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ABSTRACT
                An evaluation was made of the biomedical Computer
Assisted Instruction (CAI) Network Experiment, established by the
National Library of Medicine in 1973 to test the feasibility of
sharing CAI learning materials through a national computer network.
The evaluation was designed to assist decision makers in planning a
future mechanism for distributing biomedical CAI. The study focused
on the institutions (95 as of October 1974) and people who use the
network and the contractors who supplied the CAI library. Data
sources included case studies, user reports, and interviews with
hospital and medical school administrators, faculty, librarians,
computer laboratory staff, and students. Network usage by program
type, by user institution, and by class of user were analyzed. Also
analyzed were the impact of the network on curricula, faculty,
students, libraries, and media centers as well as the cost/benefits.
The report includes a roster of the participants in the network
experiment. (Author/EMH)

Evaluation of the Experimental CAI Network (1973-1975) of the Lister Hill National Center for Biomedical Communications, National Library of Medicine

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This report describes the evaluation of the biomedical CAI Network Experiment, established by the National Library of Medicine in 1973 to test the feasibility of sharing CAI learning materials through a national computer network. The evaluation is designed to assist decision makers in planning future mechanism for distributing biomedical CAI. The study is focused on the institutions (95 as of October 1974) and people who use the Network and the contractors who supplied the CAI Library. Data sources include case studies, user reports, and interviews with hospital and medical school administrators, faculty, librarians, computer laboratory staff, and students. Network usage by program type, by user institution, and by class of user is analyzed. Also analyzed is the impact of the Network on curricula, faculty, students, libraries, and media centers as well as the cost/benefits. The report includes a roster of participants in the Network Experiment.

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PREFACE

This report describes an evaluation, made by the Human Resources Research Organization for the National Library of Medicine, of the Lister Hill Center Experimental Computer-Assisted Instruction Network, a biomedical communications network. Data for the evaluation were obtained from several sources, including interviews with administrators, faculty, library personnel, and students; Network user reports; and meetings of the Health Education Network User's Group.

The Network Experiment provided a wealth of experience for educators, students, and technologists among many dimensions, including quality of computer-assisted instruction (CAI) materials, distribution of the libraries, the costs of networking as a distribution mechanism, and institutional variables affecting CAI use.

The work for this project was performed by HumRRO's Eastern Division, Alexandria, Virginia, Dr. J. Daniel Lyons, Division Director. Dr. Robert J. Seidel was the Principal Investigator, and Martin L. Rubin was the Project Director. Other members of the research staff were Beverly Hunter, Marilyn Knetsch, and Rosalake Coleman.

The Lister Hill Center Experimental CAI Network (referred to in this report as the "Network Experiment") was established in July 1972. Its purpose was to test the feasibility of sharing CAI learning materials through a national computer network.

The Network Experiment was not intended to establish an operational distribution mechanism for CAI libraries, but rather, to provide an experiential setting for evaluating the new medium and the problems and prospects for national distribution. Formal support from the National Library of Medicine (NLM) for the Network is programmed to terminate in May 1975.

The Human Resources Research Organization (HumRRO) conducted an evaluation of the Network which was designed to assist decision makers in planning future mechanisms for distributing biomedical CAI, and to identify additional research and development needs.

The focus of the Network evaluation study was on the institutions and people who use the Network. Information was gathered from:

(1) Field trips to selected user and contractor institutions to interview administrators, faculty, library and media center personnel, and students.

(2) Bimonthly reports to the Lister Hill Center from user institutions. These reports address a wide range of technical, educational, financial, and administrative matters which were encountered in the Network Experiment.

(3) Data from contractors on CAI program usage by user institutions.

(4) Meetings of the Health Education Network Users' Group (HENUG) of the Association for Development of Computer-Based Instructional Systems (ADCIS).

USER INSTITUTIONS

A total of 95 institutions had participated at some time in the Network Experiment as of October 1, 1974. These institutions included medical schools, teaching hospitals, research institutes and associations, health science centers, continuing education centers, schools of dentistry, and schools of nursing. Administrative support at user institutions was lacking. Medical school administrators were impressed with the educational utility of CAI but were not convinced that the add-on costs could be justified. They wanted proof of the learning benefits of CAI. The positive evidence that surfaced during the study—highly favorable opinions, surprisingly high levels of usage, willingness to bear part of the Network costs—was not sufficient.

Participating institutions varied widely in the extent to which they used the Network. By August 1974, Network users had logged a total of 11,090 hours on the Ohio State University (OSU) system. Of the 72 institutions that have used the OSU system, six institutions accounted for approximately 60% of the usage hours;[1] twenty of the institutions used less than 10 hours each.

By August 1974, Network users had logged a total of 21,220 hours on the Massachusetts General Hospital (MGH) system. Of the 90 institutions that have used the system, six accounted for 37% of the total usage hours.[2]

[1] University of California at Los Angeles (UCLA), University of Washington, George Washington University, University of Oregon School of Nursing, University of the Pacific, and Fort Worth Osteopathic Hospital.

[2] UCLA, University of Pennsylvania, Harvard, Medical College of Virginia, University of Arizona, and George Washington University.

By February 1974, when the University of Illinois Medical College (UIMC) left the Network, users had logged a total of 5,144 hours on the UIMC system. Of the 63 institutions that used the system, six accounted for 54% of the total usage hours.[1] Twenty-four institutions used the UIMC materials for less than 10 hours each.

Most institutions made some physical modifications in order to accommodate the computer terminals. Study carrels were built in media labs and libraries. Users built or designed special facilities to house the computer terminal. Soundproof rooms were constructed so that students, working in small groups, would not disturb other library users. Stanford University had a unique CAI study area. The terminal was located in the Media Center, in front of a comfortable couch where small groups of students could easily work together. The terminal was connected to a large video display monitor that provided a large screen image of the text. The typical Lister Hill user had one terminal but some of the larger users had as many as four terminals.

The University of Connecticut School of Medicine provided portable terminals in addition to having several terminals within its center. In the short time that these terminals have been in use, they have become very popular. There have been recent requests by physicians to borrow a terminal for trial use in their offices.

The Network resource was not cost-effective for user institutions. The CAI materials provided a supplement to existing curricula. The costs of using the Network could not be taken out of existing budgets.

The user institutions' Network funds came from outside sources, such as grants, donations, and special funds. In some cases support came from funds from the dean's office but not from the operational departmental budgets. Institutions were required to pay for their own terminals. Many schools purchased the terminals since they were a relatively small, one-time cost. The schools also were required to pay the local charges for linking into the nearest TYMSHARE communications node. If the school was at some distance from the nearest node, phone charges for this hook-up could amount to as much as $1,000/month. However, if the institution was in a TYMSHARE node city, such as Los Angeles, there were no local phone charges.

Initially, the Network service itself was free to users. It was later decided to have Network users pay an increasing portion of the cost. The initial charge was $2.50/hour as of February 1974. In July 1974, the charge was raised to $5.00/hour. Since total Network costs range between $16 and $20 an hour, depending on total usage, Lister Hill is still subsidizing the major portion of the Network cost. Approximately 45% of these costs were communications costs; another 25% was the computer cost at the Network host facilities. Personnel staff at the host sites and at the Lister Hill Center made up the cost balance.

CAI LIBRARY USE

The CAI materials were used as a supplementary learning resource. While the CAI learning materials were perceived by both faculty and students to be a valuable educational addition, as measured by student usage and opinion surveys, they did not

[1] UCLA, University of Pennsylvania, Medical College of Virginia, University of Texas at San Antonio and Galveston, and Stanford University.

bring about any major changes in course objectives or content. The CAI materials served mainly to enrich, or supplement, the regular program.

Curriculum integration is of paramount importance for long-term commitment. There were only scattered instances of any attempt to integrate the MGH clinical encounter programs into the clerkship curriculum. Even at UCLA, the largest user school, there was virtually no faculty interest in becoming involved with CAI. A major reason for this lack of enthusiasm at most institutions was that faculty members were hesitant to reorganize their courses to include CAI materials because of the planned termination of the Network. Without this faculty involvement, the schools will not back large budgetary expenditures for CAI.

The OSU materials, because of their tutorial nature, require some form of curriculum integration. This may explain why OSU's program usage has been far less than MGH's program usage.

Several user institutions stated that the principal reason for terminating their participation in the CAI Network was that they could not justify the Network charges if the materials were to be only an appendage to the regular curriculum.

Institutions with a traditional lecture-oriented, lock-step curriculum reported difficulty in scheduling CAI usage. The computer tutorials were in no instance used as final examinations. Therefore, the utilization of CAI did not have any effect on established procedures for grading. Many of the user institutions had previously shifted from a high lecture orientation to a high emphasis on self-directed study. These institutions had excellent facilities for self-directed learning. They were anxious to provide still another modality in addition to video cassettes, audio tapes, heart sound synthesizers, and other devices. A recurring problem in the experimental Network was the lack of a constituted body to judge the merits of CAI programs. Network hosts were placed in the position of having to determine the quality of their own programs.

A major strength of the Network approach to CAI distribution was the facility it provided for improving and revising curricular materials. The user institutions played an indispensable role in providing feedback to the authors concerning errors in the medical content, program logic problems, deficiencies in explanation, and alternative treatments and diagnoses. MGH received literally thousands of individual comments from interested users who expressed a personal interest in correcting perceived weaknesses of the CAI programs. In as many cases as possible the user received a personal reply, and when the author was in agreement the programs were revised.

Recommendations

It would be of significant benefit to involve the various speciality boards and associations in a review function. The Association of American Medical Colleges would be the logical organization to develop the overall objectives, goals, and procedures for establishing CAI program review mechanisms.

Similarly, the Lister Hill Experiment indicates the inadequacy of the scope of the offered CAI programs. A survey of the educational needs of various user populations should be undertaken to learn those subject areas in which CAI materials are needed.

CAI MATERIALS ASSESSMENT

One finding that emerged clearly from the Network Experiment was that the benefits of CAI distribution accrued directly to students, rather than to the institutions or faculty. Students benefitted in a number of ways, receiving:

- Remedial learning.
- Counseling.
- Review for examinations.
- Problem-solving experiences.
- Computer awareness they can apply later as practicing physicians. .
- Wide range of simulated clinical experience.

Students in medical schools and other health professions used Network CAI materials an average of 1800 hours a month. Usually the students used materials on their own initiative, without faculty direction. The great majority of Network materials were used by medical students in their clerkship and pre-clerkship years.

No provision was made in the Network Experiment for a systematic assessment of the impact of the materials on student learning. Each user institution was expected to provide its own evaluation of the materials and their use. However, only a few institutions were able to complete any kind of systematic study. Furthermore, each institution that performed some kind of study performed it in its own way. Objective summary data regarding students learning are available for only a few institutional evaluations. A number of problems prevented most of the studies from being completed: lack of faculty member time to spend on educational research, legal and technical problems in using the Network (especially in the first year of the Network Experiment), and priorities given to medical research.

Recommendation

The Lister Hill Network Experiment indicates a strong need for more substantial evidence of CAI program benefits, including in-depth studies of learning benefits. The Library, therefore, should sponsor experiments by CAI user institutions which measure changes in student performance directly attributable to CAI.

FACULTY ATTITUDES

The Network had much less impact on faculty than on students. Faculty members who attended demonstrations of the Network Experiment had a generally favorable reaction to the materials. Most faculty endorsed the idea of using the resource but left it up to the students as to how they would use it.

As a condition for receiving use of the Network facilities, user institutions were asked by the Lister Hill Center to prepare CAI materials to be added to the library. Medical school faculty members were expected to develop these materials. In fact, it was hoped that they would become involved with the total process. However, faculty (with some exceptions) did not develop such materials or use them in their courses. The Network Experiment did not provide funds for faculty release time to perform these development activities. Authoring course materials or devising new computer-oriented

curricula is extremely time consuming and, in addition, requires specialized computer skills. Therefore, the lack of faculty involvement was not surprising.

In the final year of the Network Experiment, faculty members are beginning to take a more active role, with over 50 instructional units currently being developed by faculty at user institutions.

Schools with a full-time faculty devoted to teaching and research (and without outside private practice) were more amenable to committing time to exploring CAI. At the University of Washington, which has a full-time faculty, there are as many as 25 faculty members working on and developing CAI modules, including the extensive reworking of the visual materials that accompany CAI programs. This involvement contrasts with UCLA faculty members who have heavy involvements in private practice and thus participated very little in the use of the Lister Hill Network. The faculty committee at UCLA voted against continuing the project after termination of Lister Hill support.

Recommendation

Faculty should be given a more prominent role in future Lister Hill CAI programs.

POSSIBLE ALTERNATIVES TO NETWORK

Other methods of CAI distribution may provide less expensive distribution service (e.g., physical transport of programs). This would not, however, provide the built-in compatibility, feedback, and revision process of a hardwired network. Alternatives such as a clearinghouse, online bibliographic service, intelligent terminals, and desktop computers should be explored.

Recommendation

Lister Hill Center should sponsor a research program to evaluate low-cost distribution mechanisms, such as a Network of microprocessors, intelligent terminals, or a clearinghouse.

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Evaluation of the Experimental
CAI Network (1973-1975) of the
Lister Hill National Center for
Biomedical Communications,
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Chapter 1

INTRODUCTION

PURPOSE OF THE STUDY

This report, undertaken by the Human Resources Research Organization in May 1974, summarizes the findings of the evaluation of the Lister Hill Center Experimental Computer-Assisted Instruction (CAI) Network (referred to in this report as the "Network Experiment"). The purposes of the study were to describe and analyze the impact and experience of the Network Experiment in ways that would assist decision makers in planning future mechanisms for distributing biomedical CAI, and to identify additional research and development needs.

This report is addressed not only to the sponsors and participants of the Network Experiment, but also to educators and technologists who have an interest in sharing learning resources through technology-based distribution systems. Much of what was learned in the biomedical Network Experiment has general applicability to other educational networking efforts and attempts to share CAI materials.

DESCRIPTION OF THE NETWORK

The Lister Hill Center Experimental CAI Network was established in July 1972. Its purpose was to test the feasibility of sharing CAI learning materials through a national computer network.

Soon after the establishment of the Lister Hill Center, Dr. Martin M. Cummings, Director of the National Library of Medicine, asked the American Association of Medical Colleges (AAMC) to take a leadership position in involving the academic medical community in Network plans. A conference was held in February 1969 to consider the educational services that a network might provide (Smythe, 1969). Subsequent to this conference, the AAMC was asked to recommend more specific plans, which resulted in the production of a report from the Steering Committee, Council of Academic Societies, Association of American Medical Colleges (Stead, *et al.*, 1971). This report covered the state-of-the-art of instructional technology, the need for a biomedical community network, factors governing selection of materials, organization and administration, evaluation, and staff. The Steering Committee report included many recommendations, one of which is covered in the following statement:

"The Steering Committee advocates the organization of a biomedical communications network designed to meet some of the needs of medical education and medical practice and to capitalize on the current state of development of various phases of communications and computer technology. Of primary importance is the requirement to maintain a high level of learning experiences for growing numbers of students to whom medical, dental, nursing and other health career schools are committed."

The AAMC report was presented to members of the Board of Regents of the National Library of Medicine. The Board appointed a Priorities Review Committee to

study the report. This committee presented four recommendations which were adopted unanimously by the Regents. One of the four recommendations read:

"The Committee advocates the organization of a biomedical communications network fundamentally conceived as providing the mechanism by means of which inter-institutional cooperation and sharing of resources will *be used to meet some of the needs* of medical education. Implementation of this goal began in September 1971."

The original Network was based on four contracts with the National Library of Medicine (NLM): one with a commercial timesharing service and three with institutional centers having CAI expertise. The three institutions are Massachusetts General Hospital, the University of Illinois Medical Center, and Ohio State University College of Medicine.

