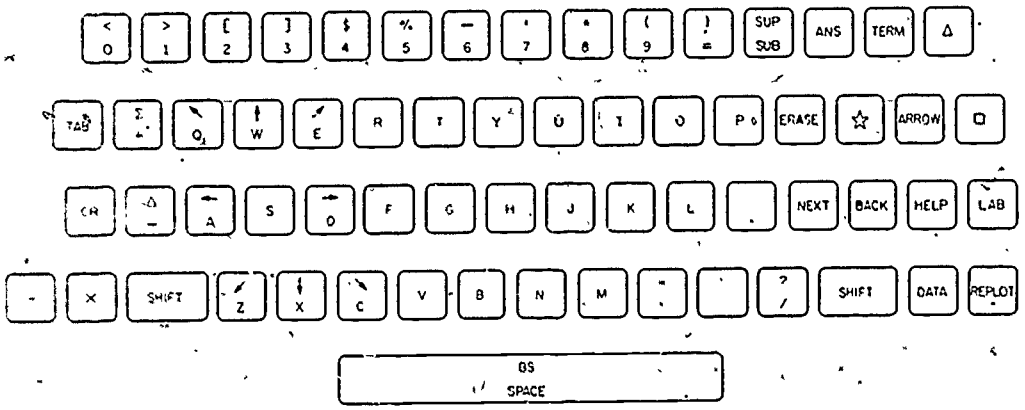

Figure 5
Keyboard used for Pharmacology Lessons
(TUTOR Logic)

Procedure

A. Subjects

140 student nurses representing 2 and 3 year diploma and associate degree programs at Mercy Hospital School of Nursing, Urbana, Illinois and Parkland Community College, Champaign, Illinois, participated in this study. None of the subjects had had prior experience with computer-based instruction. Their ages ranged from 18 to 47 years and their prior knowledge or experience in the content area varied from none to that gained as an LPN. Approximately fifty students from two classes received from 6 to 22 of the maternity nursing lessons during the lesson writing and evaluation phase of the project. In the following year, twelve students received the entire course on PLATO, while the other half of the class served as a control, receiving instruction in the conventional classroom. Approximately 80 students from four subsequent classes received the entire course on PLATO. Since the termination of the project, the course has continued to be offered, and an additional 200 students have now received all or part of the course via PLATO, bringing the total number to approximately 340.

B. Instructional Content

1. Maternity Nursing

A course in maternity nursing being taught to the Mercy students was chosen for this experiment. The theoretical material is usually presented over a fifteen week period, by lecture, discussion, films and assigned readings with 120 hours devoted to classroom instruction and 126 hours devoted to learning experiences in the clinical area.

A series of lessons containing the basic theory of maternity nursing was written, adapted for the computer, tested and revised. These twenty-two computer lessons contained nearly all of the basic theory taught to students in both the diploma and associate degree programs.

The content was basic, centered around hypothetical patients, emphasized the normal, and presented problems which required knowledge of the normal as a basis for recognition of and action concerning the abnormal. (See Appendix B-2 for examples of lesson material.) Students had to apply this knowledge first to hypothetical situations in the computer class and then to real-life situations in the clinical area. Behavioral objectives were developed for each of the question-centered lessons. The lesson objectives related to content which are found in Appendix B-1 were provided to each student in mimeographed form. In addition, the questions in the lessons served as objectives since in order to complete the course the student had to answer correctly every question in every lesson.

The lessons are divided by content rather than time, and the material presented in a manner which seemed best suited to the particular content. Thus, the lessons vary in length and range in complexity. For example, a simple identification exercise is an effective method of instruction in a lesson which provides a review of anatomy. This lesson requires an average of 45 minutes to complete. In contrast, in order to provide a good understanding of the material in a physiology lesson, a student-directed investigative procedure is utilized. Here the computer generates and graphically plots the development, maturation, and fertilization of an ovum, in addition to other pertinent information, in response

to student specifications. The average student requires 90 minutes to gather and analyze the data provided in this lesson.

Though some basic knowledge of nutrition, anatomy, and physiology is presumed, this course has been used successfully with beginning students as well as advanced students. The sequence of lessons can be, and has been, reordered to meet the particular needs of a class.

The end product was a basic course containing informational content (presented in such a manner as to actively involve the student in searching for and applying information) which was utilized as the core of a maternity nursing course, and, with the exception of the experimental group, integrated with other methods of instruction, i.e., films, discussions, and clinical experience. The computer course did not include manipulative skills which were taught in the clinical area, where the clinical experience of the students remained the same.

2. Pharmacology

In addition to the maternity nursing course, a series of pharmacology lessons were written. The faculty identified this as a problem area because the amount of material was much greater than the time available to teach it and the students demonstrated insufficient retention and transfer of the learning to the clinical area.

The students often seem to be overwhelmed by pharmacology, perhaps because they attempt to remember the names of the vast variety of drugs on the market, or try to think of drugs in terms of the disease for which they were most commonly prescribed. Undoubtedly, the student should have a thorough knowledge of certain types of drugs and their actions so that she may administer them intelligently. However, she should keep the patient as her main focal point when administering drugs.

Although some lessons on the mathematics of drugs were to be prepared, the main emphasis in this series of lessons was to be on the action of drugs on body systems and nursing implications.

By classifying the various types of drugs according to their actions on the body and allowing the students to investigate the effects of these various types of drugs on the systems of the body, we hoped to encourage the student to think in terms of the total patient.

Plans were to simulate patients to whom the student would administer prescribed medication and note its effects. This approach would allow the student to learn that although the effect of drugs can vary from individual to individual, the major drug action of most drugs can be fairly accurately predicted. Unfortunately, this approach to the presentation of material has not yet been put into effect as planned. A series of 11 lessons or units was developed. Lesson objectives related to the content of these lessons is found in Appendix C-1. Sample lesson material which illustrates the student-directed inquiry approach is found in Appendix C-2. This material is taken from a lesson on General Principles of Drug Therapy where the student performs experiments until she is able to formulate generalizations regarding drug dosage, absorption, metabolism and action. The content of these lessons comprises what was believed to be a realistic knowledge requirement for the technical graduate.

The pharmacology lessons were programmed in TUTOR, a special author language which had been developed after this project had begun. Detailed descriptions of this new PLATO logic are available in other reports.[14,15] Revision of some of the pharmacology lessons was completed before termination of the project. All of the lessons are still in use at this time.

C. Lesson Preparation

The lessons were developed by the nurse educators on the project with supportive and technical services such as photographic, art, computer programming being provided by CERI personnel. Although the time required for lesson preparation varied with the amount and type of branching in a lesson, on the average it required one man week to provide approximately 1/3 of an hour of computer instruction which replaced one hour of classroom instruction.

D. Content Evaluation

In the maternity nursing course, revision of lesson material took place after each group of students. Student records kept by the computer were utilized as a basis for these revisions. Student comments---both to the instructor and the computer (via the "Comment Mode"), along with suggestions from faculty members (in the areas of obstetrics, pediatrics, anatomy, physiology, and nutrition) and consultants served as the basis for some changes. Students generally thought the content of the course to be thorough, interesting, and relevant.

The completed series of lessons was submitted to consultants representing associate degree and baccalaureate programs for evaluation of the content and its potential for utilization in other levels of nursing education. (A materials evaluation form developed to assist them is found in Appendix D.) It was generally agreed that the computer-based course in maternity nursing can be effectively utilized, in different degrees, by all levels of nursing education. Some representative comments from consultant's evaluation reports are:* "materials complete as compared to theoretical content ordinarily presented..." "concise; every word counts,

*Complete reports found in Progress Report, October 1, 1968

basic and conserves student's time" "Theoretical content suitable for student learning in associate degree programs... psychomoter skills to be gained in additional learning experience" "specific objectives for each lesson... lesson well prepared as to content specifically related to objectives" "clear and concise presentation" "depth, accuracy, and specificity of material sufficient to aid the student in learning the theoretical material required for him to function effectively as a maternity nurse." Suggestions included additional lessons dealing with the psychology and sociology of the family, of ethnic groups and sub-cultures and the use of films to teach procedures. The addition of audio was also thought to be desirable.

The pharmacology lessons were also submitted to consultants for evaluation, in this instance, primarily for checking content accuracy.

E. Instructional Method

In addition to transmission of information, objectives of the project were to increase learning efficiency, to develop the student's ability to use the skills and strategies of critical thinking and problem solving, and to promote attitudes favorable to such skills. The method of presentation or teaching strategy was the vehicle used for attaining these objectives.

F. Guidelines for Developing the Teaching Logic

In formulating the teaching strategy, several general rules were set up as guidelines. These guidelines and the assumptions underlying them are discussed briefly.

1. Allow maximum student control - Most learners have a greater

potential for achieving than they ever reach, and in many instances of failure the fault can be attributed more to the learning system than to the learners. Students may use different learning strategies in the same learning situation. What is an optimal learning strategy for one student is not for another. Therefore, one should not force students to learn in a certain way and no other, especially since some material has no obvious "best" sequence. Too often our conventional classroom teaching does not take into account the fact that different individuals learn best in different ways, and that the same individual's optimal learning strategy may differ with the learning situation.

A computer-based education system with great flexibility and a teaching strategy which provides the student with maximum control over his learning, gives each learner the opportunity to discover or use the optimal way in which he learns. One must, however, be willing to recognize and accept the learner's ability to determine his own approach to learning and problem solving and allow him to err and resolve problems in his own way.

2. Encourage self-directed inquiry or discovery - Encouraging the student to take the initiative in his learning experiences results in increased efficiency. Learning activities which encourage self-directed inquiry will develop attitudes of self-reliance and investigation as well as result in more efficient learning. Dr. Jerome Bruner of the Center for Cognitive Study states that the attitudes and activities which characterize "figuring out" or discovering things for oneself also seem to have the effect of making material more readily accessible in the memory.[4]

3. Encourage student to seek, sort, organize, interpret and apply data

Learning is more efficient- faster and better- if organized in some way. Organization of the memory by permitting scanning of small categories rather than the entire memory, results in retrieval of information which is both faster and less dependent upon the exact context of learning, the latter resulting in greater transfer to other situations. Recognition and use of categories and classifications is one method of organizing the memory. It was decided that presentation of material in a manner which forces the student to seek, sort, organize, interpret and apply information himself would not only result in more efficient learning, but would develop this type of approach to learning situations in general.

4. Allow natural language responses - In order to diminish the notion that there is only one correct answer to every problem, and thus encourage an open-mindedness in approach to problems, the student was allowed to construct natural language responses to questions. A "key-word" judger was developed in order to allow for judging of various multiple acceptable alternative answers.

Although the majority of questions presented to the student in the lessons required them to formulate a response for a completion or open-ended type question, other question formats such as multiple choice, identification, or matching, were also used, depending upon the objective. This variety helped to maintain student interest. Sixteen different types of judging routines allowed us to use these various question formats and judge the student's answers in a variety of ways.

Having students construct answers to open-ended questions seemed to encourage them to think more than they did in responding to a multiple choice

question where the alternatives were provided and their decision was only as to which alternative was the best. Granted that well-constructed alternative answer questions must provoke thought, we have observed that rather than think through the alternatives, students very often choose alternatives, randomly or systematically, until they find the one that gives an "OK". This procedure is made desireable to them by the very rapid feedback which means that it is quicker for them to guess all of the possible alternatives than to carefully read and consider each of them. On this type of question, in order to prevent students from just learning the correct answer without understanding why it is the best alternative or why the other alternatives are not better, we use a "forced help" on an incorrect answer. This "forced help" is a message explaining why that alternative is not acceptable. Had we used more of this type of question, other approaches would have been attempted as well. We think that questions which require student constructed responses are the best type for another reason. In the clinical situation where the student will function, she will be identifying and solving nursing care problems, and she will be identifying problems and possible solutions on the basis of data which she collects and analyzes. She will, in very few instances, be confronted with a list of several alternatives from which she can choose, but rather will need to be able to identify or formulate the possible alternatives herself.

5. Allow material to dictate the media - Material which was thought to be presented better via film, discussion, or laboratory experience was presented in that manner. Authors wrote and programmed material in a manner which they decided was the best method of presenting that particular material. Thus, computer programs were modified in order to present the material in the desired manner rather than the material adapted to existing

computer routines. The lessons vary then, with the type of material being presented, in complexity and structure as well as in length.

