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COMPUTER ASSISTED INSTRUCTION IN AIR FORCE MEDICAL TRAINING: PRELIMINARY FINDINGS

By
Raymond E. Steinkerchner, Major, USAF
School of Health Care Sciences
Shepperd Air Force Base, Texas 76311

Gerard M. Deignan
Brian K. Waters, Major, USAF
Philip J. DeLeo

TECHNICAL TRAINING DIVISION
Lowry Air Force Base, Colorado 80230

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

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Technical Training Division

DAN D. FULGHAM, Colonel, USAF
Commander

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The present report documents development procedures and findings from an initial exploratory application of computer interactive instructional terminals within Air Force medical training. An experimental problem-oriented medical curriculum (POMC) constituting less than 10 percent of the total instructional hours during the first year of training was developed and administered by means of PLATO IV computer terminals to School of Health Care Sciences students enrolled in the Physician Assistant (PA) course at Sheppard AFB, Texas.

To assist informed judgment by decision-makers, preliminary information on the suitability of the POMC was required to determine if subsequent in-depth study of the comparative effectiveness of computer-assisted instruction

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(CAI) as opposed to alternative conventional modes of instruction was warranted. The present report provides Phase I preliminary information on development procedures, implementation conditions, student reactions, lessons learned, and cost data analyzed by Air Force health care scientists. The second phase, currently in progress, emphasizes the systematic and objective comparison of CAI with alternative instructional modes on dimensions of: (a) instructional effectiveness, (b) student/instructor attitudes, (c) characteristics of learners whose performance-effectiveness was differentially facilitated or otherwise influenced by CAI and non-CAI instructional modes and (d) comparative cost data of alternative instructional treatments.

SUMMARY

Objective

The major purpose of this study was to develop and evaluate a computer-based problem-oriented medical curriculum (POMC) in the Physician Assistant (PA) course at Sheppard AFB, Texas. Specifically, the objectives were to: (a) research and develop a problem-oriented medical curriculum in a portion of the PA course, (b) conduct comparative evaluation of the instructional effectiveness of the POMC with the traditional lecture curriculum, and (c) document development procedures and lessons learned.

Background

The instructional approach employed in the conventional lecture version of the PA course consisted of a linear sequencing of isolated instructional material which often lacked integration with, and practice in, clinical diagnosis. In contrast, the new POMC was envisioned as a means of integrating medical material while providing functional practice of diagnostic skills in the context of computer-simulated patient encounters. In brief, the POMC was to instruct students in an essential body of medical knowledge in a clinical context. The POMC included functional learning and applied practice in solving clinical problems by requiring students to: (a) gather subjective data (history), (b) gather objective data (physical and lab exam), (c) analyze diagnostic data, (d) formulate plans of action, (e) prescribe treatments, and (f) obtain feedback on treatment effectiveness.

Instructional development and delivery of the POMC was accomplished by means of 16 interactive computer terminals (PLATO IV) with graphic capability which afforded a high degree of individualized instruction through tutorial methods. Approximately 10 percent of the total instructional hours during the first year of training was administered to School of Health Care Sciences students enrolled in the PA course at Sheppard AFB, Texas.

Specifics

Many of the experimental findings were inconclusive due to implementation constraints which precluded rigorous comparisons. However, initial application of computer-assisted instruction (CAI) in medical training proved useful as lessons learned for conduct of subsequent research currently underway at Sheppard AFB, Texas. For example, within lesson development, author-coded divisions of labor were more effective when the coder was competent in the subject matter. and the author and coder were physically located at the same station for ease of communication. Situations in which these necessary conditions were absent proved ineffective and resulted in the fusion of the author coder responsibilities within the author role. Other lessons learned contributing to the conduct of the follow-on effort included: (a) provisions for ensuring identical criterion measures administered at the lesson test and block test levels, (b) high student flow courses, (c) faculty involvement in the selection, development, and review of instruction mediated by computer terminals, (d) pre-course measurement of learner characteristics to assist in formative and summative evaluation, and (e) separate CAI and control groups for an entire block of instruction.

The follow-on investigation is currently in progress with improved evaluation and implementation procedures designed to ascertain the comparative instructional effectiveness, time savings, and delivery cost differences between CAI and conventional instruction (lectures and programmed instructional text). Three different courses representing widespread differences in medical tasks and student aptitudes have been selected for investigation. The follow-on effort benefited greatly from the experiences and numerous lessons learned in the PA initial application of CAI in medical training. Discussion of lessons learned and recommendations are incorporated within the main body of this report.

Conclusions

The present report provides preliminary information on development procedures, implementation conditions, student reactions, lessons learned, and cost data on the POMC/CAI effort. Subsequent in-depth study of the comparative effectiveness of CAI as opposed to alternative modes (programmed instructional text and lecture) of instruction is currently in the formative evaluation stage in three medical courses at Sheppard AFB, Texas. Redirection of the effort to high student flow courses more suitable to comparative analyses between CAI and non-CAI modes of instruction commenced in March 1976. This follow-on effort

will provide decision-makers with data on the comparative instructional effectiveness, time savings differences, and delivery costs of CAI and non-CAI modes of instruction.

PREFACE

This report represents a portion of the research program of project 1121, Technical Training Development, Dr. Marty Rockway, Project Scientist; task 112102, Applications of Computers in Air Force Educational and Training Systems, Dr. Joseph Y. Yasutake, Task Scientist; work unit 11210211, Evaluation of PLATO IV in Air Force Medical Training, Dr. Gerard M. Deignan, Project Monitor. Earlier project monitorship was performed by Capt William P. Mockovak during the 1973–1974 period and Dr. Philip J. DeLeo in early 1975.

The authors' gratitude is expressed to the professional members of the PLATO IV Author Development Team whose diligent efforts and observations formed the basis for this report: Lt Col Brent Seager, Majors Robert LaCoe, Ronald Kimball, Gerald Roseman, Robert Stutz, Captains Arland Eyl, Jr., James Romanchek, William Gage, SMSgt Lawrence Russell, SSgt Bradley Fincher, and A1C Michael Smith. This dedicated team of health care scientists performed admirably under extremely difficult circumstances to get the job done. Their efforts are thankfully acknowledged.

The authors also wish to acknowledge the professional and technical support provided by course and administrative personnel within the School of Health Care Sciences (SHCS) and the Military Training Center (MTC) support group at CERL (Center for Education Research Laboratory), University of Illinois. Appreciation is expressed for manuscript reviews and comments from ARPA, SHCS, and ATC/SG representatives. The comments were competently typed in final draft by Mrs. Virginia Bahnsen of AFHRL/TTT.

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I. INTRODUCTION

Providing sufficient numbers of competent health care personnel in the least time possible at an acceptable cost to meet Air Force needs poses a decision-making dilemma to Air Force health care executives. Rising training costs, inflation-eroded training budgets, and attrition among experienced health care professionals are expected to continue. Substantially increased training budgets, protracted training time or fewer graduates to meet medical needs are unsatisfactory solutions. One promising alternative solution currently in use in some academic, governmental and industrial settings is the application of computer-assisted instruction to instructional areas.

Computer-assisted instruction (CAI) offers the opportunity to individualize instruction in a tutorial manner such that instructional objectives are achieved in less time than in conventional lock-step modes of instruction. By means of PLATO IV plasma display CAI terminals connected to a large centralized computer at the University of Illinois, individual students can respond to and interact with instructional material. Immediate analysis of student performance is afforded to include the capability of quickly adapting the difficulty level or type of presentation approach employed for an individual learner. Aside from the motivational impetus generally reported by students, CAI offers standardization, quality control, and objectivity with respect to instructional objectives attained.

To assist informed judgment by Air Force decision-makers, preliminary information on the suitability of CAI was required to determine if subsequent in-depth study of the comparative effectiveness of CAI as opposed to alternative modes of conventional instruction was warranted. Whereas the present report provides preliminary information on the development procedures, implementation conditions, student reactions and cost data analyzed by Air Force health care scientists, the second phase, currently in progress, emphasizes the systematic and objective comparison of CAI with alternative instructional modes on dimensions of: (a) instructional effectiveness, (b) completion time, (c) delivery costs, (d) student/instructor attitudes, and (e) characteristics of learners whose performance-effectiveness is differentially facilitated or otherwise influenced by alternative instructional modes.

Preliminary findings in the present report constitute the experiences and observations of the PLATO IV Development Team at Sheppard AFB, Texas. Though performance and attitudinal data are customarily analyzed by appropriate statistical methods, the two distinctly separate and small student samples (N=8, N=14) did not permit meaningful statistical interpretation. Qualitative analysis of student performance and attitudes, which included student interviews performed by the PLATO IV Staff Clinical Psychologist, forms the basis for much of the information contained herein.

In December 1973, a formal research agreement was signed by representatives of the School of Health Care Sciences (SHCS), the Advanced Research Projects Agency (ARPA), and the Air Force Human Resources Laboratory (AFHRL) (Appendix A). This agreement tasked the School of Health Care Sciences with two major objectives:

1. The research and development of a new problem-oriented medical curriculum in the Physician Assistant (PA) course, using an advanced, computer-based educational system, and,

2. A comparative evaluation of the instructional effectiveness of this curriculum vis-a-vis the present traditional curriculum.

Impetus for origination of this program stemmed from a critical shortage of physicians' services, both nationwide and in the USAF. As a result, a new category of health specialist; i.e., the PA course, was developed. Like most of the civilian PA programs, the original Air Force program was modeled after the traditional medical school curriculum. The instructional approach was characteristically one in which there was a linear sequence of basic medical sciences which temporarily preceded clinical practice. The usual modes of instruction and learning were lectures/demonstrations in a group lock-step pattern.

SHCS officials noted that the major problem with such a curriculum was the core of medical knowledge which must be memorized is usually taught without a fundamental frame of reference, that is, basic medical sciences are often presented in isolation from their clinical relevance, both intellectually and

temporally. Consequently, the basic frame of reference missing in the traditional PA curriculum was a core of clinical applications which characterized the clinical problem-solving process in problem-oriented medical contexts.

During the time of the original research proposal, the faculty of the traditional PA course had initiated a comprehensive planning effort which examined the feasibility of converting the entire PA course to the problem-oriented format. This effort culminated with the identification of 24 "modules" designed to replace the traditional PA curriculum. Had this total conversion been pursued, many of the evaluation problems detailed elsewhere in this report would have been avoided, and the instructional impact of computer-assisted instruction (CAI), as well as the problem-oriented medical curriculum (POMC) could have been evaluated with more confidence.

The final research agreement tasked the School of Health Care Sciences to provide (a) adequate classroom and laboratory space to accommodate 20 PLATO IV terminals and associated hardware, (b) provide students for the conduct of the PLATO evaluation, (c) provide subject matter specialists and technical support personnel (Appendix A) to produce approximately 200 hours of PA course materials for delivery on PLATO, (d) document development procedures and lessons learned for future reference, (e) develop a test plan for the evaluation of PLATO IV with AFHRL, and (f) provide monthly progress reports to the various interested agencies.

To insure a common frame of reference, the SHCS PLATO staff defined a problem-oriented medical curriculum as:

> The grouping of course content under clinical problems and the presentation of material in a clinically oriented mode such that the clinical relevance of the course content is stressed in order to develop problem-solving skills, patient management, and investigative skills. Included in this curriculum are certain basic science materials that cannot be directly related to clinical problems. This material will be included in the curriculum as prerequisites to bring students up to a minimal acceptable level of knowledge. To the maximum extent possible, this material will be presented in such a way as to contribute to the development of problem-solving skills through the use of inquiry learning techniques.

The basic POMC concept required that academic subject matter *not* be introduced as isolated units, and emphasized integration into the context of clinical diagnosis of actual patient problems. Consequently, this innovative curriculum drew upon 1,400 hours of instructional material from three distinct trimesters and then integrated this information into a problem-oriented context. The new POMC course material was not an hour-for-hour replacement of traditional instruction, but rather an entirely new integration of academic information and skills. Inherent in this type of curriculum was the notion that as information was disseminated, the individual student would acquire and practice diagnostic problem-solving skills. Problem-solving *per se* was not addressed, but the use of patient problems and simulations served as a point of reference and departure, thereby orienting the individual's thinking toward problem-solving.

The respiratory system was selected as a feasible area for instructional development of 135 POMC hours. The rationale behind the selection of the respiratory system and total POMC hours is detailed elsewhere in this report.

As comprehensive implementation and evaluation plans were being formulated in the fall of 1974, a number of difficulties surfaced. For example, to insure sufficient numbers of students (N>50) were exposed to the POMC, the POMC implementation date was moved forward from January 1976 to October 1975, and then finally to July 1975. This rescheduling severely compressed the lesson development schedule, but did not result in any student delays. Additionally, serious comparative evaluation problems (POMC versus traditional curriculum) surfaced and were discussed at evaluation conferences during October 1974 and March 1975 with representatives from Hq Air Training Command (ATC), AFHRL, ARPA, the Educational Testing Service (ETS), and SHCS. The major obstacle was the lack of a valid and reliable instrument which could objectively measure the impact and effectiveness of the POMC which constituted less than 10 percent of the 1,400 PA curriculum hours spread over a twelve-month period. It was believed at the time that latent image simulations, a feedback technique for displaying processes and outcomes resulting from student answers to questions, could provide such a measure. ETS representatives pointed out that although latent image simulations were used on many national board type examinations, empirical evidence of their ability to predict clinical success was lacking. This fact was disseminated to all interested agencies and it was agreed that the project should continue since it would still generate a substantial amount of attitudinal and "subjective" data concerning the POMC and computer-based education in general.

The evaluation section of this report details the impact of implementation, evaluation strategies and student attitudes on the outcome of the project. It became readily apparent during November 1975 that the impact of a number of factors was seriously confounding the entire POMC research effort. A thorough project analysis subsequently dictated a major change of focus. The termination of the POMC project and redirection of the SHCS PLATO IV research effort was agreed upon and finalized during February 1976.

The following sections provide an in-depth examination of the School of Health Care Sciences' computer-based POMC research and development effort. This report discusses problems encountered and lessons learned for future reference.

II. INSTRUCTIONAL MATERIALS SELECTION AND DEVELOPMENT

Subject-Matter Selection. The following considerations were of prime concern in choosing a subject-matter area for the POMC:

1. Subject matter selected had to be fairly circumscribed, clinically relevant, and capable of basic science subject matter integration since these characteristics lent themselves to a problem-oriented approach.

2. Subject matter selected had to be confined to approximately 10 percent of the conventional year-long PA curriculum.

3. The choice of topics had to be compatible with the human resources and equipment with which the PLATO IV project was provided.

Lesson Material Selection. The PA curriculum, like other Air Force training courses, was well described in a Plan of Instruction (POI), a document outlining the subjects taught and the hours devoted to any particular portion of the curriculum. Thus, for any of the possibilities being considered, the hours of instruction could be identified and easily totaled.

In developing the prototype mini-curriculum on the "Respiratory System and its Diseases," the project had to insure that the logical flow in the existing discipline-oriented approach was maintained. Practically speaking, this seemed difficult because the current PA curriculum consisted of a number of indivisible units as described in the POI. It was from these specified blocks of material that the subject matter for the project's curriculum was extracted and subsequently revised into a problem-oriented approach.

Since the entire body of knowledge in the POI had to be taught to each PA student during the year-long course, the PLATO IV project staff assumed responsibility for teaching individual units of respiratory instruction to the students in the pilot POMC group. POMC students were to cover the material in PLATO IV lessons in lieu of the lectures their classmates would be attending. This resulted in inconsistencies in project curriculum. For example, to assume responsibility for teaching the topics "Allergic Rhinitis and Asthma" to the pilot group, it was also necessary to assume responsibility for the entire topic of "Clinical Allergy," rather than just a portion, since all of this material was in the same POI unit and was inseparable. In this case, material not directly pertaining to the respiratory system was included in the project's curriculum so that relevant topics could be covered.

In contrast, despite the interdependent relationships between certain subject-matter areas; e.g., respiratory physiology and acid-base balance, relevant material could not always be neatly extracted from a related body of material without destroying the integrity of the entire subject area. It appeared to be beyond the scope and resources of the project to cover the entire topic and, consequently, no POI responsibility was taken for teaching certain basic science material to the students.

Basically, the material extracted from the POI included the following major topics: anatomy of the upper airway, chest, and lungs; the physiology of ventilation, diffusion, and oxygenation of blood; interpretation of chest X-rays; the pharmacology of antihistamines and antibiotics; laboratory staining and culture procedures; diseases of the nose and throat; clinical allergy; and pulmonary disease. These POI topics are enumerated in the attached document, "POMC Implementation Plan, 10 February 1975" (Appendix B).