Course material from Massachusetts General Hospital (MGH) is primarily intended for supplemental use by medical students and physicians involved in continuing education and contains programs in Abdominal Pain, Coma, and Jaundice, among others. The University of Illinois Medical Center (UIMC)[1] offered two types of material: (a) a computerized random item bank (CRIB) and (b) a computer-aided simulation of the clinical encounter (CASE). The programs from Ohio State University College of Medicine (OSU) cover a broad spectrum of health problems and were written for many different educational levels (Wooster and Lewis, 1973).

The purpose of the Network Experiment was not to establish an operational distribution mechanism for CAI libraries, but rather, to provide an experiential setting for evaluating the new medium and the problems and prospects for national distribution. Formal NLM support for the Network itself is programmed to terminate in May 1975.

DESCRIPTION OF THE EVALUATION STUDY

The focus of the Network Evaluation Study is on the institutions and people who use the Network.[2] Information was gathered from four main sources:

(1) Field trips to selected user and contractor institutions to interview administrators, faculty, library and media center personnel, and students.

(2) Bimonthly reports to the Lister Hill Center from user institutions. These reports address a wide range of technical, educational, financial, and administrative matters which were encountered in the Network Experiment.

(3) Data from contractors on CAI program usage by user institutions.

(4) Meetings of the Health Education Network Users' Group (HENUG) of the Association for Development of Computer-Based Instructional Systems (ADCIS).

The information gathered from these sources was interpreted and organized into several categories of study. This report is organized around the following categories:

- Impact of the Network Experiment on Users
    - Institutions
    - Curricula
    - Faculty
    - Students
    - Libraries and Media Centers
- Institutional Variables Affecting Utilization of Network
- Evaluation of CAI Materials

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[1]The University of Illinois withdrew from the Network Experiment in February 1974. Its CRIB system was not considered to be a cost-effective use of computers. The CASE system, however, was transferred to the Ohio State University computer.

[2]Principal persons involved in the Network Experiment are listed in Appendix A.

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- Cost/Benefit Analysis
- What was Learned from the Network Experience
  - Materials
  - Development of materials
  - Distribution mechanisms
  - Evaluation methods
- Functional Requirements of a CAI Distribution System
  - User Tailoring
  - Feedback-Revision Process
  - Support Services
  - User Documentation
  - Peer Review
  - People Networks
- Recommendations for Future Distribution Mechanisms

Chapter 2

IMPACT OF THE NETWORK EXPERIMENT

Qualitative and quantitative indicators of the impact of the Network Experiment on users are organized into five categories:

- Institutions
- Curricula
- Faculty
- Students
- Libraries and Media Centers

IMPACT ON INSTITUTIONS

A total of 95 institutions had participated at some time in the Network Experiment as of October 1, 1974. A breakdown by type of institution follows:

Medical Schools	65
Teaching Hospitals	9
Research Institutes and Associations	7
Health Science Centers	2
Continuing Education Centers	5
Schools of Dentistry	2
Schools of Nursing	2
Other	2
Total	95

Fifty institutions have participated in the Network Experiment for a year or longer; twenty-one institutions participated for three months or less, and then dropped out. As of December 1974, there were approximately 65 active institutional Network users.

At the beginning of the Network Experiment, users were designated "trial" or "operational," with operational users having greater responsibility to contribute evaluative data. It was also anticipated that operational users would contribute to the network CAI library. This designation was dropped in February 1974 when usage charges were initiated.

Dr. Harold Wooster and Ms. Jinnet Lewis of the Lister Hill Center conducted a statistical analysis of the significance of the presence of an Office of Medical Education on the incidence of institutional participation in the Network Experiment (Wooster and Lewis, 1974). Using a chi-square analysis, they found that institutions that have an Office of Medical Education were much more likely to participate in the Network Experiment. Of the three components of a medical institution (i.e., education, research, and service), it is presumed that the presence of an Office of Medical Education is an indication of the degree of emphasis placed on the educational component. It also means that there is an individual with the time and interest to help investigate and nurture a new learning modality.

The participating institutions varied widely in the extent to which they used the Network. (See Table 1 for lists of Network users and dates and amount of time used.)

By August 1974, Network users had logged a total of 11,090 hours on the Ohio State University (OSU) system. Of the 72 institutions which have used OSU's system, six institutions accounted for approximately 60% of the usage hours: University of California at Los Angeles (UCLA), University of Washington, George Washington University, University of Oregon School of Nursing, University of the Pacific, and Fort Worth Osteopathic Hospital. Twenty of the institutions using Ohio State's program library used a total of less than 10 hours each.

By August 1974, Network users had logged a total of 21,220 hours on the Massachusetts General Hospital (MGH) system. Of the 90 institutions which have used the system, six of them accounted for 37% of the total usage hours: UCLA, University of Pennsylvania, Harvard, Medical College of Virginia, University of Arizona, and George Washington University.

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● Most institutions made some modifications to the physical plant in order to accommodate the computer terminals. Study carrels were built in media labs and libraries. Most large institutional users built or designed special facilities to house the computer terminal. At UCLA, special soundproof rooms were constructed so that students working in small groups would not disturb other library users. Stanford University had a unique CAI study area. The terminal was located in the Media Center, in front of a comfortable couch where small groups of students could easily work together. The terminal was connected to a large video display monitor which provided a large screen image of the text. The typical Lister Hill user had one terminal but some of the larger users had as many as four terminals.

The University of Connecticut's School of Medicine has adopted the portable terminal concept in addition to having several terminals within their center. In the short time that these terminals have been in use, they have become very popular. There have been recent requests by physicians to borrow a terminal for trial use in their offices.

The user institution's Network funds came from outside sources, such as grants, donations, and special funds. In some cases support came from funds from the dean's office but not from the operational departmental budgets. Institutions were required to pay for their own terminals. Many schools purchased the terminals since they were a relatively small, one-time cost. The schools also were required to pay the local charges for linking into the nearest TYMSHARE communications node. If the school was at some distance from the nearest node, phone charges for this hook-up could amount to as much as $1,000/month. However, if the institution was in a TYMSHARE node city such as Los Angeles, there were no local phone charges. A list of TYMSHARE nodes is contained in Appendix B.

Initially, the Network service itself was free to users. It was later decided to have Network users pay an increasing portion of the cost. The initial charge was $2.50/hour as of February 1974. In July 1974, the charge was raised to $5.00/hour. Since total Network costs range between $16 and $20 an hour, depending on total usage, Lister Hill is still subsidizing the major portion of the Network cost.

While the Network provided an entirely new learning modality to many user institutions, it did not affect the overall educational philosophy and program as much as

Table 1

Summary of Network Use

User	Usage Period		Time Used		Mean Hours/ Month Usage
	Start	Continuing,[a] or Ending Date[b]	Months[c]	Hours	
Alabama, Univ. of—School of Medicine, Birmingham	11/72	C	22	483.9	22.0
Albany Medical College of Union University, Albany, N.Y.	4/73	C	17	546.5	32.2
American Academy of Orthopedic Surgeons, Chicago, Ill.	6/74	7/74	2	.8	.4
American College of Radiology, Boston, Mass.	3/73	C	2	38.2	19.1
American Heart Association, Brookline, Mass.	11/72	12/72	2	5.5	2.7
Arizona, Univ. of—Arizona Medical Center, Tucson	10/73	C	11	1,264.2	114.9
Augusta General Hospital, Augusta, Me.	11/72	12/73	14	72.5	5.2
Baylor Univ., Waco, Tex.	11/72	12/72	2	3.1	1.5
Beth Israel Hospital, Boston, Mass.	1/73	9/73	9	93.0	10.3
Bird, Kenneth T., M.D., Massachusetts General Hospital, Boston	4/74	C	3	18.4	6.1
Boston Univ. Medical Center, University Hospital	1/73	5/74	11	24.5	2.2
Brown Univ., Providence, R.I.	2/73	C	7	167.2	23.9
CAPO (Bolt, Beranek, and Newman)	11/72	12/72	2	4.4	2.2
California, Univ. of, Davis	11/72	C	20	328.1	16.4
California, Univ. of, Los Angeles	11/72	C	22	3,235.1	147.1
California, Univ. of—Los Angeles, Cedars-Sinai Medical Center	1/74	C	8	40.1	5.0
California, Univ. of—Los Angeles, Harbor General Hospital	1/74	C	8	112.0	14.0
California, Univ. of, San Diego	6/73	C	15	162.5	10.8
Case Western Reserve Univ., Cleveland, O.	1/73	C	19	682.2	35.9
CBX Project, National Board of Medical Examiners	11/72	10/73	12	318.6	26.6
Chicago, Univ. of	8/73	9/73	2	19.8	9.9
Cincinnati, Univ. of	4/74	6/74	3	1.4	.5
Columbia Univ., New York—College of Physicians and Surgeons, Medical Library	5/73	C	16	461.8	28.9
Columbia Univ., New York—College of Physicians and Surgeons, Dept. of Pathology	3/73	C	13	186.1	14.3
Connecticut, Univ. of—Health Center, Farmington	5/73	C	16	621.8	38.9

————————(Continued)————————

Table 1 (Continued)

Summary of Network Use

User	Usage Period		Time Used		Mean Hours/ Month Usage
	Start	Continuing,[a] or Ending Date[b]	Months[c]	Hours	
Emergency Medical System Medical Group, Palo Alto, Calif.	9/73	6/74	5	23.6	4.7
Florida, Univ. of—J. Hillis Miller Health Center, College of Dentistry, Gainesville	6/73	1/74	8	39.1	4.9
Fort Worth (Texas) Osteopathic Hospital	4/73	C	17	611.9	36.0
George Washington Univ., Washington, D.C.	11/72	C	22	1,513.4	68.8
Georgia, Medical College of, Augusta	12/72	12/73	13	278.2	21.4
Hahnemann Medical College of Philadelphia	9/73	C	12	665.7	55.5
Harvard Medical School—Francis A. Countway Library of Medicine, Boston, Mass.	11/72	C	23	1,599.5	69.5
Howard Univ., Washington, D.C.	7/73	C	14	131.8	9.4
Kentucky, Univ. of, Lexington	11/72	2/74	16	29.8	1.9
Loma Linda Univ., Loma Linda, Calif.	9/73	C	6	70.9	11.8
Los Angeles County (Calif.) Medical Association	12/72	1/74	14	115.3	8.2
Louisville (Ky.), Univ of—Health Sciences Center	4/73	10/73	4	9.8	2.5
Maryland, Univ. of—School of Medicine, Baltimore, Md.	2/73	C	19	296.1	15.6
Massachusetts General Hospital, Boston, Mass.	8/73	C	11	40.4	3.7
Massachusetts General Hospital— Continuing Education	10/73	C	11	549.4	50.0
Massachusetts, Univ. of, Boston	6/74	C	3	13.2	4.4
Matthew Thornton Health Plan, Nashua, N.H.	1/73	6/74	18	73.0	4.1
Mayo Foundation, Rochester, Minn.	11/72	8/73	10	142.5	14.3
McGill Univ., Montreal, Canada	9/73	12/73	4	104.5	26.1
Michigan State Univ., East Lansing	11/72	C	22	327.2	14.9

(Continued)

Table 1 *(Continued)*

Summary of Network Use

User	Usage Period		Time Used		Mean Hours/ Month Usage
	Start	Continuing,[a] or Ending Date[b]	Months[c]	Hours	
Michigan, Univ. of—School of Nursing, Ann Arbor	3/73	C	18	154.8	8.6
Michigan, Univ. of—School of Dentistry, Ann Arbor	5/73	8/73	4	23.1	5.8
National Institutes of Health, Clinical Center, Bethesda, Md.	1/73	6/73	3	25.4	8.5
National Library of Medicine, Lister Hill Center	11/72	C	22	167.1	7.6
Naval Medical Research Institute, National Naval Medical Center, Bethesda, Md.	11/72	C	23	125.2	5.4
Nebraska, Univ. of, Medical Center, Omaha	11/72	C	22	226.8	10.3
New England Deaconess Hospital, Boston	11/72	C	22	146.7	6.7
New York, State Univ. of, Buffalo	4/73	C	15	228.5	15.23
New York, State Univ. of—Children's Hospital, Buffalo	8/74	C	1	2.2	2.2
New York, State Univ. of, Downstate Medical Center, Brooklyn	11/72	C	22	927.9	42.2
New York, State Univ. of, Stony Brook	11/72	C	22	152.7	6.9
New York, State Univ. of, Upstate Medical Center, Syracuse	11/72	C	22	407.7	18.5
Northwestern Univ., Chicago	11/72	1/74	15	573.3	38.2
Ohio, Medical College of, Athens	11/72	12/72	2	1.3	.7
Ohio State Univ., Medical School, Columbus	11/72	C	17	36.5	2.2
Oklahoma Univ., Norman	5/74	5/74	1	45.2	45.2
Oregon, Univ. of—School of Medicine and School of Nursing, Portland	3/73	C	14	1,117.4	79.8
Pacific, Univ. of—Pacific Medical Center, San Francisco	2/74	C	7	28.7	4.1
Pennsylvania, Medical College of, Philadelphia	3/74	C	8	44.6	5.6
Pennsylvania, Univ. of—School of Medicine, Philadelphia	11/72	C	22	2,583.7	117.5

(Continued)

Table 1 *(Continued)*

Summary of Network Use

User	Usage Period		Time Used		Mean Hours/ Month Usage
	Start	Continuing,[a] or Ending Date[b]	Months[c]	Hours	
Pittsburgh, Univ. of—School of Medicine, Eye and Ear Hospital	3/73	C	18	517.4	28.7
RAND Corporation, Santa Monica, Calif.	3/74	5/74	3	8.3	2.8
Rochester, Univ. of, Rochester, N.Y.	11/72	1/74	15	391.1	26.1
Rush Medical College, Chicago	4/73	8/73	5	83.7	16.7
Rutgers Univ., New Brunswick, N.J.	5/74	C	4	27.7	6.9
South Carolina, Medical Univ. of, Charleston,	5/73	C	16	654.6	40.9
Southern California Univ. of, Los Angeles	11/72	1/74	15	531.2	35.4
Southern Illinois Univ., Carbondale	5/73	C	16	530.2	33.1
Stanford Univ.—School of Medicine, Stanford, Calif.	11/72	C	22	1,033.0	46.9
Texas College of Osteopathic Medicine, Fort Worth	8/73	C	13	466.0	35.7
Texas Tech Univ., Lubbock	10/73	12/73	3	16.0	5.3
Texas, Univ. of, San Antonio	11/72	C	22	1,121.1	51.0
Texas, Univ. of, Galveston	3/73	1/74	11	317.4	28.9
Texas, Univ. of, Houston	9/73	1/74	5	162.4	32.5
Texas, Univ. of—Southwestern Medical School, Dallas, Tex.	11/72	1/74	16	517.4	32.3
Tufts Univ., Medford, Mass.	5/73	C	16	170.8	10.7
Utah, Univ. of, Salt Lake City	1/73	C	18	389.1	21.6
Vanderbilt Univ., Nashville, Tenn.	6/73	8/73	3	17.1	5.7
Virginia Commonwealth Univ.— Medical College of Virginia, Richmond	1/73	7/74	19	1,913.2	100.7
Washington Hospital Center, Washington, D.C.	11/72	C	22	335.5	15.3
Washington Univ., St. Louis, Mo.	11/72	C	22	961.6	43.7
Washington, Univ. of, Seattle	11/72	C	22	3,662.2	166.4
Wayne State Univ., Detroit, Mich.	3/73	4/73	2	64.9	32.5
Wisconsin, Medical College of, Milwaukee	1/73	C	18	473.6	26.3
Wisconsin, Univ. of, Madison	6/74	C	3	4.3	1.4

[a]Continuing participants are indicated by a "C."

[b]Cut-off date for data analyzed is August 31, 1974.