It was anticipated that time spent on lessons would vary greatly with the individual student. Therefore, lessons (or units) are designed to cover certain topics and are divided according to logical groupings of content. We found that some students spent 2 - 2 1/2 times as long on some lessons as did other students.

G. Description of The Teaching Logic

Using these five general rules as a guideline, a teaching strategy was developed. The general method of presentation which was utilized is referred to in this paper as student-directed inquiry. In this teaching logic the computer presents the student with simulated patients and commonly encountered questions or problems, and the teaching rules are arranged so that she must think about what information she needs; think of and investigate possible solutions or sources of information, interpret and sort the data provided, select her solution (response), and test (judge) it. The information needed to answer the questions or solve the problems is prestored in, or calculated by, the computer and is provided in pictorial or graphic form to the student in response to her inquiries. The computer provides appropriate feedback to the student's constructed response, thereby reinforcing a correct approach (answer) or, in the case of an incorrect response, encouraging (forcing) the student to a new approach while providing her with specific assistance for particular error habits. The computer is utilized as a computational tool when simulating experiments, calculating results, and processing student responses. While the use of multiple choice questions requires relatively

simple processing, allowing students to construct responses to open-ended questions requires a large amount of computation. For example, the student's response is analyzed to ascertain if it is misspelled, complete enough to be acceptable, is an equivalent correct answer, or a merely reworded duplication of a previous response. Misspelled words are detected by use of an algorithm which checks a word for insertions, deletions, and inversions. The computer indicates the degree of correctness of a response by underlining misspelled words, slashing unacceptable words or incorrect words, and providing a notation of NC in the event of an incomplete answer which is correct as far as it goes.[5]

A flow diagram of the teaching logic used in the maternity Nursing Course is shown in Figure 6. A detailed description of the programming is available in CERL Report X-1, Instructions for Using the PLATO Logic, General.[6]

The teaching rules can be described simply as follows:[7] The large block labeled Main Sequence is the minimum amount of material that must be used by the student and consists of instructions, text, and questions. If there are no questions to be answered on a slide, the student may continue to the next page in the lesson by pressing the CONT (Continue) button. Questions on a page may be answered in any order, but the student must answer any or all questions correctly before she proceeds to the next page. She may return to review the preceding pages by pressing the REV (Reverse) button.

After typing her response, the student, by pressing the JUDGE key, asks the computer to evaluate her answer. If she has responded "massage the fundus" and it is the correct answer, she receives an OK and may continue to the next question or the next page. However, if her response

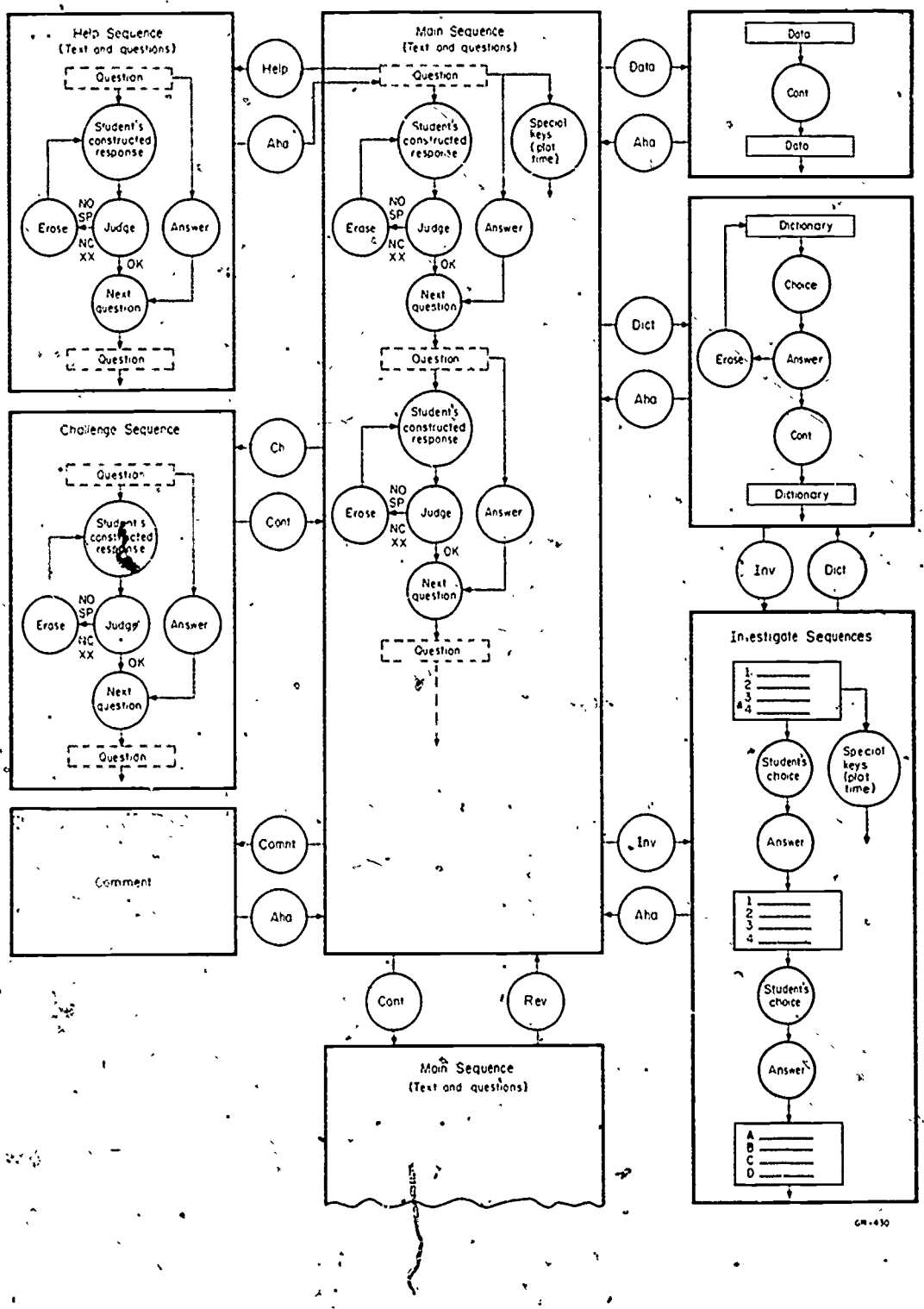

Figure 6
Diagram of Teaching Logic

is merely "massage", the computer prints NC (Not Complete), and if her response is "masage the back", the computer says "NO" and x's out "back" as incorrect and underlines "masage" as a misspelled word, thus indicating which parts of the answer are incorrect and why. Incorrect responses are erased by pressing the ERASE key. In this logic, the student may attempt to answer a question as many times as she wishes.

Several types of branching from the main sequence may take place. Since the material is presented so that the student must gather the information she needs, we have provided, under the heading Investigate Sequence, a variety of ways in which she may collect information. She may ask questions of the computer, have the computer simulate experiments, and determine the results of treatments and tests performed under conditions which she specifies. By pressing the INV (Investigate) button, she is presented with some general categories of information which are available in the lesson - for example: "You may investigate: 1) Patient's Condition, 2) Effects of Nursing Strategies on Patient's Condition, 3) Factors Implicated in Bleeding During Pregnancy, and 4) Effects and Nursing Implications of Various Medications." After selecting the area of general information she wishes, she is given a subcategory from which she makes a more detailed specification - for instance: If the student chooses to investigate category number 2, "The Effects of Nursing Strategies on the Patient's Condition," she is then requested to specify which nursing strategy she wishes to test and the condition of the patient at the time of testing. When the student has found an effective nursing strategy or any other information she needs, she returns to the main sequence by pressing the AHA button.

There are also special buttons such as PLOT with which the student requests the computer to do graphical plotting on her screen. In one such lesson the computer draws arrows that trace the flow of blood through the fetal circulatory system.

A student having difficulty may press the HELP key and can be given a subproblem, a hint or the answer. In this course, she is usually given directions on how to find the answer. A special type of help, such as a table of clinical norms, may be provided as quick reference when the student presses the DATA key. An unfamiliar term may be checked in the dictionary by pressing the DICT button, and typing the word she wants defined. From any of these branches the student returns to her place in the lesson by pressing the AHA button.

Just as the Help Sequence enables the author to provide remedial material for students needing additional assistance, the Challenge Sequence allows supplementary material to be added as enrichment for faster students. Upon pressing the CH (Challenge) button these students are provided with more challenging questions or complex problems.

At any time in the lesson, the student may press a COMNT (Comment) button and type in her comments; thus, she has a means of expressing her feelings. The comments are valuable to the instructor, who uses student suggestions to improve her material, and students are often gratified to see their suggestions acted upon by the next class session. An "author mode" allows the instructor to quickly modify or update material. This authoring, or manipulation of parameters, can be done "on-line" at a student terminal while the students are working.

The following example of a student's learning strategy and various response judgments are illustrated in Figure 7. The material shown is

During pregnancy some women seem to be particularly prone to varicosities of the lower extremities. This is a result of:

1.

2.

A

Circulatory System

↑ in blood volume, 50% increase in cardiac word load. Left ventricular hypertrophy. ↑ progesterone produces vasodilation. Pressure from enlarging uterus slows return venous circulation.

D

INVESTIGATE

Indicate area of investigation desired:

1

1. Anatomical and physiological changes of pregnancy
2. Nursing strategies
3. Prenatal records

Push (ANS)

B

Dictionary		Page 2
hematocrit	orifice	stasis
hemoglobin	os	symphysis pubis
hemorrhoids	papilla	thoracic
hyperplasia	perineum	transient
hypertrophy	physiologic	trimester
labia	predisposition	urethra
lactiferous	preeclampsia	varicosities
LMP	prenatal	vasodilatation
micturition	promontory	VDRL
myometrium	pseudoanemia	vital capacity
Nageles rule	phelonephritis	xiphoid

Type word to be defined:
Press ANS **VASODILATATION**

E

Investigation Now in Progress

Type name of part desired: **CIRCULATORY SYSTEM**

(for listing of acceptable requests see (DATA))

Indicate trimester of pregnancy: 3

(use 1, 2, or 3)

Push (ANS)

C

Dictionary		Page 2
hematocrit	orifice	stasis
hemoglobin	os	symphysis pubis
hemorrhoids	papilla	thoracic
hyperplasia	perineum	transient
hypertrophy	physiologic	trimester
labia	predisposition	urethra
lactiferous	preeclampsia	varicosities
LMP	prenatal	vasodilatation
micturition	promontory	VDRL
myometrium	pseudoanemia	vital capacity
Nageles rule	pyelonephritis	xiphoid

Type word to be defined:
Press ANS **VASODILATATION**

WIDENING OF BLOOD VESSELS

F

Figure 7 (part 1)

During pregnancy some women seem to be particularly prone to varicosities of the lower extremities. This is a result of:

1. **INCREASED PRESSURE FROM ENLARGING UTERUS HINDERS VENOUS RETURN** OK

2. **HORMONAL CHANGES CAUSE DILATATION OF BLOOD VESSELS** OK

G

Investigation Now in Progress

Designate choices by typing number or letter of item. To obtain result always push ANS.

6 Symptoms

1. Dyspnea
2. Heartburn
3. Backache
4. Hemorrhoids
5. Constipation
6. Varicosities
7. Morning sickness
8. Urinary frequency

3 Strategies

1. Diet
2. Drugs
3. Activities

J

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1.

2.

3.