Curriculum Development. Several approaches were considered for curriculum development. Initially, it was felt that the curriculum should be composed of a series of descriptive patient encounters,

representing the gamut of respiratory disease. From each of these descriptive cases, the lesson would digress to teach the appropriate basic science material (anatomy, physiology, microbiology).

Because the project had to cover all of the objectives identified in the POI, and as a result of continuing experience with PLATO as an instructional tool, the initial approach was slightly modified. Experience with PLATO suggested that lesson material had to be presented in a series of temporally manageable modules that were well defined and limited in their content. It was felt that an initial basic science overview was required prior to exposure to the bulk of the curriculum. This basic science overview maintained a clinical orientation whenever possible, with references to the clinical applications of various basic science principles.

Following the initial basic science overview, a series of primarily clinical modules was presented. Each of these modules dealt with a clinical topic in pulmonary disease which reinforced and amplified the related basic science material.

Simulated patient encounters were distributed throughout the POMC sequence of lesson material. In these situations, the student gathered subjective data (history), objective data (physical and lab exam), assessed the information, and formulated appropriate plans. These simulated patient encounters were designed to reinforce systematic techniques of data collection and analysis, as well as to serve as a vehicle for teaching and reinforcing clinical science subject matter. A sample of a typical simulated patient encounter is provided and more fully discussed in Appendix D.

Lesson module sequence is shown in Figure 1. POI objectives corresponding to each block in the flow chart are described in the Implementation Plan (Appendix B) and listed in greater detail in Appendix C.

Lesson Development. Responsibility for developing individual modules ("lessons"), depicted on the flow chart, was assigned to individual subject-matter experts ("authors"), and lesson development proceeded as follows.

POI Lesson Objectives. The objectives stated in the POI for a given topic were identified and reviewed. In many cases, the objectives were not sufficiently precise to serve as lesson objectives or to serve as the framework for construction of test items. Examples of some of the non-specific "behavioral objectives" were:

1. Block XIII, paragraph 3a: Describe the anatomy and explain the physiology of the respiratory system.

2. Block XXI, paragraph 13d: Discuss mononucleosis.

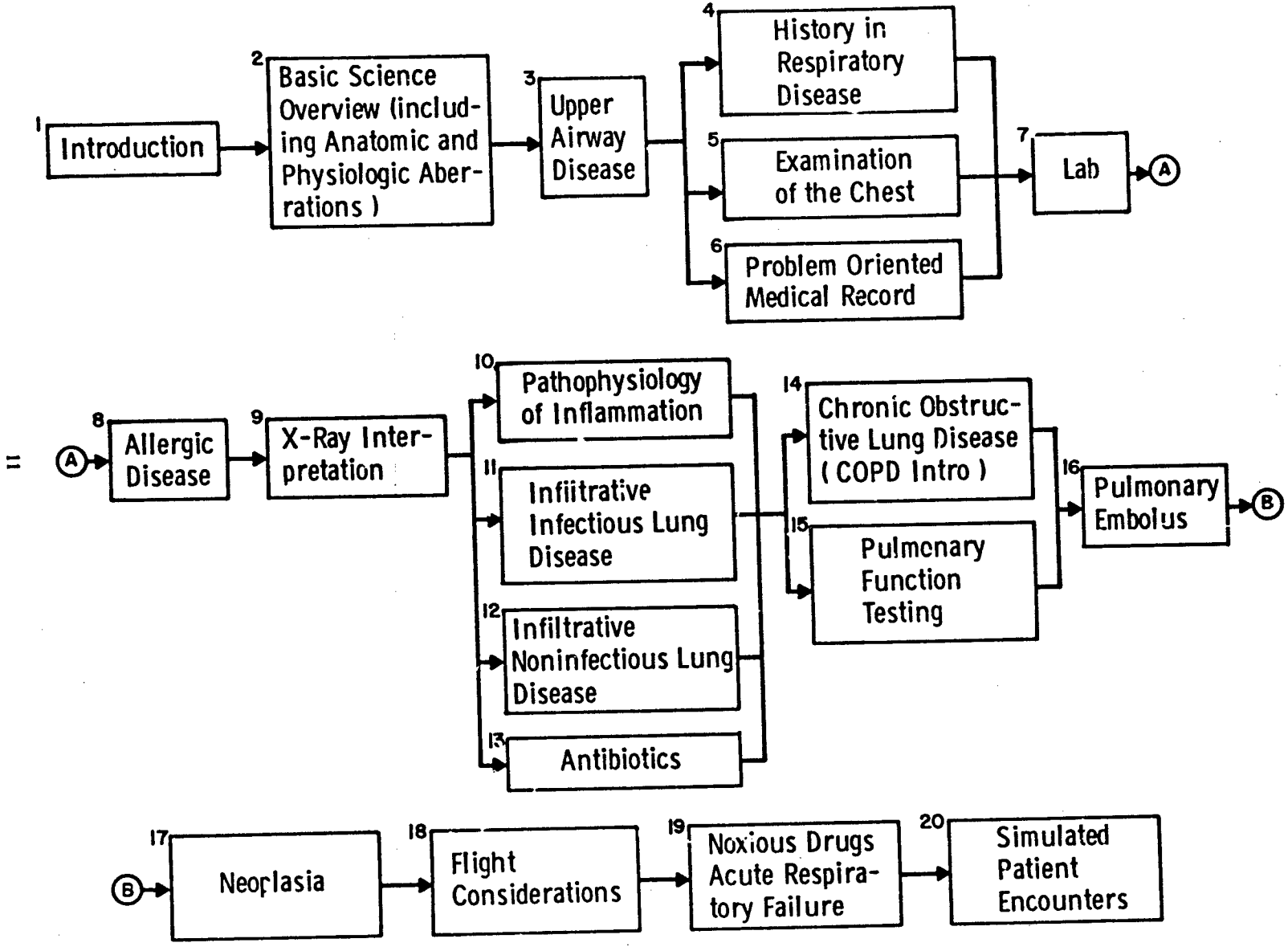
In contrast, some of the objectives in the POI were more specific which facilitated lesson development. For example:

1. Block IX, paragraph 4: List the steps in the Gram stain, Acid Fast Stain, and KOH preparation, and list the purposes for performing microbiological stains on clinical preparations.

The imprecision of many of the topic objectives in the PA course was primarily a reflection of the failure to carefully define the PA role, and consequently, the content of much of the PA training. Accordingly, there was tremendous instructor latitude in determining the breadth and depth of presentation for any given topic, especially those that were directly clinical.

For example, in the objectives for Block XIII, paragraph 3a, there were no guidelines for what was important and hence, what should be stressed. Should the student know the complex sources of respiratory control in the brain stem, or at a lower level of understanding, was it sufficient to know merely that the respiratory drive is centered in the brain stem? Responsibility for demonstrating mastery of instructional material placed instructors, but especially students, in an exceedingly difficult position, given the ambiguity of vague POI lesson objectives. How was the student to know which materials were important and essential, and which were not?

The most reasonable answer was to present subject matter which the instructor regarded as important and not confuse the student with a deluge of peripheral material. Since the PA clinical role was evolving toward increased independence and responsibility, there was a great temptation to present as much material as possible in the lectures. Furthermore, because the breadth of the PA professional role was not strictly defined, students attempted to absorb as much as they possibly could. Students also felt insecure if someone in their class had been exposed to material to which they had not. Unfortunately, students lacked


1
Introduction
2
Basic Science Overview (including Anatomic and Physiologic Aberrations)
3
Upper Airway Disease
4
History in Respiratory Disease
5
Examination of the Chest
6
Problem Oriented Medical Record
7
Lab
A
A
8
Allergic Disease
9
X-Ray Interpretation
10
Pathophysiology of Inflammation
11
Infiltrative Infectious Lung Disease
12
Infiltrative Noninfectious Lung Disease
13
Antibiotics
14
Chronic Obstructive Lung Disease (COPD Intro)
15
Pulmonary Function Testing
16
Pulmonary Embolus
B
B
17
Neoplasia
18
Flight Considerations
19
Noxious Drugs Acute Respiratory Failure
20
Simulated Patient Encounters

the professional experience and, therefore, the discrimination to determine what subject matter was essential and what was not. In many cases, because of vague and excessively broad topic objectives, standardized determination was not made for them.

PLATO Lesson Objectives. After reviewing the POI objectives for the identified flow chart block, the PLATO author developed specific instructional objectives for the particular lesson. The objectives were reviewed by the instructional system development (ISD) specialist for clarity and adherence to Air Force ISD standards. The objectives were also critiqued by a specific associate at the Center for Education Research Laboratory (CERL), University of Illinois, and by others including the PLATO staff physician and the physician assistant.

In the early stages of the project, the process was often quite lengthy. As the authors became more expert in writing instructional objectives, the review procedures became less time consuming.

Criterion Test. Once the behavioral objectives were clearly written and reviewed to delete ambiguities, test questions were written so that initial student mastery of the objectives could be assessed after the lesson was completed. Criterion test items were critiqued by the CERL Sheppard east (Shpeast) associates, with dialogue carried out in Sheppard review (Shprev). Test items were also evaluated by onsite peer authors. In addition, a consulting group at the University of Illinois, consisting of members of the CERL staff, was assigned to work with the Sheppard project to provide lesson reviews and technical assistance in programming.

Author and Coder Lesson Roles. Lesson objectives and criterion test items provided the basis for lesson development. In general, the author who wrote the script for the lesson also coded it in the PLATO computer program. Several attempts were made to separate the roles of author and coder; some were successful, while some were not successful due to constraints to be discussed subsequently.

The series of lessons comprising the pulmonary embolism sequence was written by the PA and coded by the Medical Service Corps officer. This arrangement was successful because of the physical proximity of the individuals involved (working in the same office and able to sit at the terminal together). In addition, the Medical Service Corps officer had served as a hospital administrator and, therefore, was familiar with medical procedures. Therefore, the transcription of the lesson to the terminal and the subsequent editing were able to proceed without communication problems and with a minimum of delay.

The chest X-ray sequence of lessons was a joint effort, with the script written by the PA staff member and the physician. The coding was shared by the physician and the Medical Service Corps officer, and development proceeded smoothly.

Of two other attempts at dividing the roles of author and coder, only one was partially successful. The prototype simulated patient encounter was the joint effort of the physician and an associate at Shpeast. The working arrangement was successful for the development of the data collection sequence, and the expertise of the individual at Shpeast proved invaluable. For the balance of the lesson, where less sophisticated coding was required, the working relationship was less than optimal because of the communication problems involved in working 700 miles apart.

When an author coded his own script, there was a great deal of editing during the transcription process so that the subject matter could be adapted to the PLATO medium. Choices of display techniques and the amount of material on a given frame greatly affected the emphasis given to any given portion of the script. These editorial choices could not be made intelligently unless the coder had a background in the medical sciences. Communicating on-line via notes or "term-talk" proved time consuming and insufficient for the resolution of many of the choices to be made during coding. In addition, since the lessons were being validated at Sheppard, it proved much more efficient for the author to be able to edit them quickly, rather than transmit comments to the coder 700 miles away, particularly with the inherent delays in implementation and problems in communication.

The other attempt at separating the roles of author and coder occurred in the Pulmonary Function Studies lesson. Since little sophisticated coding was required, it became apparent very early that the shortcomings noted above far outweighed freeing the author of coding responsibilities. In essence, it proved impossible to separate the content from the medium. Unless the coder and author were actually working together at the same site and unless the coder also had some expertise in the subject matter, it was much more beneficial to combine the roles of author and coder.

Lesson Review and Validation. Prior to completion of entire lessons, completed segments were reviewed by associates at Shpeast and by author peers at Sheppard. Lesson review was both formal and informal (oral comments and casually written impressions). Formal review by associates at Shpeast was generally a formal critique recorded in the lesson space "Shprev." Informal review by peers at Sheppard was generally oral, supplemented by casually written notes. These casually written notes were discarded after they were read and suggested changes were made.

Student Review. After initial reviews at the author level, lessons were revised appropriately and initial trial evaluation commenced. Lessons were administered on a trial basis to several groups of students.

One group consisted of four early arrival PA students who completed all of the available lesson material. Data were collected on-line and included:

1. Time required to complete an entire lesson.
2. Time required to complete a given segment of a lesson.
3. Responses to interactive lesson material.
   a. Number of attempts required to correctly answer a question.
   b. Incorrect answers that had been anticipated by the author.
   c. Incorrect answers that had not been anticipated by the author.
4. Number of requests for assistance (–HELP–).
5. Performance on the concluding quiz to assess immediate mastery of the material.

The data were collected in a data file and subsequently analyzed. Where –HELP– was sought by the student and not available, it was added if it were felt by the author that it would enhance the lesson. Interactive material was edited to incorporate answers that had been unanticipated so that specific feedback could be given for wrong answers.

COMMENT: Despite concurrent relative instability of the system (transmission errors and system "crashes"), the students displayed a very high threshold for frustration. Their verbal comments reflected a high degree of interest both in the system and the individual lessons. It must be noted that the students were under no other academic pressures because their classes had not started and they displayed a very relaxed attitude. Despite a favorable response, none of the students returned frequently to review or take new lessons during the semester. The students stated that the pressures and time demands of the PA curriculum prevented their returning on a frequent basis.

Review by Other Medical Personnel. Lessons were also taken by personnel who worked in medical areas but who were not PA students. This group included nurses, laboratory and pharmacy technicians, as well as hospital corpsmen. Some of these individuals were stationed at Chanute Air Force Base, Illinois.

The same data were collected on-line from these individuals as were collected from the trial group of PA students. Comments were made on an informal basis regarding the mode and clarity of presentation, as well as any perceived inaccuracies in the lesson material.

COMMENT: Formal and informal data from all of these pilot studies indicated that:

1. The PLATO medium was well received and perceived by the student an an effective instructional medium.
2. Transmission errors and system "crashes" at this time caused a minimum of frustration.
3. Coding problems in individual lessons were not a major source of frustration.

III. STUDENT SAMPLE

Sample Selection. A random selection process was used for assigning students to either the PLATO IV or lecture group conditions. Each Navy PA student and Air Force PA student was assigned a number and numbers were randomly drawn from the population pool for assignment to one of the conditions. Statistical analysis of historical data indicated that within the PA program the only variable with any alleged success of prediction potential for completion of course was the Scholastic Aptitude Tests (SAT)

score. In the first class (June 1975), the mean SAT score for the Air Force PLATO IV group was 1062.5 (S.D. 111.7), while the lecture control group mean SAT score was 1009 (S.D. 149.5). Naval personnel did not have SAT scores, but rather provided similar aptitude scores on Navy-developed General Aptitude Tests. The Navy PLATO IV group mean score was 127.0 (S.D. 9.2), while the Navy control group mean score was 128.7 (S.D. 7.1). No statistically significant differences existed on these a priori measures between the PLATO IV and lecture groups. In the second class (November 1975), the Air Force mean SAT score for the PLATO IV group was 1148 (S.D. 124.6), while the mean SAT score for the control group was 1100 (S.D. 115.5). The mean SAT scores of the control and PLATO IV groups were analyzed using the t-test and no significant difference was found. Naval aptitude scores were not available for Navy personnel involved in the second class. In both classes, the proportion of Air Force and Navy students was not significantly different from the ratio of Navy and Air Force students in the total PA program. This sampling process was in concurrence with the guidelines set forth in the sampling considerations portion of the attached Evaluation Plan (Appendix E).

Student Characteristics. Many unique characteristics of the PA curriculum and the PA students should be discussed in order to understand the target population and the academic environment in which they worked. First, the average age of the military PA student was 28 years. Student ages ranged from 23 to 37 years, most were married, and had been on active duty for four to thirteen years. Most of the students were corpsmen with considerable experience in the medical field.

The military PA education program differed in many ways from the PA programs at civilian institutions. In the military program, the students attended class (5-day week) from 0800 to 1700 daily. There were no elective courses so each class was an integral part of his education and was material for testing. After the eight hours of solid class work, the students studied in groups for three to five hours each night and four to eight hours each weekend. All classes were mandatory so there were no "cuts" to catch up for an examination or prepare for another class. There were usually one or two block examinations each week, plus at least one physical examination report each week for clinic patients. Students were in an extremely rigid, high-pressure, lock-step regimen. The students had two one-week breaks between the trimesters, which were used to fulfill military training requirements, tend to personal business, and take leave if desired.

With all these pressures and the long hours of intense study, why did people apply for the PA school and continue to work when they were accepted? Basically, these mature individuals were very ambitious and highly competitive. The rewards for completing the course included more responsibility in their chosen field of medicine, increased pay and rank, acquisition of college credits through the University of Nebraska which could lead to a baccalaureate degree, and training which was useful for them in a civilian community when they retired. All of these positive incentives to succeed were reinforced by several strongly negative aspects if they did not succeed.

