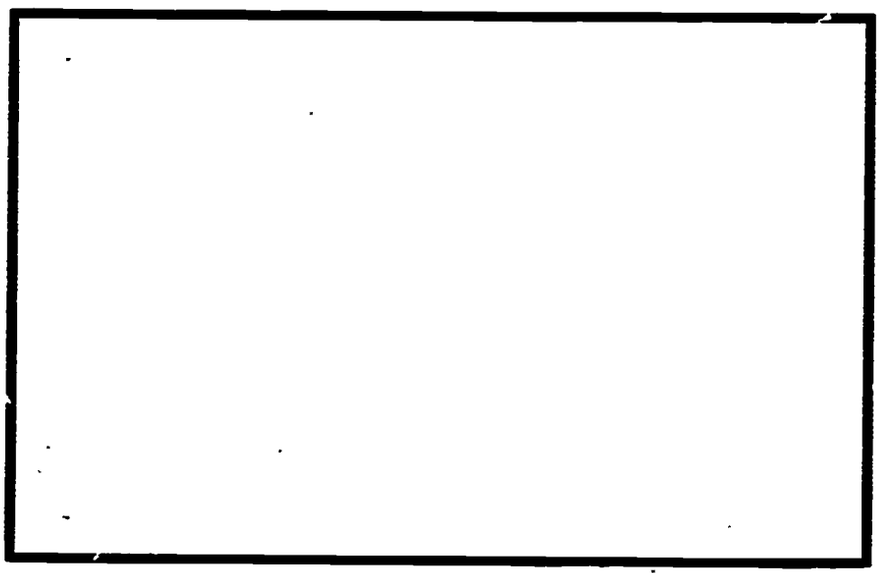
DOCUMENT RESUME

ED 072 627 EM 010 712

AUTHOR	Judd, Wilson A.
TITLE	The University of Texas at Austin Computer-Assisted Instruction Laboratory: A Program of Research and Development. Technical Memo Number 7.
INSTITUTION	Texas Univ., Austin. Computer-Assisted Instruction Lab.
PUB DATE	Jul 72
NOTE	14p.; Paper presented at the International School on Computer in Education (Pugnochiuso, Italy, July 3-21, 1972)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Computer Assisted Instruction; *Computer Based Laboratories; Computers; Educational Research; *Higher Education; Instructional Media; *Research and Development Centers
IDENTIFIERS	*Computer Assisted Instruction Laboratory; University of Texas at Austin

ABSTRACT

The history, facilities, management, research and development programs, curriculum, and future of the University of Texas Computer Assisted Instruction Laboratory are presented in this memo. Particular attention is paid to the research and development program which since 1967 has developed a wide variety of instructional applications. (MC)



THE UNIVERSITY OF TEXAS AT AUSTIN

Computer Assisted Instruction Laboratory

AUSTIN

The University of Texas at Austin

Computer-Assisted Instruction Laboratory:

A Program of Research and Development

TECHNICAL MEMO NO. 7

Wilson A. Judd

Paper Presented at the

International School on Computer in Education

Pugnochiuso, Italy

July 3-21, 1972

The University of Texas at Austin
Computer-Assisted Instruction Laboratory
Wilson A. Judd and Harold F. O'Neil, Jr., Co-Directors
Austin, Texas 78712

History and General Information

The Computer-Assisted Instruction Laboratory of The University of Texas at Austin was initiated in June 1965 by Dr. C. Victor Bunderson as part of an overall objective of bringing the University of Texas to a position of leadership in the applications of computers to the problems of a large university. It was organized with no formal ties to any particular academic department under Dr. Wayne H. Holtzman, then Dean of the College of Education.

Through a contract agreement, IBM initially furnished and maintained, on a rent-free basis, a system for computer-assisted instruction (CAI), including an IBM 1401 computer and four on-line student terminals. In return, the University supplied personnel to operate the system and to conduct basic research and course development projects in instruction and learning. The Laboratory's contribution was financed by a grant from the Carnegie Corporation and by funds from The University of Texas.