[c]Based on number of months of actual usage rather than a straight calculation of start and end dates. If there were three or more consecutive months of nonusage, these were not counted.

could have been anticipated. Although the learning resource was much in demand, it failed to stimulate any broad curriculum reform.

However, the CAI-Network utilization did benefit greatly from curricular reforms and educational innovations that were already in place in many user institutions. Many of the user institutions had previously shifted from a high lecture orientation to a high emphasis on self-directed study. These institutions had excellent facilities for self-directed learning, and were anxious to provide still another modality in addition to video cassettes, audio tapes, heart sound synthesizers, and other devices.

Institutions with a traditional lecture-oriented, lock-step curriculum reported difficulty in scheduling CAI usage. The computer tutorials were in no case used as final examinations. Therefore, the utilization of CAI did not have any effect on established procedures for grading.

The Network Experience has exposed administrators, faculty, staff, and students to the possibilities of the computer as a learning medium. When individual institutions made a decision to terminate Network involvement, students invariably were vociferous in their objections to losing this learning tool.

Faced with the termination of the experimental Nework in May 1975, faculty members have been asked to review their thinking and to establish long-term policies toward this new media. However, only a few schools have made firm alternative plans for continuing CAI without the availability of the national Network. Many of them hesitate to make the heavy capital outlay for equipment and staff required to run their own facility.

Some institutions are developing network substitutes. The University of Washington is working with the University of California at Davis on the use of a Meta compiler to translate their WISP Coursewriter programs to a language of the PDP-10 which is on order. George Washington University has acquired a minicomputer system and is gradually translating some programs in the CAI library to that system.

IMPACT ON CURRICULA

The CAI materials were used, with few exceptions, as a supplementary learning resource. While the CAI learning materials were perceived by both faculty and students to be a valuable educational addition, as measured by student usage and opinion surveys, they did not bring about any major changes in course objectives or content. The CAI materials served mainly as enrichment, or supplements, to their regular program. Third-year and fourth-year students had an opportunity to diagnose medical problems in coma, jaundice, abdominal pain, diabetes, heart irregularities, and other diseases. Computer simulations guarantee that students will "see" a large variety of cases with different symptoms and prognoses.

At the University of Pennsylvania the discussion of the CAI clinical diagnostic exercises was a major component of a course on the introduction to clinical medicine. These programs enabled the students to develop problem-solving skills in a way not possible in the traditional "making-the-rounds" with a faculty member. While the CAI programs do not supplant the rounds-making experience, they have demonstrated their ability to augment this method.[1]

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[1] A future direction may be the development of a clinical core curriculum which is performance-based (i.e., the student's ability to diagnose and treat medical problems is measured), and uses the computer as a major educational tool.

Most student usage of the CAI library was strictly voluntary. That is, on their own initiative they sought the use of the CAI library. (This practice supports the fact that students are highly goal-oriented and self-motivated by the time they reach medical school.)

Ohio State's tutorial learning units are most effectively used in conjunction with specific courses. Many of the CAI learning modules, when used in conjunction with textbooks, could substitute for lectures. However, few institutions revised curricula to make use of the OSU materials in this way. At the Medical College of Wisconsin, a series of Ohio State's anatomy modules was made an integral component of the gross anatomy course unit.

In summary, the CAI library was used (a) as an augmentation of clinical experience, (b) as a self-assessment tool in basic science subjects, and (c) as a supplement to regular course work.

IMPACT ON FACULTY

Demonstrations were carried out in over a hundred institutions, at which time faculty had an opportunity to try out the learning materials. Many of the faculty members were so intrigued that they spent hours at the terminal going through the materials. While they were quick to point out deficiencies, they generally reported favorably on overall quality.

Ohio State requested that its users evaluate the suitability of its learning modules prior to initiating use. The college counseled the user institution to establish faculty committees to review learning objectives of the learning units. Therefore, many faculty members were brought in on some aspect of the program even though they were not active creators of CAI materials.

As a condition for receiving use of the Network facilities, user institutions were asked by the Lister Hill Center to prepare CAI materials to be added to the library. The medical school faculty was expected to develop these materials. It was hoped that they would become involved with the total process. However, the faculty at most institutions maintained a hands-off attitude toward CAI. They generally endorsed the idea of using the learning resource but left it up to the students as to how they would use it.

In many of the schools that were the largest users (e.g., UCLA and Stanford), faculty members were not interested in becoming CAI developers, since research was their primary interest.

Only in the final year of the experiment has an interest developed in authoring materials. Ohio State University has worked closely with the University of Pittsburgh Eye and Ear Hospital to develop learning units on diseases of the eye. CAI course content is being developed at the University of Pittsburgh, and the programming is taking place at Ohio State. In December 1974, Ohio State University reported that a total of 53 instructional units were being developed by Lister Hill Network users.

The Network Experiment did not provide funds for faculty release time to perform development activities such as authoring course materials or devising new computer-oriented curricula. These activities are extremely time consuming and, in addition, require specialized computer skills. Therefore, the lack of faculty involvement was not surprising.

Typical faculty attitudes regarding the Network Experiment and CAI materials are reflected in the following excerpts from copies of the Bimonthly User Report:

"Demonstrations to faculty have, for the most part, been met with varying degrees of interest but as yet little commitment. However, there has been one encouraging development. A neurologist, the chairman of the second year Neural Sciences Group, who has been a

leader here in innovative teaching, is prepared to utilize CAI heavily in his course. Since he plans the development of a modular sequence of course topics with student self-pacing, he would like to use a program such as UIMC's-CRIB to store a large number of test items which students could use both to monitor their own progress through material and approach as a criterion test at the completion of each course module."

Letter from Paul L. Grover, Jr., PhD., Assistant Professor,
Division of Medical Education and Communication,
University of Rochester, School of Medicine and Dentistry,
March 6, 1973.

"Most faculty members agree that time is the greatest factor in *requiring* use of CAI. With the present curriculum load for first- and second-year students, it is difficult to find a block of time to take advantage of those programs considered valuable. There have been few who have found no merit in the system at all, and the verbal consensus of the faculty seems to be in favor of a teaching tool so well accepted by the students."

Texas College of Osteopathic Medicine, Experimental Network
Users Report, March 1, 1974, for the period January 1 -
February 28, 1974.

"Although thirty of these letters were sent out, unfortunately the faculty response has been poor and the materials have only been demonstrated to approximately ten faculty members."

Letter from Robert F. Johnston, M.D., Director, Division of
Pulmonary Diseases, The Hahnemann Medical College and
Hospital of Philadelphia, November 6, 1973.

"Faculty usage has declined as most have had one or more demonstrations. Several instructors have returned to the terminal on their own and it is this group that I hope to interest in more substantive CAI input."

Trial Users Report from Marilyn Margon, Staff Development
Specialist, Department of Educational Resources and Devel-
opment, Southern Illinois University, School of Medicine,
December 26, 1973.

"Up to this time we have interviewed all faculty . . . users of the programs.

"The Pharmacology faculty has indicated that, in their view, several of the MGH programs provide an excellent means of bridging the disciplines of pharmacology and therapeutics.

"Introduction to the Patient (Physical Diagnosis), the faculty has expressed some interest in considering UIMC-CASE as a means of introducing students to the experience of interviewing patients.

"Faculty of the Department of Medicine concerned with the clinical clerkships and third- and fourth-year electives are enthusiastic about

the capability of the programs to instruct the students in the approach to the management of disease processes (MGH programs)."

College of Physicians and Surgeons of Columbia University, August 3, 1973, Report on use from Norman Kahn, D.D.S., PhD., Pharmacology and J. Thomas Bigger, Jr., Associate Professor of Medicine and Pharmacology.

IMPACT ON STUDENTS

Network materials received the most usage from students, usually on their own initiative. It was evident from this heavy continuing use that students perceived the learning experience to be important.

Some user institutions attempted to keep data on number and types of students using the resource, but had difficulty getting users to complete survey forms. Data on system usage, however, are available from the contractors. Massachusetts General Hospital was the only Network node which gathered usage data by type of student. The Massachusetts General data cannot indicate how many students used its system, since individual students did not have unique identifiers. Its data show how many times a particular category of student used the programs.

Table 2 shows the usage time of the Massachusetts General Hospital system, by class of user at UCLA and Stanford, two major user institutions.

Table 2

Usage Time of Massachusetts General Hospital System, by Class of User (11/1/72-10/1/74)

Institution/Class of User	Usage Time[a]
UCLA	
Med 1 (pre-clerkship)	747
Med 2 (clerkship)	631
House Physician	299
Nonmedical	128
Auxiliary Medical	79
Physician	55
Nurse	22
Fellow	11
Stanford	
Med 2 (clerkship)	254
Med 1 (preclerkship)	235
Nonmedical	45
House Physician	29
Physician	22
Auxiliary Medical	14
Fellow	6
Nurse	0

[a]Rounded to the nearest hour.

25

No provision was made in the Network Experiment for a systematic assessment of the impact of the materials on student learning. Each user institution was expected to provide its own evaluation of the materials and their use. However, only a few institutions were able to complete any kind of systematic study. Furthermore, each institution that performed some kind of study performed it in its own way. Objective summary data regarding student learning are available for only a few institutional evaluations.

Surveys of faculty and student opinion were conducted by five institutions: Medical College of Virginia, Mayo Foundation, Albany Medical College, State University of New York Downstate Medical College, and the University of Pittsburgh. Findings were submitted to the Lister Hill Center.

Students at Albany Medical College were specifically asked to rate the educational value of specified CAI materials. Summary results of this study are shown in Table 3.

Table 3

Ratings by Albany Medical College Students on Educational Value of Specified CAI Materials (October 1973)

Program Number and Name	Number of Times Used	Average Rating (Scale, 1-10)[a]
1. Abdominal Pain	3	7.67
2. Anticoagulant Simulation	5	8.40
3. Cardiac Simulator	1	4.00
4. Cardiopulmonary Resuscitation	15	8.67
5. Coma	4	9.00
6. Diabetic Ketoacidosis	8	8.63
7. Digoxin Dosage Advisor	1	6.00
8. Idiopathic Respiratory Distress in the Newborn	2	8.00
9. Jaundice	3	8.33
10. Pediatric Cough and Fever	1	9.00
11. A Bird's-Eye View of Pediatrics	6	7.50
12. Acid Base Balance	5	8.70
13. Anticoagulant Medication	2	8.50
14. CAI Demonstration Games	6	2.00
18. Introduction to CAI	1	3.00
20. Juvenile Diabetes	1	8.00
30. Reading the Medical Record	1	2.00
37. CASE	12	9.08
38. CRIB	8	8.00

[a]Highest possible score, 10.

Controlled experiments to determine the effects on student performance were too costly in faculty time to be carried out at most institutions. One study was conducted with 34 resident nurses at Cape Cod Hospital (Hoffer et al., 1974). In this study, 22 nurses using 90 hours of computer time made statistically significant improvements in a test of their knowledge of cardiopulmonary resuscitation. A control group, of 12 nurses who had no access to the computer programs, showed no improvement in knowledge.

IMPACT ON LIBRARIES AND MEDIA CENTERS

The Lister Hill Network terminals were located in a variety of places (emergency rooms, hospital corridors, hospital wards, libraries, learning resource centers, medical association headquarters, student and faculty lounges, laboratories, etc.)

When terminals were moved from inconvenient places into a conspicuous location in the library, their usage greatly increased. A list of terminal locations by type and number is provided below:

Biomedical Libraries—25
Student Biomedical Labs (planned)—17
Learning Resources Centers (multi-disciplinary lab)—16
Computer Laboratories and Centers—12
Medical School Departments (Surgery, Pathology, Ear, Nose and Throat)—16
Terminal Rooms—5
Conference Rooms—4
Offices of Medical Education—4
Student Study Areas—3
Emergency Rooms—3
Offices of Continuing Education—3
Resident Lounges—2
Ward Rooms—2
Cardiac Care Units—2
Hospital Library—1
Family Practice Clinic—1
Health Testing Unit—1
Unspecified—29

Individual librarians interviewed (e.g., Gloria Werner, Assistant Biomedical Librarian, UCLA) were very enthusiastic about the potential of CAI service. The UCLA library constructed special facilities for CAI library use—sound-proofed enclosed study areas where groups of students could work at the terminals without disturbing other library activities.

Ms. Louise Darling, the Biomedical Librarian at UCLA, recognizes CAI as an important service of the library but also feels that it is not the library's role to become involved with curriculum matters that inevitably arise whenever CAI is used to augment traditional instruction. Because of this problem, UCLA established a special CAI Faculty Curriculum Committee to review UCLA's long-term commitment to CAI.

When librarians and media center directors were questioned about their interest in having their own local system (desktop computer or intelligent terminal) they liked the concept but were somewhat apprehensive about possible technical problems and the availability of instructional programs. The idea of a CAI program cassette library was particularly appealing to the librarians since they were already using cassettes for video and tape instruction.

Chapter 3

INSTITUTIONAL VARIABLES AFFECTING UTILIZATION OF NETWORK

The CAI Network Experience has pointed up the following key variables that determine the quantity and quality of usage of CAI materials in an institution.

(1) Curriculum Integration. This factor is of paramount importance for long-term commitment. There were only scattered instances of any attempt to integrate the MGH clinical encounter programs into the clerkship curriculum. Even at UCLA, the largest user school, there was virtually no faculty interest in becoming involved with CAI. Without this faculty involvement, the schools will not back large budgetary expenditures for CAI.

The Ohio State materials, because of their tutorial nature, require some form of curriculum integration. This may explain why Ohio State's program usage has been far less than MGH's program usage.

Several user institutions stated that the principal reason for terminating their participation in the CAI network was that they could not justify the network charges if the materials were to be only an appendage to the regular curriculum.

(2) Faculty Type. Schools that had a full-time faculty who were devoted to teaching and research (and who did not have an outside private practice) were more amenable to commiting time to exploring CAI.

At the University of Washington, which has a full-time faculty, there are as many as 25 faculty members working on and developing CAI modules, including the extensive reworking of the visual materials that accompany CAI programs. This involvement contrasts with UCLA faculty members who have heavy involvements in private practice and thus participated very little in the use of the Lister Hill Network. The faculty committee at UCLA voted against continuing the project after termination of Lister Hill support.

(3) Educational Philosophy and Program. This variable greatly influences the usage level. The CAI learning materials, particularly those from MGH, are ideally suited for use in an unstructured curriculum. Typically, high levels of usage would be found where lecture attendance is not required and the students are expected to study on their own. Stanford University is the most striking example where the faculty considered it highly desirable that the students have several different learning modalities available to them. Even though Stanford does not have a formal Independent Study Program (ISP), as do Ohio State and the University of Washington, the ISP modules are extensively used for self-assessment by pre-clerkship students weak in basic sciences.

In schools that have a highly structured learning approach, faculty members often stated that schedules were so tight there simply was not enough time for the students to use additional CAI instructional units.

CASE EXAMPLES

The interaction of these institutional variables can be seen in these case examples, which are discussed in detail on the following pages.

UCLA School of Medicine
University of Washington School of Medicine

Stanford University School of Medicine
University of Southern California School of Medicine
Los Angeles County Medical Association
University of Oregon
University of California at San Diego, School of Medicine
Medical College of Virginia

INSTITUTION VISITED: UCLA, School of Medicine

DATE OF VISIT: July 31, 1974

INDIVIDUALS INTERVIEWED:

Mrs. Gloria Werner
Assistant Biomedical Librarian
   for Public Services

Dr. Robert Robinson III
Assistant Director
UCLA Hospital and Clinic

Ms. Louise Darling
Biomedical Librarian

Dr. Alan Forsythe
Health Sciences Computing
   Facilities

Dr. Bernice Wenzel
Assistant Dean
School of Medicine
Office of Curricular Affairs

The UCLA School of Medicine, as the largest single user in the Lister Hill network, might be expected to exhibit a cohesive sense of direction. However, attitudes on CAI value vary from high levels of enthusiasm to skepticism.

