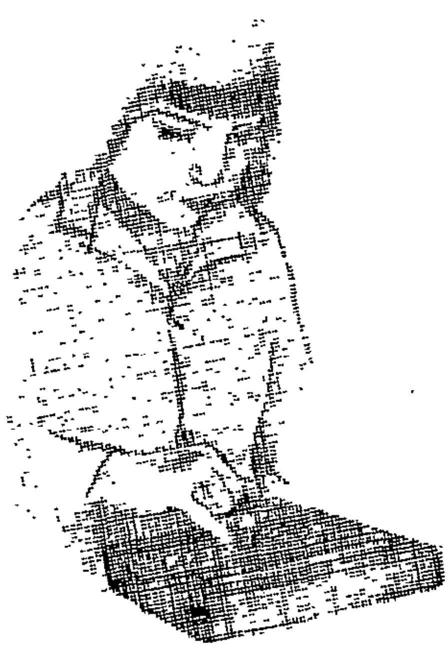
CENTER FOR INTERNATIONAL EDUCATION

School of Education
University of Massachusetts
Amherst, MA 01003

Microcomputers for Basic and Vocational Skills

IV. A Review of Evaluations



Electronic Aids for Literacy Project

Microcomputers
for
Basic and Vocational Skills

IV. A Review of Evaluations

Electronic Aids for Literacy Project
Center for International Education
University of Massachusetts
Hills House South
Amherst, MA. 01003

Prepared for :
Office of Education
Bureau of Science and Technology
U.S. Agency for International Development

Contract: A.I.D./DPE-1108-C-00-3062-00

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Kathe Conrad

April, 1984

A REVIEW OF EVALUATIONS

The project was asked to compile an annotated bibliography of recent evaluations of computer-assisted instruction (CAI) and submit copies of key studies.

Material was identified in two ways. The first was a general search of the ERIC database, focussing on evaluations of CAI for basic and vocational skills. This search led to an annotated bibliography of some 72 studies. It includes articles published between 1966 and August, 1983. This 32 page bibliography is contained in the Appendices. The second method of identifying material was sifting through bibliographies of studies that tried to integrate or synthesize findings on CAI effectiveness. This kind of "macro" approach seemed necessary because of the potentially large volume of literature evaluating CAI. For example, the study by Kulik et al (1980) listed below identified some 500 studies comparing the effects of college-level CAI to conventional teaching. Copies of articles or abstracts of key articles were obtained from the library. The key studies are listed below, and copies of the studies are found in the Appendices. For this part of the search, the concern was with how well the information contributed to an overall understanding of the effectiveness of CAI and was not restricted to basic and vocational skills. In general, studies written more than ten years ago were not considered "recent" and not included in the collection of key articles. The list of key studies includes the following:

1. Kulik, J.A., Bangert, R.L., and Williams, G.W. "Effects of Computer-Based Teaching on Secondary School Students." Journal of Educational Psychology, 1983, Vol. 75, No. 1, pp 19-26.

This important study uses meta-analysis techniques to integrate the findings from 51 evaluations of CAI at the secondary level. A copy of the article is contained in the Appendices.

2. Ragosta, M., Holland, P.W., and Jamison, D.T. "Computer-Assisted Instruction and Compensatory Education: The ETS/LAUDS Study: Executive Summary and Policy Implications." U.S. National Institute of Education. June 1982.

This is a discussion of a project conducted by NIE and the Educational Testing Service with the Los Angeles Unified School District. The four-year study looked at the use of CAI for compensatory education in elementary schools. The results of the study and a brief resume of research on CAI effectiveness are presented in the Executive Summary, which is contained in the Appendices. The complete Final Report for this project is being submitted separately. Sections of this report dealing with costs and "meta cost-effectiveness analysis" should be especially relevant for AID's activities in the area of instructional technology.

3. Orlansky, J. and String, J. "Cost-Effectiveness of Computer-Based Instruction in Military Training. Arlington, VA., Institute for Defense Analysis. Report No. IDA-P-P-1375. April, 1979.

This comprehensive study reviews 30 evaluations of CAI in military training. An abstract of this study is contained in the Appendices. Because of the length of the study, one copy of the two volumes of the complete study is being submitted separately.

4. Fisher, G. "Where CAI is Effective: A Summary of the Research," in Electronic Learning, 1983, Vol. 3, No. 3, pp. 82-84.

This article is a short but useful summary of research on CAI effectiveness. A copy of the article is enclosed in the Appendices.

5. Jernstedt, G.C. "Computer-Enhanced Collaborative Learning: A New Technology for Education," in Technological Horizons in Education, May 1983, pp. 96-101.

This is an excellent discussion of conditions for effective use of computers in instruction. It relates its own experimental findings to the literature on educational concerns such as direct instruction, peer learning, and time on task. A copy of the article is contained in the Appendices.

6. Vinsonhaler, J.F. and Bass, R.K. "A Summary of Ten Major Studies on CAI Drill and Practice," in Educational Technology, 1972, 12, pp. 29-32.

This article synthesizes the results of ten studies of CAI drill and practice in the areas of mathematics and language arts. A copy of the article is contained in the Appendices.

7. Kulik, J.A., Kulik, C.C., and Cohen, P.A. "Effectiveness of Computer-Based College Teaching: A Meta-Analysis of Findings," in Review of Educational Research, 1980, Vol. 50, No. 4, pp. 525-544.

This is a review of 59 independent evaluations of CAI at the college level. Like the other Kulik study, this one uses quantitative meta-analysis procedures to integrate findings. The study contains an excellent bibliography. A copy of the article is contained in the Appendices.

8. Forman, D. "Search of the Literature," in The Computing Teacher, 1982, Vol. 9, No. 5, pp. 37-51.

This is an excellent summary of the research on the effectiveness of CAI in schools. The study draws heavily on experience from Canada. Some interesting cost data have been included. A copy of is contained in the Appendices.

9. Burns, P. and Bozeman, W. "CAI and Math Achievement: Is There A Relationship?" in Educational Technology, October, 1981, pp. 32-39.

This is an important review of the effectiveness of the literature on the effectiveness of CAI in general and a focused integrating of findings on the effectiveness of math CAI. For the latter, meta-analysis techniques were used. A copy of the article is contained in the Appendices.

10. Jamison, D., Suppes, P., and Wells, S. "The Effectiveness of Alternative Media: A Survey," in Review of Educational Research, 1974, Vol. 44, No. 1, pp.1-67.

Although ten years olld, this study is still an important piece of the literature on the effectiveness of CAI. In view of its length, a two page summary of the article was prepared and is included in the Appendices.

11. Avner, A., Moore, C., and Smith, S. "Active External Control: A Basis for Superiority of CBI," in Journal of Computer-Based Instruction, 1980, Vol. 6, No. 4, pp. 115-118.

This study is an important attempt to understand what feature unique to CAI actually contributes to its effectiveness. The study contains a good discussion of other CAI research. A copy of the article is contained in the Appendices.

12. Mravetz, P.J. The Effects of Computer-Assisted Instruction on Student Self Concept, Locus of Control, Level of Aspiration, and Reading Achievement. (Doctoral dissertation, University of Akron, 1980). Dissertation Abstracts International, 1980, Vol. 41, No. 3, p. 994-A.

This dissertation reports results of a study where CAI had a significant impact on reading achievement among junior high school students. A copy of the abstract is contained in the Appendices.

13. Wilkinson, J. The Effectiveness of an Individualized, Computer-Assisted Instructional Program (PLAN) with Students from a Low Socio-Economic Community. (Doctoral dissertation, St. John's University, 1979). Dissertation Abstracts International, 1979, Vol. 40, pp. 1889-A.

This dissertation reports findings of a study where disadvantaged junior high school pupils having follwed a CAI program scored significantly higher on mathematics, reading, and social studies achievement tests than counterparts receiving traditional instruction. An abstract of the dissertation appears in the Appendices.

14. Litman, G.H. Relation Between Computer-Assisted Instruction Reading Achievement among Fourth, Fifth, and Sixth Grade Students. (Doctoral dissertation, Northern Illinois University, 1977). Dissertation Abstracts International, 1977, Vol. 38, pp. 2003-A.

This dissertation reports the results of a study where CAI had a positive impact on reading achievement among middle grade pupils. The study found that the increased achievement was obtained at relatively low cost. An abstract of the dissertation is contained in the Appendices.

15. Annelli, C.M. Computer-Assisted Instruction and Reading Achievement of Urban Third and Fourth Graders. (Doctoral dissertation, State University of New Jersey, 1977). Dissertation Abstracts International, 1978, Vol. 38, pp. 6662-A.

This dissertation found that in a study of third and fourth grader pupils reading achievement was not affected by total CAI time or frequency of CAI sessions. An abstract is included in the Appendices.

Other

1. Included in the Appendices are abstracts of twenty technical reports dealing with the use of computers in classrooms. These reports were produced by the Bank Street College of Education.