If a student was unable to carry a passing average in any major subject block, an academic board was convened. If the board felt the student could continue, he was given a makeup examination. If this examination was passed, the student continued his normal course. If he failed the retest there were two alternatives. First, the student was recycled to begin the entire trimester for a second time. This was necessary because there were no provisions for a student to receive remedial training in any single area. If the student was recycled, it required rescheduling Phase II training, adjusting family plans for transfer, and resulted in many complications to the plans of the Air Force and the student.

If the student failed the retest and the academic board did not feel the student could succeed in the PA course, he was subject to elimination. This failure was not of major trauma to the student's military career, but usually had many negative connotations to the student himself. Being highly competitive, these students perceived failure as a reflection on their capabilities. Being very ambitious, they also realized that by not completing the course, they did limit their potential to function in a highly responsible role in the field of military medicine.

Considering all of these factors, it became obvious that there were a multitude of pressures inherent in the academic environment which were accentuated by the compulsive, ambitious, competitive characteristics of the students. The students were constantly tense and anxious, and they had a low frustration tolerance for unanticipated problems or extra demands upon their inflexible schedules. The effects of this low resistance to frustration upon the acceptance of the PLATO IV project will be discussed at length in the Student Attitude Survey section.

IV. IMPLEMENTATION

One of the major tasks confronting the SHCS PLATO staff was to provide for the orderly integration of the POMC into the traditional PA curriculum. Ideally, this integration would have been done in such a way that:

1. Disruption of the traditional curriculum was minimized.

   a. Steps had to be taken to insure that prerequisite material was taught prior to the time it was required as a basis for other material.

   b. The logical flow of content in discipline-oriented blocks of instruction was not jeopardized.

2. The integrity of the POMC was maintained; i.e., presentation of material was not excessively fragmented.

3. No degradation of training would result.

4. Evaluation of the POMC was facilitated.

In attempting to develop implementation plans against which the above criteria could be applied, several alternatives were considered. These alternatives included the following possibilities:

1. Extension of the course so that inclusion of POMC materials would require no changes in the conduct of the course. Under this approach, students selected for the test group would have been brought to the school about four weeks before the start of their normal PA class to complete the POMC lessons prior to beginning the traditional curriculum. This approach was suggested by the PA course director, but was not considered to be feasible by the PLATO staff for the following reasons:

   a. Since only one module of the POMC was being developed, certain prerequisite material was still contained in the traditional curriculum and, therefore, students could not be exposed to the POMC in isolation from the traditional curriculum.

   b. A comparative evaluation would not have been possible because a control group, parallel to a POMC test group, would not have existed under this approach.

   c. Extension of the course could not be accommodated within Hq ATC budgetary and training day restrictions.

2. Another alternate approach considered was to create an additional block of instruction in the second or third trimester in which the POMC material would be concentrated, with hours for this additional block coming from several different traditional blocks. Under this approach, major reorganization of the course would have been required. Units of instruction would have had to be moved from one semester to another, and the basic science lectures, in particular, would have had to be restructured. Because of the class size (64 students) and the number of PLATO terminals available, the approach would also have required either the development of lectures comparable to the computer-based POMC lessons or a highly complex scheduling effort, with lectures being repeated as groups alternated between the PLATO classroom and the traditional classroom, which posed an unacceptable lecturer manpower problem.

3. At the time the request for personnel research was submitted, considerable effort had been expended on preliminary planning to convert the entire PA course to a series of problem-oriented modules without computer-based instruction. With the inception of the PLATO project and throughout the discussions regarding implementation of the PLATO POMC module, no further steps toward this possibility were entertained. This, in large part, was due to a change in course management and an almost total turnover in the physician staff assigned to the conventional course.

A compromise was reached whereby the POMC module developed by the PLATO staff was implemented in the following way.

On the basis of criterion objectives listed in the POI, specific hours of instruction to be included in the POMC were identified. Students in the test group were to complete PLATO materials in lieu of the corresponding work in the traditional curriculum. They attended all of the scheduled lectures, except those that had been replaced by PLATO lessons. Considerable concessions were made in the selection of material included in the POMC so that discrete lecture hours of the traditional curriculum were identified. At the time these lectures were given, PLATO students left the classroom and reported for computer-based

instruction. Overall, the same criterion objectives were to be met by all students, but the temporal sequencing of POMC differed from that of the traditional curriculum. To some extent, the sequencing of POMC materials was dictated by the traditional curriculum because of the problem of insuring that prerequisite material was taught prior to the time it was required in the traditional curriculum, even if this material was a part of the POMC. For example, in the problem-oriented approach, lessons on sputum processing and staining procedures would normally have been taught in conjunction with material on infectious lung disease, but because of a staining laboratory exercise early in the traditional curriculum, these lessons were presented during the second scheduled hour on PLATO.

In examining the criteria, listed previously, with regard to the implementation scheme finally adopted, it is clear that the preponderance of effort was made to meet the first criterion, that of minimizing disruption of the traditional curriculum. Attention was also given to insure that "no degradation in training" was also met, but this was never thought to be a strong possibility under any implementation considered. Criteria regarding maintaining the integrity of the POMC and facilitating its evaluation were compromised to obtain "minimized disruption of the curriculum." The only milestones contained in the research agreement were the start date, completion date, and final report date. An implementation date of January 1976 had been assumed by members of the PLATO staff in the belief that six months would be adequate for the evaluation phase of the project, thereby allowing the bulk of the project time to be devoted to curricular design and lesson development. Since the POMC was to be implemented over the entire year-long PA course rather than being concentrated into a segment of the course, it became imperative that implementation and evaluation begin at the earliest possible date; i.e., June 1975. This date enabled administration of the curriculum to two classes for evaluation and preparation of the final report. Implementation was, in fact, accomplished with the June 1975 class, but the expected time available for lesson development was reduced by six months.

The POI hours from the traditional course included in the POMC were distributed over the three trimesters of the PA course as stated in Table 1:

Table 1. **Traditional Course Hours**

Trimester	POI Class/CTT[a] Hours
1st	14/4.5
2nd	15/3.0
3rd	50/20
	79/27.5

[a]Student Homework

In the first trimester, the fourteen hours of lecture (replaced by PLATO material) were scattered across the first thirteen weeks, with as much as four weeks intervening between PLATO sessions. A detailed distribution of hours is shown in Table 2. It should be noted that all PLATO sessions were either one hour or two hours long with never more than one PLATO session per day. In the second trimester, the hours replaced were primarily concentrated in weeks seven, eight, and nine, so that some continuity within the POMC was obtained. Table 2 also shows the detailed distribution of second trimester hours.

Table 2. **Distribution of Plato Hours by Trimester/by Week**

	Weeks													
Trimester	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1st (Hrs)	1			3	2		2	2					4	
2nd (Hrs)			.				1	8	2		2		2	

Since students in the PLATO group were not working on the same subject matter at the same time as the rest of the class, some modification of the normal end-of-block criteria measurement procedures was required. A waiver of the provisions of ATCR 52-3 was applied for and granted by Hq ATC so that the procedures, described next, could be implemented regarding testing.

1. Prior to administering an examination or quiz which covered objectives for which PLATO materials were involved, the PA faculty member planning to administer the measurement instrument contacted his PLATO staff counterpart. Jointly, the PLATO staff member and PA faculty member determined which questions were to be excluded from the examination for PLATO students.

2. At the same time of the examination, PLATO students were directed not to answer the questions identified by the previous procedure. The instructor was to write the numbers of the questions to be excluded on the blackboard and have the students in the PLATO group circle those numbers on their answer sheets.

3. At the time the examination was graded, percentage scores were calculated for PLATO students on the basis of the number of items answered correctly out of the subset of items administered. For example, if five questions were excluded on a test which normally contained fifty questions, the PLATO student score was the number answered correctly divided by forty-five.

4. The PLATO staff was responsible for testing objectives covered by PLATO material. Formal PLATO tests were administered and the results of these tests were used to adjust both raw scores and percentage scores of tests from which questions were excluded. The following procedures were used in adjusting these scores.

a. A weighting factor was determined for each test in the regular curriculum that was affected by the adjustment procedures. For example, a test which normally contained 50 questions from which eight questions were excluded, had a weighting factor of .84. The weighting factor of the PLATO test was therefore .16, such that the sum of the weighting factors equaled 1.00.

b. At the completion of a PLATO testing cycle, all affected test scores (percentage) in the regular curriculum which had not been adjusted previously were adjusted according to the following formula.

Test Weighting Factor	x	Raw Score	+	PLATO Weighting Factor	x	Plato Score	=	Adjusted Test Score	Adjusted

Raw scores were calculated by the formula:

Adjusted Test Score	x	Total Questions on Test Before Exclusions	=	Adjusted Raw Score

An example of testing/grading procedures used for PLATO students is shown in Appendix F.

Implementation Constraints. Many of the problems discussed in the evaluation chapter of this report regarding student attitudes had their origin in, or at least were exacerbated by, implementation constraints which resulted in student reaction to differences in the material, when material was provided, and how PLATO students were tested compared to conventional students. For example, POMC material was intermittently diffused across three trimesters with sessions scheduled based upon available hours as dictated by the traditional PA class schedule. The continuity of the POMC was severely disrupted as a result. Fragmentation of the curriculum was so excessive that familiarity with terminal operation was never fully achieved such that students were not completely at ease and comfortable with the system.

Another key implementation issue with students dealt with competing time schedules between lecture and PLATO conditions. Much of the self-pacing aspect of PLATO was lost or severely confined, due to the schedule within the traditional classroom lecture to which the POMC student returned on time regardless of POMC lesson completion. Lessons not completed during a scheduled PLATO session had to be completed either at the next session, which could be a considerable time later, or on the student's own time during lunch hour or after normal duty hours.

V. EVALUATION PLAN

As a result of several meetings with ARPA, AFHRL, and ATC, agreement was made to evaluate three primary areas. The first area was academic effectiveness. It was important to insure that the introduction of

the POMC was not accomplished at the expense of overall academic understanding of the subject-matter content. Indeed, the intention of the POMC was to promote a greater understanding of content through an organized problem-oriented approach. To evaluate the instructional effectiveness of the POMC in teaching respiratory disease, it was necessary to develop a common academic test which could be given to both the experimental and control groups at the end of the first year training (Study 1, Appendix E). The test covering respiratory disease was to be constructed using items that were similar to those found on the American College of Medicine board examinations. The pool of items for this examination was to be obtained through combined contributions of several civilian universities that were sponsoring PA training. To eliminate bias, questions on respiratory disease from other PA programs were considered the most appropriate source for items since the student populations were essentially the same. Once this pool of questions was refined, a group of PA students who had completed Phase I of the two-year program were to be given the test for standardization purposes. Item analyses were planned to statistically insure that only items which distinguished trained from untrained students would be used for the final evaluation instrument. The refined version of this test was to be administered to both the test (POMC) and control (traditional lecture) groups at the end of the 1,400-hour Phase I training program.

The second area to be evaluated was that of clinical problem-solving skills. Simulated patient encounters were to be used to test the students' ability to integrate their knowledge toward successful diagnosis and treatment of patients. These instruments were developed through collaborative efforts between the SHCS PA staff, the PLATO staff, and the ETS. These tests were designed to be interactive patient simulations which would allow the students to request information, obtain histories and lab results, prescribe treatment, and select diagnoses. Simulations included not only patient simulations for respiratory disease, but also included several other patient simulations in the area of internal medicine. The inclusion of two types of simulations was intended for comparisons of general problem-solving skills and specific problem-solving skills in the area of respiratory diseases.

The third major area of evaluation was to determine what effect the POMC and the use of the PLATO system had on students' attitudes toward learning. (See Study 3, Appendix E). Toward this end, a 30-item revision of the Brown questionnaire (1968) composed of Likert-type items was selected as an attitude measure (Appendix G). This instrument had demonstrated reliability (r=.80) with college students in computer-based education and included many specific questions which permitted inferences about various features of the PLATO system. In addition to the Likert-scaled items, there were two open-ended questions which were intended to elicit specific comments about areas not covered by the 30 questions and explanations of responses in the initial portion of the questionnaire. Analyses of the relationship between attitude and performance on the final academic test and the patient simulations were planned.

In addition to the end-of-first-year evaluation of academic effectiveness, a study was planned to determine if POMC students were meeting learning objectives at the lesson level as they progressed through the course. This evaluation was to be achieved by determining the number of lessons repeated, the number and duration of special or remedial sessions, and the number of eliminations and washbacks. Relationship between student achievement at the lesson objective level (and subsequently at the block level) were also deemed an appropriate index of evaluation.

In addition to evaluation of student attitudes and progression, there was considerable interest in determining CAI author characteristics. If, in the future, computer-based education is to become an operational form of military training, information on criteria for CAI author selection will be needed. Several qualitative areas for identification of author characteristics were reviewed. First, evaluation of author performance was considered. Author performance was to be measured in three ways:

a. Average quality of lesson produced as judged by the University of Illinois personnel and POMC students.

b. Supervisory ratings of author performance.

c. Peer ratings of author performance.

Performance dimensions to be rated were to include programming ability, efficiency in lesson design, creative use of instructional techniques and novel applications of the PLATO system.

An evaluation of author attitudes was also planned. The purpose of this study was to determine the relationship between the authors' attitudes toward CAI and their performance as effective authors. Because

of the small number of actual authors in the sample, statistical analysis of information was not considered, but subjective analyses of various areas of evaluation were possible and practical.

The last study to be accomplished with the authors was an attempt to relate author personal and background characteristics to performance on the PLATO project. Toward this end, data were collected on such variables as educational level, age, rank, IQ, attitudes, volunteer versus nonvolunteer status, and interest in computer-based education. The aim of this study was to develop a set of criteria for selection of future PLATO authors.

The final portion of the evaluation plan was to provide recommendations regarding the effectiveness of PLATO as a teaching medium The PLATO system was to be evaluated in terms of instructional effectiveness, overall costs and reliability. Basic cost data were available through the Resource Management Division of the School of Health Care Sciences and through capital investment figures obtained from ARPA. System reliability was to be evaluated by means of system logs which were to be maintained to show the number of terminals in commission per day, percentage of down time per terminal, and cause of equipment failure.

VI. STUDENT ATTITUDE SURVEY

One of the major objectives of the student attitude survey was to evaluate students' attitudes toward the POMC and PLATO IV as a medium of instruction. The attitude questionnaire was administered after at least one month of exposure to PLATO coursework to obtain initial sentiments. Retest was to be accomplished at the end of the entire curriculum, which permitted comparisons to be made on a one-year exposure. In the original evaluation plan, it was proposed that all of the attitude surveys for both POMC PLATO classes be combined and the combined data used to indicate PA attitudes toward the POMC-PLATO condition. Termination of the POMC and redirection of the PLATO project to courses more suitable to a comparative analysis of PLATO and conventional instruction therefore precluded the opportunity to conduct the one-year test-retest of attitudes. Consequently, analysis of students' attitudes was confined to separate examinations of individual class attitudes in the two PLATO test groups. Discussion of the attitudinal differences between the two classes as they related to experience with the POMC specifically, and PLATO IV in general, follows the separate analysis.

Class 1. Initial attitude testing of the first PA group demonstrated a rather large number of neutral to mildly negative responses toward PLATO CAI. Many of the negative responses were related to system malfunctions or to technical programming difficulties with individual lessons. The difficulty with individual lessons was generally related to the lack of smooth sequencing through large, complex lessons. On occasions, students encountered areas where they could not proceed or were inadvertently rerouted to the beginning of a lesson rather than continuing after a –HELP– sequence. The area of major dissatisfaction was the number of system malfunctions that consistently were present. Although there were no major system problems of down time with which the students had to contend, the minor irritation of transmission line errors which obscured legibility appeared to have a cumulative effect and became a major irritant to the students.

The favorable comments toward CAI were primarily related to the ability to progress through the course on a self-paced basis and the capability to review lesson material at any time. A third area of favorable comments by the students related to the accessibility and concern of the PLATO staff. During each of the scheduled sessions at least one monitor was available to assist students with either technical or subject-matter problems. If the monitor was unable to satisfactorily answer the questions related to subject matter, the author of the lesson in question was immediately available to discuss and clarify any student's questions on an individual basis. This individualized attention was an additional advantage of CAI in contrast to the lock-step, large classroom lecture approach of the traditional course which inhibited an instructor's ability to pursue individual questions.

The retest of the first PLATO class coincided with the early termination of the POMC project during the second trimester. At this time, eight of the original sixteen students (class 1) were in the program. Five of the original POMC students were academically eliminated which was similar to the number of students (N=6) eliminated from the conventional PA course during the same time period. Three students remained in the PA program, but withdrew from the PLATO project. The five students who were academically eliminated were interviewed to ascertain if their involvement in the PLATO project was related to their

failure in the overall course. None of the students felt that there was any correlation between their failure and the PLATO project. Most of the students felt that the traditional course was too rapid and found the PLATO CAI programs superior in comparison. Two of the students felt that they could have completed the curriculum if the entire course were self-paced. It is also interesting to note that all five students had completed all of their required lessons on PLATO and all had a passing average in the PLATO portion of their coursework.