A special advisory committee has recently been formed to establish a long-term policy regarding the future of CAI at the UCLA School of Medicine. Dr. Wenzel is chairing the committee for this study.

Departmental chairmen at the School of Medicine are conservative; they want definitive proof of the educational value of CAI. The difficulty of establishing this proof is well known in CAI circles. Presuming that experiments were carried out using control groups, there is always the question as to whether some other method of instruction would have produced as satisfactory an effect. Although the prevailing attitude is noncommittal, there has been some support, especially by Dr. Lampson, Director of the UCLA hospital. The library has received the requisite money from extramural sources to meet current network charges.

Until now student use of CAI has been entirely library oriented. The CAI programs have not been integrated into the curriculum. Yet there is evidence that the students have found it more than just an interesting diversion since they have continued to make use of it over an extended time. Students have indicated to the faculty that UCLA is behind the times for not having CAI as a regular part of the curriculum.

Although the CAI programs have been a popular library offering, Ms. Darling feels that they should not be the sole responsibility of the library. In her view, the faculty should involve themselves in curriculum-related aspects of the CAI program. It was suggested that the CAI network might become a permanent National Library of Medicine service similar to MEDLINE. At the same time, it was felt that the network should not be continued indefinitely in an experimental state.

A major problem is that the faculty does not have the time to devote to CAI. Just now CAI is a stepchild insofar as any real long-term commitment is concerned.

The advisory committee has many basic issues to work out about the possible future role of CAI. Since the overall commitment to CAI is in question, little thought is being given to the immediate problem of network termination. However, a negative feeling about the feasibility of developing a satisfactory alternative to the national network persists.

Dr. Robinson expressed grave concern about the problem of updating and maintaining a CAI library. He feels that the initial language conversion is a major undertaking itself; additionally there is the problem of ever-changing CAI program content. Therefore, he feels that the best solution is through an interactive library where the user could dial-in for the latest version of the CAI program which would then be run on a local computer. The type of facilities that Dr. Robinson envisions are similar to those

found on the experimental ARPA network where programs or files created at one site are shifted to another site for execution.

During the interviews, the need for an evaluative system for CAI programs was continually mentioned. If such a system was in effect it appears that greater faculty support could be obtained. At the same time, UCLA has no money for evaluation and would require outside support to conduct such evaluation.

UCLA has several options should the network be discontinued:

(1) Purchase intelligent terminals.
(2) Purchase mini-computers.
(3) Utilize large campus computers.[1]
(4) Join a regional network.
(5) Individual negotiation with vendors.
(6) Drop CAI.

In the on-site interviews, the concept of a regional or state CAI network appeared to be most acceptable. The UCLA School of Medicine already serves as a regional biomedical library and it would be natural to extend this·to CAI.

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[1]An IBM 360/91 computer is currently operating in the Health Sciences Center. The current charges are approximately $3.50 per connect hour. The main problem with using this facility for local or regional use is that it is principally used as a research computer. This means that two or three times a day the computer may be down for software development work.

INSTITUTION VISITED: University of Washington, School of Medicine

DATES OF VISIT: August 8-9, 1974

INDIVIDUALS INTERVIEWED:

Ralph E. Cutler, M.D.   George Brengelmann, M.D.
Director   Faculty Member of CAI Committee
Washington Independent Study
    Program   Starkey Davis, M.D.
                                               Faculty Member of CAI Committee
Gary E. Striker, M.D.
Assistant Dean for Curriculum

In contrast to other user institutions visited, the University of Washington's School of Medicine is a forerunner in integrating CAI into the mainline curriculum. The Washington Independent Study Program (WISP) is designed to permit the student to progress at his own rate through the pre-clerkship portion of the medical curriculum. This self-pacing permits a student to spend additional time on particularly difficult material or concepts while moving quickly through material he can command easily. The program is organized into instructional units (modules); objectives to be learned in each module; selected references to learning resources (books, journal articles, films, slides, tapes, etc.) which may be pursued to meet the objectives; a computer-assisted, self-evaluation exercise designed to help determine how well the objectives have been met; and the names of the faculty members who are responsible for consultation regarding the module.

Since the majority of the students' activities in the WISP are designed to be pursued independently, there are few scheduled activities. Most days students are free to manage their own time as they choose; however, one or two days a week, there are scheduled activities (average 3-6 hours per week). Throughout the two-year program, students are free to take electives from the traditional program.

A student may seek consultation with a faculty member at any time. When students are satisfied that they have learned the material which was specified in the objectives for the module, they go to a computer terminal to take a computer-assisted, self-evaluation exercise which consists of questions and case studies. The computer reacts to the student's response with reinforcement, corrective hints, or tutorial coaching depending on the nature of the student's answer. A self-evaluation exercise is provided with each module and is based on the objectives for the module. It provides the student with regular feedback related to his attainment of the objectives. Upon satisfactory completion of the self-evaluation exercise, the student proceeds to the next module.

Faculty evaluation of the student's performance occurs in the form of nine written objective examinations which are administered after a sequence of three to four modules.

WISP students are volunteers who make a commitment to the program. The program provides an alternative to the lecture method for students who prefer to direct themselves.

WISP was conceived about the same time as the Lister Hill Biomedical Data Communications network. The University of Washington's School of Medicine sent a special committee to Ohio State University to review and evaluate that medical school's Individual Study Program (ISP). The committee recommended that the Ohio State ISP modules be adapted for use in their medical school. Approximately 20-30 faculty members participated in the decision and subsequent revision of the Ohio State materials. Revisions have varied from minor changes in sequence to complete rewriting of course modules.

Faculty involvement in CAI at the University of Washington's School of Medicine is probably greater than any other school in the network. The primary reasons are:

    (1) Curriculum development has a high priority.

(2) Grant monies are available for curriculum development through the WISP and Washington, Alaska, Montana, Idaho (WAMI) projects.

(3) Faculty are not allowed to have a private medical practice.

(4) There is an assistant dean for curriculum.

Dr. Striker, Assistant Dean for Curriculum, feels that the computer must be integrated into the regular course of study if it is to remain an effective learning tool. This appears to be substantiated by the experiences of other network users like UCLA, where the continuation of CAI is up in the air.

The School of Medicine's plan for the next three to five years is to develop a curriculum in which clinical simulations will become an integral component of the clerkship years. The school's bias is towards quantitative assessment of student performance, and simulations offer this possibility for 3rd and 4th year students.

The University is planning to use the WISP evaluation programs in their WAMI project which involves the rural communities in Washington, Alaska, Montana and Idaho. These states, except for Washington, do not have medical schools. The WAMI program is designed to provide medical education in remote locations. Course committee chairmen at the University of Washington meet with corresponding faculty at the WAMI sites to establish a common course content. Further, WAMI faculty members have participated in the revision of Ohio State's independent study programs. The WAMI program will be using a satellite system capable of two-way interactive conversation.

Some independent study students have expressed anxiety over the experimental program. One student said, "I wonder if I am learning anything." The knowledge data base to which WISP students are exposed is actually far greater than that of their counterparts in a traditional program. Even though they are exposed to this wealth of information, they are nervous about acquiring the specific knowledge necessary to pass the final exams and the Boards.

A major outgrowth of the independent study program is that faculty members have had to integrate the learning resource materials (films, video cassettes, slides, audio tapes, CAI programs) into their thinking, and curriculum planning.

Not everyone on the faculty is an advocate of CAI. Dr. Brengelmann was vociferous in his objection to CAI. He maintains that, at best, some of the modules are routine, and, in addition, CAI is not particularly cost-effective. He further said, "The reading speed of an intelligent medical student is faster than a 30-character/second terminal, and people should work with people."

Dr. Davis is more favorably disposed toward the computer, although he is not in favor of using it for something that can be done just as well with paper and pencil. Dr. Davis developed a series of computer clinical exercises to be used as part of the microbiology course unit. These exercises help students perceive the clinical relevance of basic scientific knowledge. At the end of each unit of study, Dr. Davis spends 2 to 3 hours discussing every question on the final exam with each student. He feels that individual conferencing is a more productive learning process than the time he used to spend lecturing the students.

INSTITUTION VISITED: Stanford University, School of Medicine

DATE OF VISIT: August 16, 1974

INDIVIDUALS INTERVIEWED:

James B. Williams, Director   James Steward, M.D.
Division of Instructional Media   Associate Dean for Student Affairs

Stanford University has a highly unique environment. First, the university has been a forerunner in CAI research and development through the work of Dr. Patrick Suppes of the Institute for Mathematical Studies in the Social Sciences.

Second, the School of Medicine is overwhelmingly a research-oriented institution, even to the point that students are expected to independently pursue their individual learning interests. Third, under the Stanford curriculum plan, the medical student is recognized as a graduate student inasmuch as he is allowed wide freedom to plan his own program. Dependence on didactic teaching is minimized. Instead, seminar methods and the use of small groups, fostered by the physical arrangement in the multi-discipline laboratories and by the provision of many small conference and demonstration rooms, are emphasized. The student is actively encouraged to undertake independent study and research and to widen his horizons, both medical and non-medical, through the judicious choice of study in other divisions of the university. This does not, however, imply a de-emphasis of the primary importance of the medical sciences.

In the current curriculum, there are no required courses per se, classroom attendance is not mandatory, and listings of prerequisite courses are for guidance only.

The Committee on Courses and Curriculum strongly recommends that the students be given an opportunity to try out the new modality, namely, the Lister Hill CAI network. This response is in complete agreement with their general philosophy of presenting the student with as many alternative methods of learning as possible.

While the faculty is very much in favor of CAI use, they are not interested in diverting themselves from their research efforts to the development of their own library of CAI materials. For this reason Stanford would find a network library of CAI materials of special benefit.

Even though the curriculum is completely unstructured, the medical school faculty is very much aware of the need to verify that the students have acquired fundamental knowledge of the medical sciences. Stringent final exams are given in each course unit such as pathology and anatomy, with "pass" levels set even higher than the National Boards.

Dr. Steward mentioned that consideration is being given to combining the present three National Board exams into a single exam to be given prior to the beginning of internship. This would introduce the problem that students would be called upon to remember basic science materials studied during the first two years of medical school. The utilization of CAI as a modality for review would be of decided advantage to the Stanford curriculum plan.

Although the Stanford University School of Medicine attracts extremely intelligent students who are highly motivated, there is still a need for remedial education in the basic sciences. The School of Medicine has a significant percentage of minority students who are deficient in background knowledge in the basic sciences. These students were heavy users during the experimental period and appear to have found the Ohio State materials especially helpful for review and catch-up.

A little over a year ago a Division of Instructional Media was established to consolidate technology-based educational use. The installation of the CAI terminal is an integral part of the overall Fleischmann Teaching and Learning Center. The CAI terminal is located in a lounge area just as you enter the center. What is striking is the informal atmosphere surrounding the terminal. The terminal sits

on a low table in front of a large couch. It was especially purchased with a video output jack so that the image can be displayed on a large TV monitor sitting in the corner of the lounge area.

Dr. Steward and Mr. Williams both indicated that they feel that a national network is the best possible arrangement for the sharing of CAI materials. Regional networks, however, would be a good alternative. At the present time, "CAI users have no common project, just common problems." There has been little or no contact between network users.

INSTITUTION VISITED: University of Southern California, School of Medicine

DATE OF VISIT: August 2, 1974

INDIVIDUALS INTERVIEWED:

Nelson Gilman, Librarian   Elaine Adams, PhD.
Norris Medical Library   Learning Resource Coordinator

Roger W. Jelliffe, M.D.
Associate Professor of Medicine

    The CAI programs were a phenomenal success at USC's School of Medicine, although subsequently the "patient" died. One terminal was installed in the library and programs from MGH, University of Illinois, and Ohio State University were made available. Because of the demand and the availability of only one terminal at the library, it was decided that scheduling appointments for terminal use would be the most efficient method. The terminal was located in the lower level of the library, in the library's group study area. In addition to the terminal at the library, there were several terminals at the hospital which were used primarily for other purposes, but were also made available to network users.

    Nearly $1,000 was spent on the initial publicity for CAI which had a large payoff in terms of subsequent student usage. A great deal of effort was expended in attempting to demonstrate the CAI programs to the faculty, but the faculty was negatively disposed toward CAI because they felt:

    (1) It was a dehumanizing educational experience.

    (2) Many factual errors were contained within the CAI programs.

    (3) Conflicts existed with the way that courses were taught at USC (sequencing of topics, emphasis placed on particular topics, etc.).

On the other hand, many of the faculty members who took the time to come to the demonstrations liked the programs and found them stimulating.

    When Lister Hill announced the network charges, the Medical Education Committee reconsidered their CAI posture. They decided that the programs should undergo formal evaluation. In the interim, they withdrew from the network since the committee has given no further attention to the matter. CAI, in effect, was given a pocket veto.

    Dr. Jelliffe is the most knowledgeable staff member at USC in interactive computer programming. His interest in the CAI network was principally curiosity about the work at MGH. In his opinion, the program on digoxin dosage presents an oversimplified view of variables which affect dosage level. He has developed a sophisticated set of his own drug kinetics patient care programs. His aim is to have the computer determine drug dosages (e.g., the amount and rate for intravenous feeding).

    Dr. Jelliffe was, in general, critical of the CAI programs. (His comments on the MGH programs were at variance with almost every other doctor's assessment as to their value.) His focus is on patient care programs and not on teaching programs. He currently utilizes the G.E. Mark III communications network. This network is available by local telephone from nearly 350 cities in North America, Western Europe, Australia and Japan. Dr. Jelliffe stated that he found the G.E. network to be more reliable than the Tymshare network. During the period in which he used the Tymshare network, the conversations were plagued by unexplained interruptions.

INSTITUTION VISITED: Los Angeles County Medical Association

DATE OF VISIT: August 5, 1974

INDIVIDUALS INTERVIEWED:

    Ben Z. Krentzman, M.D.   Milton G. Sheinbein, M.D.
                                        LACMA Computer Committee
                                              Chairman

     The Los Angeles County Medical Association (LACMA) visit provided an insight into some of the problems of utilizing technology for the continuing education of medical practitioners. Dr. Krentzman, when he initially considered using the network, envisioned the possibility of providing thousands of doctors (LACMA has approximately 10,000 members) with a "first hand experience using a computer."

     Because of the computer's increasing role in all aspects of medicine, Dr. Krentzman feels that every physician should have some basic computer knowledge. LACMA frequently holds large dinner meetings which are attended by 200-300 physicians. These meetings are held at the LACMA auditorium and at individual hospitals throughout the metropolitan community. Dr. Krentzman had planned to demonstrate the materials before such audiences using large screen projection of the terminal printout. He investigated the cost of portable projection systems and found one that costs approximately $5,000. The LACMA computer committee was approached about funding the purchase of this equipment, but voted it down. Dr. Krentzman feels that the committee's negative vote was a reflection of the senior age profile of its membership.

     Dr. Sheinbein, the chairman of the committee, provided a different perspective on what happened. When the committee first voted to use the network it was to be at no cost to LACMA. The availability of a rented terminal at the LACMA headquarters for CAI demonstration was given wide publicity. Dr. Sheinbein said that the request for funds came in the midst of an austerity mood at LACMA and it was felt by the committee that they could not afford to invest in the equipment at that time.