2. Most of the references cited above tend to be explicit evaluations of CAI activity. For a wider discussion of issues about the effects of computers in schools, reference should be made to the case studies in Appendix A of the Office of Technology Assessment report entitled, Informational Technology and Its Impact on American Education, Washington, D.C., 1982, pp. 187-259.

APPENDIX

THIS OFFLINE BIBLIOGRAPHY HAS BEEN PREPARED FOR:

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DATE: 09/09/83

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BIBLIOGRAPHIC RETRIEVAL SERVICES, INC.
1200 ROUTE 7
LATHAM, NEW YORK 12110

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AN ED227260.
AU WELLS, QUENTIN T.
TI JOB SIMULATION--THE FUTURE IN BUSINESS AND OFFICE EDUCATION.
IS RIEAUG83.
YR 82.
AB UNLIKE ORDINARY COMPUTER SIMULATIONS THAT IMITATE THE CONDITIONS OF A REAL-LIFE SITUATION AND ALLOW SEVERAL VARIABLES TO BE INPUT, JOB SIMULATIONS PROGRAM A MICROCOMPUTER TO SIMULATE THE FUNCTIONS OF ONE OR MORE PIECES OF BUSINESS OR OFFICE EQUIPMENT AND TO PROVIDE HANDS-ON, INTERACTIVE INSTRUCTION TO STUDENTS ON HOW TO USE THAT EQUIPMENT. GOOD JOB SIMULATION PROGRAMS PERFORM AT LEAST FIVE FUNCTIONS. THEY SIMULATE THE FUNCTIONS AND OPERATIONS OF A BUSINESS SYSTEM, PROVIDE EXERCISE DATA FOR STUDENTS TO INPUT INTO THE SIMULATED SYSTEM, PROVIDE HANDS-ON EXPERIENCE IN THE USE OF BUSINESS FORMS AND PROCESSES, GIVE INSTANT FEEDBACK TO STUDENTS ON THEIR PERFORMANCE, AND RECORD AND STORE STUDENT PERFORMANCE SCORES FOR LATER EVALUATION BY INSTRUCTORS. WHILE JOB SIMULATION PROGRAMS ARE NOT WITHOUT THEIR LIMITATIONS, THEY ARE WORTH THEIR PRICE IN THAT THEY PROVIDE REALISTIC JOB-TASK TRAINING IN A MANNER THAT IS CHALLENGING BUT DOES NOT CREATE A THREAT OF FAILURE. (APPENDED TO THE REPORT ARE DESCRIPTIONS OF 27 BUSINESS AND OFFICE JOB SIMULATION PROGRAMS THAT ARE PART OF THE COURSEWARE FOR HANDS-ON INDIVIDUAL COMPUTERIZED EDUCATION (CHOICE) MICROCOMPUTER JOB SIMULATION SERIES.) (MN).

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AN ED226121.
AU ADAMS, WILLIAM H.; BIELICKI, RAYMOND J.
TI TRANSITION TO NON-CATEGORICAL VOCATIONAL TRAINING THAT UTILIZES COMPUTER ASSISTED EDUCATIONAL INTERVENTION AND NONTRADITIONAL CHILD STUDY TEAM FUNCTIONS.
IS RIEJUL83.
YR 82.
AB BECAUSE IT MUST PLACE SPECIAL NEEDS STUDENTS AS WELL AS REGULAR STUDENTS IN VOCATIONAL TRAINING PROGRAMS, THE SALEM COUNTY BOARD FOR VOCATIONAL EDUCATION HAS INITIATED A NON-CATEGORICAL VOCATIONAL TRAINING PROGRAM MODEL. DEVELOPED IN RESPONSE TO THE GENERAL PRACTICES CONCERNING PLACEMENT AND A NEED FOR AN INDIVIDUAL VOCATIONAL PLAN FOR STUDENTS WHO ARE CLASSIFIED AS SPECIAL NEEDS STUDENTS, THE MODEL INVOLVES THE FOLLOWING PROCESSES: (1) INTEGRATING BASIC DATA FROM THE ACADEMICALLY-ORIENTED INDIVIDUALIZED EDUCATION PROGRAM (IEP) WITH VOCATIONAL ASSESSMENT RESULTS IN A PLAN OF EDUCATION INTERVENTION THROUGH NON-CATEGORICAL PLACEMENT; (2) IMPLEMENTING EDUCATIONAL INTERVENTION OR SERVICES BASED ON THE INDIVIDUAL STUDENT NEEDS THROUGH THE SUPPORTIVE RELATIONSHIPS OF NONTRADITIONAL CHILD STUDY TEAM MEMBERS APPLIED DIRECTLY TO STAFF AND STUDENTS; AND (3) DIRECTING EFFORTS TOWARD DESIRED OUTCOMES IN THE AREAS OF ENTRANCE-LEVEL OCCUPATIONAL SKILLS, DEVELOPMENT OF RELATED ACADEMIC SKILLS, AND A PURSUIT OF BEHAVIORAL PROGRESS INVOLVING RELIABILITY AND GENERAL RESPONSIBILITY FACTORS RELATED TO EMPLOYMENT. (MN).

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AN ED225541.
AU GILPIN, MARIELLEN G.
TI PLATO AT GRAHAM CORRECTIONAL CENTER: STARTING AN INNOVATIVE CLASSROOM.
SN ILLINOIS STATE DEPT. OF CORRECTIONS SCHOOL DISTRICT #428, SPRINGFIELD. (BBB20986).
IS RIEJUN83.
YR 82.
AB THE QUESTION OF WHAT HAPPENS WHEN A PRISON ADDS PLATO COMPUTER-BASED EDUCATION TO ITS SCHOOL PROGRAM IS ADDRESSED IN THIS PAPER DESCRIBING THE PLATO CORRECTIONS PROJECT (PCP), WHICH GREW OUT OF A NEED TO ACCOMMODATE STUDENTS TOO ADVANCED FOR ADULT BASIC EDUCATION CLASSES AND NOT WELL TRAINED ENOUGH TO SURVIVE IN HIGH SCHOOL EQUIVALENCY, OR GED, CLASSES. THE PROGRAM DESCRIBED WAS DEVELOPED TO PROVIDE A CLASS STRUCTURE IN WHICH SUCH STUDENTS COULD LEARN BASIC ACADEMIC SKILLS, STUDY SKILLS, AND THE SELF-MONITORING SKILLS NEEDED FOR THE GED CLASSES. BASIC INFORMATION IS PROVIDED ON STARTING A PLATO CLASSROOM IN A CORRECTIONAL CENTER WHICH IDENTIFIES WHAT BOTH THE PCP AND THE SCHOOL WILL NEED TO DO, AND A SHORT CASE HISTORY OF THE IMPLEMENTATION OF THE PCP PACKAGE AT GRAHAM CORRECTIONAL CENTER, A MEDIUM SECURITY PRISON IN HILLSBORO, ILLINOIS, SHOWS HOW THE PACKAGE WORKED AT ONE INSTITUTION. THE CASE HISTORY INCLUDES BACKGROUND INFORMATION, PREPARATIONS FOR AND INSTALLATION OF THE CLASSROOM, TRAINING FOR TEACHERS AND INMATE AIDES, CLASSROOM ROUTINES, MONITORING OF THE PROGRAM, ACHIEVEMENT RESULTS, THE FUTURE OF PLATO AT GRAHAM, AND A BRIEF ASSESSMENT OF THE INSTRUCTIONAL EFFECTIVENESS AND ADAPTABILITY OF THE PROGRAM. A SIX-ITEM SUGGESTED READING LIST IS ATTACHED. (LMM).

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AN EJ270728.
AU SELDEN, PAUL H.; SCHULTZ, NORMAN L.
TI WHAT THE RESEARCH SAYS ABOUT CAI'S POTENTIAL.
SO TRAINING; V19 N11 P61-62,64 NOV 1982. NOV82. *
IS CIJMAR83.
YR 82.
AB THE AUTHORS DISCUSS RESEARCH FINDINGS CONCERNING THE POTENTIAL OF COMPUTER-ASSISTED INSTRUCTION IN TRAINING PROGRAMS. RESEARCH STUDIES CONCERNED LEVELS OF SKILL ACQUISITION, RETENTION OF LEARNED MATERIALS; AND COST EFFECTIVENESS. (CT).