The three students who withdrew were also interviewed. One student felt that he could not learn as well in a self-paced mode as he could from a lecture. He stated he always retained more when he could hear the information and then take notes. Additionally, he felt his reading comprehension was low and to continue using a medium which was totally visual could be detrimental to his success in the overall program. The other two students who withdrew felt that they were not learning as much as their counterparts in the traditional classroom. They stated that the PLATO program required more of their time, and they resented the fact that they had to come back to the school to review PLATO CAI, rather than reviewing notes at home like their peers in the lecture group. All three of these students were shown that their end-of-lesson tests and overall block examinations demonstrated they were learning well and were on par, or ahead of the students in the traditional course. Despite the objective test evidence and reassurance of the PLATO staff, the students could not resolve their anxieties about being involved in an innovative curriculum unlike their former mode of learning via conventional lecture methods.

Of the eight students (class 1) who remained in the project, most had the same anxieties about not learning as much in the POMC PLATO condition as in the traditional classroom lectures. Based on interviews, the primary reason for student concern was the fact that there was not an hour-for-hour identical replacement of material, and students could not comprehend why their counterparts were learning one set of materials, whereas they were frequently performing entirely different learning tasks. The concept that the POMC was drawing the required information into a different sequence, but all the material would be covered eventually at the end of the year, never appeared to be adequate to resolve student concerns. By the end of the second trimester, six of the remaining eight students requested to return to the classroom. Student anxiety about not learning the same material (and consequently perceiving a high risk regarding successful course completion) was a major contribution to the termination of this project. A more complete discussion of this problem will appear later in the integration of the two POMC classes' attitude surveys.

The results of the retest of the first PLATO class indicated their primary complaint was still frustration with system malfunctions. It should be pointed out that there were no major system crashes which prevented a class from using the system, but rather the consistent disruption of their work by transmission line errors. Line errors distort the readability of displayed information. The next area of disfavor was the need for acceptable correct answers. In theoretical material, a concept judging sequence was attached to the answer judger, but the variety of student answers, though correct, could never be completely anticipated. Hence, some students were not immediately credited with a correct response. The last major problem area was that the PLATO project was viewed as an extra course and, consequently, the students commented on the extra time needed to do PLATO lessons. This misunderstanding about extra time was a second major contribution to the decision to terminate this project, and also reflects rumor pervasiveness and distortion. These areas will be elaborated upon in a later portion of the discussion of student attitudes.

On the attitude survey, none of the test-retest mean item scores was significantly different at the .10 level of confidence. However, in the task of deriving meaning from small sample size attitudinal data, customary statistical analyses may be less appropriate than a contextual analysis of information. The following analyses were conducted by the PLATO IV staff clinical psychologist. Attitude items for which there was a change of one-half point or more between the test-retest means were selected by the PLATO staff as reflecting a detectable change in the students' attitudes after extended exposure to PLATO. These items will be discussed in relation to student interviews conducted by the staff psychologist.

Item 7 (Appendix G) indicated on the retest that students became more aware that their answers were correct before being indicated correct on the screen. Students reported that as they became more comfortable with the terminal and more experienced with the lesson methods, they became more confident of their responses. An increased favorable response on item 13 showed that students felt the lessons and computers were less mechanical as their exposure to PLATO increased.

Responses to items 21 and 22 appeared to be in contrast to the comments about initial test frustration with PLATO and inflexibility of acceptable student answers. The students felt that the lessons

had improved such that students progressed more easily through the lessons. The previously mentioned system malfunctions continued to be a problem, but the improved lessons caused a more positive attitude toward computerized education. The students further stated that the improved lessons, experience with PLATO, and better understanding of the lesson material made it easier to give an answer acceptable to the computer. It appeared that the students had developed a system by which they could quickly determine what answer was appropriate, by combining the information from the hints given with a wrong answer and a quick review of the previous lesson material.

The improved attitude of students on item 23 indicated a more favorable attitude toward PLATO CAI compared to initial attitudes. General improvements in the quality, interaction, and animation of the coursework made the POMC material more interesting and meaningful to the student. Students commented that the first series of courses appeared to be slow-moving and boring, but the second trimester courses were more enjoyable and educational.

Item 27 indicated that CAI was not viewed as a depersonalizing experience, perhaps because at least one monitor was available at all times and any problems could be solved immediately on a one-to-one basis. Students reported that although they were working independently, the knowledge that personalized assistance was available removed any depersonalizing aspect from the learning situation.

On item 10, the students were not interested in finding out more about the subject matter because they felt that the major points had been adequately presented. They did, however, desire handouts or reprints to carry with them for review purposes.

Items 11 and 19 were reiterations of the same point. Students felt (item 11) that they were over-involved with running the terminal because of the consistent disruption of their work due to line errors. Item 19 reflects student annoyance when answers were not accepted and at other times, when part of the text would not appear, or there would be serious overprinting. This required extra steps on the student's part to retype the answer or go back in the lesson to get a readable reprint of the text which was missed. Problems of this nature were the difficulties constantly discussed by the students as being a frustration with PLATO IV.

Class II. The second PLATO class to experience first trimester material was administered the initial attitude survey after six weeks of POMC material (approximately seven hours of coursework). At that time, the students reported considerable problems with system malfunctions and difficulty with acceptable answers being too specific. Based upon feedback and problems with lessons which were encountered by the first PLATO class, many modifications and improvements had now been made to the first trimester material. The improvements in lesson sequencing were successful and eliminated any comment by the students concerning difficulties progressing through the lessons. In addition to the sequencing modification, most of the "answer judging concepts" were expanded to accept a wider range of correct responses; however, the expanded range still did not succeed in anticipating the combination of words given by the second class, as documented by the comments on acceptable answers being too specific. Improvements in lesson material were reflected in favorable student comments about course material in the second POMC class. Malfunctions which students found irritating were not major system crashes, but rather the frequent momentary disruptions resulting from line errors. The next major area of discontent was student perception of the POMC project as an "extra course." Despite numerous attempts by the PLATO staff to inform students that the POMC material was a replacement of class material, it was never fully accepted by the students. POMC student concern about what their counterparts were learning and the fact that the PLATO material was not identical to the lecture material caused considerable anxiety about participating in the project.

There were mixed feelings about the review capability in the first trimester. Three students felt the review capability was a strong positive feature of the PLATO program, while five students felt it took too much time to review. This acute awareness of time factors reflected the pressures that these students felt about their time. Delay or disruption of their schedule was regarded a major difficulty. Another favorable comment described the staff as being interested in the student's progress and staff accessibility as being helpful to the students. The final major favorable comment was that PLATO provided variety to the standard curriculum.

The comments on the retest of attitudes indicated that the pressures of time caused concern that participation in PLATO hindered success in the overall course. Frustration with system malfunctions also remained a prominent complaint of the students. The irritation with the specificity of acceptable answers

diminished somewhat as the students became more accustomed to this innovative teaching system. The favorable comments on the retest still listed self-pacing, review capability, and attitude of the PLATO staff toward the students as the three major benefits of the PLATO experience.

No statistically significant differences ($p < .10$) were found between test-retest scores in class II. Customary statistical analyses were deemed by the PLATO staff to be less meaningful than contextual interpretation by the staff clinical psychologist. Only items which had a change of one-half point or more between the initial scale and the retest were regarded as a qualitative index of change.

The most noticeable improvement in student attitude occurred in the reduction of feelings about isolation (item 4) and depersonalization (item 27) in computerized instruction. As the students had more exposure to PLATO, they became more comfortable with working on their own. This was a marked accomplishment since 80% of the students' time was spent in large classes and study groups for after-hours study sessions.

Students' anxieties about not learning the same material as the control group and pressures of time generated many negative feelings about PLATO coursework. Students questioned the productivity of the time spent on PLATO (items 20 and 24). The notion of working at their own pace, which was a positive aspect in initial comments, later precipitated problems. The students felt they could work at their own pace, but found that this did or could present problems if they exceeded PLATO classroom hours. If students exceeded PLATO hours, important information in the on-going conventional classroom might be missed. Likewise, PLATO students not completing PLATO lessons within the scheduled time periods produced an additional tradeoff. Additional time had to be rescheduled after the regular PLATO class, which was an infringement on study time for assignments in the conventional class. Thus, if students worked at their own pace, it was a welcomed change, but it became problematic when they tried to schedule extra time. The students further commented that the terminal was too slow. They felt that the text took too long to appear, graphics took too much time to complete, and animations were sometimes distracting. When interviewed further about these attitudes, students repeated that they did not have time to watch the animations, work the graphs, or wait for text. This led to boredom (item 30) and guessing at answers (item 8) in order to get the hint from the –HELP– sequence which would allow them to speed up their progress through a lesson.

Integrated Attitudinal Data Discussion. Review of overall attitudinal data disclosed several areas important to an understanding of problems encountered in the POMC project. Additionally, the following information constitutes important lessons to be learned for development of future computer-based education (CBE) programs in the military environment.

The first area to be explored was an observable change in student attitudes with exposure to CBE. Initially, both the first and second classes were apprehensive about engaging in an innovative learning program. Concerns about both the value of the coursework and the capability of the software were prevalent. The new PLATO IV medium appeared to be a source of frustration. As students worked their way through lessons, they were perplexed by the use of various function keys, such as –HELP– and BACK. This was reflected in their comments about distractions by the terminal. As their experience and expertise using the keyboard increased, this frustration diminished and there was a noticeable shift in the students' attention from the mechanics of the operation to the educational value of the material.

A second area of common concern was the students' apprehensions about not learning as much as their counterparts in the traditional lecture. Despite numerous supportive counseling sessions by the PLATO staff and the introduction of objective test results which clearly demonstrated successful learning of course objectives, students persisted in the misconception that they were falling behind their counterparts in the traditional lecture system. Attempts to dispel this concern were complicated by the fact that the POMC was an integrated curriculum drawing information from several areas encompassing subject matter from all three trimesters rather than an hour-for-hour subject-matter replacement. Students could not be convinced that the POMC program would eventually cover all of the required material, because the sequence was not the same as depicted in the traditional course outline. Moreover, the instructional topics and sequence differed from their counterparts in the lecture condition. The staff's inability to resolve the students' concerns about the POMC and PLATO project was further complicated by the fact that approximately 90 percent of student time was spent in a rapid group-paced, lock-step curriculum. Transistion to this self-paced, innovative approach to learning created apprehension rather than alleviation of pressures related to learning.

Time constraints and voluminous amounts of material to be learned added a third dimension of complication to the students' attitudes and psychological acceptance of the project. As previously mentioned in the introductory description of the PA student's curriculum, the student engaged in eight hours of continuous class work each day which was followed by three to six hours of study each night. There was no latitude for digression from this schedule and any unanticipated addition to their learning requirements had many adverse affects. The students' misconceptions about the POMC created the distorted opinion that the PLATO project was an "extra course." This view of the project resulted in the POMC students feeling that they were in a way penalized by being involved in PLATO.

This combination of fear of academically falling behind their peers, misconceptions about the POMC, and viewing the PLATO project as an "extra course" produced a severe attitude problem which could not be resolved. The students' negative attitudes were reinforced by the see-saw alternation between rapid paced lectures and self-paced instruction, from large lecture classes to CAI tutorial instruction, and from traditional didactic information to an innovative, integrated curriculum. With all of the external pressures of the overall curriculum and the realization that their military careers could be affected by their performance in the PA course, these attitudes compelled POMC students to request to be removed from the PLATO project. It was at this point that the Sheppard PLATO staff decided to terminate the POMC project because nothing further could be done to resolve the misconceptions, relieve the anxieties, or change the negative attitudes of the students. Furthermore, continuation of the project could be detrimental to the students' overall learning and lead to erroneous interpretation of subsequent research data.

VII. STUDENT PERFORMANCE

Originally, the primary comparison of academic performance anticipated to have the most validity, was an end-of-course board certification-type examination to be developed from a pool of questions from civilian PA programs. This examination would have permitted a comprehensive examination of both groups' knowledge of the respiratory system and related diseases after all coursework was completed. Rationale for this examination as a comparative measure of academic performance included the notion that regardless of whether a student experienced the POMC or the traditional lecture system, both groups might be expected to have a similar amount of basic knowledge of respiratory systems and respiratory illnesses upon completion of 1400 hours of training at the end of the first year. However, since less than 10 percent of the total curriculum could not be expected to produce achievement differences on the comprehensive end of year board examination, statistically significant achievement differences between the POMC and traditional lecture were improbable. In addition, though a valid comparison was theoretically possible, dwindling sample size, student reactions and differential confounding factors discussed previously precluded valid interpretative comparisons. The discussion of performance data, which follows, is therefore presented as an attempt by the Sheppard PLATO staff to share their experiences and lessons learned with colleagues contemplating the use of computers in an operational environment.

It was expected that intermediate comparisons of POMC end-of-lesson and block tests could not be compared directly with end-of-lesson or block examinations in the traditional system because of differences in sequencing, presentation of material and test items. Since these performance measures could not be compared, evaluation of remaining comparative measures of student performance was attempted by means of logical analyses and personal knowledge of the conditions. Despite these obvious limitations, there were some useful comparisons which will be discussed in the context of the above-mentioned constraints.

The first area of performance evaluation to be discussed is that of student time spent on POMC lessons compared with actual number of hours replaced in the traditional course. In the first trimester, the POMC replaced 14 classroom hours. The actual time spent on the computer by the POMC students was 15 hours 53 minutes, as collected by the lesson timing program developed by the SHCS PLATO staff. This method of timing was an improvement over the old method because it calculated actual time in the course without adding timing artifacts. Thus, 15 hours and 53 minutes *included review time.* The actual time to initially complete the course material was 11 hours 27 minutes; therefore, 4 hours and 26 minutes were spent in review. If the ATC developed review time requirement is added to the traditional hours, 14 hours of coursework and 4.5 hours of study or review, sums to a total of 18.5 hours. Using these figures, the POMC students used approximately 2.5 hours less of overall classroom plus study time. A statistical comparison was not warranted because there was no way to determine exactly how much study time the

traditional course students used for review. In addition, some POMC students did review some of the material off-line; this review time, of course, was not recorded. Whatever addition or subtraction of the unknown study hours, it was very doubtful that there were any significant time differences between the POMC and lecture.

There is some validity to speculating that the POMC students in the first trimester required less time for initial study and review. This fairly objective finding about time spent in POMC was particularly significant when compared with the attitudinal data previously discussed. The POMC students' feelings that they had an extra course which demanded more time was definitely an attitudinal discrepancy rather than a reality. Further comparisons of time could not be clearly developed because the first trimester times for the first test group used a less sensitive and less precise timing recorder, and the second trimester times were incomplete because several students had not completed all of the course material. The best summary of time comparison data appears to be: (a) based upon the limited sample of data, it appeared that the POMC students were not required to expend any extra time in classroom work and study; and (b) perhaps there was a slight reduction in overall time when compared with the traditional classroom hours and study time.

Summary statements regarding student performance must be made in a very general context due to the small sample sizes and differing criterion measures. A between-group (POMC-Lecture) academic comparison was not warranted due to the differences in subject-matter content, sequence and criterion measures. However, a within-group assessment of POMC instructional effectiveness on POMC students solely may provide some estimate of educational effectiveness.

POMC students' mean score (77.6, SD 6.90, N=8) on a block area test over specific instructional objectives taught via PLATO did not differ significantly from the same POMC students' scores (79.0, SD 4.14, N=8) on other first trimester instructional objectives presented by the lecture method. Though achievement performance increased for the second class of students who experienced both POMC and lecture methods on different instructional objectives, the achievement differences were non-significant (POMC 90.0, SD 5.53; lecture 84.6, SD 8.18). It might be argued that the POMC material was at least as effective in teaching material in the FA course as the traditional lecture and that this instructional effectiveness was achieved with possibly some overall student time savings.

One other important factor which influenced student academic performance was the temporal sequencing of the curriculum. In the first trimester, 13 hours of class material was spread over three months. The students received nine hours of class material over a one-month period and the tenth hour did not occur until eight weeks later. Although the basic material may not have been continuous in nature, the basic POMC problem-solving orientation certainly was not facilitated by the lengthy disruption in presentation.

The second trimester demonstrated the same scheduling problem. It was explained that the POMC was a method of training students to incorporate basic science material into a clinical problem-solving mode. This learning process was difficult enough in an intense, concentrated teaching approach, but was virtually impossible using the scheduling sequence which was dictated by the implementation agreement.