A second development project funded by the Texas Coordinating Board for Higher Education, was begun in September 1966 to foster interdisciplinary programs in experimental computer-assisted teaching by enlarging the research staff and obtaining a larger computer system designed expressly for CAI. In February of 1967 the 1401 was replaced with an IBM 1440 system which supported a network of fourteen terminals, many being teleprocessed to other universities and public schools in Texas and Louisiana. These terminals were used to provide orientation and training in CAI for teachers, administrators, and potential authors. This development was funded through a contract with the Southwest Educational Development Laboratory and a second contract with IBM Corporation.

In June 1967 the Laboratory purchased the first production model of the IBM 1800/1500 instructional system to serve as an independent complement to the 1440.

A major effort to implement a remote terminal capability for CAI on an IBM 360/50 computer shared with the University's Data Processing Division was undertaken in January 1969. This project was funded primarily by the Colleges of Education and Business and by a CAI program development contract with IBM. It was hoped that this 360 system would be viable for the evolutionary development of operational CAI at the University of Texas, but due to a number of financial and technical problems, the project was terminated in May 1970. During this

period the 1440 system was phased out when the original IBM-UT agreement came to an end. The CAI Laboratory's activities are now centered around an expanded 1500 instructional system.

In late 1970, the Laboratory was awarded a major subcontract for the production of junior college-level courseware for TICCIT a market-oriented computer-based learning system being developed by MITRE Corporation under National Science Foundation funding. A similar subcontract was awarded to the Brigham Young University Division of Instructional Services. Due to a reduction in funding in late 1971, a decision was made to consolidate both subcontracts at Brigham Young. Due to his interest and involvement in this work, Dr. Bunderso resigned as Director of the Laboratory and joined the faculty at Brigham Young. The direction of the Laboratory was undertaken by Drs. Harold F. O'Neil, Jr., and Wilson A. Judd in April, 1972.

Facilities

The CAI Laboratory instructional computer facility is now the IBM 1800/1500 system, consisting of five 1810 disk drives, two 2402 tape drives, a 1442 card read/punch and a 1443 printer. The system drives nine 1510 cathode ray tube (CRT) terminals, with 1512 image projectors and light pens and three 1518 typewriter terminals. Four of the CRT terminals are also supplemented by 1506 fast access audio units. Eight of the CRT terminals and two of the typewriter terminals are located in a special terminal room in the College of Education's Sutton Hall. The CRT terminals are in individual, acoustically treated carrels, while the typewriter terminals are located in a separate section of the room, available for general access by students and the instructional proctors. The 1500 system itself and the remaining terminals are located in the basement of the building in a specially-constructed machine room and an adjacent programming area. A CAI materials library is also available for use by faculty, staff and students.

The system is currently running under Coursewriter II version 4.2 and APL version 3.1. The two cannot run simultaneously. A preprocessor to facilitate the production of Coursewriter code from author's draft materials has been developed and is currently in use, being run on the University's CDC 6600-6400 system. A data management system is used on the 1500 which sorts, merges, and summarizes student data for analysis. In addition, special purpose data analysis programs have been developed in FORTRAN IV as the need has arisen.

Since the IBM 1800/1500 system is not suited for extensive data analysis, the CAI Laboratory utilizes the University of Texas Computation Center's facilities, a CDC 6600 and a CDC 6400, for this type of work. In addition, the facilities of the University of Texas Measurement and Evaluation Center are utilized for batch mode, off-line computer-managed instruction and computer-based testing. These facilities include an OpScan 100 system for optically reading responses gridded on standard mark sense forms and for converting test scores, item responses, and questionnaire responses to punched card form for subsequent computer analysis. Finally, the CAI Laboratory draws upon the facilities of the University Media Center and Television Center on an as-needed basis.