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AN ED221349.
TI MICROCOMPUTER COURSEWARE/MICROPROCESSOR GAMES. EPIE MATERIALS REPORT 98/99M.
SO EPIE REPORT; V15 N1-2M FALL-WIN 1981. 81.
IS RIEFEB83.
YR 81. *
AB THIS DOCUMENT IS A QUARTERLY REPORT OF THE EDUCATIONAL PRODUCTS INFORMATION EXCHANGE (EPIE) INSTITUTE, A NOT-FOR-PROFIT, CONSUMER-SUPPORTED AGENCY. THIS ISSUE IS DIVIDED INTO TWO MAJOR SECTIONS, MICROCOMPUTER COURSEWARE AND MICROPROCESSOR GAMES. THE FIRST MAJOR SECTION IS DIVIDED INTO TWO PARTS. PART 1, DEFINING

EFFECTIVE MICROCOMPUTER COURSEWARE CONTAINS THE FOLLOWING: INTRODUCTION; THE EVALUATION PROJECT; EXPLOITING MICROCOMPUTER ATTRIBUTES IN COURSEWARE DESIGN; STATE OF THE ART REPORT; AND GLOSSARY. PART 2, COURSEWARE ANALYSES AND EVALUATIONS, HAS: EDUCATIONAL MICRO SYSTEMS, INC. (EMSI); MICROSYSTEMS 80, CRITICAL READING; MILLIKEN MATH SEQUENCES; RADIO SHACK K-8 MATH PROGRAM; SRA COMPUTER DRILL AND INSTRUCTION: MATHEMATICS; AND SRA FACT TRACK. THE SECOND MAJOR SECTION CONTAINS PARTS 3 AND 4, ALSO SUBDIVIDED. PART 3, THE EDUCATIONAL IMPACT AND POTENTIAL OF MICROPROCESSOR GAMES: A FIELD STUDY, CONTAINS: INTRODUCTION; THE GAMES TESTED; THE STUDY DESIGN; AND FINDINGS. THE FINAL PART, PRODUCT DESCRIPTIONS, PROVIDES DETAILS ON: DATAMAN, MATH MASTER, LIL GENUS, LITTLE PROFESSOR, QUIZ KID, SPEAK AND SPELL, SPELLING B, AND QUIZ WIZ MICROPROCESSOR-BASED GAMES. (MP).

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AN ED220654.
TI HOMEBASED COMPUTER ASSISTED ADULT EDUCATION PROJECT--PHASE II. FINAL PROJECT REPORT, SEPTEMBER 1, 1981, THROUGH AUGUST 31, 1982.
SN LOUISIANA STATE DEPT. OF EDUCATION, BATON ROUGE. BUREAU OF ADULT AND COMMUNITY EDUCATION. (BBB14696).
IS RIEFEB83.
YR 82.
AB A PROJECT WAS CONDUCTED BY THE UNIVERSITY OF SOUTHWESTERN LOUISIANA IN COOPERATION WITH LOCAL ADULT EDUCATION PROGRAMS TO DEVELOP A DELIVERY SYSTEM FOR ADULT EDUCATION THROUGH EXPANDED OUTREACH OPPORTUNITIES USING COMPUTER-ASSISTED INSTRUCTION (CAI) AND COMPUTER-MANAGED INSTRUCTION (CMI). DURING THE 3-YEAR PROJECT, A HOMEBASED CAI DELIVERY SYSTEM FOR ADULT BASIC EDUCATION (ABE) AND GENERAL EDUCATIONAL DEVELOPMENT (GED) STUDENTS WAS DEVELOPED AND TESTED. A CURRICULUM GUIDE FOR INSTRUCTORS THAT CORRELATED THE COMPUTER PROGRAM LESSON MATERIAL WITH COMMONLY AVAILABLE RESOURCE MATERIAL IN ADULT EDUCATION PROGRAMS IN LOUISIANA WAS PREPARED. THIRTY-NINE ADULT EDUCATION STUDENTS RECEIVED SUPPLEMENTARY COMPUTER-ASSISTED INSTRUCTION DURING 93 2.5-HOUR SESSIONS IN FALL 1981 AND SPRING 1982. ADULT STUDENTS MANIPULATED THE COMPUTER HARDWARE AS THEY STUDIED THE ABE/GED CURRICULUM MATERIALS. THE AVERAGE GRADE-EQUIVALENCE ELEVATION SCORE FOR THE CAI STUDENTS WAS 2.2, WHICH WAS .8 GREATER THAN NON-CAI STUDENT SCORES FOR A GROUP NOT USING THE CAI PROGRAMS, BOTH ON A LOCAL AND STATEWIDE BASIS. IT WAS CONCLUDED THAT UNDEREDUCATED ADULTS CAN MANIPULATE CAI ADULT EDUCATIONAL SYSTEMS OF THE TYPE TESTED AND THAT THE CAI AND CMI SYSTEM SEEMS TRANSPORTABLE TO A HOMEBASED ENVIRONMENT. (KC). *

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AN EJ268638.
AU BROWN, BETTY.
TI PLATO PROMISES GRADE GAINS.
SO ELECTRONIC EDUCATION; V1 N2 P10-12 OCT 1981. OCT81.
IS CIJJAN83. *
YR 81.
AB DESCRIBES A FIELD STUDY IN WHICH THE MATHEMATICS PORTION OF THE PLATO BASIC SKILLS LEARNING SYSTEM WAS USED IN REMEDIAL COURSES FOR HIGH SCHOOL AND ADULT EDUCATION STUDENTS AT THREE FLORIDA HIGH SCHOOLS. ANALYSIS SHOWS THAT THE PLATO SYSTEM IS EFFECTIVE AND COST-EFFICIENT.

(JOB).

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AN ED219540.
AU LYNCH, EDWARD J.
TI TRAINING FOR HIGH TECHNOLOGY AT MACOMB COMMUNITY COLLEGE.
IS RIEJAN83.
YR 82.
AB MACOMB COMMUNITY COLLEGE (MCC) PRIDES ITSELF ON ITS RESPONSIVENESS TO THE NEEDS OF AREA INDUSTRY FOR SKILLED TRADESPEOPLE TO ENGAGE IN THE DESIGN, TOOLING, AND MACHINING ACTIVITIES THAT ARE CRUCIAL TO THE AREA'S LONG-STANDING AUTOMOBILE AND MANUFACTURING OPERATIONS AND TO THE NEEDS OF NEW AREA HIGH TECHNOLOGY AND SERVICE-ORIENTED INDUSTRIES. THE ABILITY OF MCC TO OFFER OVER 90 PROGRAMS TO MEET STUDENT AND COMMUNITY NEEDS IS DUE LARGELY TO ITS TALENTED AND CONSCIENTIOUS FACULTY AND STAFF AS WELL AS TO ITS OVERALL COLLEGE CLIMATE THAT SUPPORTS FACULTY EFFORTS. THIS QUALITY AND RELEVANCE OF MCC'S PROGRAMING IS AFFIRMED BY ITS CONTINUED ACCREDITATION BY PROFESSIONAL ASSOCIATIONS, ITS HIGH SUCCESS RATE ON PROFESSIONAL STATE EXAMS, AND THE JOB MARKET SUCCESS OF ITS GRADUATES. INCLUDED AMONG THOSE OF MCC'S PROGRAMS THAT ARE PARTICULARLY SIGNIFICANT TO MICHIGAN'S EFFORTS TO ATTRACT HIGH TECHNOLOGY INDUSTRIES ARE COMPLETELY REDESIGNED PROGRAMS IN ELECTRONICS AND BUSINESS DATA PROCESSING AND NEW PROGRAMS IN COMPUTER-AIDED DESIGN, ROBOTICS TECHNOLOGY, AND WORD/INFORMATION PROCESSING. IN ADDITION TO THESE COURSES, WHICH INCIDENTALLY PROVIDE HANDS-ON EXPERIENCE AS WELL AS CLASSROOM INSTRUCTION, MCC IS DEVELOPING A BASIC SKILLS COMPONENT AND NON-TRADITIONAL SHORT-TERM AND QUICK-START OCCUPATION SPECIFIC COURSES/PROGRAMS. (MN).

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AN ED216150.
AU WADSWORTH, SAMUEL G.; FRAZIER, WILLIAM D.
TI PLATO USE IN OKLAHOMA SKILL CENTERS. FINAL REPORT.
IS RIEOCT82.
YR 82.
AB THIS STUDY WAS CONDUCTED TO EVALUATE THE USEFULNESS OF THE PLATO INSTRUCTIONAL SYSTEM TO TEACH ADULT BASIC EDUCATION AND GENERAL EDUCATIONAL DEVELOPMENT STUDENTS BASIC MATHEMATICS AND READING SKILLS. THE STUDY WAS CONDUCTED WITH A CONTROL GROUP OF STUDENTS WHO HAD NO USE OF PLATO DURING AN 18-MONTH PERIOD, A SECOND GROUP OF STUDENTS WHO HAD LESS THAN 20 HOURS OF PLATO IN A GIVEN SUBJECT, AND A THIRD, EXPERIMENTAL GROUP WHO HAD MORE THAN 20 HOURS OF PLATO INSTRUCTION IN A GIVEN SUBJECT. RESULTS INDICATED THAT THERE WAS NO DIFFERENCE IN ACHIEVEMENT LEVELS AMONG THE THREE GROUPS; THAT RETENTION WAS PERHAPS SOMEWHAT BETTER FOR THE STUDENTS WHO USED PLATO, AND THAT TIME SPENT IN CLASSES WAS MUCH GREATER FOR THE STUDENTS WHO USED PLATO. ALTHOUGH FEW CONCLUSIONS COULD BE DRAWN BECAUSE OF LACK OF CONTROL OVER THE STUDY AND LACK OF APPROPRIATE USE OF THE PLATO SYSTEM, ONE POSSIBLE CONCLUSION IS THAT MIXING INSTRUCTIONAL METHODS, I.E. APPLYING TRADITIONAL INSTRUCTION AND PLATO INSTRUCTION INTERMITTENTLY IN THE CLASSES, WAS CONFUSING TO THE STUDENTS. THIS COULD ACCOUNT FOR INCREASED TIME IN CLASSES FOR STUDENTS WHO USED THE PLATO SYSTEM WITHOUT INCREASING ACHIEVEMENT. (AUTHOR/KC).