The preceding findings are very general and tenuous because of the numerous constraints on the potential for statistical analysis and direct comparisons. To avoid these problems, future research should be designed to: (a) Permit block-for-block materials replacement on an hour-for-hour schedule. This would allow direct comparison of results with minimal complication of contamination. (b) Avoid the pitfalls of presenting small amounts of material over a prolonged period of time. (c) Provide ample time for lesson completion. Courses selected should be planned to allow students to take the entire lesson within a short period of time to enable students to maximize transfer of information, the benefits of reinforcement, and drill and practice. (d) Select courses which have a high student flow to insure an adequate sample size. (e) Require clearly defined criterion objectives and measurement instruments used to evaluate dimensions of instructional effectiveness; e.g., degree to which newly acquired knowledge and skills are retained and correctly applied to problems representative of those most likely to be encountered on the job in medical occupations.

One final area of pre-planning for future research concerns the establishment of both pre- and post-measures of student characteristics to include pre-course knowledge of subject matter. The incorporation of these design features would serve to specify the conditions contributing to instructional effectiveness and would assist in data interpretation.

VIII. COST ISSUES/RECOMMENDATIONS

The purpose of this section is to provide data on the following cost areas: (a) Setting up an organization. (b) Procuring PLATO equipment required to support computer-based lessons. (c) Preparing existing classroom facilities for PLATO implementation. (d) Training PLATO programmers and technical support personnel. (e) Recurring computer support costs. (f) Personnel costs. (g) Support costs.

In addition to these cost areas, a number of factors which could significantly affect the cost of future computer-based education projects will be discussed. The purpose of this latter cost examination is to insure that consideration is given to a number of significant variables prior to finalizing any plan for the operational implementation of a PLATO-like computer educational system.

Hardware Costs. The PLATO IV hardware, located within the School of Health Care Sciences, was procured by ARPA through contract with the University of Illinois' Center for Education Research Laboratory (CERL). Initial hardware investment costs are reflected in Table 3.

Table 3. **Initial Hardware Investment Costs**

Item	Quantity	Total Cost
Basic Terminal and Keyset ($5,000 ea)[a]	20	100,000
Slide Selectors ($600 ea)	20	12,000
Touch Panels ($410 ea)	20	8,200
Multiplexers ($4,680 ea)	5	23,400
Connent (Port) Cost ($300 ea)	5	1,500
Audio Unit ($2,000 ea)[b]	2	4,000
		$149,100

[a]Basic terminal and keyset prices fluctuated between $4,805 and $5,215 each. The average price for each SHCS terminal amounted to $5,000.

[b]Following initial experimentation, the random access audio devices were returned to CERL and not used in the SHCS research effort.

Set-Up Costs. To support the PLATO research staff and twenty PLATO IV terminals with associated communications equipment, three 30- by 30-foot rooms were made available within the School of Health Care Sciences (building 1900) at Sheppard Air Force Base, Texas. Setup costs, including equipment, supplies and building modifications, are itemized in Table 4.

Total setup costs amounted to $18,341.74. It should be noted that building 1900 possessed a compressed air supply and sufficient power and air conditioning to support the PLATO hardware. The only setup costs incurred in these areas resulted from tapping into the existing systems.

Programmer and Technical Support Training. All SHCS PLATO personnel except the medical illustrator and stenographic specialist attended a five-day training course at the University of Illinois. The course included the use of the TUTOR programming language and lesson development protocol for CBE lessons. Follow-on training was conducted in-house by visiting University of Illinois representatives and members of the SHCS/PLATO IV technical support section.

Round trip Air Fare (SHCS to U of I)	$196.22
Per Diem @ $25/day (5 days)	125.00
	$321.22

$321.22 x 11 = $3,533.42

Table 4. Setup Costs

Equipment	Quantity	Total Cost
Drawing Table	1	439.00
Kodak RA 950 Projector	2	1,184.00
Slide Display/View Cabinet	1	409.86
Davenport	1	134.00
Lounge Chair	2	108.00
Metal Office Table	3	264.00
Desk	13	2,340.00
Wood Office Table	2	142.00
Desk (Typing)	1	103.00
Storage Cabinet	2	200.00
Programming Board	1	71.00
Selectric Typewriter	1	601.88
Manual Typewriter	1	197.25
Magnetic Recorder	1	409.97
Magnetic Reproducer	1	460.10
Vacuum Cleaner	1	186.00
		$7,250.06
Supplies:		
Office Partitions; Accessories:		$2,060.62
Building Modifications:		
Electrical Power and Compressed Air		$2,821.06
Student Carrels (20 x $260.50)		5,210.00
Carpeting (100 sq yds @ $10 sq yd)		1,000.00
		$9,031.06

Recurring Computer Support Costs. Recurring computer support costs were allocated on a per terminal basis for computer support and maintenance and on a per mile basis (700 miles) for communications lines. Four terminals and one communication line were operational in March 1974, while the remaining 16 terminals and 4 communications lines became operational during October 1974. Terminal support was $2,500 per year per terminal. This figure includes $1,500 for computer support and $1,000 for maintenance to include parts. Communications costs per line according to ARPA was $427.35 per month resulting in $25,641 per year for five GSA lines. Total recurring computer support costs are reflected as follows:

1974

4 terminals x (10 months x $2,500)	=	$ 8,333.30
1 line x (10 months x $427.35)	=	4,273.50
16 terminals x (3 months x $2,500)	=	10,000.00
4 lines x (3 months x $427.35)	=	5,128.20
	$27,735.00	

1975

20 terminals x (12 months x $2,500)	=	$50,000.00
5 lines x (12 months x $427.35)	=	25,641.00
	$75,641.00	

1976 (through 1 March 1976)

20 terminals x (2 months x $2,500)	=	$ 8,333.30
5 lines x (2 months x $427.35)	=	4,273.50
	$12,606.80	

Therefore, total recurring computer support costs for the SHCS POMC effort from March 1974 to March 1976 amounted to $115,982.80.

Personnel and Support Costs. The composition of the SHCS PLATO IV Development Branch is listed elsewhere in this report (Appendix H). The personnel costs were extracted from standard Air Force cost reporting documents and do not include overhead. Consequently, actual costs may have varied slightly from the figures shown as follows:

FY74 (January 1975–June 1975)	
Military Pay	20,504
Civilian Pay	2,753
Supplies (excludes GSA partitions)	589
	$ 23,846
FY75	
Military Pay	216,788
Civilian Pay	9,543
TDY	1,500
Supplies	1,177
	$229,008
FY76	
Military Pay	161,556
Civilian Pay	6,936
TDY	1,456
Supplies	809
	$170,757

Total personnel and support costs (excluding GSA office partitions and equipment costs which are reflected elsewhere) for the period 1 January 1974 to 1 March 1976 amounted to $423,611.

Total Cost Summary. It should be noted that the costs reflected herein do not include ARPA contract costs for CERL services, ($206,000) which included lesson reviews and critiques, programming assistance, hardware development, nor staff assistance visits to SHCS by CERL representatives. Also excluded are the costs of staff assistance visits performed by ATC/SG, ATC/XP, and AFHRL/TT representatives. In summary, total costs by category for the period 1 January 1974 to 1 March 1976 are reflected as follows:

Set-Up Costs	$ 18,441.74 (SHCS)
Hardware Costs	149,100.00 (ARPA)
Programmer and Technical Support Training	3,533.42 (SHCS)
Recurring Computer Support	115,929.00 (ARPA)
Personnel and Support Costs	423,611.00 (SHCS)
	$710,615.16

Operating costs for the SHCS amounted to $445,486.16. Addition of ARPA support in the hardware and recurring computer support areas amounted to $265,082.80 which when summed with operating costs yields a total cost of $710,568.96.

Hypothetical Operational Costs. The cost of two hypothetical "operational" PLATO organizations is depicted as follows; both proposed units would be located under the SHCS Training Services Division (MST). The concept behind organization A is that the uniqueness of the PLATO system warrants the establishment of the PLATO unit as a separate entity under MST. It would have the same organizational and operational level as that enjoyed currently by the Learning Resource Center (LRC).

Organization "A"

Grade	AFSC	Title/Position	Annual Salary*
1 Capt	9XXX	Chief	$20,751
1 TSG	751X3	Instructional Systems Tech	12,336
1 TSG	9XXXX	Department Liaison	12,336
2 SSG	511X1	TUTOR Programmer	18,062

The yearly cost of this organization is projected at $63,485.
*Annual salary based on military standard rates effective 1 October 1975

Organization B is based on the premise that the following currently exists within the LRC: the management philosophy, and expertise and flexibility required to integrate a medium possessing the capability of PLATO into the current organizational structure.

Organization B

Grade	AFSC	Title/Position	Annual Salary[a]
1 MSG	9XXXX	Supervisor/Department Liaison	$14,360
1 TSG	751X3	Instructional Systems Tech	12,336
2 SSG	511X1	TUTOR Programmer	18,062

The projected yearly cost of this organization is $44,758.

[a]Annual salary based on military standard rates effective 1 October 1975.

Cost Considerations. It is readily apparent that the implementation of a CAI program is an expensive proposition. However, if instructional time savings and the quality of student graduates are demonstrated to be superior to conventional instruction, an examination of the various cost components involved indicate that a number of alternatives exist which could significantly reduce the overall expenditure level for an effort of this type.

For example, personnel costs, which exceeded 50 percent of the project's total costs, are a function of the number of individuals assigned and their relative grade level. Significant operational savings could be realized if consideration were given to converting a number of officer grade author positions to enlisted grade 511X1 Computer Programmers. These programmers would then form the nucleus of lesson development teams which would include one or more subject-matter specialists temporarily assigned (89 days) for the purpose of developing individual lessons. Two weeks of intensive in-house instruction in the areas of TUTOR programming and instructional materials development would insure a working knowledge of computer-based lesson development among the subject-matter specialists. The rank of these subject-matter specialists would be dictated by the nature of the subject matter being developed. The impact of this "small permanent cadre-augmented team" approach is a significant cost reduction (based on numbers and grade levels) coupled with an influx of fresh instructional ideas and approaches.

Another major area, that of recurring computer support, also shows a potential for cost savings. Maintenance data should be accumulated and analyzed to determine whether terminal maintenance and spares should be contracted for on a yearly basis (currently $1,000/terminal/year) or funded on an as required basis.

Besides these specific examples, the following factors will greatly influence the operational costs of computer-based education. As the number of available lesson hours increases, the number of student contact hours will increase. As student contact hours increase, operational costs should remain constant, up to the limit allowed by the configuration of the system, and the cost per student will decrease. Additionally, the number of lessons developed has a unique impact on the cost picture. As additional lessons are developed, costs increase (additional use of subject-matter specialists and programmers) but can be offset by increased student contact hours as indicated before. However, once the course material is developed, the only programming required is that required to remove any errors found and to update materials. Actual programming costs drop once courses are established.

Location of student terminals can also directly affect cost. Decentralization of student terminals makes the terminals readily available to the students; however, personnel costs are increased by the requirement for additional monitors. This depends upon the necessity of having a monitor in the room. Centralized terminal location minimizes monitor costs, yet reduces ease of use.

The number of hours the terminals are available for student use also requires examination. The number of student contact hours increases with expanded operational hours; however, expanded hours require increased monitoring costs. Therefore, it is essential that an optimal operational time be established to insure the most cost-effective use of existing resources. One must also consider the cost of developing supportive audio visuals and other supplementary materials when planning for the operational implementation of computer-based education.

Experience is an extremely important factor in the area of programming. Data gathered from many CBE research efforts indicate that development (lesson programming) time decreases with experience.

Therefore, it is essential that a small, well-trained cadre of experienced personnel be maintained pending a decision to operationally implement CBE on a large scale in the medical military training environment.

IX. SUMMARY AND RECOMMENDATIONS

The POMC PLATO project was originally conceived as a research project to compare POMC taught by a computer to POMC taught in a traditional lecture mode. As previously explained, modification of the traditional lecture course to accommodate a POMC format did not occur. Comparison of POMC PLATO CAI lessons with the traditional lecture system was deemed in 1974 to be a viable research project and was attempted. Although the project was terminated due to constraints which confounded valid evaluation, many valuable lessons and considerable information about CAI potential in Air Force medical training were obtained. This information is presently being employed in segments of the Medical Laboratory, Radiology, and Dental Assistant courses at Sheppard AFB, Texas.

The PLATO staff and many of the instructors of the traditional PA program felt strongly that a problem-oriented curriculum had many advantages and could be the most advantageous way to teach medical material. The potential instructional value of the material developed by the PLATO staff was seen as having considerable usefulness. The consensus of opinion was that a POMC does have potential in Air Force medical education.

The use of CAI in the military medical training environment was also seen to have potential. From staff experiences with PA training, several important lessons were learned regarding selection of areas to be taught, implementation safeguards, and evaluation techniques. For example, lessons considered for research or operational development should be an hour-for-hour lesson replacement. This avoids implementation problems of scheduling for either research or operational situations. If the project has a research orientation, the hour-for-hour lesson replacement allows concise, direct comparison of the different treatment groups on identical criterion measures.

Consideration must also be given to selection of courses with high student flow. In today's cost-conscious Air Force, maximizing the number of students administered a teaching method with a fixed cost will enhance cost-effectiveness. High student flow courses should not be extremely time-pressured or incapable of multiple entry points because of difficulties with scheduling classes.

Once these criteria are used to identify potential lessons, close coordination and communication is necessary to insure that the staff of the potential course views CAI as a valuable asset rather than a potential threat. The staff should realize that they will be integrally involved in lesson development, selection and review of material, and test item approval. This close working relationship facilitates quality lesson development plus establishes a sound basis for integrating and implementing a viable program.

Before lesson development begins, evaluation of student characteristics and criterion measures should be accomplished. Criterion-related student characteristics assist CAI authors in the development of instructional materials and strategies appropriate to the target population. Subsequent validation of these materials and strategies is therefore based upon a student profile of characteristics which are predictive of performance levels. Instructional revision or compensatory alternatives may then be developed and differentially assigned to students, resulting in improved student attainment of instructional objectives in less time. This approach thus affords a greater degree of individualized instruction. Similarly, criterion performance measures must be closely examined for validity to ensure consistency between the material taught and the performance standards required. Research questions bearing on the difference(s) in relative instructional effectiveness of two or more instructional methods; e.g., the POMC as opposed to lecture, are more likely to be answerable given criteria that accurately and reliably measure performance standards. Accordingly, performance measures which distinguish successfully trained students from students unexposed to the instructional material are recommended as one approach for documenting adequate criteria.

Adequate time for conducting systematic formative evaluation is not only instructionally important, it is a pre-implementation phase investment which minimizes total time expended in correcting instructional, procedural, and attitudinal problems during subsequent operational implementation. The formative evaluation sequence includes: (a) author-peer review, (b) small group validation, and (c) large group validation employing representative samples of students who have not been previously exposed to the

material. The foregoing sequence with instructional revision as required, increases the likelihood of effective instruction and decreases the probability of subsequent major problems during the implementation and comparative evaluation stages.

Experience of the PLATO IV staff at Sheppard with the technique of assigning some members of the class to an instructiona' treatment on one set of instructional objectives which differ from what student counterparts in the conventional class experience, results in student confusion, rumors about "missing" material, perceived extra workloads and complications in grading procedures.

The foregoing suggestions and recommendations were derived from the collective experiences of military health care professionals who composed the PLATO IV staff (Appendix H) at Sheppard AFB, Texas. Detailed rationale, procedures, and analyses are found in the main body of the report which hopefully will be of benefit to health care personnel contemplating problem-oriented medical training by means of computer interactive terminals.

APPENDIX A: RESEARCH AGREEMENT

1. TITLE: Evaluation of PLATO IV System in Air Force Medical Training

2. OBJECTIVES: The two major objectives of this study are: (a) the research and development of a new, problem-oriented, medical curriculum in the Physician Assistant Course using an advanced, computer-based educational system and (b) a comparative evaluation of the instructional effectiveness of this curriculum vis-a-vis the present traditional curriculum.

3. PROPOSED MILESTONE SCHEDULE:

a. Start Date: Nov 1973

b. Completion Date: Jun 1976

c. Final Report Date: Nov 1976

4. SUPPORT TO BE FURNISHED BY ATC:

a. Provide adequate classroom and laboratory space to accommodate 20 PLATO IV terminals and associated equipment at the School of Health Care Sciences, Sheppard AFB, Texas.

b. Provide students for the conduct of the PLATO evaluation.

c. Provide subject matter specialists and technical support personnel to develop 200 hours of Physician Assistant Course materials for implementation on the PLATO system, to train instructors in the use of PLATO at Sheppard, to review existing and developing, University of Illinois, PLATO programs in the health care sciences area, and to assist in the data collection, course evaluation and documentation. To the maximum extent possible all personnel assigned to the PLATO IV program at Sheppard will have sufficient tenure to see the program through its planned three-year time span. PLATO IV duties will constitute the primary responsibility of the personnel assigned to the experimental program.

d. Document the development procedures used and lessons learned for future reference.

e. Develop a test plan for the evaluation of PLATO IV with AFHRL/TT.

f. Provide a monthly report of progress to AFHRL/TT, HQ ATC/XPT, SG, and Advanced Research Projects Agency (ARPA).