INSTITUTION VISITED: University of Oregon, Medical and Dental Schools,
                        School of Nursing and Health Sciences Center

DATE OF VISIT: August 6, 1974

INDIVIDUALS INTERVIEWED:

Health Sciences Center   Dental School

Gerald W. Miller, Professor   Patrick J. Reynolds, PhD.
Educational Research & Medical   Assistant Professor of
    Psychology (School of Nursing)   Physiology

Evelyn Schindler, Coordinator   Carol Jenkins
Masters Program   Assistant Professor & Librarian
                                                Library
James McDonald
Laboratory Associate

School of Nursing   School of Medicine

Marcella Cate, Associate Professor   M. Roberts Grover, Jr., M.D.
Medical-Surgical Nursing   Associate Dean

Dorothy Elhart, Chairperson   John T. VanBruggen, M.D.
Medical-Surgical Nursing   Director of Teaching Laboratories
                                                Professor of Biochemistry
Bernice Jones, Chairperson
Pediatric Nursing   Robert E. Reichart, Ed.D.
                                                Director
Loretta Myers, Chairperson   Office of Medical Education
Maternal-Child Nursing
                                                Walter R. Petersen, Director
Doris Schindler, Assistant   Computer Center
    Professor, Psychiatric Nursing
                                                Heather G. Rosenwinkel
                                                Assistant Professor, Library

    Dr. Miller of the School of Nursing arranged for visits with a wide spectrum of people involved with CAI at the University of Oregon. Individuals interviewed included administrators, coordinators, faculty and students.

    The School of Nursing has made more progress with CAI technology than has the School of Medicine, even though the CAI programs available through the network were not specifically developed for nursing students.

    It is interesting to note that the Dean of the School of Medicine has provided the School of Nursing with financial support in CAI even though the School of Medicine itself has made little progress in technology-based education.

    School of Nursing students used both the MGH clinical assimulations and a number of programs from Ohio State. A Bird's Eye View of Pediatrics was especially popular.

    Students complained that some of the programs were not appropriate to their curriculum (e.g., nurses are not supposed to make medical diagnoses). However, in one instance a student nurse was able

to make a diagnosis from what she learned from the CAI program, Major Tranquilizers in the Pre-Med Program. She was able to apply this knowledge to a psychiatric patient who appeared to be catatonic. She thought the symptoms were drug-induced. When she suggested this to the doctor, he discontinued the drug. The next day, the patient was radically improved.

The School of Nursing has just obtained a Wang programmable calculator under a Title VI Grant. The Wang is a desktop computer system which can be time shared among several terminals. The current configuration cost is $13,500.

The options open to the School of Nursing at the University of Oregon when the Lister Hill Network terminates are:

(1) Upgrade the Wang system with disk drives, additional memory, ports, and a card reader. (The estimated additional cost would be $36,000.)

(2) Use the campus computer, an NCR Century 251. This computer uses BASIC language, but the School of Nursing would probably not attempt a conversion effort from MUMPS and Coursewriter without outside support.

(3) Use a 360/50, currently in the Chancellor's Office, which is soon to be replaced and could be used as a CAI computer. External support, however, would be required to make the system fully operational, including the purchase of the Coursewriter compiler.

(4) Use commercial or public time-sharing facilities. (A serious drawback would be the high cost per terminal hour.)

The meeting with School of Medicine faculty and administrators was surprising because of their generally negative attitude when contrasted to the level of interest found in the School of Nursing. The School of Medicine had no plans for the future for CAI, and their current network experience did not appear particularly rewarding.

INSTITUTION VISITED: University of California at San Diego
                        School of Medicine

DATE OF VISIT: August 20, 1947

INDIVIDUAL INTERVIEWED:

      John Sewell, Supervisor
      Learning Resource Center

      The philosophy of Dr. Roger Marchand, Coordinator for Learning Resources, is one of not imposing technological educational aids on faculty. It is a laissez-faire policy of making these innovations available for individual faculty evaluation. Thus far, only a few members have availed themselves of these materials; most of the use has been by second year medical students using Ohio State's ISP materials. Students in their clinical years are located in a hospital about 25 miles from the campus. However, there are plans to install a terminal at the hospital which will then be available for MGH clinical simulations.

      The School of Medicine has no formal plans for continuing access to Ohio State materials. However, Mr. Sewell has indicated that the most practical arrangement would be to tie into some other California user institution. He heard that the University of California at Irvine has received the Ohio State programs and is in the process of putting them up on their computer. He is also interested in the MUMPS interpreter being developed at the University of California Davis School of Medicine on the Burroughs 6700 since all the University of California schools, except one, have the Burroughs 6700 computer.

      A particularly interesting aspect of the visit was the opportunity to become familiar with the Datapoint intelligent terminal that is housed in the learning center. This terminal is currently being used for test scoring and analysis. Students enter their answers on a special ánswer card which is then optically scanned and the results are scored on a tape cassette built into the terminal. The answers can be displayed on the terminal device but it does not have sufficient computer power to perform the analysis. On command the data is sent to a larger campus computer for processing. Basic programs are also written at the terminal for execution on the larger computer.

      This school characterizes a typical user institution: They neither aggressively advocate CAI, nor are they passive toward its role in the educational process. The learning lab has an extremely small budget (around $5,000 annually) for the purchase of supplies and equipment. As a result, the learning resource lab facilities are sparse in contrast to laboratories found at other user sites like Stanford and UCLA.

INSTITUTION VISITED: Medical College of Virginia

DATE OF VISIT: September 30, 1974

INDIVIDUALS INTERVIEWED:

David Hopp, Ph.D.
Educational Planning and
    Development Program

John Wergin, Ph.D.
Educational Planning and
    Development Program

John Vorvell, M.D.
School of Basic Sciences
Department of Anatomy

Nelson Young, M.D.
School of Medicine
Department of Pathology

The Medical College of Virginia's termination of its network affiliation seemed to be enigmatic, at first glance. After a period of intense activity (MCV was the fourth largest user in the network during 1973) a decision was made to end the service. The peak month of usage was 280 contact hours.

During the interview it became clear that cost was the single most important factor infiuencing the decision to terminate, although a closer analysis revealed other underlying factors. A private line between Richmond and the nearest communication computer (TYMSAT) in Washington, D.C., cost the school $400/month, and MCV dropped out when Lister Hill instituted connect-time charges. Administrators at the institution expected the charges to soon climb to $10 per connect hour which would have resulted in a cost of $2,000/month. The question arose as to who would pay the bill. Dr. Young stated that $1,000 hard cash was a lot of money!

Some of the specific reasons why this expenditure, in the eyes of the staff, is not justified are:

(1) Coverage will likely continue to be small. According to the Media Center librarian, these programs are used primarily by a small, core group of students and interns.

(2) Without a specific reason for existence, the CAI programs will continue to have trouble attracting the interest of faculty members and students. This is especially true once their novelty has worn off.

(3) The benefits of these programs will continue to be difficult to measure and translate into learning outcomes, and hence the funds required for their maintenance will be difficult to justify.

Another factor in the forefront of the Educational Planning and Development Program staff's thinking is that the CAI packages have not been incorporated into the MCV curriculum. The faculty, with a few exceptions, has not been inclined to make a real commitment to CAI utilization. (In the nursing school, the program SHOCK was assigned, but the medical school faculty did not assign program use as a classroom lab.) A few faculty members were initially interested in the programs but did not follow through. One instructor even went so far as to commit himself to participate in a controlled evaluation, but he never quite found the time for the experiment. He had planned to revise his own self-instructional package to fit with one of the MGH programs so that the two self-study methods could be compared.

MCV conducted extensive questionnaire studies to ascertain the overall effectiveness of CAI. The average user response, by supplier institution, is contained in Table 4.

It is clear from the data that the students have a strong preference for this learning modality although they were less sure of their feelings as to how much knowledge they gained from it. When the students returned to campus for the new academic year, they were surprised to find that the CAI terminal had been removed. They were so upset that they petitioned the administration to reinstate it. Some of their comments were:

It was very, very useful to help develop clinical judgments.

There was much valuable information in that computer.

Table 4

Average User Response, by
Supplier Institution and Item Type[a]

Item Type	Supplier Institution		
	MGH (N = 17)[b]	UIMC (N = 14)	OSU (N = 23)
General Attitude	4.11 (N' = 9)	3.72 (N' = 11)	3.86 (N' = 9)
Knowledge Gained	3.80 (N' = 14)	3.40 (N' = 15)	3.80 (N' = 14)
Mechanics	3.69 (N' = 16)	3.67 (N' = 17)	3.58 (N' = 15)

[a]Items scaled between 1 and 5, least to most favorable: 3.0 indicates neutrality.
This means that for positively-worded items, "strong agreement" was given a score of 5;
for negatively-worded items, "strong disagreement" was given a score of 5.

[b]N = number of users; N' = number of items.

Source: Wergin, 1973.

We were going to be married.

Taking the computer out was a backward step.

It combined enjoyment with learning.

Although I realize that the computer is expensive, I feel that its use by students is extremely beneficial.

Some of these programs provided very good reviews for Part I of the National Boards.

A summary of the student judgments of the utility of the CAI programs is contained in Table 5. A chi-square analysis of these data indicates a significant tendency for different supplier offerings to have different learning benefits, at least as perceived by the respondents. The MGH programs tended to help develop problem-solving skills, while the OSU programs tended simply to transmit information. Responses to the UIMC programs are mixed between the two extremes; this latter finding is probably due to the difference in orientation between the CRIB programs (facts) and the CASE programs (problem solving).

Additional information on the type of user of MGH programs is available. It is notable that the MGH programs were found to be beneficial by a wide spectrum of users, from inexperienced students to staff doctors. The programs were also used by auxiliary medical professionals. (See Table 6.)

The table reveals that over half the usage was logged on four programs. There is absolutely no relationship between the type of program and the type of user. This finding is puzzling in view of the assumed needs of different classes of users. However, this confirms experiences at other user institutions where many students wished to be exposed to the information although they had not yet acquired the requisite background for full comprehension. If the programs had been associated with specific courses the findings would probably have been different.

MCV's curriculum development apparatus is an interdisciplinary committee. This committee chooses the topics to be taught and the objectives for each topic area. The classroom schedule has been reduced from 50 to 23 hours. One aspect of this curriculum reform movement has been the development of a number of self-study packages as a replacement for lectures. Dr. Young observed that "Everyone says that lectures are a poor method of instruction except the guy who's giving the lecture." It is already clear from the CAI experience of the user institutions that these programs will not replace

Table 5

Student Judgment of Supplier Institutions' CAI Programs

Student Judgment	Supplier Institution[a]			
	MGH	UIMC	OSU	Total
I learned terms, facts, classifications, theories, and procedures.	1	6	10	17
I learned to translate scientific knowledge into new concepts, interpret scientific data, and summarize material.	1	0	3	4
I learned to apply knowledge to problem situations.	15	7	6	28
I learned to analyze various elements or relationships in a problem.	5	1	3	9
I learned to develop hypotheses and design proposed plan(s) to solve a problem.	2	0	1	3
I learned to judge the efficacy of the proposed plan in solving the problem.	3	0	1	4
Total	27	14	24	65

[a] $x^2 + 24.58; p < .01$.

Source: Wergin, 1973.

lectures. This will happen only if there is a specific educational program such as the Independent Study Programs at the Universities of Washington, Wisconsin, and Ohio State.

Dr. Young pointed out that students now being graduated are not self-sufficient. "They still need experience and guidance. Some areas of medicine cannot be taught well with machines ... keep the artificiality out of it."

Dr. Young also pointed out that students are now being overwhelmed by a variety of learning alternatives. "Some compulsive bright students explore all of these, but some are not able to, and get frustrated." This phenomenon was mentioned at visits to several other institutions. However, in all the student comments, there is no indication that they feel bogged down by the sheer weight of the available CAI materials. A few students did, however, comment that their study schedules were so tight that they could not avail themselves of the CAI materials as much as they would like.

An advantage of CAI of particular importance to the medical field (where there is an avalanche of information) is that it facilitates retention through its question and answer approach. Not too many students actually read textbooks. "Most books present the whole field, and medical students cannot become experts in all fields," Dr. Young explained.

Table 6

MGH Program Usage, by User Type

Program	Student (Pre-Clerkship)	Student (Post-Clerkship)	Intern	Resident	Post-Training and Faculty	Other[b]		Total Times Used
Abdominal Pain	27	37	9	6	3	2A 2D	2N 2X	90
Coma	25	27	12	15	3	1A 1D	1N 1X	86
Cardiopulmonary Resuscitation	17	21	7	8		1P 1D	3N 1X	59
Diabetic Ketoacidosis	16	21	8	4	2	1A 1D		53
Jaundice	8	13	4	5	1	1A 1D	1X	34
Pediatric Cough and Fever	5	12	2	2	1	1P 1D		24 24
Anticoagulant Simulator	6	6	3	2		1A 1P	1D 1X	10
Hypertensive Emergencies	8	7	3	1		1N 1X		21
Cardiac Simulator	7	6	1	2	1	1X		18
Idiopathic Respiratory Distress in Newborn	5	5	1	1	2			14
Digoxin Dosage Advisor	3	2	1			1D 2P	1X	10
Drugs in Renal Failure	1	2				1P		4
GI Bleed	2	1						3
Total	130	160	51	46	13	37		437

[a]A group of students studying together at the terminal is counted as an entity and receives a count of 1.

[b] A = Auxiliary medical professions
   D = Dentists
   N = Nurses
   P = Pharmacists
   X = Nonmedical persons

Source: Wergin, 1973.

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Chapter 4

EVALUATION OF <u>CAI</u> LIBRARY MATERIALS

The combined libraries of Massachusetts General Hospital, Ohio State University, and University of Illinois Medical College[1] provided a wide range of biomedical subjects and pedagogical approaches for users to sample.

The program usage data for selected institutions are examined here. These institutions and the reasons for their selection are:

- UCLA—is largest user.
- Stanford—has highly unstructured curriculum.
- Oregon—includes School of Nursing users.
- Medical College of Wisconsin—has special experimental course in gross anatomy using CAI.

Evaluative comments from various institutions, as reported in the User Bimonthly Reports, are a part of this report. Those institutions include:

Hantman, Bolt Beranek and Newman, Inc.
Medical College of Virginia
National Board of Medical Examiners, American Board of Internal Medicine
University of California—Davis, Office of Medical Education
University of Arizona, Arizona Medical Center
Washington University, St. Louis, Mo.
University of Pennsylvania
State University of New York, Upstate Medical Center, Division of Educational
    Communications
Northwestern University
University of Texas, Health Science Center at San Antonio
National Naval Medical Center, Naval Medical Research Institute
Buffalo Children's Hospital, Division of Instructional Communications
University of Nebraska

PROGRAMS IN THE <u>MGH</u> LIBRARY[2]

The MGH programs are primarily simulated clinical encounters with patients. The target population is composed mainly of medical students in their clinical years of training. Nineteen different programs are available on a wide range of subjects. Some of the subject areas are:

Arrhythmias
Hypertensive Emergencies
Abdominal Pain

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[1] UIMC left the Network in February 1974. Their programs, CASE (transferred to OSU) and CRIB, are not included in this analysis.

[2] For a complete description of MGH programs, the reader is referred to the *Medical Education Programs Users' Manual*, Laboratory of Computer Science, Massachusetts General Hospital (undated).

Coma
GI Bleed
Pediatric Cough and Fever
Trauma
Jaundice
Joint Pain
Diabetic Ketoacidosis

MGH also provided programs on drug dosage: Digoxin Dosage Advisor, Drugs in Renal Failure, and Anticoagulant Simulator.

Since the programs are capable of creating an endless number of patient situations with varying symptoms, disease progression, and prognoses, the number of possible patient encounters is unlimited. However, after a student has sampled 10 or more patients within a program area, he is probably ready to progress to another segment. Average time to complete an encounter ranges from 10 to 30 minutes, depending on the simulation.

The primary purpose of the simulation programs is to help the students improve their clinical judgment. The simulation programs are a systematic attempt to define an explicit model of the intellectual processes involved in medical decisions. Under the traditional apprenticeship method of clinical training, the student receives increasingly less supervision and monitoring of his performance and may be unaware of weaknesses in his problem-solving skills. The clinical simulation programs are a means of self-assessment as well as a vehicle for certification or licensure. (Proceedings of the Twelfth Annual Conference on Research in Medical Education, 1973.)