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AN ED210052.
AU BOSSONE, RICHARD M. ED.
TI THE CONFERENCE OF THE UNIVERSITY/URBAN SCHOOLS NATIONAL TASK FORCE: WHAT WORKS IN URBAN SCHOOLS. PROCEEDINGS. (2ND, BERMUDA, MARCH 26-27, 1982).
IS RIESEP82.
YR 82.
AS THIS REPORT SUMMARIZES THE PROCEEDINGS AND PRESENTS THE PAPERS DISCUSSED AT A NATIONAL CONFERENCE ON EFFECTIVE ASPECTS OF URBAN EDUCATION. THE FIRST PAPER DISCUSSES THE DEVELOPMENT OF THE SAN FRANCISCO (CALIFORNIA) REDESIGN PROGRAM, A FIVE YEAR MASTER PLAN FOR EDUCATIONAL REFORM WHICH AIMED TO IMPROVE THE PHYSICAL EDUCATIONAL ENVIRONMENT, COMMUNITY RELATIONS, SCHOOL ATTENDANCE, AND ACADEMIC PERFORMANCE. A SECOND PAPER DISCUSSES EDUCATIONAL IMPROVEMENT EFFORTS IN OAKLAND (CALIFORNIA) AND IN CHICAGO (ILLINOIS) THROUGH THE INITIATION OF CLEARLY STATED ACADEMIC GOALS, A WELL DEFINED CURRICULUM, AND ANTI-VANDALISM PROGRAMS. ANOTHER PAPER DESCRIBES TECHNIQUES UNDERTAKEN BY THE BALTIMORE (MARYLAND) PUBLIC SCHOOLS TO RAISE STUDENTS' ACHIEVEMENT LEVELS ON STANDARDIZED TESTS BY IMPROVING SKILLS IN READING, WRITING, AND MATHEMATICS. A FOURTH PAPER DESCRIBES THE DEVELOPMENT OF TECHNOLOGY IN AMERICAN EDUCATION AND CONCLUDES THAT COMPUTERS PROVIDE THE MEANS TO DEVELOP ALTERNATIVE STRUCTURES NEEDED TO DECENTRALIZE THE PRESENT EDUCATIONAL SYSTEM. THE FACTORS IDENTIFIED IN THE PAPERS AS INFLUENTIAL IN MAKING URBAN SCHOOLS EFFECTIVE INCLUDE: COOPERATIVE INVOLVEMENT OF SCHOOL STAFF, STUDENTS, PARENTS, AND THE COMMUNITY IN EDUCATIONAL IMPROVEMENT; THE ADOPTION OF A COMPREHENSIVE EVALUATION SYSTEM; THE USE OF TECHNOLOGY, ESPECIALLY THE COMPUTER, TO IMPROVE INSTRUCTION; AND STAFF DEVELOPMENT FOR HIGHER QUALITY INSTRUCTION. (AUTHOR/MJL).

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AN ED214549.
AU SMITH, JANET D.; AND OTHERS.
TI PLATO IN THE COMMUNITY COLLEGE: STUDENTS, FACULTY AND ADMINISTRATORS SPEAK OUT.
IS RIEAUG82.
YR 81.
AS IN THE SUMMER OF 1979, CUYAHOGA COMMUNITY COLLEGE (CCC) INTRODUCED THE PLATO COMPUTER-BASED INDIVIDUALIZED INSTRUCTION SYSTEM AS A SUPPLEMENTAL TEACHING TOOL IN REMEDIAL ENGLISH AND MATHEMATICS COURSES. AS PART OF A COMPREHENSIVE EVALUATION OF THE SYSTEM, SURVEYS OF THE ATTITUDES OF STUDENTS, FACULTY, AND ADMINISTRATORS TOWARDS PLATO WERE CONDUCTED TO OBTAIN INFORMATION TO MAXIMIZE STUDENT INTERACTION WITH PLATO AND STUDENT IMPROVEMENT IN BASIC SKILLS. RESULTS OF THE PRE- AND POST-COURSE SURVEY OF 92 STUDENTS IN THREE DEVELOPMENTAL EDUCATION CLASSES INDICATED THAT STUDENTS PREFERRED PLATO TO HAVING A REGULAR TEACHER; THAT THEY BELIEVED PLATO SHOULD BE A COMPONENT OF REGULAR CLASSES; THAT THE INDIVIDUALIZED INSTRUCTION WAS HELPFUL; AND THAT TUTORIAL ASSISTANCE SHOULD BE PROVIDED AT THE LEARNING CENTER. RESPONSES TO A QUESTIONNAIRE MAILED TO 95 ADMINISTRATORS, FACULTY, AND STAFF STRESSED THE UTILITY OF PLATO AS A SYSTEM WHICH ALLOWS INSTRUCTORS TO SELECT LESSONS THAT RELATE TO INDIVIDUAL OR GROUP WEAKNESSES; THE NEED FOR FACULTY AND ADMINISTRATORS TO FAMILIARIZE THEMSELVES WITH PLATO; AND THE SYSTEM'S DISADVANTAGES IN TERMS OF COSTS AND POSSIBLE BREAKDOWNS. RECOMMENDATIONS FOR POSSIBLE DIRECTIONS FOR CONTINUED USE OF PLATO AT

COC FOCUSED ON DEVELOPING FACULTY INTEREST IN THE SYSTEM, MOTIVATING STUDENTS, STUDENT ASSESSMENT, PHYSICAL EXPANSION, AND EVALUATION. QUESTIONNAIRES AND AN OUTLINE OF THE TOTAL EVALUATION DESIGN ARE APPENDED. (HB).

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AN ED215393.
TI MICROCOMPUTERS IN TODAY'S SCHOOLS: AN ADMINISTRATORS' HANDBOOK.
SN NATIONAL INST. OF EDUCATION (ED), WASHINGTON, D.C. (BBB18183).
IS RIEJUL82.
YR 81.
AB THIS HANDBOOK CONTAINS JOURNAL ARTICLES, REPORTS, AND DOCUMENTS COLLECTED FOR THE PURPOSE OF PROVIDING SCHOOL ADMINISTRATORS WITH CURRENT INFORMATION ON COMPUTER APPLICATIONS IN PUBLIC SCHOOLS. THE FIRST PART OF THE HANDBOOK INCLUDES REPORTS ON COMPUTER ORIENTED PROGRAMS IN THE SCHOOLS OF ALASKA AND OREGON, PROCEDURES FOR ASSESSING COMPUTER NEEDS, RECOMMENDATIONS FOR EVALUATING AND PURCHASING COMPUTER HARDWARE, AND SOME MODEL APPLICATIONS OF COMPUTERS FOR TEACHING THE HANDICAPPED AND/OR IN BASIC SKILLS PROGRAMS. THE SECOND PART PROVIDES PROFILES OF SCHOOLS AND SCHOOL DISTRICTS CURRENTLY USING MICROCOMPUTERS AS PART OF THEIR INSTRUCTIONAL PROGRAM. EACH PROFILE PRESENTS A DESCRIPTION OF A SPECIFIC COMPUTER PROJECT, INCLUDING HARDWARE, SOFTWARE, PERSONNEL, COSTS AND A CONTACT PERSON AND PHONE NUMBER FOR ARRANGING ON-SITE VISITS. ADDITIONAL SOURCES OF INFORMATION ON COMPUTER APPLICATIONS IN EDUCATIONAL SETTINGS ARE IDENTIFIED IN BIBLIOGRAPHIES ACCOMPANYING MANY OF THE REPORTS AND IN A RESOURCE LIST AT THE END OF THE HANDBOOK. (MER).

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AN ED211714.
TI EXAMINATION OF THE HEALTH OCCUPATIONS EDUCATION CURRICULUM FROM A FUTURIST PERSPECTIVE: II.
IS RIEJUN82.
YR 81.
AB A PROJECT WAS CONDUCTED TO EXAMINE THE HEALTH OCCUPATIONS EDUCATION PROGRAM IN NEW YORK STATE. THROUGH A SERIES OF COMMITTEE MEETINGS, MEMBERS OF THE HEALTH PROFESSIONS AND EDUCATORS FROM HIGH SCHOOLS, COLLEGES, TECHNICAL INSTITUTES, AND REGIONAL AGENCIES DISCUSSED A NUMBER OF ISSUES THAT SHOULD BE CONSIDERED AS THE HEALTH OCCUPATIONS CURRICULUM OF THE VARIOUS INSTITUTIONS IS PERIODICALLY UPDATED. MAIN ISSUES ADDRESSED BY THE CURRICULUM COMMITTEE INCLUDE THE FOLLOWING: HEALTH OCCUPATIONS CREDENTIALING AND LICENSURE; TECHNICAL COMPETENCIES FOR HEALTH CARE WORKERS OF THE FUTURE; NEW PRODUCT DEVELOPMENT AS IT AFFECTS USER TRAINING; SUPPORT SERVICES AND HEALTH OCCUPATIONS EDUCATION; THE FUTURE OF THE CLINICAL LABORATORY; THE USE OF COMPUTERS IN INSTRUCTION; AND COMPETENCY BASED VOCATIONAL EDUCATION. (REPORTS BY VARIOUS COMMITTEE MEMBERS, AS WELL AS REACTION FROM THE FIELD AND SUMMARIES OF COMMITTEE DISCUSSION ARE CONTAINED IN THIS REPORT.) (KC).