5. SUPPORT TO BE FURNISHED BY AIR FORCE SYSTEMS COMMAND HUMAN RESOURCES LABORATORY (AFHRL/TT):

a. Provide direction and monitoring of the PLATO IV evaluation.

b. Develop a test plan for evaluation of PLATO IV in conjunction with SHCS representatives.

c. Derive, implement, and monitor measures for student and instructor attitudes as well as student performance.

d. Consult on instructional systems development, instructional strategies, instructional materials, and media devices.

e. Plan for the incorporation of computer based educational materials developed at SHCS into the AIS following completion of the evaluation effort. If feasible, the materials developed for the Physician Assistant's Course will be integrated into and tested with the AIS management component.

f. Consult on the use of PLATO and the TUTOR programming language.

g. Serve as the primary point of contact to ARPA on all matters pertaining to the University of Illinois contract.

h. Provide quarterly reports on progress, an annual summary report of progress and findings, and a final report at the conclusion of the experimental test to ARPA and ATC.

6. RESOURCES AND SUPPORT TO BE FURNISHED BY THE ADVANCED RESEARCH PROJECTS AGENCY (ARPA) THROUGH CONTRACT WITH THE UNIVERSITY OF ILLINOIS:

a. Procurement, installation, and maintenance at the School of Health Care Sciences, Sheppard AFB, Texas, of 20 PLATO IV terminals.

b. Computer support, software, and communications services essential to providing a complete PLATO IV capability to remote terminals at Sheppard AFB, Texas.

c. Training of ATC personnel in the TUTOR language, curriculum development, operating dynamics, and instructional capabilities of the PLATO IV system.

d. Advisory assistance throughout the three year contract period in curriculum development and use of the PLATO IV system.

e. Cooperative development of curriculum materials for the project including the review of other materials on the PLATO system, conversion of selected materials to fit the Sheppard requirements, and the development of selected course materials and support modules as agreed to with the Sheppard project manager.

7. RATIONALE RELATING TO PLATO IV EVALUATION EFFORT:

a. A basic core of medical knowledge for USAF Physician Assistants exists as outlined in the Plan of Instruction, Course 3ALR91730, dated 3 August 1972.

b. A basic pattern of clinical behavior characterizes problem-solving which is straightforward, logical, and scientific.

c. A charting system exists for recording and documenting the use of medical knowledge in the solving of clinical problems.

d. Advances in educational technology and instructional systems analysis can be greatly aided by computer support which integrates and correlates 7(a) and (b).

e. Such a system will be individualized and learner oriented. Evaluative systems will constantly assess instructional effectiveness, student achievement level, and resource impact. Quality instruction and performance will not be compromised in deference to resource conservation.

8. APPROACH:

a. Approximately 200 hours of instructional material will be developed by SHCS personnel. Course development will be in accordance with provisions of AFM 50-2.

b. During the evaluation effort, students will be exposed to both curricular formats in which PLATO IV may or may not be employed. The suitability and contribution of computer based instruction will be evaluated as it stands alone and vis-a-vis the curricula.

c. The experimental PLATO curriculum will be developed and administered by a specifically designated unit within SHCS.

9. DISPOSITION OF RESOURCES AFTER COMPLETION OF PROJECT: Upon the completion of the three-year experimental service test, all PLATO IV equipment will be retained by the School of Health Care Sciences and become the property of the Air Force. These resources will provide the Air Force with a curriculum development laboratory for computer-based instruction in Air Force medical training.

10. This research agreement has been drafted in accordance with ATCR 80-1. The provisions and responsibilities listed have been entered into by all parties in good faith and in recognition of the exigencies of the Air Force.

AGREED TO BY:

SHCS/CC — DATE 18 Dec 73 — AFHRL/TT

ARPA — DATE 10 Dec 1973 — DATE 10 Dec 1973

COORDINATED IN HEADQUARTERS ATC BY:

AC

DP

LG

SG

TT

XP

XPT

XPM

XPX

DE 18 Feb 73

APPROVED BY:

DCS/Plans

APPENDIX B: POMC IMPLEMENTATION PLAN

I. References: Course Chart 3ALR91730
POI 3ALR91730
Research Agreement "Evaluation of PLATO IV System in Air Force Medical Training"

II. Plan Objective

The purpose of this plan is to provide for the orderly integration of the Problem Oriented Medical Curriculum (POMC) developed by the PLATO IV Development Branch into the present Physician Assistant curriculum. This integration will be done in such a way that:

1. Disruption of the present curriculum is minimized.

(a) Steps will be taken to insure that prerequisite material is taught prior to the time it is required as a basis for other material.

(b) The logical flow of content in discipline oriented blocks will not be jeopardized.

2. The integrity of the POMC is maintained, i.e. presentation of material is not excessively fragmented.

3. No degradation in training will result.

4. Evaluation of the POMC is facilitated.

III. Scope

This plan pertains only to the Physician Assistant Course (Phase I), 3ALR91730. The time frame for implementation of this plan is Jun 1975 - Oct 1976 to correspond with the evaluation phase of the PLATO IV project.

IV. Background

A. On 4 Apr 73, the School of Health Care Sciences submitted a proposal for personnel research to Hq ATC. The resultant research agreement calls for (1) the research and development of approximately 200 hours of a new problem oriented medical curriculum at the physician assistant level, using an advanced computer based education system, and (2) the evaluation of the instructional effectiveness of this curriculum vis-a-vis the traditional curriculum. The project covers a three year period beginning in November 1973. Evaluation is to be completed by 1 July 1976, with the final report to be rendered in November 1976.

B. A problem oriented medical curriculum is defined as the grouping of course material under clinical topics where the clinical relevance of course content can be stressed. Emphasis is placed on developing problem solving skills in diagnosis and treatment of disease. To facilitate development, the POMC has been divided into two parts. Part I presents the relevant basic science and clinical material in an integrated manner supported by illustrative case material and using clinical subjects as point of departure to teach basic sciences. Part II will consist of "Simulated Patient Encounters" which will be approached as unknowns by the students. Diagnostic and treatment skills as well as clinical problem solving skills will be amplified in Part II.

C. The task of selecting the content of the POMC from the massive amount of material included in the present physician assistant course was undertaken as follows. Selection was based on the criteria that the clinical area would (1) accommodate an integrated approach to include both the basic and clinical sciences, (2) contain fairly circumscribed and clinically relevant subject matter, (3) provide sufficient subject matter to meet the project objectives, and (4) make the best use of resources within the PLATO IV Development Branch. Jointly exhaustive lists of possible etiological and body systems were tested against the selection criteria. The respiratory system (respiratory disease) was selected as the best subject area for the purposes of this project.

D. A list of basic sciences and specific clinical topics has been developed and arranged in a curricular structure which defines the basic sequence and interrelationships of the subject matter areas. Initial planning/programming has begun in eight of the proposed 20 lesson development areas.

V. Approach to Implementation

A. Definitions and Constraints

1. Terminals. There are 16 PLATO IV student terminals. Prime time (when the system is most stable) is from 0740 to 2200 hours, Monday, Wednesday and Friday, 0600 to 2200 Tuesday and Thursday, and 0800 to 1200 hours Saturday. The total available terminal hours is a constraint, since there are 64 PA students

in any given semester, plus 30 PCNP students who attend PA clinical medicine lectures.

2. POI Hours. For planning purposes, hours are considered to be POI hours planned for a particular subject. POI hours may not necessarily equate to hours actually spent at the terminal by a given student. PLATO material at the lesson or lesson sequence level is self-paced and variations in individual students can be expected.

3. Classroom (C/L)/Complementary Technical Training (CTT) Hours. Since computer assisted instruction is designed to teach for mastery of the material, a PLATO IV lesson designed to meet a particular POI objective will replace both the associated classroom hours and CTT hours. In computing hours in the present curriculum to be replaced by PLATO material, both C/L and CTT hours are considered.

B. Hours Required for POMC Material.

1. The present PA curriculum has been examined to identify those hours in which the subject matter is essentially the same as POMC content and can therefore be replaced by the comparable POMC material. A detailed breakdown of hours by POI objective by semester is included in Attachment 1. A summary is provided in paragraph 3 below.

2. As anticipated, some material included in the POMC does not have direct comparability with hours in the present curriculum. This material is limited to "simulated patient encounters" which is expected to require 24 student contact hours. These hours are considered to be an essential part of the POMC

for review and reinforcement.

3. Summary of Hours

Replacement Hours:

	C/L	CTT	Sub-Total	Total
1st trimester	16.5	7.5	24	
2nd trimester	20.0	5.0	25	
3rd trimester	52.0	20.0	72	
Sub-total	88.5	32.5	121	121
Additional Hours:				
Simulations			24	
Sub-total				24
Grand total:				145

4. In the original research proposal an arbitrary estimation of 200 course hours was designated for PLATO IV programs. The reduction in these hours to 145 represents the integration of an effective circumscribed curriculum into the present course with the least disruption of continuity. The expansion of the PLATO hours to reach a closer approximation of the original estimation of hours would only serve to dilute the effectiveness of the PLATO project, complicate the evaluation procedures and increase the problems of integration into the present course.

C. Plan for Implementation

1. A sample of 16 Physician Assistant students will be selected from the freshman class starting in June 1975 to

serve as a pilot group. Sampling techniques developed by AFHRL will be used to select the 16 students. A second sample of 16 students may be selected from the class starting in Oct 1975 if that is considered desirable on the basis of evaluation plans and experience with the initial group.

2. Students in the sample will complete PLATO materials in lieu of the corresponding work in the current curriculum. They will attend all of the scheduled lectures, except those that have been replaced by PLATO lessons. In addition to criteria listed in IV-C above, considerable concessions have been made in the selection of material to be included in the POMC so that discrete lecture hours of the current curriculum are identifiabl At the time such lectures are given, students would leave the classroom and report to the PLATO lab for computer based instruc tion. Overall, the same criterion objectives will be met by all students, but the temporal sequencing of material in the problem oriented medical curriculum will not necessarily parallel that o the current curriculum.

3. The additional hours required for the simulated patient encounters included in the POMC will be supplemental hours to be done at the student's convenience. This will provide review and reinforcement of material covered in Phase I.

4. Since students in the sample group will not neces- sarily be working on the same subject matter at the same time as the rest of the class, some modification of the normal end of block evaluation procedures will be required. POMC students wou

take the normal end of block tests, but questions covering coursework taught in the POMC would not be counted in their test score. The PLATO IV staff will assume responsibility for determining student proficiency in the POMC subject areas on a semester basis to determine whether or not the student is competent to proceed, needs remediation, etc. The PLATO staff will also assume responsibility for needed remediation in those areas.

VI. Tasks Remaining to be Done.

A. A detailed schedule must be developed for the present curriculum that identifies specific subjects for specific lecture hours, and also identifies hours during which POMC material is to be taken by the sample group.

B. Waivers from course documentation requirements and testing standards must be requested from Hq ATC.

C. Any questions involving accreditation from the University of Nebraska for the sample group must be resolved.

1 Atch
Breakdown of Replacement Hours
by POI Objective

1st Sem - Replacements
POI 3ALR91730 (Vol 1)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
VI	6a	Identify the clinical topography of the thorax	(4/2)	Anatomy (The Trunk)	4/2
VIII	11b	Analyze the principles of the heterophile test	1.5/.5	Serology	1.5/.5
	11c	Translate the principles of the antistreptolysin-0	1/.5	Serology	1/.5
	11e	Compare the principles and procedures of the febrile agglutination tests	1/.5	Febrile Agglutination	1/.5
IX	4	List the steps in the Gram Stain, Acid Fast Stain, and KOH preparation, and list the purposes for performing microbiological stains on clinical specimens	2.5 (2/.5)	Staining Procedures	2/.5
	6a	List the proper methods of specimen collection, the pitfalls in the handling of clinical specimens, and relate the collection and handling of specimens to bacterial and viral infections	1	Specimen Collection	1
	8	Antibiotic susceptibility tests. Compare two methods of testing the susceptibility of bacteria to microbial agents and interpret results of such tests.	2/.5	Antibiotics	2/.5

Block	Paragraph	Objective	PRESENT Hours	Subject	POMC Hours
IX cont'd	9d	Identify the acid fast organisms and their clinically significant pathogenicity	4 (2/2)	Clinical Correlation of Common Pathogens (Acid Fast organisms)	2/2
X	6a	Select the basic assumptions of the theory of kinetic molecular gases	3 (2/1)	The Gas Laws	2/1
	6b	Solve problems involving changes in the pressure, temperature, volume and number of moles of gases.			
				TOTAL HOURS:	16.5/7.5

2nd Sem - Replacements
POI 3ALR91730 (Vol 2)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XII	6b	Describe the mechanisms for maintenance of fluid and acid-base balance in the body fluid compartments and determine the use of laboratory test results in classifying abnormalities.	8 (6/2)	Fluids and Electrolytes (Acid-base balance and lab tests. O_2 and CO_2 transport. Resp acidosis & alkalosis	6/2
XIII	3a	Describe the anatomy and explain the physiology of the respiratory system	12 (9/3)	The Respiratory System	9/3
XIV	6b	Identify and determine treatment of common diseases of the nose.	6 (5/1)	Diseases of Ear, Nose and Throat - (Nose)	3
	6c	Identify and determine treatment of common diseases of the oral cavity and the larynx.	5	Diseases of Ear, Nose and Throat - (Throat)	2
				TOTAL HOURS:	20/5

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XVIII	1a	Identify the atmospheric condition that can affect the human body in flight.	3	Flight problems	3
XIX	2a -n		13 (8/5)	Interpretation of Chest X-ray	8/5
	2a	Name the radiographic densities produced by roentgen beam.	(1/1)		
	2b	Name the anatomic structures described on a routine posterior /anterior and lateral chest x-ray.	(.5/1)		
	2c	Determine the systematic method for examining the roentgenograph.	(.5/1)		
	2d	Name at least six positions and/or techniques for evaluating the chest by radiography.	(.5/1)		
	2e	Interpret the silhouette sign and describe the anatomic location of chest lesions utilizing the silhouette sign.	(.6/1)		
	2f	Name primary and secondary signs of atelectasis.	(.4)		
	2g	Define the air bronchogram	(.5)		

3rd Semester (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XIX cont'd	2h	Name criteria for differentiating alveolar and interstitial lung diseases by x-ray.	(.5)		
	2i	Interpret roentgenographic features to determine the nature of the solitary lesion (benign or malignant) of the lung.	1		
	2j	Identify calcification within the lung.	.5		
	2k	Identify radiographic abnormalities associated with diseases of the pleura, extrapleural space, and diaphragm.	1		
	21	Name the three arbitrary compartments of the mediastinum and structures found in each compartment.	.4		
	2m	Describe the chest x-ray and lung scan signs of pulmonary emboli.	.3		
	2n	Delineate the major signs of chest trauma	.3		
XX	4a	Describe the actions, effects and uses of the antihistamine drugs	3	Histamines and Antihistamines	2/1

3rd Sem (Cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XX (cont'd)	22a	Explain the actions, effects and uses of drugs used to combat infection.	9/5	Chemotherapy	9/5
XXI	9	Allergy	4	Allergy (Immun. Mech)	4
	13b	Describe the syndrome and treatment of coryza, pharyngitis, bronchitis, and pneumonia, and name the characteristics of bacterial and nonbacterial pneumonia.	3/1	Infectious Diseases	3/1
	13d	Discuss mononucleosis	1	Infectious Diseases (Mono)	1
	21a - p	Pulmonary Diseases	28 (20/8)	Pulmonary Diseases	20/8
	21a	Describe special procedures applicable to etiologic diagnosis and essentials of data base.	1		
	21b	Define lung function and normal pulmonary anatomy, and describe the physiology and pathophysiology of the respiratory system.	2/1		
	21c	Name reasons for performing pulmonary function testing and describe routine tests of pulmonary function, name four mechanisms of hypoxemia, and how to detect and differentiate these mechanisms.	3/1		