H

Activity

A. Extra rest
B. Girdle
C. Cold compresses
D. Sleep without a pillow
E. Sleep in Semi-Fowler's position
F. Short rest periods with feet elevated
G. Daily outdoor exercise
H. Flat on back, elevate arms above head, deep breathe
I. Rearrange work habits
J. Walk around hourly
K. Non-constrictive clothing
L. Rest with hips elevated, legs up
M. Proper body alignment when lifting
N. Support hose
O. Low heeled shoes
P. Hot water bottle

F. YES. ENCOURAGES VENOUS RETURN

K

INVESTIGATE

Indicate area of investigation desires:

2

1. Anatomical and physiological changes of pregnancy
2. Nursing strategies
3. Prenatal records

Push (ANS)

I

Activity

A. Extra rest
B. Girdle
C. Cold compresses
D. Sleep without a pillow
E. Sleep in Semi-Fowler's position
F. Short rest periods with feet elevated
G. Daily outdoor exercise
H. Flat on back, elevate arms above head, deep breathe
I. Rearrange work habits
J. Walk around hourly
K. Non-constrictive clothing
L. Rest with hips elevated, legs up
M. Proper body alignment when lifting
N. Support hose
O. Low heeled shoes
P. Hot water bottle

J. YES. SITTING IN ONE POSITION FOR A LONG TIME INHIBITS CIRCULATION IN LOWER EXTREMITIES

L

Figure 7 (part 2)
Example of Student's Learning Strategy

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET ELEVATED OK

2.

3.

M

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET ELEVATED OK

2. SIT OR LAY WITH LOWER EXTREMITIES RAISED UP SEVERAL TIMES A DAY OK

3.

DUPLICATE ANSWER

P

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET. ELEVATED OK

2. REST WITH FEET NC

3.

N

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET ELEVATED OK

2. SHORT REST PERIODS WITH FEAT LOWERED

3.

Q

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET ELEVATED OK

2. SIT OR LAY WITH LOWER EXTREMITIES RAISED UP SEVERAL TIMES A DAY OK

3.

O

Mrs. Dodd is a secretary and has continued employment through the third trimester. To aid in the prevention of varicosities you suggest that she do the following:

1. REST WITH FEET ELEVATED OK

2. SHORT REST PERIODS WITH FEAT ~~LOWERED~~ NO

3.

R

Figure 7 (part 3)

taken from one of several lessons concerned with the antepartum care of Mrs. Dodd, the hypothetical patient whom the student cares for throughout a normal pregnancy, labor, and delivery. Mrs. Dodd suffers from many of the common discomforts of pregnancy.

To give the student a basis for understanding the cause of these discomforts, the lessons allow her to investigate the anatomic and physiologic changes which occur during pregnancy and give rise to symptoms. After determining the cause of the symptoms, the student is presented with an opportunity to theorize and test various nursing strategies to see which would relieve them. The question confronting her at this moment states that some pregnant women seem to be especially prone to varicosities of the lower extremities and asks why this is so (Figure 7A). The student presses the Investigate button and sees a slide which asks her whether she wishes to investigate anatomic or physiologic changes, nursing strategies, or prenatal records (7B). She specifies anatomic and physiologic changes and on the next slide (7C) specifies the circulatory system during the third trimester. She must then decide what information given to her by the computer (7D) is pertinent. Using the Dictionary button, she requests the computer to supply her with a definition of the word vasodilation (7E, F). After completing this, she returns to the question slide (Figure 7 part 2), types in her answers, and asks the computer to judge them. The computer writes OK after her answers (7G), and she proceeds to the next slide by pressing the Continue button.

Now she is presented with a slide that tells her that Mrs. Dodd is a secretary and remains employed during the third trimester. It asks her to list several suggestions she might make to Mrs. Dodd about how to prevent varicosities (7H). The student presses the Investigate button again, and

this time designates the Nursing Strategies category (7I). On the subsequent slide (7J) she specifies the symptom as "varicosities" and the area of nursing strategy as "activities". The computer responds with a list of such activities as "lie flat," "elevate feet," and "walk around hourly". The student may select any of these and when she types the letter corresponding to her choice (7K), the computer responds with its effect upon the patient such as "may help" or "will aggravate" (7L).

After finding some nursing strategies which may help, the student returns to the question and types in her answers. Figure 1 part 3 illustrates evaluation of answers which are: (7M) satisfactory, (7N) not complete -lacking a key word, (7o & 7p) the same answer worded differently accepted but identified as a "duplicate answer" (the student must change a duplicate answer to another correct answer which is different from the first before she may proceed to the next page) and (7q & 7r) not satisfactory - misspelled words are underlined while unacceptable or incorrect words are slashed.

Appendices B-2 and C-2 contain illustrations of other types of lesson material.

H. Record Keeping

At the same time the computer is performing the tasks just described, it is making a complete recording of the student computer interactions. This student performance data is recorded on magnetic tape and includes a record of each key pressed, the time at which it was pressed, times at which student entered and exited from a branch in the lesson, and the action within the branch. This information

can be made available as a printed history of events (total or selected) that the instructor can read immediately, or it can remain stored on the magnetic tape for later processing. A sorting routine allows the instructor to select the amount or type of data she needs from a complete, timed account of the student's work to a listing of student comments only. We have found that for immediate use in diagnosing student difficulties and the need for lesson revision, it is most valuable to have the student comments and incorrect responses printed out as soon as possible following the class so that this information may be acted upon before the next scheduled class. For example, sorting incorrect responses by problem number gives a clear picture of the total class performance on any one item and immediately pinpoints certain trouble spots such as unclear questions, common errors, and the need for specific help sequences or lesson alteration. In addition, sorting data according to student provides a profile of each student's work and a clear picture of her individual problems and progress. While developing the lesson material, lists of all student responses for each question proved invaluable in expanding the number of acceptable alternative ways of wording an answer, and proved to be essential in the use of a "keyword" judger. All other data is stored on magnetic tape and is later processed by the computer for a detailed statistical analysis such as providing summary statistics for each student on each lesson as well as for investigation of specific areas of concern such as a student's step-by-step approach to a problem. In addition, a complete re-run of the entire class can be produced by reading this record tape into the computer. This "instant replay" can be viewed at a master console which is also used

during class to monitor any student's work.

The statistical summary of each student's work included the total time spent during the session, the time spent reviewing the lesson, the time spent in the main sequence, in the investigate, help, data, dictionary, and comment sequences, as well as the total number of requests made for the following keys: INVESTIGATE, HELP, DATA, DICTIONARY, and ANSWER. Averages for each of these categories were calculated for each student for each lesson, as well as the grand totals and averages for each student and all students over all lessons.

An example of statistical analysis of the student records is shown in Table 1 where the computer has summarized the course records for thirteen students. Similar records of thirty-eight students indicate that averaged over the entire course, the slowest student spent 27% more time than the fastest student. In lessons which averaged 73 minutes, the average time spent by a student in the Investigate branch was 21 minutes, while the average time in the Main Sequence portion of the lesson was 42 minutes. An average of ten minutes was spent in review and other branching portions of the lesson; with a per lesson average of two requests for definitions of terms, three requests for data, and eight requests for help.

Thus we find that on the average the student spends approximately 1/3 of her time in the laboratory (optional portion of the lesson) and 2/3 in the Main Sequence (required portion of the lesson). The range in percentage of student time spent in the Investigate branch of the program as compared to that spent in the Main Sequence varied greatly in any given lesson, indicating both the difference in inter-student and intrastudent needs for informat... As an example of the

Table 1

Summary Statistics: Data averaged by lesson for complete course

N = 13

Average/Lesson

	Student													Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	(All Student)
Time in Min.														
Total Time	66	70	72	74	73	71	72	76	83	73	77	71	72	73
Main Seq.	28	50	39	40	47	40	38	44	42	49	46	40	45	43
Investigate	27	17	22	28	23	28	28	25	35	20	26	23	23	25
Dictionary	3	0	3	2	1	0	1	3	2	2	1	3	1	1
Help	6	2	7	2	1	2	2	2	2	1	2	1	2	2
Data	1	1	1	1	1	1	2	1	1	1	1	3	1	1
Comment	1	1	0	1	0	0	1	1	1	0	1	1	0	1
Total Requests														
Inv. Requests	37	28	39	34	34	37	34	44	52	40	43	45	0	36
Dict. Requests	1	1	3	2	1	1	2	3	2	2	1	4	0	2
Help Requests	7	7	8	7	8	11	6	10	9	7	8	8	0	8
Data Requests	3	2	4	3	3	4	3	4	4	4	5	5	0	4

differences among students, when averaged over all lessons, the percentage of time spent in the Investigate branch ranged from 30-91% of the time spent in the Main Sequence. This wide variation is also an indication of the differences in efficiency and methods of processing information.

Results

A. General Discussion

The nursing project has recorded over 10,000 student contact hours on PLATO. Nearly 340 student nurses representing three-year diploma, two-year diploma, and associate degree programs have received the computer-based nursing lessons and/or course. The first two groups of thirteen students received six and twelve lessons respectively. Here the primary objective was to collect data necessary to evaluate and revise the materi l being written and to "debug" the program. After this had been accomplished, a comparision of computer-based education and conventional classroom was attempted.

For purposes of this study, the twenty-two computerized lessons were intentionally not integrated into an instructor taught course, but rather were presented alone without discussion classes, etc. A class of twenty-two students was divided into two groups matched according to ability.

One group had the maternity nursing course on PLATO, and the other group, serving as a control, was given the course in the conventional classroom manner. The two groups had one common class per week--a two-hour clinical conference. Post-test scores indicated a significant gain by all students, and a comparison of final examination grades of the control and experimental groups did not indicate a significant difference. The total time that the PLATO students required to complete the lessons ranged from 28 to 40 hours. These students were allowed to review any lessons they wished, and if this review time and film time are included, the maximum time spent by a PLATO student was 50 hours as compared with the 84 hours each of the control students spent in the classroom. The total time required by a subsequent class of students was much the same, with a range of 21.0 to 34.4 hours. Thus the PLATO students learned the same amount of material in from one-third to one-half the time required in the classroom.

Table 2.

Comparison of Instructional Time for PLATO Students and Classroom Students

Lesson	Instructional Hours		Percentage of PLATO Group Time to Classroom Group Time
	PLATO Group	Classroom Group	
Anatomy Review	1.0	1.0	100%
Prenatal Care (1st trimester)	2.5	8.0	31
Prenatal Care (2nd trimester)	2.0	7.0	29
Prenatal Care (3rd trimester)	1.0	7.0	14
Physiology	2.0	6.0	33
Diet	2.0	5.0	40
Fetal Circulation and Fetal Pharmacology	2.5	5.0	50
Fetal Development	2.5	7.5	33
3 Ps (Powers, Passage, Passenger)	1.5	4.5	33
Mechanisms of Labor	2.0	4.0	50
Normal Labor and Delivery	2.5	6.0	42
Complications of Pregnancy	2.0	5.5	36
TOTAL	23.5	66.5	35%

A comparison of the average time spent on twelve lessons by an earlier group of students who received the lessons on PLATO with the time it took the instructor to present the same material in the classroom, indicated the average time spent by students on the computer was about one-third of the time required for presenting the material in the conventional classroom (Table 2). This time-saving feature of our computerized course has been demonstrated repeatedly and is undoubtedly due in part to organization of material.

Even though students using PLATO, on the average, spend as little as 1/3 the normal class time, there has been no reduction in student performance as measured by standardized achievement tests. In addition, thirty-five of the students who completed the full Maternity Nursing Course on PLATO have now taken the Illinois State Board Examinations. All of these thirty-five students passed Obstetric Nursing, with 68% scoring above average. Other evaluative studies of student learning and attitudes are reported in detail in the following section of this report.

Lesson material, once written, was revised and updated quickly and easily. Therefore, although the initial time investment in preparing a course for use on a CBE system is large, the course may be used repeatedly, being updated or revised as frequently as necessary at little cost in time and effort.

B. Formal Evaluation Studies

1. Format and Content

One advantage of teaching by CBE is the ease with which lessons can be evaluated and altered. Ease in revision insures that errors or outdated information need not be retained in active lessons and also allows the instructor to test alternate teaching approaches when students encounter difficulties. Constant evaluation insures that only the best approaches are retained and also serves to indicate when a point of diminishing returns in lesson development has been reached. The conscientious instructor constantly tries to improve the effectiveness of lessons, but without feedback from evaluation, may waste time making trivial alterations.

The types of lesson changes which are of greatest interest are those which produce major effects on learning. Such effects are readily observable even in comparisons between relatively small groups of students. Hence alterations can often be evaluated by administering the alternate forms to different members of the same class. Decisions can be made reliably from observations of as few as a half dozen students under each condition. Care is needed in selecting small groups which are representative of all students who will be using the material. Thus it is generally not a good idea to use, for example, only the slower students to evaluate effects of a change made during a class.