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AN EJ252806.
AU WIECHERS, G.

TI INTRODUCING CAI FOR DEVELOPING NATIONS.
SO TECHNOLOGICAL HORIZONS IN EDUCATION; V8 N1 P39-41 JAN 1981. JAN81.
IS CIJFEB82.
YR 81.
AB RECOMMENDS COMPUTER ASSISTED INSTRUCTION (CAI) AS AN EFFECTIVE METHOD TO TEACH BASIC SKILLS TO ELEMENTARY STUDENTS IN DEVELOPING NATIONS IF MANAGERIAL PROBLEMS CAN BE OVERCOME. PRESENTS RESULTS FROM TWO STUDIES USING CAI MATHEMATICS MATERIALS. (DC).

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AN ED206666.
AU ARGENTO, BARRY J.; AND OTHERS.
TI ALTERNATIVE EDUCATION MODELS--PRELIMINARY FINDINGS OF THE JOB CORPS EDUCATIONAL IMPROVEMENT EFFORT. EDUCATION AND TRAINING APPROACHES. YOUTH KNOWLEDGE DEVELOPMENT REPORT 5.2.
IS RIEFEB82.
YR 80.
AB THIS VOLUME IS ONE OF THE PRODUCTS OF THE KNOWLEDGE DEVELOPMENT EFFORT IMPLEMENTED UNDER THE MANDATE OF THE YOUTH EMPLOYMENT AND DEMONSTRATION PROJECTS ACT OF 1977. THIS INTERIM REPORT DESCRIBES THE BACKGROUND AND STRUCTURE OF THE EDUCATIONAL IMPROVEMENT EFFORT (EIE) OF THE JOB CORPS, AS WELL AS THE PRELIMINARY FINDINGS FOR THE FIRST COHORTS OF PARTICIPANTS AND CONTROLS IN THE MODELS OF EIE IMPLEMENTED EARLIEST. THE EIE FOLLOWS A LOGICAL SEQUENCE, BEGINNING WITH A SURVEY OF THE VARYING TEACHING METHODS AND POLICIES WITHIN JOB CORPS CENTERS AS WELL AS A REVIEW OF PAST EVALUATION LITERATURE. COOPERATIVELY WITH THE EDUCATION COMMUNITY, EXEMPLARY EDUCATION APPROACHES OUTSIDE JOB CORPS WERE ASSESSED FOR APPLICABILITY FOR DISADVANTAGED YOUTH IN A CENTER ENVIRONMENT. THE MOST PROMISING MODELS WERE THEN IMPLEMENTED AND JOB CORPS MEMBERS WERE RANDOMLY ASSIGNED TO THE MODELS AND TO TRADITIONAL JOB CORPS OFFERINGS. ASSESSMENT OF BOTH TYPES OF PROGRAMS YIELDED FINDINGS THAT ARE REMARKABLE IF THEY HOLD UP OVER TIME. THE TESTED GAIN RATES OF CORPSMEMBERS IN REGULAR PROGRAMS EXCEED BOTH PUBLIC SCHOOL AVERAGES AND THE LOWER LEARNING RATES PREVIOUSLY ACHIEVED BY THE CORPSMEMBERS IN SCHOOL. THE GAIN RATES ALSO EXCEED THOSE DOCUMENTED FOR JOB CORPS IN THE PAST. THE EVIDENCE ON THE RELATIVE EFFECTIVENESS OF TRADITIONAL AND INNOVATIVE APPROACHES IS LIMITED NOW, BUT IT DOES APPEAR THAT SOME ALTERNATIVES ARE PROMISING, PARTICULARLY, COMPUTERIZED INSTRUCTION. IT IS CLEAR THAT THE INDIVIDUALIZED, SELF-PACED INSTRUCTIONAL APPROACH USED IN JOB CORPS CAN POSITIVELY AFFECT LEARNING RATES OF EVEN THE MOST DISADVANTAGED YOUTH. (KC).

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AN ED205623.
AU WEST, MALCOLM R.
TI AN EVALUATION OF COMPUTERIZED INSTRUCTION FOR INSTITUTIONALIZED ADULT STUDENTS, ADDICTS AND ALCOHOLICS.
SN PENNSYLVANIA RESEARCH COORDINATING UNIT FOR VOCATIONAL EDUCATION, HARRISBURG. (BBB02135).
IS RIEFEB82.
YR 81.
AB A PROGRAM OF COMPUTER-ASSISTED INSTRUCTION (CAI), USING THE RADIO SHACK TRS-80, WAS TRIED AT EAGLEVILLE (PENNSYLVANIA) HOSPITAL AND TRAINING CENTER FOR ADULT ALCOHOLICS AND DRUG ABUSERS. MOST OF THE

STUDENTS USING THE PROGRAM HAD EXTREMELY LOW READING LEVELS AND LITTLE SUCCESS WITH SCHOOLS; A MAJORITY HAD BEEN IN TROUBLE WITH THE LAW. IT WAS HOPED THAT CAI WOULD ENGAGE THE STUDENTS IN MEANINGFUL LEARNING, FREE TEACHERS FOR MORE INDIVIDUALIZED HELP FOR STUDENTS, AND SET UP AN ATMOSPHERE OF SUCCESS IN EDUCATION FOR THE STUDENTS. A PROCESS EVALUATION OF THE PROGRAM SHOWED THAT SOME OF THESE OBJECTIVES HAD BEEN MET; HOWEVER, THERE WERE PROBLEMS IN SOME AREAS. IN GENERAL, MOST OF THE STUDENTS REPORTED THAT THEY ENJOYED THE USE OF THE COMPUTERS, AND THAT THEY WERE LEARNING FROM THE EXPERIENCE. TEACHERS SAID ABOUT HALF THE STUDENTS APPEARED TO BE BENEFITTING. ALTHOUGH IT COULD NOT BE DOCUMENTED, IT APPEARED LIKELY THAT THE SUCCESS STUDENTS HAD EXPERIENCED IN THEIR LIMITED EXPOSURE TO THE CAI COULD CARRY OVER IN FUTURE TRAINING ENDEAVORS. PROBLEMS ENCOUNTERED IN IMPLEMENTING THE PROGRAM INCLUDED SOFTWARE THAT WAS INAPPROPRIATE FOR AGE LEVEL OF THE STUDENTS, OR HAD TOO MANY PROGRAMMING ERRORS; EQUIPMENT MALFUNCTIONS AND INADEQUACY OF THE CASSETTE PLAYER/RECORDER SELECTED; AND SECURITY PROBLEMS THAT CAUSED THE COMPUTERS TO BE INSTALLED IN THREE DIFFERENT LOCATIONS AND INCREASED THE TEACHERS' WORK LOAD. AS A RESULT OF THE PROCESS EVALUATION, IT WAS CONCLUDED THAT THE MINICOMPUTERS PROVIDE A VERY USEFUL ADJUNCT TO THE EDUCATIONAL PROGRAM AT EAGLEVILLE, BUT THAT THEY ARE NOT BEING USED TO THEIR FULL POTENTIAL. RECOMMENDATIONS WERE MADE FOR HARDWARE AND SOFTWARE CHANGES, A BETTER ENVIRONMENT, AND STAFFING POSSIBILITIES. (KC).

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AN ED205762.
AU FAURIA, CHARLENE K.
TI THE ROLE THE CAREER INFORMATION SYSTEM PLAYS IN ASSESSMENT AND EMPLOYABILITY DEVELOPMENT PLANS.
IS RIEJAN82.
YR 81.
AB BECAUSE THERE IS NO "RIGHT" WAY TO DO ASSESSMENT, VOCATIONAL EVALUATION, OR EMPLOYABILITY DEVELOPMENT PLANNING, A VARIETY OF STRATEGIES AND TOOLS ARE USED BY AGENCIES THAT BEST MATCH AGENCY RESOURCES AND CLIENT NEEDS. ONE COMMON TOOL USED BY LANE COUNTY CETA, JACKSON-JOSEPHINE JOB COUNCIL, AND MID-WILLAMETTE VALLEY CONSORTIUM (ALL IN OREGON) IS THE CAREER INFORMATION SYSTEM (CIS). THE AGENCIES HAVE FOUND THE CAREER INFORMATION SYSTEM TO BE AN INVALUABLE RESOURCE FOR PROVIDING ACCURATE OCCUPATIONAL AND EDUCATIONAL INFORMATION TO CAREER DECISION MAKERS. CIS IS USED IN SEVEN MAIN WAYS: (1) TO PROVIDE CAREER EXPLORATION BY PROVIDING FACTS ABOUT JOBS; (2) TO INCREASE KNOWLEDGE ABOUT JOBS AND TRAINING SO INFORMED CHOICES CAN BE MADE; (3) TO MOTIVATE THE UNEMPLOYED SO THEY WILL BECOME MORE INTERESTED IN EXPLORING TRAINING AND PLACEMENT OPPORTUNITIES; (4) TO HELP DISCOVER COURSES OF ACTION AND THE WAY VARIOUS ALTERNATIVES MIGHT AFFECT THEIR FUTURE; (5) TO ASSIST IN APPLYING FOR AND ENTERING INTO TRAINING AND EMPLOYMENT—WRITING RESUMES, CONDUCTING INTERVIEWS, ETC. ; (6) TO ASSIST IN WRITING EMPLOYABILITY DEVELOPMENT PLANS; AND (7) TO ASSIST IN PROGRAM PLANNING. (KC).