3rd Sem (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XXI (cont'd)	21d	Name and define categories of chronic obstructive lung disease and describe pathophysiology of cystic fibrosis.	3/2		
	21e	Define respiratory failure and describe the physiologic effects, etiology, diagnostic tests, therapy, complications and prognosis.	1		
	21f	Define thromboembolism and infarction, and describe pathophysiology and treatment.	1		
	21g	Describe primary alveolar hypoventilation, alveolar proteinosis, and desquamative interstitial pneumonia.	.5		
	21h	Describe diseases associated with kyphoscoliosis and ankylosing ankylotic.	.5		
	21i	Describe Goodpasture's Syndrome and ideopathic pulmonary hemosiderosis.	.5/.5		
	21j	Describe lung abscess and diseases of pleura	.5/.5		
	21k	Describe the physical signs and symptoms of aerobic and anaerobic bacterial pneumonias, and mycotic diseases of the lungs.	2/1		

3rd Sem (Cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XXI (cont'd)	21-1	List types of neoplasms, describe primary tumors of the lungs, and discuss the significance of the solitary nodule.	1/.5		
	21m	List clinical features of pulmonary fibrosis and describe the radiographic picture and pulmonary function abnormalities associated with diffuse interstitial fibrosis and the Hamman-Rich syndrome.	1/.5		
	21n	Describe inhalation diseases of the lungs due to organic and inorganic dusts, noxious gases, and other agents.	1/.5		
	21o	Describe epidemiology, causative organisms, immunology and treatment of tuberculosis.	1/.5		
	21p	Describe the pathogenesis and clinical aspects of sarcoidosis, Wegener's granulomatosis, and eosinophilic granuloma.	1		
XXI	23j	Describe common respiratory problems in childhood, their evaluation and management	2/1	Pediatrics (Respiratory dis. of childhood)	2/1
				TOTAL HOURS:	52/20

APPENDIX C: FLOW CHART/POI OBJECTIVES

FLOW CHART BLOCK

1. Introduction
   POI Obj:

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2. Basic Sciences
   POI Obj: VI-6a, X-6a, XII-6b, XIII-3a

   Anat Term

   Intro

   Anatomy

   Functional Mechanics

   Diffusion

   Transport

   Control

---

3. Upper Airway Disease
   POI Obj: XIV-6b

---

4. History in Respiratory Disease; POI Obj: XXI-21a

---

6. Problem-Oriented Medical Record
   POI Obj: XXI-21a

---

7. Procedures/Lab Tests
   POI Obj;: IX-4, IX-6a, IX-8

FLOW CHART BLOCK

8. Allergy/Antihistamines
   POI Obj: XXI-9, XX-4a

   Allergy

   Allergens

   Antihistamines

---

9. X-Ray
   POI Obj: XIX-2a-n

---

10. Pathophysiology of Inflammation
    POI Obj: XXI-21b, VIII-11b,-11c,-11e

    Pathophysiology

    Heterophile

    ASO
    Febrile Agglut.

---

11. Infiltrative Infectious Lung Disease; POI Obj: XXI-13b, XXI-21j, -21k, -21o, -21g

    Introduction

    Lung Abscess

    Pneumonia

    Tbc

    Interstitial pneumonia

FLOW CHART BLOCK

12. Infiltrative Noninfectious Lung Disease - POI Obj: XXI-21i, -21m, -21n, -21p

13. Antibiotics
POI Obj: XX-22a

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14. COPD
POI Obj: XXI-21d, -21h

Introduction

COPD

Asthma

Emphysema

Chronic Bronchitis

FLOW CHART BLOCK

15. Pulmonary Function
POI Obj: XXI-21c

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16. Emboli
POI Obj: XXI-21f

---

17. Neoplasm
POI Obj: XXI-21l

Neoplastic Disease

Cytology

---

18. Flight Considerations
POI Obj: XVIII-1a

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19. ARF/Noxious Drugs
POI Obj: XXI-21c

ARF

Noxious Drugs

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20. Simulations
POI Obj: XXI-13d

Mono

Other

APPENDIX D: SIMULATED PATIENT ENCOUNTERS USING THE PLATO IV COMPUTER-BASED EDUCATIONAL SYSTEM

David R. Stutz, Major, USAF, MC
and
Eileen Sweeney, B.A.

Major Stutz is the Medical Director of the USAF School of Health Care Sciences PLATO IV Development Project at Sheppard AFB, Texas. Ms. Sweeney is on the staff of CERL, Computer-based Education Research Laboratory, at Champaign, Illinois, where she is director of lesson review for the Sheppard Project.

ABSTRACT

The PLATO IV Development Project at Sheppard AFB, Texas, is designing a minicurriculum on the respiratory system and its diseases for physician assistant students. A major portion of this curriculum is devoted to simulated patient encounters presented via the PLATO IV computer-based instructional system. These simulated patient encounters are designed to provide a model for systematic data collection and its analysis, and at the same time reinforce the instruction on respiratory system diseases.

The PLATO IV Development Project at the USAF School of Health Care Sciences is a minicurriculum on "The Respiratory System and Its Diseases," implemented for physician assistant students by using the PLATO IV computer-based instructional system.[1] This is a system of remote terminals operating through a central computer at the University of Illinois.[2] A major component of the instructional lessons is a series of simulated patient encounters ("Simulations"). This paper will describe a typical simulation, showing how it is used as a model for systematic data collection and its analysis, and how it serves as a vehicle for presenting clinical medical material.

STUDENT ORIENTATION

Prerequisite to the first simulation is a lesson on "History-Taking in Pulmonary Diseases." It uses the same format as the simulations that follow, with the student typing in questions and seeing immediate "patient" responses on the remote terminal's plasma panel. This lesson serves as a model for communicating with the simulated patients, and it develops the following points as the student is led through the history-taking exercise:

When encountering a patient with suspected pulmonary disease, one must inquire about the following cardinal symptoms:

Chest pain	Cyanosis
Dyspnea	Wheezing
Cough and Hemoptysis	

For any positive response, the student is told to amplify the description of that symptom by asking about:

Provocative and palliative factors,
Quality (precise nature) of the symptom,
Region of the body involved,
Severity of the symptom, and
Temporal factors.

This is reinforced by the mnemonic "PQRST."[3]

In addition, the student learns to ask about: smoking habits, allergies, occupation, and travel, since these factors can be related to respiratory system disease.

Before "seeing" the simulated patient, the student will also have completed lessons covering the physical exam of the respiratory system, laboratory studies in respiratory disease, and the problem-oriented medical record.

TYPICAL PATIENT ENCOUNTER

The student initiates the interaction in the history-taking mode, but at any time he/she may branch to the physical exam or laboratory exam mode to collect pertinent information. In each of these areas, assistance is available which summarizes the prior lesson on history-taking, or which details the list of available laboratory and other diagnostic procedures. The student is free to branch back and forth among the various data collection modes, and at any time he/she may elect to make a diagnosis.

When asking questions to the simulated patients, the student may use spontaneous and natural language. Warning is given that only one question should be asked at a time and that questions should be specific and not leading.

The patient is presented initially as follows:

Computer: A 24 year old male sergeant presents to the emergency room.

Initial observation by you reveals a well-nourished man who is sitting very quietly in his chair.

A typical dialogue is described below:

Student: Wh s the reason you have come here?

Patient: I jus n't get my breath and my chest hurts.

Student: Where is the chest pain?

Patient: The pain is here in my left side, and I also feel it in my left shoulder.

Student: What's the chest pain like?

Patient: The pain is like a knife in my side. It really hurts if I take a deep breath.

Student: Does it come on when you bend over?

Patient: Sorry, but I don't understand your question. (Please . . . avoid pronouns. Try to be more specific or phrase the question differently. Also . . . ask about one thing at a time)

–HELP– is available

Student: What brings on the chest pain?

Patient: The pain came on by itself, but it's worse when I take a deep breath.

Student: What relieves your problem?

Patient: I just try to sit still.

Student: Have you taken any medication for this?

Patient: I haven't taken anything for it.

At any time the student may branch to the physical exam mode to "perform" components of that exam.

Student: Vital signs

Response: T.99° P 104 (reg) R 20 (reg) BP 120/85

Student: Chest exam

Response: INSPECT: Rapid rate (20) without the use of accessory muscles. Left side does not appear to expand as well as the right. PALPATION: Fremitus decreased left lateral and posterior lung fields. PERCUSS: Increased resonance over left lateral and posterior lung fields. Diaphragmatic excursion normal bilaterally. AUSCULTATION: Decreased breath sounds over left lateral and posterior lung fields.

The student is also free to request laboratory data at any time. For example:

Student: Lung scan

Response: Lung scan is unnecessary if you bothered to order a chest x-ray first.

Student: Chest x-ray

Response: Chest x-ray, X-ray #B-3 to be used. Press SHIFT-LAB- for assistance interpreting the chest x-ray.*

The student may also elect to make a diagnosis at any time, but before he/she is allowed to enter a diagnosis, certain specified data must have been collected. If the specified information has not been obtained, the student receives this message when he/she elects to enter a diagnosis:

Computer: You do not have all of the information necessary for making a diagnosis. Before you are allowed to attempt a diagnosis, you should investigate the following areas:

*"SHIFT-LAB-" refers to a key on the PLATO terminal's keyboard.

When did the problem start?
Is there any cough?

The student cannot proceed until the specified questions are asked. Similarly, after the required history information is collected, if there is necessary physical or laboratory exam data that is not yet collected, the student will receive the appropriate message.

ASSESSMENT OF THE DATA

Once in the diagnosis section, the student is allowed to enter as many diagnoses as he/she wishes.

Computer: Enter as many diagnoses as you wish, but press –NEXT– after each entry. Then press –DATA– when you have given all the diagnoses you feel are relevant.*

Student: Pulmonary Embolism

Computer: Although it is difficult to rule out this diagnosis, the correct diagnosis can be made from the chest x-ray. There is no reason to suspect pulmonary embolism as well.

The student is free to return to the data collection mode to review the data that has been collected.

When in the diagnosis mode, assistance is available in the form of a "Socratic" type question and answer exchange. The student may access this by pressing the appropriate key on the keyboard (labeled "HELP").

Computer: A key to diagnosis in this case is the proper interpretation of the chest x-ray. Look at chest x-ray #B-3. You should note that this is an expiratory phase film which is the best type of film to diagnose this condition. First, look at the RIGHT lung field and notice that the vascular markings extend all the way to the periphery. Is that normal?

Student: Yes

Computer: Of course it is. Although the markings become finer as the pulmonary vessels branch away from the hilum, some markings will be present.

Computer: Now look at the superior and lateral portion of the left lung. Although it is difficult to see on this small chest x-ray, note that beyond the dashed line, no lung markings are present. What is present between the dashed lines and the parietal pleura which lines the thoracic cage?

Student: I don't know.

Computer: The substance present is one of the classical states of matter.

Student: Liquid

Computer: That would be denser. A lucency is present. Try again.

Student: Gas

Computer: Correct. Air is present in the pleural space.

Computer: What is the term for air in the pleural space?

Student: You got me.

Computer: The first part of the word is from the Greek, "PNEUMO" meaning air.

Student: I still don't know.

Computer: The second part of the word refers to the chest cavity.

Student: Pneumothorax.

* –NEXT– and –DATA– refer to particular keys on the PLATO terminal's keyboard.

Computer: That's right. The patient has a partial pneumothorax. It is partial because most of the left lung is still expanded.

After all of the diagnoses are made, the student proceeds to a section to determine the etiology of the problem. Like the diagnostic cunsultation, this section is presented via an interactive dialogue between the computer and the student.

After this section is completed, the case is summarized by using the problem-oriented record "SOAP" technique as described below:[4]

#1	Pneumothorax	
	SUBJECTIVE:	(History data is summarized.)
	OBJECTIVE:	(Physical and lab exam data is summarized.)
	ASSESSMENT:	Pneumothorax, etiology-spontaneous.
		Approximately 20% of left lung involved.
	PLAN:	Press –NEXT– to formulate a plan.

DEVELOPMENT OF THE PLAN

This section is conducted in the same way as the earlier sections. The student develops his/her diagnostic plans (further studies) and treatment plans (including follow-ups), and after this is done, a completed "SOAP" summary is shown, now including the plan. Depending on the choices made, the student may have achieved a therapeutic success or failure, and appropriate feedback is given.

DIDACTIC MATERIAL

After completion of the case, a descriptive summary of the disease entity is presented. This covers:

Eipidemiology: who is at risk.
Signs and Symptoms
Pathophysiology
Special studies required to make the diagnosis and to monitor progress.
Treatment, Prognosis, and Prophylaxis*

This is a format that the student can adopt to store and retrieve information in and from his own mind.

CONCLUSION

Although the simulated patient encounters cannot duplicate the subtleties of interacting with a living patient, the simulations and the prerequisite lessons on history-taking, physical exam, and the problem-oriented medical record, can do the following:

1. They provide an explicit model for systematic history data collection, helping to insure a complete description of any given symptom.

2. They provide an implicit model for analyses of the collected data by the use of interactive dialogues between the mentor (computer) and the student.

3. They reinforce the use of the problem-oriented medical record by using the "SOAP" format. This is excellent for organizing clinical data, impressions, and plans.

4. Finally, they present material describing disease entities, using a systematic format that the student can also use to store and retrieve descriptive medical material. Thus, the lessons provide a model for systematic solving of medical problems as well as techniques for personal storage and retrieval of medical material.

REFERENCES

1. Stutz, D.R., and Steinkerchner, R.A. The USAF School of Health Care Sciences PLATO IV Project: A problem-oriented curriculum for physician assistants. J. Med. Educ., forthcoming.

2. Alpert, D., and Bitzer, D.L. Advances in Computer-Based Education. Science, 167: 1582-90, 1970.

3. DeGowin, E.L., and DeGowin, R.L. Bedside Diagnostic Examination. New York: The MacMillan Co., 1969.

4. Weed, L.L. Medical Records that Guide and Teach. N. Eng. J. Med., 278: 593-599, 1968.

(prepared by AF RL/TT as a result of evaluation conference held 6-7 Mar 75 at Sheppard AFB)

BACKGROUND

Under the auspices of the Advanced Research Projects Agency (ARPA) and Air Training Command (ATC), a Problem-Oriented Medical Curriculum supported by PLATO IV technology is being introduced in the School of Health Care Sciences. PLATO can provide individualized instructional material presented through a computer controlled plasma panel. The essential notion behind the Problem Oriented Medical Curriculum (POMC) is that academic subject matter should not be introduced in isolated units, but rather in the context of clinical diagnosis of actual patient problems. In this fashion, it is anticipated that problem solving skills will be developed to a greater degree, that retention of information will be enhanced, and that student motivation will be increased. Details covering introduction of this innovation into the Physician's Assistant Course can be found in the POMC Implementation Plan, 10 Feb 75.

PROBLEM

The goal of this evaluation plan is to develop a set of procedures for assessing the effectiveness of the proposed POMC.

RATIONALE

The initial step in the process is to define a rationale which underlies and supports the entire evaluation. Proper evaluation is

obviously a complex matter, for the concept of "effectiveness" is clearly multidimensional. However, two sets of questions seem to be generated almost immediately. The first group is primary and basically operational in nature; these questions are designed to create a rational policy for or against full scale implementation of the innovation. Simply stated, this set of questions asks:

- can it be done?
- is it instructionally effective?
- what does it cost (to institute, to operate, to maintain)?
- is it reliable?

A secondary, or research-oriented group of questions is also of interest. These are directed at explaining the success or failure of the innovation in the particular environment studied. This set consists of asking

- how was it done?
- why was it effective?
- how could it be improved (in terms of costs lowered or effectiveness increased)?

These latter questions are not unimportant, but higher priority must be given to the first set since they were judged to be more relevant to the purposes of the sponsoring agencies (ARPA and ATC). To some extent the secondary questions will be addressed in the final report, especially with regard to describing the process involved in setting up the POMC, but the major emphasis of available resources is being placed on answering the first group of questions.

Another issue which was faced in planning the evaluation concerns the extent to which comparative measurement will be made, as distinguished from following purely descriptive procedures. This distinction is analogous to the difference between norms referenced and criterion referenced measurement. In the comparative approach, procedure A is compared with procedure B on various criteria of effectiveness, while in the descriptive approach, effectiveness is measured with respect to meeting standards or specifications in some absolute sense. Each approach has its own peculiar advantages, but, where feasible, it was decided to use comparative measures as much as possible in order to contrast the POMC approach with traditional instruction.

Another conceptual consideration important for this rationale deals with focusing on which aspects of the situation should be studied. Although not exhaustive of the possibilities inherent in this situation, three major aspects were identified for intensive study--students, authors, and PLATO IV itself.

A final concern involves deciding which specific characteristics and variables need to be measured. Since student and author performance are crucial to judging effectiveness, these naturally are emphasized. But it was also viewed as important to measure attitudes and to sample opinions from the participants. In addition, concern with author background characteristics and their relation to performance was seen as both researchable and important for

future implementation. With respect to the PLATO device, its various cost factors and overall reliability must be addressed.