As an example of the ongoing evaluation process used in development of the Nursing material we can examine some data taken near the final stage of work on a typical lesson. The lesson (concerning abnormalities in the newborn) consisted of well-structured material which was already considered to be adequate. However, a project member felt that more use of branching and "HELP" sequences would produce a significant improvement. Two additional classes of 13 students each were determined to be essentially equivalent on the basis of background and abilities. Pretest scores of one group averaged only .846 points lower than scores of the other group (a non-significant difference; $t=.73$, 24 d.f., $p=.47$).

The new lesson, constructed by adding branching features to the original lesson, was used by the class with the lower pretest score while the other class used the original lesson. Average gain of post-test scores over pretest scores was greater for the revised lesson but the gain was not significant ($t=1.69$, 24 d.f., $p=.10$ for two-tailed test). In fact, less than 11% of the variance in gain scores was accounted for by the difference in forms of the lesson. Although the revised form of the lesson was ultimately adopted it was clear that little more was to be gained by adding more features of the same type to that particular lesson.

II. Retention Effects

The simple demonstration (via posttest-pretest score differences) that the student "knows" more after a class than she "knew" before is of course neither surprising nor an adequate basis for a complete evaluation of instruction. Granted that information was imparted during the class it remains to be shown that (a) the information will be retained until it is needed and (b) the retained information will be of the sort needed for effective behavior as a nurse.

On the matter of retention there appears to be good evidence that instruction which is well organized and which forces the student to generalize from examples leads to excellent retention.[8] The inquiry approach used in much of the nursing materials has precisely such an instructional structure. One of the more interesting findings in the initial nursing study[9] was a highly significant increase in learning and long-term retention found for an anatomy lesson taught by PLATO as opposed to a lecture presentation. Such a gain could be attributed to two factors; (1) superiority of the inquiry presentation and/or (2) enhanced distinctiveness of the material due to a novel method of presentation. The reference cited above supports consideration of the first of these factors. Research in generalization of learning[10] indicates that the second factor may have also contributed to the better learning observed. The anatomy lesson was one of the first encounters these students had had with PLATO or the inquiry teaching approach. This novel situation could have both increased student interest (thus aiding learning) and increased distinctiveness of the material (thus aiding retention).

A series of studies made to determine the source of the learning enhancement is outlined in Table 3. The first lesson listed (anatomy)

is a partial replication of the Anatomy lesson with another group of students who had much more extensive experience with inquiry learning via PLATO. While 86% of the variance in posttest scores can be ascribed to the lesson effect, the test performance was significantly poorer than that of the original group. It thus appears that novelty did indeed contribute greatly to the originally observed effect.

Another partial replication of the Anatomy lesson was made to compare the PLATO presented inquiry with a classroom inquiry approach. An additional feature of this second study was a multiple posttest design in which students were retested without warning four times after the lesson. Such a design has drawbacks since repeated posttests have been shown to produce additional learning when given within a short period.[11] It was hoped that delays of at least 4 weeks between successive posttest would minimize this effect and allow a rough measure of loss in retention. The results of this second study showed highly significant gains for both PLATO and Classroom inquiry approaches over the original lecture approach. Of even greater interest was the fact that essentially no loss in retention was found over a seven month period following the lesson (see line 2, Table 3 - only results for PLATO group are shown). The same students used in the second study were also given successive posttests for two other lessons with similar results (see lines 3 and 4, Table 3). Still another lesson with only an immediate posttest showed the mediocre retention found in the first study.

As a result of this series of studies it seems clear that the combination of well-structured inquiry type material followed by successive multiple posttests at about one month intervals produces superior initial learning and excellent retention. While the demands for individualized processing that each of these devices make would be difficult to meet on a large scale in the typical classroom

Table 3
Study of Retention Effects

Lesson	Times at which students were tested: Pre	Post	4 Wks	8 Wks	12 Wks	24 Wks	28 Wks	Final % Variance Accounted for by Treatment
Anatomy	1.00	--	--	--	.40	--	--	86
Anatomy	1.00	--	.32	.25	.16	--	.24	91
Physiology	1.00	.12	.20	.19	--	.19	--	95
Fetal Circulation	1.00	.14	.17	.14	--	.15	--	94
Neonatal Complications	1.00	.24	--	--	--	--	.53	86

Ratio of number of wrong answers on posttest to number of wrong answers on pretest

setting, both are ideally adaptable to computer-based education. The computer can easily handle the sophisticated simulation required in the inquiry approach and testing is generally only a matter of simple linear programming.

III. Quality of Learning

As was mentioned in the previous section, one objective of classroom instruction in a Nursing course is to provide information which is of the sort required for proper behavior at some critical moment in the future. Some of the material which must be taught in the classroom requires extensive individualized student-teacher interaction to insure that the student has indeed grasped the principles involved. The areas of Physiology and Fetal Circulation contain much material of this type. As may be seen in Appendix A-2 and in the last column of Table 3, PLATO can be programmed to present even this difficult material in such a manner that superior learning and (subject to the further evaluation indicated in section II above) retention appear to result.

An even better demonstration of learning of basic subject matter is displayed by the performance on standardized achievement tests by nursing classes which have participated in the PLATO studies. Despite several problems associated with use of such standardized tests (see Appendix A-3) it seems clear that no measurable reduction in student performance occurs even though students using PLATO spend as little as 1/3 the normal class time to complete subcourses. All of the 35 students who completed the full Maternity Nursing course on PLATO passed the Illinois State Board Examination in Obstetric Nursing, with 68% scoring above average.

Another aspect of successful nursing performance is the ability to gather and use information effectively in clinical situations. Inquiry-type instruction given by PLATO is intended to teach such information-processing behavior to the

student as well as imparting the information itself. Unfortunately it is rather difficult to evaluate applied problem-solving or critical thinking skills. Evaluations based on observations made in real-life situations are usually unreliable for two reasons. First, the observation may itself influence the behavior in question, e.g. through the presence of an "outsider" or a superior. Second, different subjects can rarely be evaluated in equivalent situations since similar nontrivial events rarely occur under precisely the same circumstances in a clinical situation. Evaluations under special "work sample" test conditions also suffer from the first of these drawbacks.

Standardized tests of general problem-solving ability have other drawbacks. Probably the greatest deficiency is the fact that all relevant information is usually provided to the subject, whereas in real life the subject is usually required both to note the fact that insufficient information is present and to acquire the required information. As an example, at the time this study was begun, the Watson-Glaser Critical Thinking Appraisal appeared to be the best commercially available standardized test of general problem solving ability. This test consists of 100 items divided into subtests which are designed to measure abilities in inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. Scores are only moderately correlated with intelligence ($r = .60$ with Otis IQ for 5297 Liberal Arts Freshmen). While the Watson-Glaser test does require that the subject be able to distinguish between relevant and irrelevant information, it cannot test for the important skill of identification and collection of data which are not provided. If we accept course grades given for nursing performance during work in clinical areas as at least being indicative of the type of applied problem solving behavior of interest here,

it is rather disappointing to observe the small (albeit significant) relationship between Watson-Glaser scores and such grades. Less than 15% of the variance in grades could be accounted for in a linear prediction model given a knowledge of Watson-Glaser scores ($r = .38$, 24df, $p = .056$). Similarly, the nonsignificant gain in Watson-Glaser scores after exposure to inquiry-type PLATO lessons ($t = .8$, 25df, $p = .43$) is difficult to interpret. At best it appears that behavior of the type measured by the Watson-Glaser appraisal makes up only a small part of successful problem solving behavior in the clinical training situations observed during this study. It is felt that the wide range of problem-solving ability observed in our subjects makes it unlikely that the low correlation between the Watson-Glaser scores and grades was merely due to attenuation of range.

An alternative approach to use of commercially available measures is construction and validation of an instrument specifically for this task. This alternative has been chosen only for lack of other courses of action. In addition to the problems outlined earlier, the small number of students available in this study severely limits the number of chances for testing and revising new instruments. As a result, only the preliminary stages of development can be reported here.

The present one-page rating scale (see Appendix A-4) was produced after joint conferences with the teaching, experimental, and evaluation staffs of the project. Preliminary user evaluation was then carried out by a member of the instructional staff who had been only indirectly connected with development (all members of the staff were shown preliminary versions of the form and asked for suggestions, criticisms and comments). Limitations in staff caused this preliminary evaluation to be carried out under less than ideal, (or, from another viewpoint, highly realistic) conditions. The evaluator was responsible not only for carrying out the lengthy observations needed but also for supervision

of the students during their clinical sessions. As a result, the forms were all completed after rather than during the sessions as had been the intention. Correlation of averaged evaluation scores with clinical grades was high ($r = .84$, 24 df, $p < .00005$), however it should be remembered that as the rater was also the instructor this correlation may simply measure rater reliability. Evaluation scores seemed to be a satisfactory indication of learning also (see Table 4).

TABLE 4

Contrast of Clinical Evaluation Scores in Four Areas Before and After OB Clinical Experience

	Identifies Needs	Collects Data	Technical Skills	Evaluation
Mean number of observations per student	10.79	34.06	2.33	7.06
Mean gain in score after experience	.91	.84	.70	.90
t	12.21	13.60	5.66	27.15
df	25	25	21	24
r_{pb}	.93	.94	.78	.98

Following OB Clinical experience, students showed significant gains in each of the four areas evaluated. As is desired in a reliable measure of learning, total treatment effects (where the "treatment" consisted of all experience gained formally or informally in the period between evaluations) accounted for a major portion of the variance in the difference scores. Treatment accounted for 60% of variance in scores in technical skills, the least reliably sampled behavior (based on an average of 2.33 observations per student). Treatment accounted for over 85% of score variance in each of the other three areas.

The next step in development seems best directed toward a further simplification of the rating form to the point where raters find it more convenient to indicate ratings on the form as they are observed rather than relying on memory or notes. Obviously there are diminishing returns in reliability of ratings as fewer observations are used, however, it appears that three to five observations in each of the four areas indicated in Table 4 should provide a reasonable compromise. Such a simplified measure would greatly reduce the workload of the rater (an average of 54 observations were made on each student during each rating for the data reported in Table 4) and may allow a single form to be used for an entire class.

IV. Student and Instructor Attitudes toward PLATO

Educational material or media must be accepted by both student and instructor if it is to be of practical use. Unfortunately subjective evaluations made by these individuals tend to be contaminated by several factors. Instructors who contribute to development of material generally rate that material more favorably than they rate material produced by other instructors of equal status. Students and instructors who participate in novel learning situations frequently respond favorably because of novelty alone

or the increased attention given them in an experimental situation. Other students or instructors come to the learning situation with strong prejudices against technological innovations in education.

Influences of such contaminating factors are most easily reduced by time. Prejudice and novelty are major influences when exposure to the new learning situation is minimal. With increased exposure to the situation opinions come to be based more and more on reaction to factors intrinsic to the situation. Thus, user evaluations of educational media or material are of questionable value when these evaluations are based on short exposures (of the order of 1 to 5 hours). However such evaluations come to be of much higher value as exposure time approaches that of the typical formal educational course of one academic quarter or semester. Evaluations by students and instructors in institutions other than the developing institutions are also of value in demonstrating the generality of claimed advantages. The following evaluations are based on responses from students both from a hospital-associated school of nursing (the population for which the material was originally produced) and an associate degree program. Instructor evaluations are also from instructors of both programs.

A one page student evaluation form (see Appendix A-5) was designed to measure the three factors in computer-based instruction which seemed to be of most interest to both instructors and students. The three factors((a) possible difficulty in use of equipment, (b) capability of teaching complex concepts, and (c) perceived acceptability and effecti eness compared to other media) were determined from analysis of responses to interviews and extensive questionnaires.

The final evaluation form also requested completion of open-ended items indicating most and least favorable aspects of learning from PLATO.

Significant shifts from opinions occurred in each of the three areas after the first week of exposure to PLATO. Initially, 54% of the students indicated difficulty in concentrating on the lesson because of attention needed to operate the equipment. Those 15 - 20% who still expressed difficulty after several classes frequently qualified their opinions by phrases such as "but only infrequently."