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AN ED205743.
AU LEISING, J.; WILKINS, RUSSELL.

TI INSERVICE WORKSHOPS ON NEW AND EMERGING AGRICULTURE/NATURAL RESOURCES OCCUPATION INSTRUCTIONAL MATERIALS. FINAL REPORT, JANUARY 1, 1980-JUNE 30, 1981.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEJAN82.
YR 81.
AB THIS DOCUMENT CONTAINS THE FINAL REPORT AND APPENDIXES FROM A PROJECT TO DEVELOP RESOURCES FOR USE BY COMMUNITY COLLEGE AGRICULTURAL EDUCATION INSTRUCTORS IN BETTER UTILIZING COMPUTER TECHNOLOGY IN INSTRUCTION AND TO PROVIDE INSERVICE WORKSHOPS TO MAKE THE INSTRUCTORS AWARE OF AVAILABLE HARD- AND SOFTWARE. THE FOUR-PAGE NARRATIVE LISTS OBJECTIVES, ACTIVITIES, AND CONCLUSIONS. THE MAJOR APPENDIX IS THE PRODUCT, MICROCOMPUTER RESOURCE GUIDE FOR AGRICULTURE. DEVELOPED TO SERVE AS AN INTRODUCTORY TEXT FOR MICROPROCESSORS AND SOFTWARE INDEX FOR AGRICULTURAL PROGRAMS, THE GUIDE PROVIDES DESCRIPTIVE EXPLANATION OF MICROCOMPUTERS AND THEIR RELATED SOFTWARE. HARDWARE SELECTION CRITERIA ARE DISCUSSED. A COMPUTER PROGRAM INDEX FILE USING THE AGDEX SUBJECT TITLES LISTS MORE THAN 100 APPLICATION SOFTWARE PROGRAMS FOR AGRICULTURE IN THESE AREAS: FIELD CROPS, HORTICULTURE, FORESTRY/NATURAL RESOURCE, ANIMAL SCIENCE, SOILS, DISEASES AND PESTS, AGRICULTURAL ENGINEERING, AND AGRICULTURAL ECONOMICS. EACH PROGRAM ENTRY PROVIDES THIS INFORMATION: SUBJECT/ENTERPRISE, COMPUTER LEVEL, LANGUAGE, COST, COMPUTER TYPE, MODE OF TRANSFER, PROGRAM TITLE AND DESCRIPTION, REFERENCES, AUTHORS, AND SPECIFIC COMMENTS. SOME APPENDIXES CONTAIN LISTS OF USER GROUPS AND MICROCOMPUTER MANUFACTURERS, REFERENCES, AND GLOSSARY. OTHER APPENDIXES INCLUDE WORKSHOP MATERIALS AND EVALUATION INSTRUMENTS AND RESULTS. (YLB).

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AN ED205216.
AU WATSON, NANCY A. ED.
TI MICROCOMPUTERS IN EDUCATION: GETTING STARTED. CONFERENCE PROCEEDINGS (TEMPE, ARIZONA, JANUARY 16-17, 1981).
IS RIEDEC81.
YR 81.
AB INCLUDED IN THESE PROCEEDINGS ARE BRIEF WRITE-UPS OF MANY OF THE 55 PRESENTATIONS GIVEN AT A CONFERENCE FOR ELEMENTARY AND SECONDARY TEACHERS AND ADMINISTRATORS. THE STRANDS OF THE CONFERENCE EMPHASIZED USING MICROCOMPUTER TECHNOLOGY IN ELEMENTARY EDUCATION, SECONDARY EDUCATION, SPECIAL EDUCATION, AND ADMINISTRATION. GENERAL INTEREST SESSIONS WERE ALSO HELD. THE KEYNOTE ADDRESS ENTITLED "THE CHALLENGE OF THE 80'S: COMPUTER LITERACY," WAS GIVEN BY DR. ANDREW MOLNAR OF THE NATIONAL SCIENCE FOUNDATION. SESSIONS FOCUSED ON: COMPUTER LITERACY, COMPUTER ASSISTED INSTRUCTION IN THE BASIC SKILL AREAS AT ELEMENTARY AND SECONDARY LEVELS, APPLICATIONS FOR MICROCOMPUTERS IN SPECIAL EDUCATION AND GIFTED EDUCATION, EVALUATING MICROCOMPUTER SYSTEMS, HARDWARE AND SOFTWARE COMPARISONS, CAREER EDUCATION AND GUIDANCE INFORMATION SYSTEMS, INSTRUCTIONAL TECHNIQUES FOR TEACHING BASIC PROGRAMING LANGUAGE TO ELEMENTARY AND SECONDARY STUDENTS, DESIGNING COMPUTER PROPOSALS FOR FEDERAL FUNDING, AND MICROCOMPUTERS IN THE FINE ARTS AREAS. APPENDED IS A BIBLIOGRAPHY OF BASIC COMPUTER BOOKS AND LISTS OF COMPUTER JOURNALS, FILM COMPANIES PRODUCING FILMS ABOUT COMPUTERS, MICROCOMPUTER MANUFACTURERS, AND SOFTWARE VENDORS. (AUTHOR/LLS).

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AN ED201772.
AU BROUSSARD, ROLAND L.
TI COMPUTER ASSISTED INSTRUCTION IN ADULT BASIC EDUCATION.
IS RIEOCT81.
YR 81.
AB COMPUTER-BASED EDUCATION HAS BEEN EXTENSIVELY STUDIED IN THE LAST TWO DECADES. SUCH STUDIES HAVE SHOWN THAT APPLICATIONS OF COMPUTERS, SUCH AS COMPUTER-AIDED INSTRUCTION (CAI) AND COMPUTER-MANAGED INSTRUCTION (CMI), CAN BE USEFUL IN SOME FACETS OF EDUCATION, ESPECIALLY TEACHING BASIC SKILLS AND FOR DRILLS. CAI IS THE USE OF A COMPUTER TO HELP PRESENT INSTRUCTION AND/OR TO INTERACT WITH A STUDENT TO ENHANCE LEARNING. IT CAN EMPLOY AS MANY AS FOUR INSTRUCTIONAL FORMATS: TUTORIAL, DRILL AND PRACTICE, DIALOGUE, OR A COMBINATION OF ANY OR ALL OF THESE. CMI CAN BE DEFINED AS A TOTAL EDUCATIONAL APPROACH WHICH CAN PROVIDE THE TEACHER OR TRAINER WITH A MANAGEMENT INFORMATION SYSTEM--A COMPUTERIZED MEANS OF TESTING, RECORD KEEPING, AND DECISION MAKING, THAT ASSISTS EFFECTIVE ADMINISTRATION, OPTIMIZED LEARNING, AND INDIVIDUAL LEARNER MANAGEMENT. CAI HAS THE VIRTUES OF AIDING DRILL AND ASSISTING IN INDIVIDUALIZING INSTRUCTION. FOR A VARIETY OF SUBJECT AREAS AND GRADE LEVELS, CAI HAS BEEN SHOWN TO BE COST EFFECTIVE. AT THIS TIME THERE IS LITTLE USE OF CAI IN ADULT EDUCATION, ESPECIALLY IN ADULT BASIC EDUCATION (ABE), BUT SYSTEMS EMPLOYING CAI AND CMI HAVE THE POTENTIAL IN THE NEAR FUTURE FOR DRAMATICALLY EXTENDING EDUCATIONAL OPPORTUNITIES TO UNDEREDUCATED ADULTS. HOMEBOUND PROGRAMS ARE POSSIBLE, AND THE SYSTEMS' FLEXIBILITY WILL PERMIT GREATER INDIVIDUALIZATION OF ABE PROGRAMS. (KC).