The system is available for daily use (50 to 80 hours per week) with a proctor on duty in the terminal room. To use the spring 1972 semester as a typical example, terminals were available for student use 12 hours per day, between 8 a.m. and 10 p.m. The noon and supper hours were used for system utility as was the period from 10 p.m. until midnight. Saturdays were used for special projects such as experiments requiring well controlled conditions.

Student scheduling is on an ad lib basis in terms of one-hour blocks. That is, students call in and make appointments to use a particular course during any of the regular hours. Since a major course may require up to four disk packs and since students tend to spread themselves out through a course, we have found that the system's limiting factor is the number of disk packs rather than the number of terminals. If all students working on a particular course were required to schedule during restricted hours, the limiting factor would be the number of terminals, but thus far such a restriction has not been necessary.

The 1500 system was designed for research purposes. This is one of the Laboratory's activities and for these purposes the system is quite satisfactory. The flexibility provided by the sophistication of the terminal devices is quite advantageous. System response time is slower than might be desired for some purposes. Data retrieval often appears to be unnecessarily cumbersome, but, in general, the system provides a powerful and convenient research tool. Use of the 1500 for broad-scale, production CAI is somewhat less satisfactory since the system, as it is configured at The University of Texas at Austin, is too small to support an extensive CAI curriculum effort.

Management and Personnel

The CAI Laboratory is a separately-budgeted administrative unit of the University, receiving continuing financial support for administrative personnel and functions from the College of Education. The great majority of the Laboratory's funding, however, must be derived from outside sources--Federal and State agencies and public and private foundations.

The Directors of the Laboratory report to the Dean of the College of Education, Dr. Lorrin G. Kennamer. While the Co-Directors are both involved in almost all aspects of the Laboratory's activities, Dr. O'Neil assumes primary responsibility for project management, while Dr. Judd is responsible for the day-to-day operations. Both also hold joint appointments in the Department of Educational Psychology.

In addition to the Co-Directors, the current staff consists of 17 members: a faculty-level research associate, an instructional designer, six graduate assistants, a systems and programming manager, two programmers, a systems operator, two instructional proctors, and a three-member secretarial staff. The Laboratory also draws on the expertise of a number of other members of the College of Education faculty for specific projects.

Research and Development Program

One of the Laboratory's earliest research projects was a two-year program concerning the relationship of cognitive abilities to learning, begun in October 1967. Its purpose was to develop theorems of instruction based on the interaction of task variables and individual differences, and to relate them to the task of the instructional designer. On the basis of this work, a model for research in the area was recommended, cognitive processes relevant for concept and rule learning were hypothesized, a model of simple concept learning was outlined, and specific recommendations were made for a systems approach to instructional design, utilizing differences in intellectual abilities.

In 1968, the Laboratory undertook the development of computer-assisted programs in chemistry, selected topics in precalculus mathematics, a punctuation and English usage course, and a prevocational training program for educable mentally retarded high school children. These programs were designed to adapt to individual differences by means of embedded performance measures. The programs all received extensive evaluation and were revised on the basis of that evaluation. A number of them are currently being used for instruction at The University of Texas and elsewhere.

In conjunction with the installation of the IBM 360 system, IBM funded the development of an extensive program in precalculus mathematics. This program, named MATH-S, was designed for the 360 system but both 360 and 1500 versions are now available. The program provides instruction in the topics of exponents, logarithms, and dimensional analysis, and remedial drills in prerequisite arithmetic skills.

In 1969, the CAI Laboratory received a major grant from the National Science Foundation for research into the empirical and theoretical foundations of instructional design for computer-based instructional systems. A number of research and development projects have been completed under this funding. A program was developed which teaches the Arabic writing system to university-level students in a very short period of time. This program provided intensive interaction with a variety of media and was highly individualized. The success of the program in comparison to alternative instructional methods is considered to demonstrate the soundness of the instructional design principles mentioned previously.