The foregoing considerations gave rise to Fig. 1 which outlines the major studies to be completed as part of this evaluation. Two further constraints which influenced the choice of particular studies were (a) the necessity to work within the guidelines of the POMC Implementation Plan, and (b) the limited manpower resources of both the PLATO Development Branch and AFHRL.

SAMPLING CONSIDERATIONS

For those studies involving comparative evaluation of students, a POMC test group (numbering 16) will be selected from personnel entering June 1975. These students will be presented specific problem oriented material on PLATO IV, rather than receiving the "equivalent" instructional material in the traditional classroom setting. These materials will be distributed throughout the entire three semesters of classwork at the School of Health Care Sciences (SHCS). The remaining 48 students from the June 1975 class will serve as a control group and will not be exposed to the problem oriented material related to Respiratory Disease on PLATO IV.

The POMC test group will be randomly selected from the PA students entering in June 1975. If the sample chosen by this method does not differ significantly from the control group on SAT composite scores, the sample will be accepted as representative. If there is an appreciable difference between the control

	STUDENTS					AUTHORS		PLATO IV	
	Instructional Effectiveness		Job Task Performance	Atti-tudes	Perform-ance	Atti-tudes	Personal Charact-eristics	Cost	Reliability Maintain-ability
	Knowledge	Skill							
COMPARATIVE	X	X	X						
DESCRIPTIVE	X			X	X	X	X	X	X

Figure E-1.

and test group on SAT composite scores, a new selection of groups will be necessary since it has been shown that there is a high correlation between high composite SAT and success in the PA course. If a second selection process is necessary, the entire class will be rank ordered on SAT scores. An equal number of students will be randomly selected from the high and low strata. Sample size can be increased to 32 by following the same procedures for the next entering class, thus increasing the power of this design.

STUDENTS

1. Academic Knowledge (Study 1)

The purpose of this comparison is to determine whether there are differences between POMC students and students in the traditional curriculum with respect to academic knowledge of respiratory disease subject matter. If the POMC succeeds in teaching this material at least as well as currently, then academic quality will have been maintained.

Since slight differences in emphasis and content are found between the POMC and the traditional curriculum, academic test items from currently used block tests could be unfair to POMC students. Likewise, the POMC generated end-of-block test items could be biased against the traditional students. To resolve this difficulty, a test covering respiratory disease will be constructed consisting of items that are similar to those found on the American College of Medicine/Board Examination. These items will come from the Educational Testing Service (ETS) item banks. In the event that ETS

cannot supply these items or more items are necessary, experts in respiratory disease from outside the SHCS (for example, University of Nebraska PA staff) will be asked to contribute test items. These procedures will insure content validity since these test items will tap knowledge that is considered important by independent experts in respiratory disease.

This initial item pool will be further refined by testing a group of Physician's Assistants just at the end of their second year of training. Item statistics will be computed on this sample, and items for the final form of the test will be chosen in accordance with statistical criteria so that only reliable and discriminating items of appropriate difficulty are included. In addition, this procedure will provide a normative sample against which scores of the test and control groups can be compared.

The final form of this test will be administered to test and control groups at the end of phase I of the course, thus delayed retention will be measured for both groups.

2. Problem Solving Skill (Study 2)

The skill to be assessed in this comparison is problem solving or diagnostic skill. By presenting several simulated patient encounters, we can test the student's ability to integrate his knowledge toward successful diagnosis and treatment of a patient. These exercises will essentially be paper and pencil problem descriptions, but the student will be able to request information,

prescribe treatments, and note effects. In a limited sense he will be able to "interact" with the simulation. Scoring criteria would include correct use of available information (lab tests, patient history, physical examinations, special tests, etc), correct sequence of steps toward diagnosis, accuracy of diagnosis, appropriate indication of treatment, time to completion.

Two or three Simulated Patient Encounters will be presented to both groups at the end of the course. It is planned that these simulations will be available from ETS or drawn from simulations which are already in existence. It is felt that creation of simulations by the PLATO and PA staffs should be avoided to eliminate bias.

3. Student Attitude Questionnaire (Study 3)

The main objective of this study is to discover whether POMC students have positive (or negative) attitudes toward the curriculum and/or the PLATO system. To this end, a 26 item version of the Brown questionnaire, used by Florida State University in a recent study, has been selected. This instrument has demonstrated reliability with college students (r=.80), and includes many specific questions which will permit inferences about the various features of PLATO (e.g. perceived reliability of terminals, depersonalization, etc).

It is anticipated that the attitude questionnaire will be given in the first and twelfth month of the course in order to detect

differences as experience with the POMC and PLATO increases. Analyses of the relationship between attitude and performance on the final academic test and simulations are planned.

4. Lesson and Block Tests (Study 4)

Here the evaluation will be descriptive and formative in contrast to the previous study which was comparative and summative. The goal is to show that POMC students are meeting learning objectives as they progress through the course. Number of lesson repeats, number and duration of special remediations, eliminations or washbacks will be reported.

AUTHORS

1. Performance (Study 5)

Author performance will be measured in three ways: (a) average quality of lessons produced (as judged by University of Illinois Personnel and student), (b) supervisory ratings of performance, and (c) peer ratings of performance. Performance dimensions to be rated will include programming ability (competence with Tutor language), efficiency in lesson design, creative use of instructional techniques, novel applications of PLATO, etc.

Questionnaire instruments will be designed by AFHRL for administration as soon as possible, so that time comparisons can be made to show the effect, if any, of experience.

2. Attitudes/Opinions (Study 6)

Attitudes of authors will be measured primarily by a questionnaire yet to be developed. Two purposes are paramount here--

(a) to be able to describe specific strengths and weaknesses of the PLATO equipment, and (b) to investigate the relationship between attitude and performance. Dimensions to be sampled include: attitudes toward CAI in general, feelings about individualized instruction and the problem-oriented approach, human factors aspects of terminal design, problems in lesson design, etc.

Questionnaire data should be supplemented by interview data with interviews to be conducted by AFHRL. Also open ended opportunities will be included in the questionnaire format.

Two measurements of attitudes and performance will be made at different times. Cross-lagged correlation analysis may yield some insight into whether attitudes cause performance or vice versa.

3. Characteristics (Study 7)

An attempt will be made to relate author personal and background characteristics to performance on the project. To this end, data will be collected on such variables as level and type of education, age, rank, IQ, attitudes, volunteer/nonvolunteer status, interests, etc. The aim here is to predict what kinds of people make successful authors for possible selection purposes.

PLATO IV

1. Cost (Study 8)

Since the PLATO Development Branch is a cost center, aggregate operating and development cost figures can be readily obtained. Management analysis personnel will be contacted for consultation purposes. Capital investment figures should be available from ARPA. A projection of expansion costs under several scenarios should be a part of the final report.

2. Reliability (Study 9)

Logs will be maintained to show number of terminals in commission per day, percent of down-time per terminal, cause of failure. Time phased analyses can be made to detect trends.

SUMMARY

Figure 2 gives an overview and summary of the plan with responsible agencies and deadlines specified.

EVALUATION

MILESTONES* AND RESPONSIBLE AGENCIES**

	Study Design	Measurement Instrument Development	Data Collection	Data Analysis
Students				
Study 1	C (HRL)	Apr 76 (ETS)	May 76 (MSDM)	Jul 76 (HRL)
2	Oct 75 (MSDM)	Apr 76 (ETS)	May 76 (MSDM)	Jul 76 (HRL)
3	Apr 75 (HRL)	C (MSDM)	Jul 75 (MSDM)	Jul 76 (HRL)
4	May 75 (MSDM)	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 76 (HRL)
Authors				
Study 5	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM)	Aug 76 (HRL)
6	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM/HRL)	Aug 76 (HRL)
7	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM)	Aug 76 (HRL)
PLATO				
Study 8	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 75 (MSDM)	Sep 76 (MSDM/HRL)
9	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 75 (MSDM)	Sep 76 (MSDM/HRL)

HRL = Human Resources Laboratory, Technical Training Division
ETS = Educational Testing Service
MSDM - PLATO Development Branch

* date given is deadline, interpreted as Not Later Than
** indicated in parenthesis
C completed

Figure E-2.

APPENDIX F: TESTING/GRADING PROCEDURES

DEPARTMENT OF THE AIR FORCE
School of Health Care Sciences, USAF, (ATC)
Sheppard Air Force Base, Texas 76311

MSDM 11 Sep 75

Testing/Grading Procedures for Students Participating in the PLATO Project

MSDM (LCol Seager) MSDM (Cdr Peterson MSOR

1. PLATO material has been developed which is designed to meet specific objectives taken from the Plan of Instruction for Course 3ALR91730 (Physician Assistant). When lectures are given which address these same objectives, PLATO students are to be excused and report to the PLATO classroom. Because the PLATO project involves an experiment in curriculum design as well as the application of computer-assisted instruction, the sequencing of material presented via PLATO will not correspond to sequencing in the regular curriculum. Hence, PLATO students may not have had the material that corresponds to lecture material from which they were excused when scheduled testing takes place in the regular curriculum. Therefore, HQ ATC has granted a waiver of the provisions of ATCR 52-3 for students who are part of the PLATO "test" group so that normal testing procedures can be modified to accommodate them.

2. The following procedures apply for testing these students:

a. Prior to administering an examination or quiz which covers objectives for which PLATO materials are involved, the PA faculty member planning to administer the measurement instrument will contact his PLATO staff counterpart. Jointly, the PLATO staff member and PA faculty member will determine which questions are to be excluded from the examination for PLATO students and MSORM will be advised.

b. At the time of the examination, PLATO students will be directed not to answer the questions identified by the procedure above. The instructor will write the numbers of the questions to be excluded on the blackboard and have students in the PLATO group circle those numbers on their answer sheets.

c. At the time the examination is graded, % scores will be calculated for PLATO students on the basis of the number of questions answered correctly out of the number of questions not excluded. For example, if five questions were excluded on a test which normally contains 50 questions, the PLATO student score would be the number answered correctly divided by 45.

3. The PLATO staff is responsible for testing objectives covered by PLATO material. Formal tests will be administered as often as three times per trimester and the results of these tests will be used to adjust both raw scores and percentage scores of tests from which questions were excluded. The following procedure will be used in adjusting these scores.

a. On the basis of the number of questions not excluded in comparison with the number of questions normally contained in the test, a weighting factor will be determined for each test in the regular curriculum that was affected by the procedures outlined in para 2 above. For example, on a test which normally contains 50 questions from which eight questions were excluded, the weighting factor would be .84 and the weighting factor for the PLATO test would be .16 (so that the sum of the weighting factors equal 1.00).

b. At the completion of a PLATO testing cycle, all affected test scores (percentage) in the regular curriculum which had not been adjusted previously will be adjusted according to the following formula:

Test weighting factor	X	Test Score	+	PLATO weighting factor	X	PLATO Score	=	Adjusted Test Score

Raw scores may be adjusted by the formula:

Adjusted Test Score	X	Total Questions on Test before exclusions	=	Adjusted Raw Score

Attachment 1 of this letter contains a completed example of the procedure.

4. The above procedures become effective immediately and will remain in effect for the duration of the PLATO project.

NICHOLAS C. NICHOLAS, Col, USAF, BSC
Chief, Department of Medicine

1 Atch
Example of Procedures

EXAMPLE OF TESTING/GRADING PROCEDURES FOR PLATO STUDENTS

Test in regular curriculum:	50 Questions
PA – PLATO staff members exclude:	8 Questions
PLATO students responsible for:	42 Questions

PLATO student who answers correctly:

# of Questions	% Score
42	100.0
40	95.2
30	71.5

Weighting Factors determined by:

# of Questions not excluded	÷	Total Questions on Test	=	Weighting Factor for test

42 ÷ 50 = .84

1.00 – Weighting factor for test = PLATO test weighting factor

1.00 – .84 = .16

Adjusted Grade:

Weighting Factor for test	X	Test Score	+	Weighting Factor for PLATO test	X	PLATO test Score

= Adjusted Score

If a student received a score of 90% on the PLATO test, his score would be adjusted as follows:

Weighting Factor		Test Score		Weighting Factor		PLATO Score		Adjusted Score
.84	X	100.0	+	.16	X	90	=	98.4
.84	X	95.2	+	.16	X	90	=	94.4
.84	X	71.5	+	.16	X	90	=	74.5

Raw scores can then be adjusted as follows:

Adjusted Score/100	X	Total Questions	=	Adjusted Raw Score

Unadjusted Raw Score	Adjusted Score/100		Total Questions		Adjusted Raw Score
42	.984	X	50	=	49
40	.944	X	50	=	47
30	.745	X	50	=	37

APPENDIX G: ATTITUDE SURVEY

Instructions: Please answer each of the following questions as objectively as possible. There are no wrong answers so give only your own opinion, not what you think someone would like to hear.

Key: SD-Strongly Disagree D-Disagree U-Undecided A-Agree SA-Strongly Agree

For each of the following questions, circle the desired response.

1. While taking Computer-Assisted Instruction I felt challenged to do my best work.
   SD D U A SA
2. I was concerned that I might not be understanding the material.
   SD D U A SA
3. I was not concerned when I missed a question because no one was watching me anyway.
   SD D U A SA
4. While taking Computer-Assisted Instruction I felt isolated.
   SD D U A SA
5. I felt uncertain as to my performance in the programmed course relative to the performance Of others.
   SD D U A SA
6. I found myself just trying to get through the material rather than trying to learn.
   SD D U A SA
7. I knew whether my answer was correct or not before I was told.
   SD D U A SA
8. I guessed at the answers to questions.
   SD D U A SA
9. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.
   SD D U A SA
10. As a result of having studied some material by Computer-Assisted Instruction, I am interested in trying to find out more about the subject matter.
    SD D U A SA
11. I was more involved in running the machine than in understanding the material.
    SD D U A SA
12. I felt I could work at my own pace with Computer-Assisted Instruction.
    SD D U A SA
13. Computer-Assisted Instruction makes the learning too mechanical.
    SD D U A SA
14. I felt as if I had a private tutor while on Computer-Assisted Instruction.
    SD D U A SA
15. I was aware of efforts to suit the material specifically to me.
    SD D U A SA

16. I found it difficult to concentrate on the course material because of the hardware.

SD D U A SA

17. Questions were asked which I felt were not relevant to the material presented.

SD D U A SA

18. Computer-Assisted Instruction is an efficient use of the student's time.

SD D U A SA

19. While on Computer-Assisted Instruction I encountered mechanical malfunctions.

SD D U A SA

20. Computer-Assisted Instruction made it possible for me to learn quickly.

SD D U A SA

21. I felt frustrated by the Computer-Assisted Instruction situation.

SD D U A SA

22. The Computer-Assisted Instruction Approach is inflexible.

SD D U A SA

23. Even otherwise interesting material would be boring when presented by Computer-Assisted Instruction.

SD D U A SA

24. In view of the effort I put into it, I was satisfied with what I learned while taking Computer-Assisted Instruction.

SD D U A SA

25. In view of the amount I learned, I would say Computer-Assisted Instruction is superior to traditional instruction.

SD D U A SA

26. With a course such as I took by Computer-Assisted Instruction I would prefer Computer-Assisted Instruction to traditional instruction.

SD D U A SA

27. I am not in favor of Computer-Assisted Instruction because it is just another step toward depersonalized instruction.

SD D U A SA

28. Computer-Assisted Instruction is too fast.

SD D U A SA

29. Typing experience is necessary in order to perform easily on Computer-Assisted Instruction.

SD D U A SA

30. Computer-Assisted Instruction is boring.

SD D U A SA

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

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

NAME_____

APPENDIX H: PROFESSIONAL STAFF

Staff at USAF SHCS, Sheppard AFB, Texas

AFSC	Name and Rank
9166 (Aerospace Physiologist)	Brent C. Seager, Lt Col, USAF, BSC
9156A (Lab Officer)	Robert E. LaCoe, Major, USAF, BSC
9011 (Health Service Admin)	Robert M. Kimball, Major, USAF, MSC
9156C (Lab Officer)	Gerald J. Roseman, Major, USAF, BSC
9186 (Clinical Psychologist)	Raymond E. Steinkerchner, Major, USAF, BSC
9386 (Physician)	David R. Stutz, Major, USAF, MC
9156A (Biochemist)	Arland W. Eyl, Jr., Capt, USAF, BSC
5135B (Systems Analyst)	James J. Romanchek, Capt, USAF
9246 (Pharmacist)	William V. Gage, Capt, USAF, BSC
91790 (Physican Assistant)	Lawrence Russell, SMSgt, USAF
75173 (Instructional Systems Design Specialist)	Bradley D. Fincher, SSgt, USAF
23151A (Illustrator)	Michael W. Smith, A1C, USAF
70450 (Stenographic Spec)	Norina D. Kendrick, GS-04

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