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AN ED201492.
AU SUYDAM, MARILYN N. ED.; KASTEN, MARGARET L. ED.
TI INVESTIGATIONS IN MATHEMATICS EDUCATION, VOL. 14, NO. 2.
IS RIESEP81.
YR 81.
AB TWELVE RESEARCH REPORTS RELATED TO MATHEMATICS EDUCATION ARE ABSTRACTED AND ANALYZED. THREE OF THE REPORTS DEAL WITH ASPECTS OF LEARNING THEORY, THREE WITH TOPICS IN MATHEMATICS INSTRUCTION (FRACTIONS, PROBLEM SOLVING, AND APPLICATION ORIENTATION), TWO WITH ASPECTS OF COMPUTER ASSISTED INSTRUCTION, AND ONE EACH WITH ADVANCED PLACEMENT, CALCULATORS, MATHEMATICS ANXIETY, AND SEX DIFFERENCES. RESEARCH RELATED TO MATHEMATICS EDUCATION WHICH WAS REPORTED IN CIJE AND RIE BETWEEN OCTOBER AND DECEMBER 1980 IS LISTED. (MP).

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AN ED198794.
AU LEVIN, HENRY M.; WOO, LOUIS.
TI AN EVALUATION OF THE COSTS OF COMPUTER-ASSISTED INSTRUCTION. PROGRAM REPORT NO. 80-B7.
SN NATIONAL INST. OF EDUCATION (DHEW), WASHINGTON, D.C. (BBB06621).
IS RIEJUL81.
YR 80.
AB COST DATA WERE COLLECTED FROM A STUDY ON THE EFFECTIVENESS OF COMPUTER ASSISTED INSTRUCTION (CAI) FOR CULTURALLY DISADVANTAGED

CHILDREN IN THE LOS ANGELES UNIFIED SCHOOL DISTRICT. BASED UPON THE RESOURCE INGREDIENTS APPROACH TO MEASURING COSTS, IT WAS FOUND THAT UP TO THREE DAILY 10-MINUTE SESSIONS OF DRILL AND PRACTICE COULD BE PROVIDED FOR EACH CHILD WITHIN THE PRESENT ALLOCATION OF FUNDS FROM TITLE I OF THE ELEMENTARY AND SECONDARY EDUCATION ACT OF 1965. IF THE COMPUTER SYSTEM WERE SHARED BETWEEN TWO SCHOOLS, THE HIGHER COSTS WOULD PERMIT ONLY TWO DAILY SESSIONS. COSTS WERE ALSO ESTIMATED FOR A MORE ADVANCED CAI SYSTEM, AND WERE FOUND TO BE IN THE SAME RANGE, PROBABLY BECAUSE THE COSTS OF SOFTWARE DO NOT DECLINE WITH MORE ADVANCED TECHNOLOGY. (AUTHOR/BK).

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AN ED196777.
AU MONTGOMERY, DAVID C. ED.; DUCKWALL, JULIA, ED.
TI EXPECTATIONS FOR QUALITY: SHOULD THEY BE SATISFIED OR QUESTIONED? PROCEEDINGS OF THE ANNUAL FLORIDA STATEWIDE CONFERENCE ON INSTITUTIONAL RESEARCH (13TH, TALLAHASSEE, FLORIDA, JUNE 11-13, 1980).
IS RIEJUL81.
YR 80.
AB PROCEEDINGS OF A FLORIDA STATEWIDE CONFERENCE ON QUALITY IN HIGHER EDUCATION ARE PRESENTED. TOPICS INCLUDE THE FOLLOWING: DATABASES, THE COMMUNITY COLLEGES' ACCOUNTING FOR QUALITY, PROGRAM BUDGETING, AND TRENDS IN TRUTH IN TESTING. TRANSCRIPTS OF A PANEL DISCUSSION ON DATABASES AND THE FOLLOWING PAPERS AND REPORTS ARE INCLUDED: "QUALITY AND THE STATE COMMUNITY COLLEGE COORDINATING BOARD," BY MYRON BLEE; "REPORT OF THE ACADEMIC QUALITY SUBCOMMITTEE: A CONCEPT AND RECOMMENDATIONS"; "PROGRAM MAPPING: QUALITY CONTROL FOR ACADEMIC PROGRAMS," BY RICHARD BEDICS; "ONE STEP BEYOND," BY MANTHA MEHALLIS; "THE IMPACT OF PROGRAM BUDGETING UPON OFFICES OF INSTITUTIONAL RESEARCH IN THE SUS OF FLORIDA," BY ALBERT HARTLEY; "TOWARD PRINCIPLES OF POSTSECONDARY EDUCATION FUNDING," BY PAT BARRETT; "RESHAPING THE DIALOGUE," BY BILL SHADE; "MICROCOMPUTERS: A CATALYST FOR THE IDENTIFICATION AND IMPROVEMENT OF QUALITY INSTRUCTION," BY AL MIZELL; "A PROPOSED TAXONOMY OF EDUCATIONAL BENEFITS," BY LESTER RUTH; "ESSENTIAL ACADEMIC SKILLS PROJECT: PROGRESS REPORT," BY MARGARET MANEY; "BILL CONSIDERED IN 1980 FLORIDA LEGISLATIVE SESSION"; "SHOULD THERE BE LEGISLATION TO REGULATE TESTING'? BY THOMAS REDMON; "TECHNICAL ISSUES ASSOCIATED WITH LEGISLATION TO REGULATE TESTING," BY MARGARET WEBER; "AN ACT VIEWPOINT ON TESTING LEGISLATION," BY JIM CARR; AND "SOME FACTS ABOUT THE PREDICTIVE VALIDITY OF THE ACT ASSESSMENT," BY JAMES MAXEY. (SW).

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AN ED197202.
AU BUCKLEY, ELIZABETH; RAUCH, DAVID.
TI PILOT PROJECT IN COMPUTER ASSISTED INSTRUCTION FOR ADULT BASIC EDUCATION STUDENTS. ADULT LEARNING CENTERS, THE ADULT PROGRAM, GREAT NECK PUBLIC SCHOOLS, GREAT NECK, NEW YORK. FINAL THREE YEAR REPORT (2/77-6/79).
SN NEW YORK STATE EDUCATION DEPT. ALBANY. BUREAU OF BASIC CONTINUING EDUCATION. (BBB01477).
IS RIEJUN81.
YR 79.
AB A THREE-YEAR STUDY EVALUATED THE COGNITIVE AND AFFECTIVE EFFECT OF

COMPUTER-ASSISTED INSTRUCTION (CAI) ON ADULT BASIC EDUCATION (ABE) STUDENTS AT THE GREAT NECK ADULT LEARNING CENTERS. THE SYSTEM WAS USED BY LEARNING LABORATORY STUDENTS IN 1977 AND BY BOTH LEARNING LABORATORY AND CLASSROOM STUDENTS FROM 1977-1979. THE 100 STUDENTS ENROLLED FROM 1976-1979 USED CAI REGULARLY AS A CORE PART OF THEIR STUDY. THE CURRICULUM IN THE DRILL AND PRACTICE PROGRAM CONSISTED OF ADULT READING SKILLS, ADULT ARITHMETIC SKILLS, AND ADULT LANGUAGE SKILLS I AND II. IT WAS BASED ON MASTERY LEARNING AND RANGED IN LEVEL FROM THIRD THROUGH SEVENTH GRADE. THE STUDY USED AN EXPERIMENTAL-CONTROL GROUP DESIGN CONTAINING THREE ELEMENTS: (1) COMPARISON OF GROWTH ON CALIFORNIA ACHIEVEMENT TEST IN READING AND MATHEMATICS, (2) COMPARISON OF TIME SPENT IN PROGRAM, AND (3) EXAMINATION OF STUDENTS' ATTITUDES TOWARD LEARNING AND USE OF CAI. STAFF AND STUDENT REACTIONS CONCERNING USE WERE UNIFORMLY POSITIVE. THIRD-YEAR AND THREE-YEAR STUDIES' RESULTS CONFIRMED THAT USE OF CAI LED TO SIGNIFICANT COGNITIVE AND AFFECTIVE GROWTH. IN STRUCTURE AND DESIGN CAI SEEMED AN EFFECTIVE SUPPLEMENTARY LEARNING MEDIUM FOR ABE STUDENTS. CHANGES WERE INDICATED IN CURRICULUM SCOPE AND SYSTEM CAPABILITY. (AN ANALYTICAL SUMMARY PRECEDES THE GENERAL REPORT.) (YLB).