A second project has concerned the investigation of student-controlled CAI as contrasted with the conventional use of branching algorithms. The majority of the work in this area has been conducted in the context of the previously mentioned MATH-S program and has indicated that student control can have a definite role in CAI and that a student's ability to utilize such control effectively increases with practice. Two recent studies in this area, conducted in the contexts of a rule learning task and a concept learning task, have demonstrated affective advantages for learner control, i.e., reduction in anxiety, as contrasted with algorithmically controlled programs.

An ongoing project under NSF funding is investigating computer-controlled branched or sequential testing techniques. The pilot work conducted thus far was done in the context of a precalculus mathematics class. Criterion-referenced tests were programmed and paper and pencil instructional packages were developed for the topics of set algebra and trigonometric identities. Homogeneous pools of test items were constructed for each of the objectives in the two topics and the objectives themselves were ordered in an hypothesized hierarchy on the basis of a task analysis. The number of test questions administered for each objective was a function of student performance, i.e., the student continued to receive test questions until the probability of a misclassification error

dropped below a predetermined value. At the conclusion of the test, the students were given a typewriter listing of the objectives passed and failed.

In the test's final form, a student would be tested on an objective from the middle of the sequential hierarchy. Mastery of that objective would be assumed to indicate mastery of all of the lower-order objectives in the hierarchy and the student would be tested on only the higher-order objectives. Similarly, performance short of mastery would be assumed to imply that all higher-order objectives would also be failed. At this time, only the decision rule concerning the number of questions to be administered for each objective has been implemented. Students were tested on all objectives as a means of evaluating the hypothesized hierarchies. Results of our pilot work indicated that only one of the two hierarchies was valid. The second will require substantial revision.

A second current project is the development and evaluation of a simulated classroom to test the identification skills taught by a CAI program developed at Pennsylvania State University. The instructional program, Computer-Assisted Remedial Education, was designed to prepare in-service teachers to recognize previously undiagnosed handicaps to learning in their students. The simulation was designed to provide a realistic posttest and a means of allowing teachers to practice their new skills. The simulation program provides access to student records and work samples, photographs of the children, samples of their speech, and the comments of previous teachers. With the exception of the handicapped children embedded in the class, the characteristics of individual children are generated from data pools at run time. Therefore, no two teachers ever have the same class of children. Appropriate medical and psychological reports are generated for those children whom the teacher selects for referral, thus providing him with feedback with regard to his identification skills. The simulation is in the final stages of debugging and will be operational late this summer.

The Laboratory's major current project is an individualized, computer-managed instruction (CMI) sequence of five modules being developed for an introductory educational psychology course. This work involves a task analysis of the subject matter to be covered, the preparation of appropriate off-line study materials, and the development of strategies and techniques for computer-controlled testing and diagnostic remedial feedback for the student. An expanded

student response data collection and reduction system is being implemented to provide class instructors with up-to-date summaries of their individual students' progress. The CMI program is scheduled to be operational in September 1972 for use by approximately 600 students per semester. The instructional materials are undergoing formative evaluation this summer. The test program and remedial prescriptions will be evaluated during the fall semester and revised as appropriate for use in January 1973. This second administration will be followed by a second evaluation and revision.

A particularly interesting feature of this CMI project is that short anxiety measurement scales will be embedded in the on-line tests. Students who indicate a particularly high degree of test anxiety and who perform poorly on the test will be selectively advised of the availability of desensitization therapy for test anxiety. In the project's later stages, automated desensitization techniques will be incorporated into the testing program itself.

The final current project also concerns the measurement and reduction of anxiety but in the context of an adult intelligence test administered on-line. This work is supported by the U.S. Office of Education funding which began in May 1972.

Current Curriculum and Its Evaluation

During the past year, the CAI Laboratory adopted a policy of concentrating its instructional efforts within the College of Education. At this time, most of the education students using the system are concerned with just two subject matter areas: introductory statistics and diagnostic screening for handicapping conditions.

This summer, students in introductory statistics have been using three different programs. Those who performed poorly on an arithmetic skills test administered the first day of class were advised to review and practice these skills by means of the drill routines in the MATH-S program.