Faculty and student response to the MGH library was generally favorable and often highly enthusiastic. Some MGH programs were far more popular among students than others, even though they did not stand out on faculty ratings. One reason suggested for this popularity is that these programs provide the student with simulated clinical experience in treating cases they usually do not see in their "live" clinical experience. The four most popular MGH programs among clerkship students were:

The Comatose Patient (COMA)
Abdominal Pain (ABD)
Diabetic Ketoacidosis (DKA)
Cardiopulmonary Resuscitation (CPR)

Available information on usage, faculty opinion, evaluation, and user comments for three of these programs is provided on the following pages. For contrast, information is also provided on one less popular MGH program—Hypertensive Emergencies. User comments indicate this program is too specialized for widespread use. However, it may be valuable for special purposes.

COMA (The Comatose Patient)

AUTHORS: Edward P. Hoffer and Harvey Botman
            Massachusetts General Hospital

DESCRIPTION: This program presents a model for evaluating a comatose patient as such patients are presented to the emergency department. Thirty-eight causes of coma are considered, including both primary neurologic disorders and toxic-metabolic conditions. The user's goal within the program is to arrive quickly and efficiently at a differential diagnosis and to begin appropriate therapy. Work-up of the patient, then, must be directed toward differentiating among the most probable diagnoses and also toward gathering data needed to make immediate management decisions.

The setting in each of the cases is an emergency department. The user is given a brief introductory description of the "patient," and can then request further history, physical findings, and lab test data by entering the appropriate number from the vocabulary list. Therapies can be ordered at any time, again by selecting numbers from the vocabulary.

TARGET AUDIENCE: Medical students in clinical years and beyond.

USAGE: COMA was one of the most popular MGH programs. It was used over a thousand times at UCLA from November 1972 to August 1974 (581 hours usage).

FACULTY OPINION: COMA was reviewed and rated by faculty at SUNY Downstate Medical Center, Mayo Foundation, Albany Medical College, and Medical College of Virginia. Compared to other MGH simulated patient encounters, COMA did not receive unusually high ratings by faculty, on either medical content or pedagogy.

COMMENTS: "Tough, really difficult, well thought out. Evidences a fantastic amount of research."

> Report #4, CAPO Use of the Lister Hill Communications Network, Period
> Ending August 30, 1973. From Leonard M. Hantman, Bolt Beranek and
> Newman, Inc.

"Good simulation and review; well explained, evaluation helpful; introductory part should be shorter; does not explain why certain lab tests should not be ordered."

"Best structure; very good on difficult diagnosis and acute management."

> May 1973 Operational Users Report, Medical College of Virginia, David I. Hopp,
> Ph.D., Assistant Professor, Educational Planning and Development Program.

ABOOMINAL PAIN

AUTHOR: Octo Barnett, Massachusetts General Hospital

OESCRIPTION: In this computer-based exercise, the student is given a short description of a patient with a chief complaint of abdominal pain. The patient may have any one of 33 different causes of acute abdominal pain. The student has available an index of history, physical exam, and lab data items about which he can obtain information, in any order he desires. The quality of the student's performance is measured by the efficiency with which he sequentially selects questions or tests, and by the accuracy with which he interprets the information. The different items are considered to have different costs (e.g., a history question is less expensive than a laboratory test).

TARGET AUOIENCE: Medical students in clinical years and beyond.

USAGE: ABOOMINAL PAIN was one of the most popular MGH programs. It was used about 1,500 times at UCLA during the period November 1972 to August 1974 (443 hours usage).

FACULTY OPINION: Faculty who rated ABOOMINAL PAIN along with other simulated patient encounters, did not give it particularly high marks on content or pedagogy.

PROGRAM EVALUATION: "The results [of the evaluation] were most intriguing and indicated that the major increase in the ability to make a proper diagnosis of a problem of abdominal pain came between the second and fourth year of medical school, and that relatively little gain in diagnostic ability was evident between the graduating medical students and the more experienced physicians. The latter group were clearly superior, however, to the graduating medical students as well as to the younger medical students with respect to the efficiency with which they reached the diagnosis, the speed with which they reached the diagnosis, and the reduction in costs associated with the overall workup process. These preliminary data provide some most intriguing insights into the way in which people learn diagnostic skills, and the stages at which certain aspects of these skills may be acquired."

Letter from John R. Senior, M.D., National Board of Medical Examiners, American Board of Internal Medicine, June 1, 1973.

"Programs rated as most interesting . . . were as follows:

Coma:	9 responses
Abdominal pain:	6 responses
Cardiopulmonary resuscitation:	6 responses"

Letter report from Richard F. Walters, Ph.D., Assistant Professor, Office of Medical Education, University of California, Davis, May 16, 1973.

COMMENTS: "The ABO Pain program was by far the most popular program among the student users. It was referred to as a great learning experience and challenge, the performance evaluation was good; it was fun and educational. The student users felt it would build their problem-solving ability . . .

Overall, those student users that did fill out evaluation slips, were willing to put thought into their comments. The enthusiasm was high among the student users and they did much of the promotion for the program by word of mouth. Of course the users did not have prior terminal experience nor

instruction via computer, for an evaluative point of reference. Nonetheless, the present responses indicate the worth of the program."

Arizona Medical Center, CAI Report, October 15, 1973 — December 15, 1973., The University of Arizona.

"Those listed by students represent basically problems in instructional format. They included: (1) inability to ask certain questions not in the vocabulary (e.g., in the abdominal pain program) (2) inability to start at any point in the program other than the beginning (3) inherent limitation in the programs to get or give information except that which has been previously specified by the author of the program."

Summary Evaluation: MGH Computer Assisted Instruction Programs, from Linda Smith, Trainee in Computer Librarianship, Washington University, April 19, 1973.

"The abdominal pain program, developed as a testing and not as a teaching program, is not suitable in its present formulation as a teaching program: the interpretation is too involved for student understanding, and timewise, it is too long for efficient use of student-computer contact time."

Biomedical Communications Network Progress Report, no. 1, April 1973, from Jerome S. Rauch, Chief Medical Librarian, Project Director, University of Pennsylvania.

" . . . one student stated that the statistics reported in the abdominal pain section were pointless."

Letter report from Richard F. Walters, Ph.D., Assistant Professor, Office of Medical Education, University of California, Davis, May 16, 1973.

"The abdominal pain problem . . . is very popular. The detailed analysis of student errors, however, is considered tedious."

Bimonthly Report to Educational Component Data Communications Service (LHC), from Herbert Schneiderman, M.D., Associate Director (CAI), Division of Educational Communications, Upstate Medical Center, State University of New York, March 15, 1973.

"A brief description of a patient coming to an emergency ward is given to the student, who then, with the aid of a glossary, can elicit a history and do physical examination and lab tests, in order to make his diagnosis. An evaluation of the student's management is also presented upon request."

Report on Usage of MGH-CAI by Julian Aguda, May 9, 1973, Northwestern University.

"Program did not understand my diagnosis (noise on line, other transmission problems?) although they were identical to program generated answers."

"Trouble with machine typing extra characters as I was trying to type."

"Garbage was occasionally received; program was cut off without warning."

University of Texas Health Science Center at San Antonio, Analysis of CAI Utilization, Jan. 18 - Feb. 28, 1973. From David A. Kronick, Ph.D., Librarian and Director, Medical Communications.

DIABETIC KETOACIDOSIS

AUTHOR: Edward P. Hoffer, Massachusetts General Hospital

DESCRIPTION: This program presents a dynamic simulation of a patient in diabetic coma. The user is given a brief initial description of the patient and may then request physical findings, order lab tests, and institute therapies in that order. The "patient" is represented by a mathematical model; this model is updated based on considerations of time and user interventions, and the "patient's" condition changes accordingly. (Dr. Hoffer, in a recent paper, described the rationale for using computer simulation modules.) (Hoffer, 1973) The physical exam · lab test therapy cycle is repeated for a simulated hour at a time, until the "patient" either is brought into metabolic balance or dies.

Important parameters controlled by the model include blood sugar and acetone, serum K, serum pH, urine volume, etc. The interaction seems to be realistic enough that the student receives a vivid exposure to the challenge of therapeutic management of a complex time-changing disease entity.

An interactive program attempting to instruct in the methods of therapeutics and management using simulated models of diabetic patients.

TARGET AUDIENCE: Medical students in clinical years and beyond.

USAGE: DIABETIC KETOACIDOSIS was one of the most popular of the MGH programs. It was used about 600 times at UCLA in the period November 1972 to August 1974 (313 hours usage).

FACULTY OPINION: Faculty members who rated this program in opinion surveys did not give it unusually favorable marks.

COMMENTS: "[The student] found this program to be realistic, stimulating and a good review of a topic which many internists lose familiarity with, soon after leaving the residency and fellow-ship years.

"I had no specific criticisms to make, except that the program did not permit me to obtain radiographs of the chest and abdomen, which I consider to be important diagnostic aids early in the management of this condition."

> *Letter from Lawrence Raymond, M.D., Program Manager, Research Clerks,*
> *Naval Medical Research Institute, National Naval Medical Center,*
> *18 September 1973.*

"Good introduction to patient management; feedback good; difficult to understand."

> *May 1973 Operational Users Report, Medical College of Virginia, David I.*
> *Hopp, Ph.D., Assistant Professor, Educational Planning and Development*
> *Program.*

"The students appreciated the ability of several programs, particularly Diabetic Ketoacidosis, to delay laboratory results just as would happen in an actual case, and the student must proceed with his therapy prior to receiving all of his laboratory data."

Lister Hill Center CAI Experimental Network Users Report, for the period January-February 1974 by Ronald G. Davidson, M.D., Director, Division of Instructional Communications, Buffalo Children's Hospital, March, 1974.

"One student cited the diabetic ketoacidosis as being too complicated."

Letter report from Richard F. Walters, Ph.D., Assistant Professor, Office of Medical Education, University of California, Davis, May 16, 1973.

HYPERTENSIVE EMERGENCIES

AUTHOR: Edward P. Hoffer, Massachusetts General Hospital

DESCRIPTION: This program presents a simulated hypertensive patient, and uses a series of multiple-choice questions to direct the user in managing the "patient." Occasionally the user is asked to name a drug choice rather than select one from a list. Type the name of the drug to be prescribed; any reasonable drug selection will be recognized by either its generic or trade name.

Each management decision is commented on, and the "patient's" reaction to the management is reported. The interaction continues until the "patient" is stabilized on therapy, or in some cases is lost to follow-up.

TARGET AUDIENCE: Medical students in clinical years and beyond.

USAGE: HYPERTENSIVE EMERGENCIES received relatively low usage. It was used about 120 times at UCLA in the period November 1972 to August 1974 (28 hours usage).

FACULTY OPINION: Hypertensive Emergencies received slightly higher ratings than other MGH simulations by staff at Mayo whose opinions were solicited.

COMMENTS: "Well liked."

> *Report #4, CAPO Use of the Lister Hill Communications Network, Period Ending August 30, 1973, from Leonard M. Hantman, Bolt Beranek and Newman Inc.*

"Material is good but too much emphasis on dosage and specific drugs for student level. These are rare problems, although important, but I believe more common things should be emphasized. The material is appropriate for HO 1 or 2. I think content is too specialized for our usual student in three year program."

> *Comments by R. L. Grissom, M.D., Summary Comments on the Evaluation of CAI Materials, University of Nebraska*

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PROGRAMS IN THE OSU LIBRARY[1]

The materials in the OSU CAI library are designed for use in the following major areas:

(1) Curricula for medicine, nursing, and allied health professions, as a supplemental teaching tool.

(2) Continuing medical education for health professionals.

(3) Student self-study and self-evaluation in an independent study environment for basic science for medical students.

Ohio State has approximately 120 available instructional units offering approximately 300 interactive hours of CAI. The CAI materials cover a wide range of subject matter and pedagogical techniques. Some of the course materials are:

Reading the Patient's Medical Records
Acid-Base Balance
Enzyme: Identification, Classification, and Significance
Gross Anatomy Self-Evaluation Exercise
Hi, Baby (for new mothers)
Histology
Juvenile Diabetes-Patients
Examination of the Fundus
Oral Cancer Recognition
A Bird's-Eye View of Pediatrics
Cardiac Arrhythmias
Anticoagulant Medication
Differential Diagnosis of Toothache
PILOT Independent Study Program (33 self-evaluation modules (encompassing the pre-clerkship portion of the medical school)
Medical Terminology

Most require the use of slides or other auxiliary materials at the terminal. The time to complete any one program ranges from a few minutes to several hours.

Use patterns for OSU materials are far more variable than for the MGH materials. Use of the OSU materials is highly dependent on curriculum integration. Thus, a particular program may receive very high usage one semester because an instructor assigns it as part of the course work. The program may be dropped after the course is over.

Similarly, the target audience for OSU materials varies widely. Thus, a program receiving very high usage in a nursing school may not be used at all in a medical school.

Most OSU programs are targeted toward the pre-clinical years of medical training. Thus, audience use does not overlap greatly with the MGH library which is clinically oriented.

Five OSU program packages receiving very high usage at one or more of the sample institutions are discussed on the following pages.

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[1] For a complete description of the OSU materials, the reader is referred to *User's Guide to Computer Assisted Instruction (CAI)*, Ohio State University College of Medicine, September 1974.

PSYMED (Psychotropic Medications)

AUTHOR: Kathleen Lennon, RN

DESCRIPTION: Major tranquilizers, minor tranquilizers, and antidepressants are reviewed in this program. General information on these three classifications is coupled with specific material on the most commonly used medications.

TARGET AUDIENCE: Nurses, physicians, pharmacy

USAGE: PSYMED was the most used program by the University of Oregon where the School of Nursing was the heaviest user. (Total of 99 hours usage from February 1973 - September 1974.) Forty senior students in psychiatric nursing were assigned the use of PSYMED by their instructor. Since PSYMED takes approximately 2 1/2 hours to complete, these 30 students may account for all of the usage. PSYMED received almost no use at Stanford, UCLA, or the Medical College of Wisconsin.

FACULTY OPINION: No data

PROGRAM EVALUATION: Forty senior students were assigned the program PSYMED during Quarter II. The students were randomly assigned to two groups: one group (10 students) to complete the program individually, the second (30 students) to complete the program in randomly assigned groups each comprising three students. Within-and-between-course comparisons were to be made on the basis of mid-term and final examinations sampling the content identified in the program. The control group had been identified as those students in NUR 327 (Quarter I); experimental groups consisted of the two identified during Quarter II, and two additional groups to be identified during Quarter III. Unfortunately, technical difficulties were encountered and an insufficient number of students completed the program to make valid statistical comparisons. The original intention was to compare the students' performance on standard Board scores and the National League of Nursing scores. However, the only data produced were subjective. The nursing students who completed the CAI program reported that the program materially improved their knowledge level.

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Project Coordinators: Ms. Doris Schindler
Assistant Professor of Psychiatric Nursing
University of Oregon
School of Nursing

Mr. Rick Duffield
Instructor of Psychiatric Nursing
University of Oregon
School of Nursing

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HIST1 (HISTOLOGY)

AUTHOR: Beth L. Wismar, Ph.D., Ohio State University

DESCRIPTION: Utilizing a great number of slides, HIST1 aids the student in recognizing the identifying characteristics of 40 organs. The majority of the questions will be accompanied by two photomicrographs of the same organ but different magnifications. You will be asked to study both slides before identifying the organ. A few questions will present only a list of structures and tissues from an organ and you will be expected to identify the organ from the description.

The organ ID course is a teaching device, not a test. Some of the organs shown may be new to you and you may not get them correct on the first try, but you should be able to "logic" them out. In the context of this course, you will be asked to distinguish between fundic and pyloric stomach, cervix, uterus, various calibers of vessels and many of the organs of the body.