Similar shifts in attitude with experience were found in student acceptance of PLATO as a legitimate educational medium for fairly difficult material. By the end of courses over 50% of students typically rate PLATO as "Best," "Easiest," and "Most preferred" medium over lecture, textbook, or movie while from 0 to 15% rate PLATO as "Worst" or "Hardest" to learn from. No clear differences are usually seen between the other media.

Negative factors listed in open-ended responses on student evaluation forms have largely fallen into two broad areas: (1) the need to produce concise, explicit answers (and the attendant refusal of PLATO to accept responses that were "only slightly" wrong) and (2) the requirement of having to search for information to answer inquiry problems. Inasmuch as the objectives of these courses include the inculcation of precise habits and the ability to acquire information in realistic situations these "negative" factors may be interpreted as evidence that the lessons are forcing students to engage in the desired behaviors. It is questionable whether human instructors could be

patient enough to carry through the almost painful reshaping of poor habits frequently permitted in normal classroom teaching. A system such as PLATO thus patiently rejects any but precisely the correct response (where the lesson author has decided that such precision is necessary) in situations where a human instructor would probably give up and supply a correct answer to allow the class to move on. Indeed it is rare for a human instructor to have sufficient time to supply such feedback to a single student. More often a single response is made and either accepted or rejected (as on an examination). In the usual instructional setting poorer students quickly observe that if they don't know the answer to an item they can usually get "off the hook" simply by saying so, making a guess, or otherwise escaping the necessity to think.

Another area of complaints was concerned mainly with the problems of using a computer-based system which is essentially saturated with users. Every effort was made, through scheduling of evening and weekend review periods when PLATO was made available on a voluntary basis, to insure that each student had ample time available. However daytime scheduling of PLATO did not permit use of terminals at the convenience of students. This problem is obviously not a function of of the material or subject area, nor will it be present in the next version of PLATO.

In addition to the formal evaluation studies, student comments were collected on a daily basis. At any time during a lesson that a student wished to make a comment or express an opinion, she could do so by merely entering a special "Comment Mode" and typing the desired

comment. "Comment Mode" is a very effective method of enhancing the interaction between student and PLATO. If the student thinks she has found an error or inconsistency in the material she can immediately type a note of the fact. The fact that these comments appear to be made to a machine rather than a person seems to produce a much higher proportion of extremely frank comments than would be expected when the comments were directed to a person. Frequently the comments are explicitly addressed to PLATO and it is not uncommon for students to apologize to PLATO for an error or for prior complaints later found to be unwarranted. One student's comments to PLATO at various stages of the course illustrate these points. Her initial encounter was brief and pleasant, and resulted in the comment, "I love you computer." Two days later she wrote, "You did a very good job yesterday. Why did you goof up today? You were very frustrating at times--in fact, I almost punched all your keys at once--how does that grab you--I'm not so sure I like a machine teaching me--it's going to take me awhile but I'm not promising you anything--I may never get to like you--take that and that." "I hate you!" At the end of the second week she entered another comment. It read, "I enjoyed this lesson. I'm not sure if it was because it was easier or if it was because I finally got the hang of using the investigate button and did not get as frustrated." Near the end of the course, she typed the following, "I'm very glad you dwelled upon the normal. It is more important for us to know the normal so that we may determine the abnormal. This lesson called for quite a lot of investigation which is very good. When you have to look for the answer, you learn a lot more."

Instructor evaluation of the material was almost uniformly favorable. Two of the four instructors who have used the nursing lessons in the associate degree program specifically requested that more of the nursing courses be placed on PLATO. One instructor was favorably impressed with the ease of running classes by PLATO and gratified at the degree of control she had without having to worry about the technicalities of computer operation ("It is a lot like driving a car--I know how to make it go and about some of the more common things that go wrong with it--which meets my needs without having to know about combustion, valve lifters, etc..."). Several instructors commented on the degree of generalization that students made from the material learned on PLATO and indicated that students frequently cited information gained from PLATO courses during other lecture and discussion courses. Other instructor comments were largely related to organization of material. Since the order in which they introduced topics differed somewhat from that used by the authors of the material there was a desire for more "unitized" lessons which could be presented independently and in any desired order. This problem does not appear to differ from the analogous situation in which an instructor assigns chapters from a textbook out of their original order. The evaluation form used by instructors can be seen in Appendix A-6.

Summary

Obviously, by objective measurement, students can learn successfully on the PLATO computer-based education system. Studies have indicated that students learn the same material presented in a classroom as well or better in 1/3 to 1/2 the time. Unlike the conventional classrooms, here the students are allowed to determine their own rate and direction of learning, while receiving instantaneous and individual attention from the computer. At the same time, instructors can update or modify material from the student terminal. Record keeping by the computer is complete, but the processing of data is tailored to the individual instructor's needs or specifications. Teaching strategies can vary from a simple drill and practice to a tutorial approach, a student-directed inquiry in a simulated laboratory, or a complex dialogue between student and machine. The recent additions of audio and touch sensitive capabilities to the system will add new dimensions to the instructional materials.

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APPENDIX A-1

Comparison of Two Forms of Lesson 12 (Abnormalities in the Newborn)

1. Twenty-six students were taught the same material by two different methods on the PLATO system. Group A received material which made greater use of the branching and "Help" sequence capability of CBE and was predicted to give the better results. Group B received the same well-structured material but without benefit of as many special branching options.

2. Students were divided into two groups of 13 each. Scores on a pretest showed group B to have a group mean of .846 points greater than that of group A. Since the difference was nonsignificant (t = .727, 24 d.f., p = .474) the groups were assumed to be equivalent.

3. Post-tests were given shortly after presentation of the material via PLATO and 28 weeks following. In order to reduce possible masking effects of between-subject variability, gain-from-pretest scores were computed for each subject. A two-tailed t test was used to evaluate the effects.

Mean Gain from Pretest

Posttest	Group A	Group B	t	d.f.
Immediate	+ 9.73	+ 7.15	1.69	24
28 Weeks	+ 5.73	+ 3.95	1.62	21

Three students in Group B left the program shortly before the last posttest was given, thus reducing the size of Group B to 10 for the 28 week posttest A non-significant difference ($.10 < P < .20$) in favor of treatment A is seen in each posttest. Learning effects (pretest-immediate posttest and pretest-28 week posttest differences) and the "forgetting" effect (immediate posttest-28 week posttest decrement) for both treatments are highly significant ($P < .001$). It is concluded that there is marginal evidence that added use of branching and "help" sequences in this PLATO program has a beneficial effect on learning of this material and that the relative gains produced are retained during normal forgetting.

APPENDIX A-2

Evaluation of Learning for Lessons 2 (Physiology) and 3 (Fetal Circulation)

1. Lessons 2 and 3 contain material which an experienced instructor had indicated as being most difficult for students to grasp and retain. A total of 26 students were given this material via PLATO lessons which made use of the individualized instructional capability of CBE. A 30-item criterion test was administered prior to and immediately after instruction and then at 4, 8, and 24 weeks after instruction to evaluate learning and retention.

2. Five of the 26 students were dropped from the analysis since complete data were not available for them. Two of the five did not take the pretest and the other three did not take the 24 week test. Comparison of mean scores of these five students with mean scores of the other students on the three tests taken by all students indicates that elimination of these students from the analysis is unlikely to bias the results to any great extent.

Test	Lesson 2	Lesson 3
posttest	26.80	26.40
4 week	26.00	26.60
8 week	25.60	28.20

Mean test scores for 5 students eliminated from analysis.

3. Average test scores for the 21 students remaining are indicated below:

Test	Lesson 2	Lesson 3
pretest	9.143	8.952
posttest	27.667	27.238
4 weeks	25.857	26.381
8 weeks	26.048	26.762
24 weeks	25.905	26.762

One-way analysis of variance indicated significant overall treatment effects in each case.

Lesson 2

Source	SS	df	MS	F
Between	5032.82	4	1258.20	303.9 ($P < .00005$)
Within	414.57	100	4.14	
Total	5447.39	104		

Lesson 3

Source	SS	df	MS	F
Between	5350.63	4	1337.66	242.8 ($P < .00005$)
Within	551.33	100	5.51	
Total	5901.96	104		

Duncan's Multiple Range test indicated in each case that:

(a) pretest means were significantly lower than all other test means ($P < .01$),

(b) means for the immediate posttests were significantly higher than all other test means ($P < .01$) for Lesson 2, $P < .05$ for Lesson 3),

(c) no significant difference ($P > .10$) between means of tests given at 4, 8, and 24 weeks was demonstrated.

4. Point-biserial correlations between the present means and the 24 week test means were as follows:

Lesson 2 $r_{pb} = .973$ $r^2_{pb} = .947$

Lesson 3 $r_{pb} = .968$ $r^2_{pb} = .938$

Thus, 24 weeks after presentation of the lessons, about 94% of the variance in test scores was ascribable to the treatment effect.

5. The above analyses indicate that the long term effects of presentation of the material in Lessons 2 and 3 by CBE, as measured by scores on the criterion test, are highly significant and account for a major part of test score variance. No significant decrement in retention was measured from the 4th to the 24th week after treatment. Significant loss was, however, observed during the period between the immediate posttest and the 4th week test.

APPENDIX A-3

Comparison of Student Nurses on Standardized Tests

1. Comparison between performance of classes at Mercy Hospital over the past several years is difficult for two reasons:

   (a) Increased selectivity is evident in acceptance and graduation of applicants for the school. Thus students are not generally of equivalent ability levels from year to year.

   (b) Normative data and tests vary from year to year. Increased knowledge in the area and higher standards require that standardized tests be continually altered if they are to be of value to the profession.

Thus only very general conclusions with respect to treatment effects may be drawn from examination of class performances on these standardized tests.

2. The proportion of original applicants who were accepted and who ultimately graduate during the past five years are shown below.

Class	% applicants accepted	% applicants graduated
1967 (3 yr.)	46	28
1968 (3 yr.)	39	27
1968 (2 yr.)	27	16
1969 (2 yr.)	31	16

3. A proper treatment comparison may be made between members of the same class. The 1968 2-year class was divided into equivalent groups based on past test scores and teacher evaluations. One group received instruction in Obstetrical Nursing via PLATO while the other group received their instruction in a classroom setting. Comparison of performance by these groups on the NLN Medical-Surgical test (covering material which was taught to both groups by standard methods) supported the view that the two groups were well matched academically. Differences in raw scores on the Medical-Surgical test were not significantly different from chance ($t=.290$, 17 d.f., $p = .775$). Differences between the groups on tests covering the experimental material were also not

significantly different from chance despite the fact that the PLATO group covered the material in one-third to one-half the time that the classroom group did.

Test	Evaluation of differences in raw scores
Obstetrics (NLN Achievement test)	t = .028, 17 d.f., P=.978
Obstetrics (State Board)	t = .003, 17 d.f., P=.998

APPENDIX A-4

Relationship between Learning and Response Behavior for Nursing Lessons

1. Lesson performance data for three groups of nursing students (fall, 1968, two groups, N = 13 each; fall, 1967, one group, N = 12) were examined. Data included numbers of requests for special information (Investigate, Dictionary, Help, and Data) and total time spent for Lessons 3 and 21. Several criterion measures for the same students were also examined.

2. Correlations between criterion measures are indicated in the following table. Numbers in parenthesis are the associated degrees of freedom for r. Only the correlation between course and final grade is significant (r = .73, 35 dF, P < .00005). Course grade and NLN scores (raw scores on sections related to lesson material) were used as dependent variables on the evaluations below.

	NLN	ACE	Course Grade	Final Grade
NLN	---	.23(33)	.26(35)	.27(34)
ACE		---	-.27(33)	-.13(32)
Course Grade			---	.73(35)
Final Grade				---

3. Correlations between course grades, NLN scores, and lesson variables are shown below. Correlations involving NLN scores have 35 degrees of freedom while correlations involving Course Grades have 36 degrees of freedom.