The topics of central tendency, variability, and graphing were presented by means of paper and pencil self-instructional modules and a corresponding CAI program written in APL. This program generates practice problems for the student. He may either answer the problem himself or ask the program to work out the problem, showing the intermediate steps. Interleaved among the problem sequences are short simulation programs which allow the student to see concrete demonstrations of some of the concepts he has been taught, e.g., the sum of a distribution

deviation scores from the mean is equal to zero; the sum of the squared deviations from the mean is less than that from any other value etc. Finally, the program provides a calculator function which computes descriptive statistics for selected distributions. The student may alter one or more scores and observe the effect on the statistics or enter his own distribution.

Students are administered a weekly test in the classroom. (It is anticipated that eventually this test could be placed on-line.) Any student who fails the test may retake a parallel form of the test three days later but only if he has completed an appropriate workbook assignment. The student completes the workbook problems off-line and then makes an appointment to use the IBM produced program Stat-Lab. Stat-Lab presents the problem numbers and requires the student to enter his answer. If the answer is correct, the next problem answer is requested. If the answer is wrong, however, the student is branched into a remedial loop which leads him, step-by-step, to the correct solution. The problems are keyed to a small number of specific concepts. If a student misses a number of problems relating to a certain concept, he is given additional review and problems relating to that concept. The instructor determines the number of incorrect problem solutions which trigger this review. He can also delete problems which he does not consider to be important.

Stat-Lab is the only one of the three programs which has been previously evaluated for use in statistics at The University of Texas. Attitudes and posttest performance of students using the program were contrasted with those of students attending a conventional weekly statistics laboratory. While there was a slight advantage for the program in terms of student attitudes, no performance differences were found. It is anticipated that the selective use of the program for students requiring remedial assistance will prove to be more beneficial.

The second program receiving heavy use is the previously-mentioned Computer-Assisted Remedial Education program (CARE-1). CARE-1 is a general survey course in special education designed for the 1500 system and utilizing all of the terminal's components--CRT, image projector, and audio--quite heavily. Developed under the direction of G. Phillip Cartwright and Harold Mitzel at The Pennsylvania State University, CARE was designed to give in-service preschool and elementary teachers the skills necessary to identify handicaps to learning

in children. The course requires approximately 30 hours of student work at the terminal. It covers mental retardation, emotionally disturbed and disadvantaged children, visual, hearing, speech, motor, and learning disabilities, an introduction to testing and measurement, and documentation and referral procedures, as well as a general introduction to the problems of working with exceptional children.

CARE-1 was first informally evaluated for use at The University of Texa by a group of special education graduate students. These students, who were considered to be subject matter experts worked their way through the program, filling out a rating form after each chapter which asked them to consider the clarity and comprehension level of the general language, accuracy, depth, and scope of the information presented interest value of presentation style· step size, and logical order of presentation. A group critique of the program was also held following their completion of the program. In general, the evaluations were quite favorable.

Having established the adequacy of the program for content and presentation, it was next administered to a group of in-service teachers, the populatio for which it was designed. All of these teachers filled out a student opinion survey developed by the Penn State Laboratory. This is a 42-item questionnaire administered on-line following the final examination. It treats student attitudes toward CAI, the operation of the equipment, likes and dislikes concerning the course, and the trainees' general feeling about the learning situation. Each item is rated on an eight-point Likert scale. A neutral score for the complete survey is 189, with lower scores expressing a negative attitude, and higher score a positive attitude. The obtained scores ranged from 181 to 294, with a mean of 241. The final examination consisted of 75 constructed response and multiple choice questions randomly selected from a larger pool of items. The group had a mean score of 62, with a range of 48 to 73.

During the fall semester of 1971, the major part of the CARE-1 program was first offered as an adjunct to a regular course for teacher trainees. The 69 students in the course were randomly assigned to one of three groups. All three groups attended class lectures. The first group also worked with the CARE-program. The second used the CARE-1 handbook and met for weekly, one-hour discussions. The third met for discussions but used other instructional materials.