TARGET AUDIENCE: Health professionals who desire a review in histology; first year medical students.

USAGE: At the Medical College of Wisconsin, HIST1 received the second highest OSU usage in hours; at UCLA it received fifth highest usage in hours. It did not receive any usage at Stanford or Oregon.

PROGRAM EVALUATION: "Students who had demonstrated a weakness in tissue and organ identification were advised to utilize the OSU HIST1 program, in addition to continued work at the microscope. Most of the 16 students in this group did so. In previous practical examinations on tissue and organ identification, these 16 students scored 15% points below the class average (69.7% against a class average of 84.3%). On the final practical examination, this group of students scored 78% against a class average of 78.9%. We feel that the OSU HIST1 program contributed significantly to the astounding recovery demonstrated by this group of students."

> *January - February 1974 Lister Hill Center User Report, Medical College of Wisconsin (MCW 222) from Weston D. Gardner, M.D., Professor of Anatomy, LHCBC Program Monitor.*

"The HIST1 program was used on a voluntary basis by about 30 students in the General Pathology course of the Medical Program. In addition an equal number of students taking a histology course also used HIST1 on a voluntary basis. The students in the histology course were both 1st year medical students and undergraduate pre-meds.

I felt that HIST1 is an excellent program to use in conjunction with the teaching of Pathology and Histology. The format is excellent and the program has been cleverly put together. However I would hope that in the future more teaching can be incorporated into this type of program. While realizing the difficulties involved, it would appear that the best kind of program for organ identification would be one in which a large number of comments, suggestions or explanations are presented before the organ is actually identified. The order in which the various organs were presented was not very obvious to us. It very likely reflects a sequence of teaching used at OSU and it would be useful information for trial users to receive when using the program."

> *Evaluation of CAI Programs on TYMSHARE Network, from Nelson Fausto, M.D., Associate Professor, Medical Sciences (Pathology), Brown University, May 30, 1973.*

"There is no particular pattern to periods of demand for the system which are dependent upon the area of study by students who are scattered throughout the curriculum. Recently, students, in

reviewing earlier material, have gathered in groups of 4-7 to take various courses like HIST . . . They appear to have strong positive feelings about the educational value of this kind of interaction, which seems to approach class recitation."

*Lister Hill Center CAI Experimental Network - Operational Users Report, from
Ralph E. Cutler, M.D., Director, Washington Independent Study Program,
University of Washington, 18 June 1973.*

"The technical unavailability of OSU complete HIST1 program, with continual access only to the DEMO program compromised the effectiveness of an announced program which proved to be largely unavailable to them.

The inability to commence later study at the specific point to which a student had progressed previously compromised the effectiveness of programs, especially OSU HIST1.

Although apparently approved, the inability of 'go to' shifts in program alternatives within a category reduced effectiveness. Students complained that if evaluation on a group of program items showed satisfactory knowledge they had to complete a whole unit before the vendor computer would allow a shift."

*January - February 1974 Lister Hill Center User Report, Medical College of
Wisconsin (MCW 222) from Weston D. Gardner, M.D., Professor of Anatomy,
LHNBC Program Monitor.*

GANAT1 (Gross Anatomy Self-Evaluation Exercise—tutorial)

AUTHORS: Medical students and faculty of the Anatomy Department, Ohio State University

DESCRIPTION: Review and self-evaluation in anatomy. Ten sections, each with a multiple choice test, include: anterior abdominal wall; abdomen; pelvis, thora, lower and upper extremities; back, head, neck, eye.

TARGET AUDIENCE: Any health professional as well as first year medical students.

USAGE: GANAT1 was the most used (in hours) of all the OSU programs used at UCLA, and at the Medical College of Wisconsin. It was used only an hour or two at Stanford and at Oregon.

FACULTY OPINION: GANAT1 was given a low rating on pedagogy by faculty at SUNY Downstate Medical Center. It received low ratings by Mayo staff on "flexibility of response to student error" and "quality of feedback." Quality or validity of program content was given an average rating by both groups.

PROGRAM EVALUATION: The Medical College of Wisconsin used the Ohio State University Gross Anatomy Course, GANAT1, in a paired experiment in teaching Gross Anatomy. In the 1973-74 academic year, the Department of Anatomy presented two simultaneous courses in medical Gross Anatomy.

Ninety-seven students formed a base group undertaking Gross Anatomy in the conventional course (Section A) which has evolved from other course development in the past.

Section B was a special course. For this course 24 students were selected to represent a cross section of abilities in the class. The basic selection process was to take every fifth student from a ranked list, but derandomizing the selection process to include at least one black and one female). Section B, directed by Dr. Weston D. Gardner, undertook a seminar and peer group instruction approach, using less scheduled classroom time. This group explored body systems in a series of tutorial seminars. Laboratory work consisted of in-depth study of one major body region per student. The latter part of the course was devoted to peer group instruction, in which students, who had made the in-depth study of a particular region, teamed up to use a variety of audio-visual methods to explain their understanding of the region to the other students. A particular feature of the Section B approach was the use of CAI and self-evaluation, using programs from OSU, UIMC, and MGH to self-evaluate their progress in learning.

The Section B course was a practical attempt to learn if a shortened systems course, with (a) less individual dissection but increased tutorial-seminar discussions, (b) varied audio-visual reinforcement, (c) computer-assisted self-evaluation, and (d) peer group instruction could be considered a valid approach in modern curricular planning.

Both Section A and Section B students were administered extra-mural final examinations (prepared under the auspices of the Association of Anatomy Chairmen): The National Board of Medical Examination and a short answer fill-in, diagram-type more objective examination.

"Preliminary results on the National Board Examination show that while there was no significant statistical difference between the conventional and special sections in the first year of the study (1972-73), this year's special section achieved a marked and significantly higher performance. The final report will present numerical figures and comparative data between the 1971-72 base group, and the conventional and special groups in 1972-73, and 1973-74.

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"Although it appears that the availability of CAI programs in 1973-74 may be mainly responsible for the higher achievement in the special section, several other variables must be and are being evaluated."[1]

COMMENTS: Use by students in this period shifted away from OSU-HIST1 and GANAT2 to OSU-GANAT1 and the 8 modules of OSU-PILOT for which special arrangements were made. Despite the fact that the OSU staff tend to deprecate their GANAT1 (as the oldest program with fewer program options such as branching) GANAT1 remains the single most popular most used program available to our students. Our program, despite the distinct asset of the addition of the PILOT modules, could not have been the success it has been (see Section V) without the evaluation-interaction-instruction enhancement derived from GANAT1.

Lister Hill Center User Report, Medical College of Wisconsin, March 1974

[1]This paragraph and one preceding are quoted comments from Weston D. Gardner, "User Report," January/ February 1974.

ACIBA (Acid-base Balance)

AUTHORS: Bob Clark, Medical Student, Ohio State University
Thomas Williams, M.D., Ph.D., Ohio State University

DESCRIPTION: Contains basic information on the following topics: respiration and blood-gas transport; quantitative acid-base balance (pH calculations); graphic analyses of acid-base balance; compensation systems (renal, pulmonary, body cells), anion gaps.

TARGET AUDIENCE: Clinical lab personnel, medical students, nurses, physicians, and student nurses.

USAGE: ACIBA received very high usage at nearly all of our sample schools. Its popularity is indicated by the following rankings in OSU program use for the period February 1973 - August 1974:

Oregon (Nursing)	UCLA	Stanford	Wisconsin	M.C. Virginia
3rd highest use	3rd highest	2nd highest	low use (4 hrs)	3rd highest

FACULTY OPINION: ACIBA was given average ratings by Mayo staff who evaluated it.

PROGRAM EVALUATION: NUR 312—Clinical Experience in Medical-Surgical Nursing

Sixteen sophomore students assigned to one clinical rotation will be assigned to review the programs ACIBA, COMA, JAUNDICE, VEINS, and STROKA (assigned for both 311 and 312; each of the 16 students, however, will review the program once). Performance of this rotation will be compared with the performance of the remaining NUR 312 rotations (14-16 students in each rotation) on criteria including the quality of nursing care plans produced, clinical performance, and test performance in NUR 311.

Project Coordinator: Ms. Donna Schantz
Assistant Professor of Medical-Surgical Nursing

PILOT

AUTHORS: Staff, Ohio State University

DESCRIPTION: The individual modular computer programs within the Ohio State University College of Medicine Independent Study Program serve as self-evaluation exercises for students who have studied a prescribed body of information. The ISP encompasses the preclerkship portion of medical school and the units of study are organized by body systems. Each modular self-evaluation (tutorial evaluation system, TES) presupposes student preparation in the unit of study (module) and an understanding of the designated modular instructional objectives. The questions within each self-evaluation exercise are not intended to cover all the specific modular instructional objectives, but rather to sample the student's knowledge of selected areas within the designated unit of study. The Independent Study Program is an integrated program of study with inter-disciplinary input to each module of study. Discipline coverage of a particular subject within a module can be obtained through examination of the instructional objectives. Therefore, the module objectives are not always to be considered as total coverage of a given subject, nor is the TES designed to measure the student's total comprehension of the instructional objectives.

TARGET AUDIENCE: First two years of medical school; health personnel

USAGE: At UCLA, PILOT was not used until September 1974. For the two months of September and October 1974, PILOT modules were used a total of 22 hours at UCLA, making PILOT one of the most popular OSU programs at the time.

PILOT was used far more than any other OSU program at Stanford—a total of 122 hours from January to October 1974.

At both UCLA and Stanford, students pursue independent paths of study. The PILOT programs are ideally suited to student needs in these environments.

Chapter 5

COSTS AND BENEFITS

COSTS

The Lister Hill costs for the first two years of Network operation (July 1, 1972 - July 1, 1974) were approximately $847,000—$344,000 for TYMSHARE, the communications contractor, and $503,000 for the Network contractors.

The TYMSHARE cost is subdivided into fixed costs (those costs that do not vary with increased usage) and variable costs. The fixed costs include the rental of TYCOM (there is a special communications computer at each host site), maintenance of the user name file, and invoice preparation. The TYCOM rentals are $1,950 per month, and the administrative overhead (user names and invoice preparation) a little over $1,000.

The variable portion of the TYMSHARE cost is broken down into connect time and characters transmitted. Variable costs are $5.43 per instruction hour. In a typical month's usage of 1800 hours, the variable cost would be $9,774.

The contractor costs are divided into two parts: part 1, the charge for the computer costs, part 2, the charge for the personnel support. Part 1 costs are based on a $600/month cost per communications port. Contractors are paid $600 per port each month. The number of ports for which Lister Hill has paid has varied, but as of September 1974, Lister Hill was paying for 14 ports—7 at each contractor center (OSU has donated two additional ports). At this rate of port usage, the annual hardware costs are $100,800; the annual personnel support costs are approximately $101,200.

Table 7 shows the total CAI cost per terminal hour. The table assumes there are 1800 terminal hours per month usage. (Actual monthly usage has varied from 1500 to 2300 hours.)

Table 7

Total CAI Costs Per Terminal Hour[a]

Component	Cost (Per Terminal Hour)[b]
TYMSHARE variable communication cost	$ 5.43
TYMSHARE fixed communication cost (TYCOMS, user names, invoice preparation)	3.28
Computer port charges	4.66
Computer host personnel support costs	4.69
NLM Central Staff	1.66
Total cost per terminal hour[b]	$19.72

[a]Does not include user institution costs for terminals, personnel, materials, or local communications facilities.

[b]Terminal hours are not always the same as student instruction hours. Students may work together in small groups.

Effective cost for a student hour of instruction is sometimes much lower than the terminal-hour cost. Students commonly work in small groups of two to four when using the MGH clinical simulations. For a group of three students, then, the cost per student hour would be a little over $6.00.

COSTS IN RELATION TO BENEFITS

One finding that emerged clearly from the Network Experiment was that the benefits of CAI distribution accrued directly to students but not to the institutions or faculty. Students benefitted in a number of ways, receiving:
- Remedial learning.
- Counseling.
- Review for examinations.
- Problem-solving experiences.
- Computer awareness they can apply later as practicing physicians.
- Wide range of simulated clinical experience.

None of these learning experiences replaced existing methods. Therefore, the costs do not displace any existing costs of medical training. The costs, and the benefits, were in addition to the existing curriculum. Consequently, it is inappropriate to compare the costs of the CAI learning experience with the costs of other learning modalities, such as lecture, small-group conference, individual counseling, or making clinical rounds. Such comparisons imply that the CAI might displace these other costs. Experience, to date, has not supported this.

The question is whether the additional benefits to students are worth the cost to the institutions or to the National Library of Medicine. General consensus seems to be that a cost of $19+ per hour is too high, even when maximum benefit is assumed.

Could the CAI resource benefit the institution? At OSU, there have been no cost savings by going to an independent study program for the first two years of medical training. The number of students could theoretically be increased without much increase in costs for the final two years. However, the clinical portion of training (the third and fourth years) would have to be increased to handle the additional students. Faculty-student ratio and hospital facilities required for clinical years of training are regarded as fixed constraints.

One other possible benefit to the institution would be the increased quality of its products as measured by performance of their graduates in Medical Board examinations. There are indications that such a benefit could be demonstrated. However, the complex, controlled studies needed to show such benefit have not been made.

Chapter 6

WHAT WAS LEARNED FROM THE NETWORK EXPERIMENT

Harold Wooster, Special Assistant for Program Development, Lister Hill National Center, presented a list of questions he hoped to have answered (Wooster, 1973). The summary findings are organized around these questions.

Use. "If CAI services are made available over a time-sharing communications network, will people be willing to sample them?"

The monthly average total time usage of approximately 2,000 hours attests to the fact that not only did they sample the materials but continued to use them repeatedly.

Curricula. "Can the material offered over the Network be integrated in a meaningful and useful way into existing curricula? Can it produce measurable benefits? Will it produce changes in the ways medical schools teach?"

The user institutions did not integrate the curriculum materials into their main-line curricula. Opinion surveys indicate that the MGH materials were perceived by both faculty and students to be supplementary learning devices. The OSU materials, on the other hand, were integrated to some degree. The faculty at a number of institutions assigned specific CAI learning modules as part of their classwork. While basic integration of the materials into the curriculum did not take place (except in isolated instances), this was not an obstacle to a high level of usage.

Many problems arose in attempting to measure specific educational benefits. Initially, the institutions envisioned a comprehensive program of evaluation for the CAI materials, but most did not accomplish their original objectives. Faculty found that they could not commit enough time to actually carry out a controlled study.

The Medical College of Wisconsin was a notable exception, since it conducted a scientific study of the effects of the Ohio State ISP anatomy modules.

The Medical College of Virginia encountered several difficulties in evaluating the cost-effectiveness of the network at the time it was deciding whether to continue. These difficulties included the following (Wergin, 1973):

- The usage statistics were not wholly comparable (e.g., data from Ohio State University and University of Illinois Medical College did not break down the usage by type of user).
- User resistance to answering questionnaires was encountered.
- Usage data were not related to the curricula (course performance).
- It was not possible to relate opinion survey data to cost/benefit decision-making.

The introduction of the Network into the schools·did not bring about noticeable changes in the institutions' teaching approach. The one outstanding case in which an entirely new educational program was affected, was the University of Washington's adoption of Ohio State's entire independent study program: philosophy, learning objectives, and program modules. (Although they modified the learning objectives and the CAI modules, the basic thrust of the program remained the same.) The Washington, Alaska, Montana, and Idaho (WAMI) satellite program, also operated by the University of Washington, is using the interactive satellite communication capabilities to bring the CAI programs to remote areas in these states.

CAI Materials Development. "What is the mechanism whereby new CAI material may be generated most efficiently, and cost effectively?"