Lesson 3	#Investigate	#Dictionary	#Help	#Data	Total Time
NLN	.03	.06	.33*	.18	.16
Grade	-.18	-.14	-.16	.12	-.12
Lesson 21					
NLN	-.16	.18	-.03	-.34*	.14
Grade	-.32	-.21	-.10	-.11	.18

* .05>P>.04

The two largest correlations of the 20 observed seem best interpreted as random extremes of correlations between variates having low or zero relationships.

The power of a test that a true correlation of .34 or more existed (alpha = .05) would be about .54.

4. Correlations between total time spent on lessons, number of inquiry requests and two measures of learning were essentially zero for three groups of nursing students. It would appear that demands resulting from lesson structure have a greater effect on student performance during and after lessons than do individual differences between students. It seems safe to assert that attempts to insure that all students are exposed to the minimum required information while retaining the element of self-direction inherent in inquiry learning have been successful.

Student _____

Observer _____

Date _____

Assign. _____

	Identifies Needs		Collection Data														Technical Skills	Evaluation	
	General	Specific	chart	Kardex	physician	nurse	instructor	auxiliary person	patient	family	hospital dept.	agencies	text	bibliog.	obs.		Observes, charts, performs treatments, patient care, medications, interaction etc.	Establishes Priorities	Revises Priorities
I. PATIENT CARE																			
A. Self-maintenance																			
1. Internal (O_2, etc)																			
2. External (Food, H_2O)																			
B. Safety																			
1. Physical																			
2. Psychological																			
C. IPR																			
1. Patient																			
a. psych. support																			
b. information																			
2. Others																			
a. psych. support																			
b. information																			
II. ANTICIPATED CARE (care plan)																			

COMMENTS:

MERCY HOSPITAL SCHOOL OF NURSING
URBANA, ILLINOIS

EXPLANATION SHEET FOR STUDENT EVALUATION FORM

1. Description of Problem Solving Columns
   A. Identifies needs -- indicate here (using rating scale) what patient needs the student identifies, differentiating between general and specific.
   B. Collection of data - indicate here (using rating scale) the sources the student used in collecting data.
   C. Technical skills - indicate here (using rating scale) what specific procedures the student carried out to meet the identified needs (i.e. 3-enema; 2-IM injection; 2-explaining OR; 1-charting; 4-side rails up)
   D. Evaluation - indicate here (using rating scale) how the student established and revised priorities in nursing care.

2. Rating Scale
   This indicates how well she did activities in Column A,B,C, and D.
   0 - not observed
   1 - not done (omitted something that should be done)
   2 - done, unacceptable (attempted, but failed)
   3 - done, something wrong (needs improvement)
   4 - done, acceptable

3. Comments
   This space can be used to elaborate on a rating of 1, 2, or 3 and as antidotal records for conference purposes.

4. Description of Patient Care Topics
   The purpose of the following categories is to give a general idea of what behaviors might be observed under each topic. These lists are not all inclusive and in some places may overlap. The observer may use her own preference in placement of behaviors not specifically listed.

   I. Patient Care
      A. Self-maintenance - nursing measures to provide and promote physiologic function
         1. Internal - O_2, electrolytes, IV therapy, metabolism, physiology, respiration (suction etc.), elimination (enema, foley), recording intake and output, food, water, circulation, medication.
         2. External - skin care, grooming, activity, rest, passive exercises, range of motion, physical therapy, ambulation, restful environment.
      B. Safety - nursing measures to provide and promote patient safety
         1. Physical - bed rails, restraints, isolation and sterile technique, prevent injury, checks arm bands, hazards (fire, thermal, chemical, mechanical, radiation)
         2. Psychological - professional ethics, privacy, explanation, patient self-esteem, cultural differences, ego preservation.

C. IPR - Interpersonal Relationships - Communication
   1. Patient
      a. psychological support - listening, ego preservation, interviewing technique, explanation, understanding, comfort
      b. information - teaching.
   2. Others (doctor, nurse, family, staff, hospital departments, chart, referral agencies, visitors)
      a. psychological support - promotes group solidarity, listening, understanding, interviewing technique, reinforcing staff.
      b. information - charting, referring, reporting, MD rounds, communicating, observations, consulting.

II. Anticipated Care
Evaluate student performance on nursing care plans.

APPENDIX A-6

PLATO EVALUATION

One of the best ways to improve any teaching method is by gathering the opinions of students. For this reason you may be asked to fill out this and other evaluation forms at various times during the course.

The questions on this form all refer to your most recent PLATO teaching session.

1. "I found it difficult to concentrate on the lesson because of the attention needed to operate the equipment." How do you feel about this statement? (circle one)

strongly agree	agree	undecided	disagree	strongly disagree

2. "I feel that I really learned the material covered in my most recent PLATO session." How do you feel about this statement? (circle one)

strongly agree	agree	undecided	disagree	strongly disagree

3. Suppose the material you learned most recently on PLATO was also available as a lecture, in a textbook, and in a movie. Of these methods (PLATO, lecture, textbook or movie) which do you think you would learn from..... (please fill in each blank)

best_____ worst_____

most easily_____ least easily_____

Which would you personally most prefer?_____

The items below may be completed with a few words or phrases. However, please feel free to use as much space as you want for your reply (including the back of this page). All of the information you can give us will be appreciated.

"The things that I find most annoying about computer-assisted instruction are....."

"The things that I enjoy most about computer-assisted instruction are...."

Thank you for your cooperation.

APPENDIX A-7

Instructor Evaluation of PLATO

Your responses to the following questions are to be used to evaluate the present effectiveness of PLATO as an aid to the classroom instructor and to improve future effectiveness. Together with measures of student performance, the observations and opinions of classroom instructors form one of the ultimate indications of the success or failure of PLATO.

1. What PLATO lessons did your class use (indicate general subject area if specific lesson names are not known)_____

2. Did you contribute to the actual production of the PLATO lesson(s)? If so, to what extent?_____

3. How familiar are you with the PLATO lesson(s) used? (Check applicable statements)

   Was not able to view it_____

   Saw parts while students were using it_____

   Went thru lesson acting as student before students saw lesson_____

   " " " " " " while " " " _____

   " " " " " " after " " " _____

   Reviewed in printed form_____

   Other (please specify)_____

4. How did you incorporat the PLATO lesson into your course?

   As independent "package" integrated into course with classroom discussion_____

   As independent "package" with no overlap with class coverage of topic_____

   As supplement to class presentation with some overlap with class coverage_____

   As additional emphasis for material completely covered in class_____

   Other (please specify)_____

5. What preparation did the class receive before first using PLATO?

   Objectives of lessons given to students_____

   Printed directions for operation of equipment_____

   Verbal " " " " " _____

   Introductory lesson_____

   Other (specify)_____

6. What questions did students ask in class as a result of their experience with the material taught on PLATO? (use additional pages if necessary)

7. Was material learned on PLATO used by students in other parts of the course? If so, did students demonstrate competency in the material? (cite instances if possible)

8. What was the attitude of the students toward PLATO? (cite instances of general types of comments and their estimated frequency if possible)

9. What is your general feeling of the effectiveness of PLATO as it was used with your course?

10. What suggestions have you for future use of PLATO?

11. If you wish to make other comments not covered by the above questions, please do so here. Thank you for your time and effort in completing this form.

Appendix B-1

Maternity Nursing Lesson Objectives

On completion of Lesson 1B (First Trimester of Pregnancy) the student should be able to:

1. State the duration of normal pregnancy
2. List 3 presumptive signs of pregnancy
3. List 3 nursing strategies useful in combating nausea and vomiting of early pregnancy
4. Describe a nursing strategy useful in relieving frequent night micturition during early pregnancy
5. State two reasons for the need for early prenatal care
6. List 4 probable signs of pregnancy
7. Define and describe the diagonal, conjugate, interspinous, and the bi-ischial diameters of the female pelvis
8. Assist in promotion of comfort of a woman undergoing an initial prenatal visit

On completion of the lesson on Diet During Pregnancy the student should be able to:

1. List the increased nutritive needs of pregnancy
2. List certain foods which are high in particular nutrients
3. Make food substitutions of equal nutritive value in at least one day's menu

On completion of Lesson 1C (Second Trimester of Pregnancy) the student should be able to:

1. Describe pelvic measurements that are considered adequate for normal delivery
2. List 5 possible emotional and/or psychosocial problems which may arise during pregnancy
3. List 3 community agencies which may provide emotional and/or financial assistance to an expectant family

4. List 3 topics of discussion generally available in parents' classes

5. Describe the Read and La Maze methods of natural childbirth

6. State the cause and usual treatment of monilia vaginitis

7. List 2 physiologic changes of pregnancy which result in decreased likelihood of intrauterine infection

8. Describe 3 exercises which aid in maintenance of good muscle tone during pregnancy

9. List two physiologic changes of pregnancy which may contribute to development of low backache

10. List 3 nursing strategies useful in relieving low backache of pregnancy

11. List 5 signs of possible complications of pregnancy

On completion of lesson 1D (Third Trimester of Pregnancy) the student should be able to:

1. Define pseudo anemia of pregnancy

2. List 2 cardiovascular compensations which occur during pregnancy

3. List 2 thoracic changes which occur during pregnancy

4. List nursing strategies useful in relieving physiologic dyspnea, heartburn, hemorrhoids, and constipation which may occur during the 3rd trimester of pregnancy

5. Utilize Nagele's rule to calculate EDC

6. List 2 physiologic changes of pregnancy which predispose a woman to varicosities

7. List 3 nursing strategies which aid in prevention of varicosities during pregnancy

8. List predisposing factors to development of urinary stasis during pregnancy

On completion of lesson 2 (Physiology, conception and development of fetal accessory parts) the student should be able to:

1. State the variation, in days, of a normal menstrual cycle

2. State the usual life cycle, in hours, of an ova and a spermatozoa

3. Define proliferative phase, FSH, estrogen, LH, progesterone, secretory phase, ovulation, CGH, endometrium, chromosome, autosome, meiosis, zygote

4. Determine, when given a sample basal temperature chart with testape and Spinnbarkeit results, the probable day of ovulation

5. Define morula, blastocyst, zygote, trophoblast, decidua, amnion, chorion

6. Outline the development of placental circulation

7. Utilize appropriate testing material to distinguish between amniotic fluid and urine

8. State the purposes of amniotic fluid

On completion of lesson 3 (Fetal Circulation, Fetal Pharmacology) the student should be able to:

1. List the structures peculiar to fetal circulation and the purpose of each

2. List the functions of the placenta

3. List 3 drugs which may cause embryonic damage if taken during early pregnancy

4. List and describe effects of 3 substances which pass quickly from maternal to fetal circulation

5. List and describe effects of 3 substances which pass slowly from maternal to fetal circulation

On completion of lesson 4 (Fetal Development) the student should be able to:

1. State 2 characteristics of fetal development which occur during each of the following periods of gestation: 1st month, 2nd month, 3rd month, second trimester, third trimester

2. State the relationship of maternal nutrition to condition of infant at birth

3. State the 3 leading causes of neonatal death

4. List the three layers of embryonic cells and one structure which arises from each

5. State the relationship of "crown-rump" length to gestational age.

6. State 3 positive signs of pregnancy and the approximate gestational age at which each can be detected

7. List 3 circumstances or conditions which influence premature birth

8. State expected characteristics of babies born at 28, 32, and 36 weeks gestational age

9. Explain implications of these characteristics (of babies born at 28, 32, and 36 weeks gestational age) for nursing care.