Two parallel forms of a 100-item paper and pencil test were developed. Fifty items in each form were derived from the content of the lectures and fifty from the CARE-1 content. One form was administered as a pretest, the second as a posttest. Using the pretest score as a co-variable, the first group--CAI--was found to have a significantly higher adjusted posttest score on both the CARE-1 portion of the test and the total test score. The other two groups did not differ from each other. Apparently the advantages of the CAI experience generalized to lecture portions of the course.

Since this evaluation, the program, or major portions of it, have been used in other courses in the College and it is anticipated that it will soon be accepted as a recognized course in its own right in the University's extension division.

The previously-mentioned Arabic writing program is not utilized as heavily as the statistics and CARE-1 programs but is an established part of the University's introductory course in Arabic. During the first two weeks of the course, students spend four to eight hours working at the terminal and four hours in group sessions with the instructor for additional training in pronunciation. The equivalent training period for a conventionally-taught course requires approximately 18 class hours over a six-week period.

The program leads the student through the pronunciation and construction of the printed and cursive forms of the Arabic letters. The student has to evaluate his accuracy of pronunciation but the program does provide feedback as to the accuracy of his construction of the cursive characters. After being shown the proper sequence of steps for constructing each character, the student draws the character on the face of the CRT with a crayon. At his request, the program then draws the correct character on the CRT immediately behind his construction.

The final program receiving continual use is the English punctuation and usage program PUNCT. The University of Texas International Office regularly recommends its use to new students from other countries who are experiencing difficulty with the mysteries of English punctuation and grammar.

There are a number of other programs in the Laboratory's library which are requested for use by instructors at one time or another but none have become as established as those discussed.

Future Prospects

Currently, the University of Texas CAI system is under-utilized for instructional purposes. There are a number of reasons for this: the novelty of the instructional medium, the amount of advance preparation necessary for its use, and the cost of program preparation. A major reason is undoubtedly the high cost of student terminal time. Because of the system's relatively expensive hardware and the limited number of terminals available at our facility, student terminal time costs are higher than the current cost of conventional instruction at The University of Texas. If institutions placed a dollar value on the time students spend preparing for class as well as class time, the comparison would be much more favorable to CAI.

An interesting related problem concerns the source of the funds used for a CAI program. Since cost-per-student-hour can be reduced if development expenses are distributed over a large population of students, lower-division undergraduate courses would appear to be the most promising market for CAI in a university. These courses, however, are usually taught by graduate students. If a department spends funds allocated for these courses on a CAI program, it has lost one means of supporting graduate students. Given the relative importance attached to graduate, as opposed to undergraduate, training, few departments are willing to divert funds to CAI.

The decision to concentrate the Laboratory's future activities within the College of Education is based on several of these considerations. The College, by its nature, has a basic interest in the development of improved instructional techniques. In addition, the administration and faculty have recognized the need for revising the curriculum of the College with particular emphasis on practicality and the individualization of instruction. The Laboratory staff feels that CAI has an excellent chance of being accepted on a broad scale in the resulting atmosphere of re-evaluation and innovation.

Since the Laboratory's computer facility is of limited capacity, it would be difficult to have any broad effect through CAI on an institution as large as The University of Texas at Austin College of Education. Thus, computer-managed instruction programs are being added to the Laboratory's library. Due to the relatively short periods of time which each student spends at the terminal in a CMI program, it is feasible for us to bring over one thousand students

per semester into contact with the instructional computer system. The previously discussed introductory educational psychology course will provide a major step in this direction.

Interest in a similar CMI program has developed in the Department of Educational Administration. This program would provide management for an individualized training program for in-service high school principals from Mexican-American communities.

It is certainly not our intent to neglect CAI. Activities in this area will probably be concentrated on instructional simulations, similar to the previously-discussed simulation designed to evaluate the skills developed by the CARE-1 program. Such simulations would allow student teachers to practice coping with a variety of classroom problems and give psychological counseling trainees valuable experience in simulated counseling situations prior to their contact with actual clientele.