This question was not answered by the Network Experiment. While Lister Hill initially expected the users to contribute materials to the Network CAI library as a condition of participation, this did not materialize. The predominate number of faculty members at user institutions did not have the proper incentives to spend time learning the prerequisite authoring skills, nor did they have time to do the actual authoring. Many of the faculty are preoccupied with research work in addition to their teaching responsibilities and, thus, were not interested in becoming CAI authors. Others who were interested in teaching felt that the present reward structure would work against them.

The contractors, per se, did not have a budget allocation for training user faculty as CAI authors. However, they did have a general fund for user support, primarily for support services.

Dr. Octo Barnett of Massachusetts General Hospital felt that the best use of available resources could be made through in-house authoring of materials since it would be time consuming to work with a number of authors from different institutions. Dr. Barnett has recently modified his view; he is now more receptive to working with other institutions on the development of materials.

Ohio State University, on a selective basis, has encouraged outside authorship. Dr. Paul Rehkopf of the University of Pittsburgh School of Medicine, Eye and Ear Hospital, is currently developing a series of programs on emergency room eye care. These simulation programs deal with the patient's medical history, physical examination procedures, and results of lab tests. The program content is being written at the University of Pittsburgh, and the computer programming is performed at Ohio State University by the instructional programming staff. The University of the Pacific is developing a series of cases to add to the CASE program library. The cases were developed online, using the CASE system driver program.

It was found that revision of existing materials is far more cost-effective than beginning over again on the same type of program. Washington Independent Study Program (WISP) faculty members, spending on the average only 2 hours per month over a 2-year period, have been able to make substantial revisions on Ohio State's Independent Study Program (ISP) whose initial development took many years and several million dollars.

Data Base Gaps. "What is the mechanism whereby gaps in the data can be identified and filled?"

The Network did not provide a direct answer to this question. However, some individual suggestions were made for areas and subjects in which there were clear data gaps. Users found that programs were needed which simulate nursing assessment (i.e., the identification of a problem that requires the immediate attention of a physician). These programs would be similar to the MGH programs on the clinical diagnostic simulation and treatment. Emergency medicine was an area that was frequently mentioned as a productive area for development of new CAI materials.

Many faculty members made the observation that the current Lister Hill library was limited. The Network Experiment pointed out the need for a comprehensive survey of users to identify the most important areas for library CAI expansion. This survey could be subdivided by class of user.

Network Organization. "How should the system be organized and managed? What is the best way to ensure interaction between users and providers so that the desires of both will be heard and acted on?"

The main weakness of the Lister Hill Network organization was that it did not involve key decision makers in the user institutions. This made it difficult to develop the

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proper level of support necessary to make the Network self-sustaining. Perhaps some type of policy board would have proved beneficial. The development of an effective human network proved to be the best mechanism for interaction between users and providers. Face-to-face contact between users and providers resulted in noticeable shifts in attitudes and policy.

One mechanism for assuring interaction was the on-line comments feature. This provoked thousands of comments from individual CAI library users. Another feature not available in the Lister Hill Network that would have added to this interaction is a teleconferencing facility in which two or more parties may carry on a conversation (e.g., faculty CAI authors from two different institutions conduct a conversation with a Network host about revision and expansion of the library's emergency medicine materials).

Site visits by host institution faculty with their counterparts in the user institutions were a definite stimulus to those curricula changes that occurred in the Network. After a site visit by MGH, the University of Pennsylvania offered an introductory course in clinical medicine.

Distribution. "What is the most cost-effective distribution (net-working) mechanism?"

The Network Experiment did not provide an answer to this question. Certainly the Network, as an experimental breadboard, was not the most efficient form of communications network. Communications costs were nearly 50% of total Network costs of $19/terminal-use hour. The remainder of the costs was for computer usage, host support personnel, and National Library of Medicine central staff costs.

If Lister Hill wishes to obtain concrete data on the most cost-effective distribution methods, it will have to conduct experiments on different distribution methods. This would involve producing cost estimates of these methods (e.g., the cost of a distributed computer network). In order to determine the actual cost. it would be necessary to measure the personnel cost component in an operational environment.

Economics. "How can the Network be made economically viable—
that is, how can it be placed on at least a partially self-sustaining basis?"

The Network Experiment has proven that CAI distribution can be partly self-sustaining. Network users are currently paying almost the entire variable component of the Network communications cost, which amounts to over 50% of the total communications cost. For example, the total bill to TYMSHARE for July 1974 was $12,959.91 of which $7,859.90 was billed to the user institutions. The question still remains whether the Network can be made fully self-sustaining. A stripped-down version of the present Network would cost between $8-12 per instruction hour. The $8 is a minimum amount which would cover only hardware costs, while the $12 figure would allow for some personnel support.

FUNCTIONAL REQUIREMENTS OF A <u>CAI</u> DISTRIBUTION SYSTEM

Certain functions related to distribution of CAI materials proved to be required in conjunction with the hard-wired Network.

(1) <u>User Tailoring</u>. The Ohio State's CAI tutorials demanded considerable user tailoring for acceptance at the individual schools. At the University of Washington every ISP received some revision. At the request of user institutions, Ohio State developed mechanisms for "individualizing" the learning units to meet user institutions' specifications.

(2) <u>Feedback-Revision Process</u>. One of the most valuable characteristics of the national Network was the ability to collect feedback on the material from users at many institutions. Users of the MGH clinical simulation programs wrote comments online as they went through a program. This information on content and pedagogy was based on immediate day-to-day learning experiences of students and faculty. Using these comments, authors of the materials at MGH were able to make continual refinement and improvements to the programs. (On page 58 are some examples that a user wrote as he went through a program.)

(3) <u>Support Services</u>. A key requirement of any distribution system is support services to facilitate user adoption and use. Ohio State had one full-time staff member whose primary function was to answer user questions. Users inquired about such things as the availability of particular learning materials, the availability of visual materials accompanying programs, the feasibility of writing their own CAI modules, the objectives and suitability of learning materials for their own student body, problems encountered in accessing the host institution, and programming errors encountered in some learning modules.

In addition to such services at the host institution, there was a considerable need for the same kind of service at local user sites. Learning laboratory directors and librarians were available to help overcome the initial hurdle of using a computer system. They answered questions on how to log onto the system, what steps to take in case of an accidental disconnect, and generally, to assist and orient people.

(4) <u>User Documentation</u>. In the initial stage of the experimental Network, there was a lack of instructions on how to use the CAI library, resulting in a great deal of aggravation and frustration. The contractors, in response to this problem, developed comprehensive user guides (Ohio State University College of Medicine, 1974; Massachusetts General Hospital, Laboratory of Computer Science, undated). User institutions also developed local instruction sheets and booklets to help fulfill the information requirements.

(5) <u>Peer Review</u>. The Network Experiment indicated that the absence of a review body was a significant deterrent to the enlargement of a CAI library. In the absence of a review board, the host institutions (contractors) had to pass judgment on whether new CAI materials developed at other institutions should be accepted for Network national distribution. Faculty members at user institutions asked that their materials be added to the Network library, but they were not permitted to do so. The contractors were concerned about the reputation of their institution and were, therefore, reluctant to

USE OF HYPERTENSIVE EMERGENCIES

MARTIN HORN (53.30,271.40,MSH) "GEO WASH U 1" 10/05/74
   STUDENT, HAVE NOT BEGUN PRINCIPAL MEDICAL CLERKSHIP
10/05/74   7:38 PM   TOT: 0.09
      GOOD PROGRAM

USE OF GI BLEED

JOHN MAHAN (7.01,2.43,JDM) "HAHNEMANN" 10/05/74
   STUDENT, HAVE BEGUN OR HAVE COMPLETED PRINCIPAL MEDICAL CLERKSHIP
10/04/74   9:49 PM   TOT: 0.08
      HOW WOULD YOU KNOW THAT THE PAT. BRUISED EASILY AND HAD
   NNOSEBLEEDS IF HE WAS UNRESPONSIVE. ESP. SINCE THE DX IN THIS CASE
   SEEMS ESP. DEPENDENT ON THE HX GIVEN BY PAT. (AND KNOWING THAT
   IN THE MIDDLE OF NIGHT A PTT AND PT ARE HARD TO COME BY.)

JOHN MAHAN (7.01,2.43,JDM) "HAHNEMANN" 10/05/74
   STUDENT, HAVE BEGUN OR HAVE COMPLETED PRINCIPAL MEDICAL CLERKSHIP
10/04/74   10:21 PM   TOT: 0.10
      HOW WAS ACUTE GASTRITIS RULED OUT WITHOUT HAVING THE RESULT
   OF THE ENDOSCOPY KNOWN?

LEVI YASGUR (7.01,2.44,LHY) "HAHNEMANN" 10/05/74
   STUDENT, HAVE NOT BEGUN PRINCIPAL MEDICAL CLERKSHIP
10/05/74   11:29 AM   TOT: 0.02
      HOW TO DIFFERENTIATE THIS FROM GASTRIC ULCER/

RAMON DOMINGO (53.30,271.39,RKD) "GEO WASH U 1" 10/05/74
   MEDICAL SUB-SPECIALITY, FELLOW, 3 TO 5 YEARS OUT OF MED SCHOOL
10/05/74   5:50 PM   TOT: 0.01
      WHYDIDYOUNOTALLOW ME TO GASTROSCOPE THE PATIENT /

USE OF ARRHYTHMIAS

JOE MAKINEN (53.30,271.38,LJM) "GEO WASH U 1" 10/04/74
   STUDENT, HAVE NOT BEGUN PRINCIPAL MEDICAL CLERKSHIP
10/04/74   5:30 PM   TOT: 0.05
      HX=125, I=217,05
   FIGURE 9 DOES NOT LOOK LIIKE WENCKEBACH.
   HX=125, I=222
   DEAR SIR TRANSVENOUS PACING (1) COSTS MONEY (2)   CAUSES
   PATIENNT DISCOMFORT AND (3) NECESSITATES AN INVASIVE
   PROCEDURE WHICH COULD CONCIEVABLY LEAD TO DANGEROUS

include materials in the library which they felt were of questionable merit. Ruann E. Pengor and Dr. Robert Beran of Ohio State have repeatedly stressed the need for an outside review body to pass on the quality of CAI learning materials.

(6) People Networks. In the early months of the Network Experiment, there was little or no collaboration among user institutions. The Network program did not provide explicit mechanisms for user cooperation.

Later, it became apparent to the users that a "people network" was needed in conjunction with the hard-wired network. The Health Education Network Users' Group (HENUG) was formed in the latter part of 1974 to satisfy this need. HENUG was formed under the auspices of the Association for Development of Computer-Based Instructional Systems (ADCIS).

Article II of the HENUG by-laws spells out the functions which the members believe the "people network" needs to perform. Article II, Objects of the Society, is as follows:

ARTICLE II

Objects of the Society

Section 1. To maintain and enhance medical education through inter-institutional sharing of materials as initiated by the National Library of Medicine's Experimental CAI network.

Section 2. To investigate academic and professional aspects of computer-aided instruction (including but not limited to) faculty development, curriculum development, authorship, evaluation, and peer review.

Section 3. To investigate technical and functional aspects of computer-aided instruction (including, but not limited to) networking alternatives, program transfer, documentation, distribution, and cost effectiveness.

Section 4. To develop computer-aided instruction into a disciplined literature.

Section 5. To communicate with users and with medical educators in general on the status, availability, and effectiveness of computer-aided instruction.

Section 6. To provide meetings for the reading and discussion of papers on computer-aided instruction, to discuss policy, and to disseminate knowledge.

(HENUG, 1974)

Chapter 8

PROGRAM RECOMMENDATIONS

Experimentation with the Lister Hill Biomedical Network pointed out the need for further research in a number of directions.

(1) Research on Efficient Distribution Systems. Costs continue as a significant barrier to the use of CAI as a major teaching modality. The Library should consider sponsoring a long-term research program on different methods of CAI program distribution. The Lister Hill Center should sponsor experimental programs using different delivery system methods. The Network Experiment has shown that relatively few CAI programs account for the bulk of CAI usage. If these programs were distributed in a standard language or languages to libraries having compatible intelligent terminals, the cost could be compared with other means of distribution. A report has been prepared for the Lister Hill Center on programming languages used in health sciences CAI programs (Brigham, 1973). This report will be helpful in considering the problems and prospects of language standardization.

Because of the high cost of national networking, the Library should establish experimental programs which try out other approaches to distribution, such as minicomputers, desktop computers, and intelligent terminals. A report has been prepared for the Lister Hill Center on minicomputers, comparing them to large computers (Brigham, 1973).

(2) Research on the Instructional Benefits of CAI Programs. The Lister Hill Network Experiment indicates a strong need for more concrete evidence of the beneficial nature of the CAI programs. In-depth studies of the learning benefits are called for. The Library, therefore, should sponsor a continuing evaluation program.

(3) Survey of CAI Library Needs. The Lister Hill Experiment indicates the inadequacy of the scope of the Library programs. A survey of the educational needs of various user populations should be undertaken to learn those subject areas in which CAI materials are lacking.

(4) Development of an On-Line Bibliography for CAI Programs. The availability of a CAI program bibliography service will facilitate the exchange of CAI programs. Learning resource medical center personnel and biomedical librarians need information on learning materials available in specific subject areas and compatible with their computer environment. The availability of a catalog of health sciences CAI programs will facilitate the establishment of an on-line bibliography (Brigham, et al., 1973).

(5) Development of a CAI Review Board. A recurring problem in the experimental network was the lack of a constituted body ·to judge the merits of CAI programs. Network hosts were placed in the position of having to determine the quality of their own programs. It would be of significant benefit to involve the various specialty boards and associations in a review function. The American Association of Medical Colleges would be the logical organization to develop the overall objectives, goals, and procedures for establishing CAI program review mechanisms.

(6) Establish an Experimental Clearinghouse for CAI Programs. Many CAI programs developed at local computer centers are not available for general distribution.

This means that each institution requesting a CAI program must individually negotiate the release of that program. There are numerous legal and logistical problems associated with the release of CAI programs for general distribution.

Ohio State encountered difficulty in working out the copyright arrangements for the visual display accompanying many of the CAI programs. An experimental clearinghouse function would test out many of the problems associated with exchange and distribution.

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Appendix B

NETWORK SERVICES NODE ACCESS
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State	City	State	City
Arizona	Phoenix	Maryland	Baltimore
Belgium	Brussels	Massachusetts	Boston
California	Cupertino	Massachusetts	Boston
California	Cupertino	Massachusetts	Cambridge
California	Inglewood	Michigan	Detroit
California	Inglewood	Minnesota	Minneapolis
California	Los Angeles	Missouri	Kansas City
California	Los Angeles	Missouri	St. Louis
California	Mountain View	New Jersey	Englewood Cliffs
California	Newport Beach	New Jersey	Union
California	Oakland	New Jersey	Wayne
California	Oxnard	New York	Buffalo
California	Palo Alto	New York	New York
California	Palo Alto	New York	New York
California	Riverside	New York	New York
California	Sacramento	New York	Rochester
California	San Diego	New York	Syracuse
California	San Francisco	Ohio	Columbus
California	San Jose	Oklahoma	Oklahoma City
California	San Jose	Oregon	Portland
Colorado	Denver	Pennsylvania	Philadelphia
Connecticut	Darien	Pennsylvania	Pittsburgh
Connecticut	Hartford	Texas	Dallas
DC	Washington	Texas	Houston
DC	Washington	Texas	Houston
Florida	St. Petersburg	Texas	Houston
Florida	Tampa	Texas	Midland
France	Paris	Texas	San Antonio
France	Paris	Washington	Seattle
France	Paris	Wisconsin	Milwaukee
Georgia	Atlanta		
Illinois	Chicago		
Illinois	Chicago		
Illinois	Freeport		
Illinois	Freeport		
Louisiana	Baton Rouge		
Louisiana	New Orleans		