10. Define lanugo, vernix, esophageal atresia, anencephalia, polyhydraminois, meconium, retrolental fibroplasia, hyaline membrane disease, phocomelia

On completion of lesson 5 (The Three P's) the student should be able to:

1. State the "three P's" involved in the process of birth

2. Describe 4 pelves according to shape

3. State the importance of cephalopelvic relationship

4. Identify fontanels and suture lines

5. Identify the four areas of the fetal skull which are useful in describing the birth process

6. Define fetal attitude, fetal lie, fetal presentation, obstetric position, engagement, station, contraction, cervical effacement, cervical dilation

7. "Time" contractions and differentiate the increment, acme, and decrement phase of each contraction

8. State characteristics of the three phases of the first stage of labor

9. Define the 1st, 2nd and 3rd stages of labor

On completion of lesson 6 (Mechanism of Labor) the student should be able to:

1. Describe, in order of occurrence, the cardinal movements of the normal mechanism of labor

2. List the mechanisms which may be affected when the pelvis, the powers, or the passenger deviates from the normal

3. Define episiotomy, first, second, third degree lacerations, Duncan and Schultz mechanisms of placental separation

On completion of lesson 7 (Characteristics of and Care During Normal Labor and Delivery) the student should be able to:

1. List 7 areas of information that are necessary to gain regarding a patient

in early labor and the usual method of obtaining each

2. State 5 characteristics typical of the beginning phase of the first stage of normal labor

3. State 6 characteristics typical of the midphase of the first stage of normal labor

4. State 7 characteristics typical of the transition phase of the first stage of normal labor

5. State the correct time interval for checking vital signs, FHT, and timing contractions during each of the phases of the first stage of labor

6. State 3 purposes of the perineal shave

7. State 2 purposes of an enema given during the early phase of labor

8. List 6 nursing strategies and the underlying principle of each that are necessary in giving supportative care to a patient during the first stage of labor

9. State the rules of proper analgesia administration during the first stage of labor

10. State appropriate nursing strategy and the reason for such strategy following rupture of membranes during labor

11. State the 5 signs indicative of the second stage of labor

12. State the correct time interval for checking vital signs, FHT, and timing contractions during the second stage of labor

13. State the nursing responsibilities to the mother and to the baby following the second stage of labor

14. State the signs of placental separation

15. State the correct time intervals for checking vital signs during and immediately following the third stage of labor

16. State the purposes of oxytocic therapy during and following the third stage of labor

17. List the Apgar criteria of newborn evaluation

18. State the reason for maintaining fundal firmness following the third stage of labor

On completion of lesson 8A (Infertility, Prolapsed Cord, Cesarean Section, Fetal Distress) the student should be able to:

1. State 2 general factors elemental to fertility
2. List 8 secondary influences which may affect fertility
3. List and define 6 clinical tests useful to the physician in determining fertility
4. State general safety procedures necessary in the care of patients with ruptured membranes
5. Define ballottement and state its significance in the presence of ruptured membranes
6. State one sign of fetal distress
7. List, in order of importance, necessary steps on discovery of prolapsed cord
8. Define Cesarean section and list 4 indications for its use
9. List and define four types of Cesarean section
10. List 3 nursing responsibilities in the preparation of a patient for Cesarean section and the reason for each
11. State a common side effect of spinal anesthesia
12. List the steps taken to relieve mild respiratory depression in the newborn

On completion of lesson 8B (Bleeding During Pregnancy) the student should be able to:

1. Define threatened abortion, incomplete abortion, inevitable abortion, complete abortion, habitual abortion, missed abortion, therapeutic abortion, criminal abortion
2. List 8 possible contributory causes of spontaneous abortion
3. Define ectopic gestation, tubal rupture, tubal abortion
4. Define and state the chief danger of hydatid mole
5. List 6 distinguishing characteristics of abruptio placenta, mild and severe abruptio placenta
6. List and define 3 symptoms of hypofibrogenemia

7. Define the 3 types of placenta previa

8. Differentiate between expectant and immediate treatment of placenta previa

9. Define postpartum hemorrhage

10. Differentiate between the actions of pitocin and ergotrate

11. List nursing responsibilities in the care of a hemorrhaging patient

On completion of lesson 8C (Hyperemesis Gravidarum, Toxemia) the student should be able to:

1. List the symptoms and possible causes of hyperemesis gravidarum

2. State the dietary regimen most commonly used in treatment of hyperemesis gravidarum

3. List the classifications of the acute toxemias of pregnancy

4. State the 3 cardinal symptoms of toxemia of pregnancy

5. List 6 symptoms which are suggestive of progression from preeclampsia mild to preeclampsia severe

6. Define eclampsia

7. List 5 modifications necessary in changing a general diet to a low salt diet

8. List distinguishing characteristics of the 1000 mg. sodium diet and the 500 mg. sodium diet

On completion of lesson 8D (Toxemia of Pregnancy) the student should be able to:

1. State nursing responsibilities indicated in care of a potential eclampsia patient

2. State actions and uses of magnesium sulfate and hypertonic glucose

3. List nursing precautions necessary in administration of magnesium sulfate and hypertonic glucose

4. List symptoms indicative of impending eclamptic convulsion

5. List 3 symptoms indicative of poor prognosis in an eclamptic patient

6. State indications for use of low forceps

7. State differences between preeclampsia and essential hypertension

On completion of lesson 8E (Coincidental Complications of Pregnancy), the student should be able to:

1. State the general principle underlying the care of a patient who has an acute or chronic disease during pregnancy
2. State precautionary measures taken in the care of a pregnant woman who has tuberculosis, heart disease, or diabetes
3. State the dangers in the occurrence of cystitis, pyelonephritis, measles, influenza, strep infection, pneumonia, venereal disease during pregnancy

On completion of lesson 9 (Normal Puerperium) the student should be able to:

1. State involutionary changes which occur in the reproductive system, urinary tract, cardiovascular system, and GI system during the puerperium
2. State emergency nursing strategy when relaxed fundus occurs
3. Describe 3 progressive exercises useful during the peurperium
4. State the purposes of pericare
5. Define and describe the 3 types of lochia
6. Explain the lactation process
7. Describe dietary modifications during lactation
8. State recommended nipple care during lactation
9. List drugs usually used to suppress lactation
10. State advantages and disadvantages of rooming-in

On completion of lesson 10 (Abnormalities of Puerperium) the student should be able to:

1. Define dystocia and list 3 possible causes of dystocia
2. Define uterine inertia
3. List 3 nursing strategies underlying care of patient with uterine inertia
4. Define puerperal hematoma and list 2 conditions which may predispose to its development

5. List 3 types of postpartal hemorrhage

6. Define multiple pregnancy

7. Distinguish between monozygotic and zygotic births

8. List 4 complications which may accompany multiple pregnancy

9. Define puerperal infection

10. Define subinvolution, uterine retroversion, and uterine retroflexion

On completion of lessons 11A and 11B (Characteristics and Care of Normal Newborn) the student should be able to:

1. State principles of neonatal nursing care necessary to prevent infection

2. List normal characteristics of the newborn in the following areas:

   a. temperature
   b. weight
   c. length
   d. head
   e. chest
   f. reflex behavior
   g. sleep behavior
   h. eating behavior
   i. respiratory behavior
   j. circulatory system
   k. posture
   l. metabolism

3. Describe and explain cause of the following variations:

   a. molding
   b. milia
   c. nevus flammus
   d. hormone reactions
   e. caput succadaneum
   f. cephalohematoma
   g. subconjunctival hemorrhage
   h. transitory jaundice
   i. transitory coagulation defect
   j. uric acid dust
   k. transitory fever

4. State safety precautions utilized to prevent respiratory distress in the newborn

5. State principles of neonatal feeding

6. Explain use of prophylactic vitamin K

7. Describe normal neonatal stool cycle

8. Differentiate between aseptic and terminal sterilization

9. State 3 methods of bubbling newborn

10. Define PKU

11. Define and describe colic

12. List cause, symptoms, and treatment of thrush

13. List principles of neonatal parenteral therapy

14. List 8 symptoms which may accompany neonatal infection

15. State 10 abnormalities of the newborn and a symptom which may accompany each

On completion of lesson 12 or 13 (Abnormal Conditions in the Newborn), the student should be able to:

1. Describe the signs of mild, temporary neonatal respiratory distress

Appendix B-2
Example of Lesson Material from Maternity Nursing

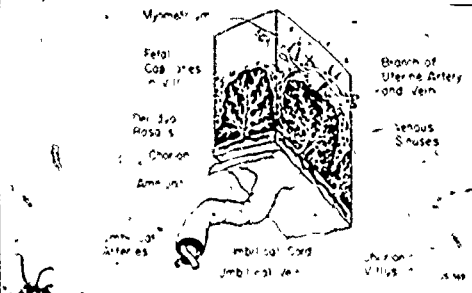
Your next area of investigation concerns the placental "barrier" and should prove interesting.

The "placental barrier" has been defined as "those tissues of the developing embryo which are in contact with the maternal tissues and which mediate transfer of substances to and from the fetus."

Cont.

A

Placental Circulation



Note that maternal and fetal blood each flows in its own capillaries. Transfer of substances takes place by osmosis through the chorionic villi.

B

You have seen that the placenta is composed of two separate sets of vessels. One set going to and from the embryo; the other set going to and from the mother. Although these vessels lie next to each other they are entirely closed off from one another.

Exchange of ingredients is possible because the walls of the vessels are permeable.

Did you know that these separate systems make pregnancy possible? If they were connected, the mother's body would reject the embryo as a foreign substance.

Cont.

C

Only recently has the area of placental transfer been investigated vigorously.

You may wish to pursue this investigation and determine which substances cross the placental barrier.

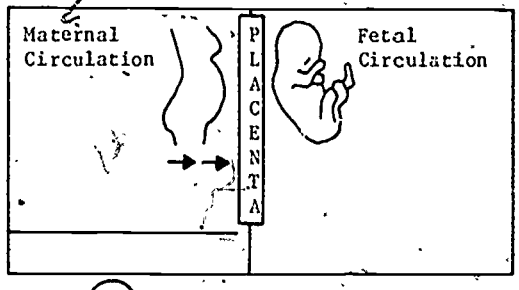
For example, introduce the drug thalidomide into the maternal circulation and check to see if it is transferred to the fetus.

Check its effect on the fetus.

Push Invest.

D

Investigation Now in Progress:

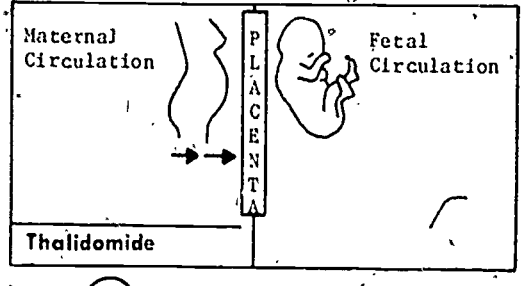


Push ANS

Effect on fetus:

E

Investigation Now in Progress:

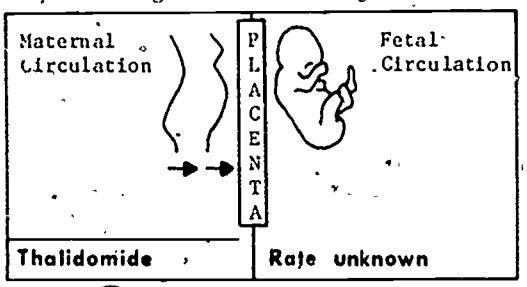


Push ANS

Effect on fetus:

F

Investigation Now in Progress:



Push (ANS)

Effect on fetus: **Teratogenic effects.**

G

The tragedy of the "Thalidomide babies" created widespread interest in the area of placental transfer. However, many things are still unknown. Recently, substances previously thought not transferable have been found in the fetus.

Some substances pass more easily than others, and it is thought that molecular weight is one determining factor.

(Cont.)

H

On her initial visit, Dr. Barns asks Mrs. Dodd if she has been immunized against poliomyelitis as pregnant women are particularly susceptible. Mrs. Dodd has had 3 doses of oral polio vaccine.

She had chickenpox and mumps during childhood, and had previously been immunized against diphtheria, tetanus, pertussis, and smallpox.

Mrs. Dodd asks if her infant will be protected against all of these diseases after birth.

You tell her that passive immunization will be acquired for 5 of the above diseases - mumps, _____, _____, _____, and _____.

I

You know that it is essential for Mrs. Dodd to maintain an adequate nutritional status for the normal growth and development of her child. Certain substances seem to play a rather distinct role. For example:

The vitamin related to development of the senses is _____.

_____.

The substance which is essential to fulfill energy requirements of the fetus is

_____.

J

You have explained that infants at birth have a transitory coagulation defect and are given a small "IM" dose of vitamin K.

Mrs. Dodd wonders if vitamin K is transferred to the fetus from the mother during pregnancy?

You say: _____

In answer to the question, "Why does the infant have a coagulation defect?", you say:

_____

K

Mrs. Dodd's sister-in-law has some Bonine left from an earlier pregnancy. She offers it to Mrs. Dodd for her nausea.

When Mrs. Dodd asks if she should take it, you say:

_____

Why?

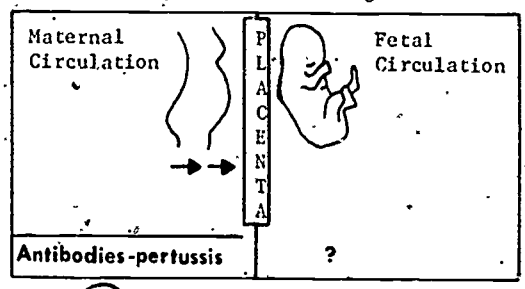
_____

L

Why are codeine and morphine rarely used as analgesics for patients in labor?

M

Investigation Now in Progress:



Push (ANS)

Effect on fetus: Little or no immunity transferred to fetus.

P

From this lesson you have seen that almost anything can and does cross the placental barrier unless it is destroyed during passage.

Some substances are broken down into simpler elements or detoxified before they are transferred.

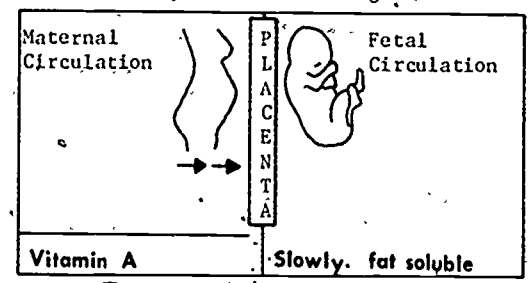
Since passage of large molecular materials (i.e. antibodies, antigens, whole cells, and drugs) is slower, smaller quantities are transferred.

However, even small quantities may have an effect upon the fetus.

Cont

N

Investigation Now in Progress:

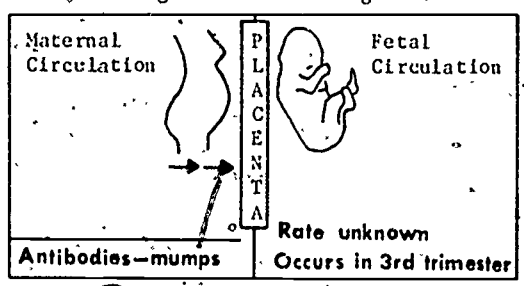


Push (ANS)

Effect on fetus: Essential to growth and development of special senses.

Q

Investigation Now in Progress:

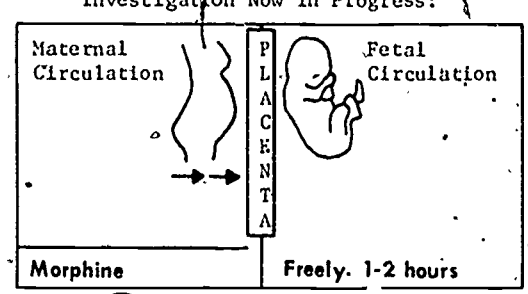


Push (ANS)

Effect on fetus: Definite 4–8 week passive immunity acquired.

O

Investigation Now in Progress:



Push (ANS)

Effect on fetus: Extensive respiratory depression if not excreted before birth occurs.

R

APPENDIX C-1

Pharmacology Lesson Objectives

Unit I. Mathematics of Drugs and Solutions

After completing this unit the student should be able to:

1. Compute equivalent dosages of medications utilizing metric, apothecary and household systems of measurements.

2. Solve problems related to drug and solution dosages.

3.5 - 6.0 hrs.

Lesson: Systems of Measurement/Metric-Problems Drill
Lesson: Systems of Measurement/Apothecary-Problems Drill
Lesson: Systems of Measurement/Household-Problems Drill
Lesson: Computing Equivalent Dosages-Problems Drill
Lesson: Drugs Given in Units-Problems Drill
Lesson: Children's Dosages-Problems Drill

Unit II. General Drug Classification

After completing this unit the student should be able to:

1. Identify the major drug classifications

2. Recognize principles of drug classification according to effects of drugs on the body.

3. Formulate generalizations and deriving basic principles of drug therapy based upon data gathered in simulated experiments.

3.0 - 4.0 hrs.

Lesson: Major Drug Classifications (includes quiz) 1.0 hrs.
Lesson: General Principles of Drug Therapy (Experiments) 2.0 - 3.0 hrs.

Unit III. Study of Major Drug Categories

After completing this unit the student should be able to:

1. Recognize fundamental principles of drug therapy.

2. Place commonly used drugs into proper drug classification given the the drug action.

3. List names of common examples of various drug groups (one or two prototype drugs)

4. Identify characteristic bodily effects of the drugs in the various drug groups

5. Recognize toxic symptoms of commonly used drugs.

6. Formulate nursing implications based on drug action

10.0 - 12.0 hrs.

The following drug groups are considered in this unit:

Lesson(s): Patient with pneumonia and severe malnutrition

- sedatives
- analgesics
- vitamins
- minerals
- antipyretics
- antihistamines
- expectorants
- bronchodilators
- antibiotics
- chemotherapeutics
- antifungals
- antiprotozoans
- antiamoebics
- sulfonamides
- anthelmintics

Lesson(s): Drugs which effect the cardiovascular system. Patients with: Congestive heart failure and pulmonary edema; coronary insufficiency.

- digitalis preparations
- diuretics
- antihypertensive agents
- vasopressors
- hemostatic agents
- anticoagulants
- cardiac stimulants
- cardiac depressants
- antilipemic agents
- fibrinolytics
- nitrites

Lesson(s): Drugs which effect the nervous system. Patients with mental and physical disturbances

- tranquilizers
- psychic energizers
- convulsants
- anticonvulsants
- CNS stimulants
- cholinergic

cholinergic blocking agents
antispasmodics
local anesthetics
general anesthetics
curare preparations
anorexiants
CNS depressants

Lesson(s): Patients with rheumatoid arthritis, diabetes, metastatic carcinoma, and a geriatric patient

disinfectants and antiseptics
antacids
laxatives
antidiarrhea agents
enzymes and acids
thyroid inhibitors
hormones
antidiabetics
hormonal
nonhormonal
antineoplastics
antiemetics

Unit IV. Application of Pharmacological Knowledge in Nursing Situations

1. Use fundamental principles of drug therapy, including dosage and drug application, by solving nursing care problems in given simulated patient situations.

2. Recognize toxic symptoms of commonly used drugs by taking appropriate action in given simulated patient situations, emphasizing individual differences of patients.

3. Identify socio-psychological aspects of drugs for given simulated patients. (These simulated patients will emphasize individual differences in response to drugs, economic aspects of drug therapy, and social problems arising from indiscriminate use of drugs.)

4. Identify important concepts of drugs and drug usages which should be taught to simulated patients, and patients presented to her.

1.0 - 1.5 hrs.

Lesson: Patient with uncontrolled diabetes mellitus and LLL pneumonia (Only 1 lesson completed in this unit.)

Appendix C-2

Sample Lesson Material: Pharmacology

In this unit you will perform some simple experiments. The results of these experiments will allow you to form certain generalizations regarding drugs.

These general principles of drug therapy will form the foundation of your study of specific drugs, their uses and action.

You may perform experiments and check your generalizations by using INVESTIGATE.

Press NEXT

A

INVESTIGATE

1. Perform experiments
2. Check generalization

Indicate area of investigation 1

Press NEXT

B

Experiment in Progress

What do you wish to study first? dosage

dosage
absorption
metabolism
action

Press NEXT

C

There are several general principles to remember regarding drug dosage. See if you can determine what they are. It is suggested that you test secobarbital (seconal). In proper doses it produces a natural type sleep; too large a dose may result in coma or even death; too small a dose may produce mild sedation.

First of all, is your patient male or female?

female

Press NEXT

D

Frequently, a smaller amount of chemical is needed to produce desired results in women than in men. You may suspect that this factor has something to do with size. Test your hypothesis by experimenting with various dosages of secobarbital for patients of different weights. When you are ready to state a general principle, press TERM and type Gen (generalization).

Give 15 mg. of oral secobarbital to a patient weighing 50 lbs.

(Secobarbital is supplied in capsules of 15 mg., 30 mg., 45 mg., and 100 mg., but any amount may be given. Please state the dose in total mg.)

Be sure to perform enough experiments (vary dosages and weights) to enable you to form a generalization.

Press NEXT

E

Give 15 mg. of oral secobarbital to a patient weighing 50 lbs.

Quick Sleep

To try another experiment press NEXT

F

Give 15 mg. of oral secobarbital to a patient weighing 250 lbs.

No Effect

To try another experiment press NEXT

G

Give 200 mg. of oral secobarbital to a patient weighing 45 lbs.

Coma. May be a lethal dose

To try another experiment Press NEXT
When you are ready to formulate a generalization Press TERM and type GEN.

GEN

H

You should have determined from this experiment that there is a direct relationship between the **size OK** of the body and the amount of a chemical needed to reach and effect the tissues.

Press NEXT

I

As weight increases, a larger amount of chemical is required to produce effects. After body size has reached a certain level, dosage must be altered more drastically to produce a change in effect.

Somewhat related to this is a generalization regarding age and dosage. It is suggested that you again test the drug secobarbital (seconal) by varying the dose and the age of the patient.

Give Seconal ____ mg. to patient age ____ years.

J

The method in which a drug is administered may affect the dose required to achieve desired results. For example, Mrs. Long, is seen in the Emergency Room with a fractured large toe. The physician wishes to relieve her pain by utilizing codeine 64 mg.

Give Mrs. Long codeine 64 mg. by **orol** method of administration.

Poor pain relief.
Larger dose necessary.

Press NEXT

K

The method in which a drug is administered may affect the dose required to achieve desired results. For example, Mrs. Long, is seen in the Emergency Room with a fractured large toe. The physician wishes to relieve her pain by utilizing codeine 64 mg.

Give Mrs. Long codeine 64 mg. by **IM** method of administration.

Quick and effective pain relief.

Press NEXT

L

The method in which a drug is administered may affect the dose required to achieve desired results. For example, Mrs. Long, is seen in the Emergency Room with a fractured large toe. The physician wishes to relieve her pain by utilizing codeine 64 mg.

Give Mrs. Long codeine 64 mg. by IV method of administration.

Quick and effective pain relief Intravenous administration of this drug may cause severe CNS depression. NOT preferred method of administration.

Press NEXT

M

Determine the metabolic rate of the following drugs when given to a person with hepatic disease.

Digitoxin: slows the beat and strengthens the muscle of the heart.

Vitamin A: essential to retinal function, proper growth, maintenance of skin tone, proper cortisone and cholesteral metabolism.

Tetracycline HCL (Achromycin V): antibiotic and bacteriostatic agent

Chloral hydrate: hypnotic, sedative

Give Vitamin A to a patient with hepatic disease.

P

Experiment in Progress

What do you wish to study first? metobolism

dosage
absorption
metabolism
action

Press NEXT

N

Give Vitamin A to a patient with hepatic disease.

Improper absorption, release, and utilization may result in deficiency state.

To try another experiment press NEXT

Q

The condition of a drug's storage site may affect its metabolism. Certain drugs are stored in the liver following absorption. There they are prepared for use in the body, distributed, eventually detoxified, and excreted. Now you will determine the metabolic rate of several of these drugs when given to a person who has hepatic disease.

Press NEXT

O

Give Chlorol Hydrate to a patient with hepatic disease.

May accumulate to dangerous blood level. Excretion is slow.

GEN

Injured or diseased storage site may result in ineffective OK drug metabolism.

R

Appendix D

Materials Evaluation Form

Materials Evaluation Form

To be used by faculty, consultants, etc. to assist them in evaluating our lessons.

Suggestions

Is the material (slides, images, etc)

Accurate

Relevant

Appropriately sequenced

Visually aesthetic

Clear, concise

Presentation

Comprehensiveness

Interesting

Efficient (method of presentation suited to material)

Opportunities to repeat material

Challenging and opportunities for

Are the Directions

Clear

Adequate

Is the student

Involved in learning process

Hindered by mechanical problems

Individual differences accounted for

Given adequate feedback - rapidly enough

Able to determine rate and progress

Allowed opportunity to express self or evaluate course and/or instructor

Aware of course objectives