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AN ED194710.
AU JELDEN, DAVID L.
TI THE MICROCOMPUTER AS AN INTERACTIVE INSTRUCTION SYSTEM IN THE CLASSROOM.
IS RIEAPR81.
YR 80.
AB A STUDY WAS CONDUCTED FROM MARCH 1976 THROUGH JUNE 1980 ON THE APPLICATION AND FEASIBILITY OF A COMPUTER MICRO-SYSTEM AS AN INTERACTIVE TUTORIAL INSTRUCTIONAL TOOL IN A SELF-CONTAINED CLASSROOM. LITERATURE ON COMPUTER ASSISTED INSTRUCTION (CAI), HARDWARE, AND SOFTWARE WAS EXAMINED. INDIVIDUALIZED CAI MATERIALS FOR INDUSTRIAL ARTS AND TECHNOLOGY ELECTRONICS WERE GENERATED. AN INSTRUCTIONAL MODEL AND GUIDELINES FOR ITS USE WERE DEVELOPED. MICROPROCESSOR SYSTEM INSTRUCTIONAL EFFECTIVENESS AND HUMAN FACTORS ASSOCIATED WITH ITS CLASSROOM USE WERE EXAMINED. FINDINGS INCLUDE THE FOLLOWING: (1) CAI PROGRAM GENERATION IS POSSIBLE ONLY IF INSTRUCTORS DEVELOP INSTRUCTIONAL UNITS WHICH STAND ALONE YET INTERRELATE WITH EACH OTHER; (2) INSTRUCTORS MUST CONSIDER INDIVIDUAL STUDENT DIFFERENCES AND USE STUDENT FEEDBACK EXTENSIVELY; (3) COMPUTERS PURCHASED FOR CAI USE SHOULD BE STANDARD, MEET CERTAIN MINIMUM CAPACITY REQUIREMENTS, AND HAVE READILY AVAILABLE MAINTENANCE SERVICES; (4) MOST STUDENTS FOUND CAI AS GOOD OR BETTER THAN OTHER MEDIA IN TEACHING CONCEPTS AND SKILLS, FELT CAI HELPED THEM BETTER MEET COURSE OBJECTIVES, AND FOUND LESSONS READABLE AND EASILY UNDERSTOOD; (5) CAI LESSONS SHOWED A POSITIVE CORRELATION TO STUDENT GRADES. FINDINGS AFFIRM CAI FEASIBILITY. INVESTIGATION OF MICROCOMPUTERS FOR SIMULATION PURPOSES OR FOR USE BY THE HANDICAPPED ARE RECOMMENDED. (A 100-PAGE APPENDIX CONTAINS CAI SAMPLE "COURSEWRITER," COMPUTER PROGRAMS, EVALUATION FORMS, COURSE OUTLINES, A PRETEST, LIST OF MICROCOMPUTER SUPPLIERS BY PRODUCT/SYSTEM, AND A BIBLIOGRAPHY.) (MKM).

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AN EJ227667.
AU DIEM, RICHARD A.; FAIRWEATHER, PETER G.
TI AN EVALUATION OF A COMPUTER-ASSISTED EDUCATION SYSTEM IN AN UNTRADITIONAL ACADEMIC SETTING--A COUNTY JAIL.
SO AEDS JOURNAL; V13 N3 P204-13 SPR 1980. 80.
IS CIJDEC80.
YR 80.
AB RESULTS SHOWED THAT COMPUTER ASSISTED EDUCATION COULD BE USED EFFECTIVELY IN A JAIL SETTING PROVIDED THAT ITS CAPABILITIES AND LIMITATIONS WERE PROPERLY UNDERSTOOD. (AUTHOR/IRT).

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AN ED189125.
AU SANDMAN, RICHARD S.; WELCH, WAYNE W.
TI EVALUATION OF TITLE I CAI PROGRAMS AT MINNESOTA STATE CORRECTIONAL INSTITUTIONS.
SN MINNESOTA EDUCATIONAL COMPUTING CONSORTIUM, ST. PAUL. (BBB15696).
IS RIENOV80.
YR 78.
AB THREE MINNESOTA CORRECTIONAL INSTITUTIONS USED COMPUTER-ASSISTED INSTRUCTION (CAI) ON PLATO TERMINALS TO IMPROVE READING AND MATHEMATICS SKILLS: (1) THE STATE REFORMATORY FOR MEN, ST. CLOUD (MALES, AGES 17-21); (2) THE MINNESOTA HOME SCHOOL, SAUK CENTRE (MALES AND FEMALES, AGES 12-18); AND (3) THE STATE TRAINING SCHOOL, RED WING (MALES, AGES 13-18). CURRICULUM PACKAGES INCLUDED PLATO CORRECTIONS PROJECT MATHEMATICS CURRICULUM, THE BASIC SKILLS MATHEMATICS CURRICULUM, AND THE BASIC SKILLS READING CURRICULUM. PROGRAM EVALUATION CONCENTRATED ON BASIC SKILLS; STUDENTS' ATTITUDES TOWARD MATHEMATICS, READING, LEARNING, AND CAI; SUCCESS IN PROGRAM IMPLEMENTATION; AND STAFF ATTITUDES TOWARD CAI. SUITABILITY OF THE CURRICULA AND TECHNICAL ISSUES IN ADMINISTERING CAI PROGRAMS WERE ALSO CONSIDERED. ACHIEVEMENT GAINS WERE MEASURED BY THE TESTS OF ADULT BASIC EDUCATION (TABE); THE STUDENT ATTITUDE SURVEY AND INTERVIEWS WERE USED TO ELICIT STUDENTS' AND TEACHERS' REACTIONS. RESULTS DID NOT CLEARLY SUPPORT CAI EFFECTS ON ACHIEVEMENT, ALTHOUGH THE STUDENTS DID SHOW PROGRESS. STUDENTS' ATTITUDES SHOWED IMPROVEMENT, BUT THIS WAS NOT RELATED TO INSTRUCTIONAL TIME OR USE OF THE COMPUTER. STUDENTS' ATTITUDES TOWARD CAI WERE GENERALLY POSITIVE. STAFF ATTITUDES WERE POSITIVE AT TWO OF THE INSTITUTIONS. (RECOMMENDATIONS, THE FOUR-PART STUDENT ATTITUDE SURVEY, AND INTERVIEW QUESTIONS ARE APPENDED). (GDC).

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AN ED186027.
AU DIEM, RICHARD A.
TI RESULTS AND ANALYSIS OF A COMPUTER ASSISTED INSTRUCTIONAL PROGRAM IN BASIC SKILLS IN A DETENTION CENTER.
IS RIESEP80.
YR 79.
AB AN EVALUATION OF A COMPUTER ASSISTED EDUCATIONAL (CAE) PROGRAM USING THE PLATO SYSTEM AT A TEXAS DETENTION CENTER INCLUDED AN EXAMINATION OF ATTITUDES AND PERCEPTIONS FROM (1) INMATES PARTICIPATING AND NOT PARTICIPATING IN JAIL EDUCATION PROGRAMS, (2) TRUSTEES, (3) EDUCATIONAL PROGRAM STAFF, (4) CHAPLAINCY STAFF, (5) GUARDS ASSIGNED TO THE EDUCATION AREA, (6) FLOOR GUARDS, (7) GUARD TRAINING

SUPERVISOR STAFF, AND (6) UPPER ECHELON JAIL AND SHERIFF'S DEPARTMENT ADMINISTRATORS. ALSO EXAMINED WERE THE RESULTS OF A BASIC SKILLS CURRICULUM STUDY WHICH COMPARED STUDENT SCORES ON VOCABULARY SKILLS, READING, SPELLING, ARITHMETIC COMPUTATION, AND ARITHMETIC PROBLEM SOLVING FROM A CAE AND A TRADITIONAL PROGRAM. FINDINGS INDICATED THAT PLATO WAS GENERALLY VIEWED AS AN EFFECTIVE AND PLEASURABLE TEACHING DEVICE, AND THAT, IN GENERAL, ACHIEVEMENT GAINS WERE GREATER FOR THE CAE PROGRAM GROUP THAN THOSE FOR THE TRADITIONAL PROGRAM GROUP OVER AN 8-WEEK INSTRUCTIONAL PERIOD. (CMV).

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AN ED176236.
AU CALDWELL, ROBERT M.
TI THE EFFECTS OF SELECTED STRATEGIES FOR TEACHING READING TO NON-LITERATE ADULT LEARNERS USING COMPUTER BASED EDUCATION. *
IS RIEFEB80.
YR 79.
AB EVALUATION STUDIES CONDUCTED IN 1978 AT THREE SITES YIELDED ENCOURAGING RESULTS REGARDING THE ABILITY OF THE BASIC SKILLS LEARNING SYSTEM (BSLS) TO ACHIEVE THE GOALS OF ADULT BASIC EDUCATION AND DEMONSTRATED THAT EFFECTIVE CURRICULUM MODELS UTILIZING WELL-DESIGNED INSTRUCTIONAL PARADIGMS CAN OFFER HIGH QUALITY INSTRUCTION IN THE BASIC SKILLS WHEN DELIVERED THROUGH COMPUTER-BASED DELIVERY SYSTEMS. THE INSTRUCTIONAL RATIONALE FOR ESTABLISHING AND DEVELOPING TEACHING STRATEGIES FOR THE READING COMPONENT OF BSLS COMES FROM RECOGNIZING FOUR CONDITIONS THAT ENHANCE VERBAL LEARNING: MEANINGFULNESS, REINFORCEMENT, INSTRUCTIONS TO LEARN, AND PRACTICE. THESE CONDITIONS ARE MET IN BSLS BY ORGANIZING THE MATERIALS INTO CONFIGURATIONS OF STRANDS, CLUSTERS, DRILL AND PRACTICE, REVIEW HELP SEQUENCES, OFF-LINE ACTIVITIES, AND MASTERY TESTS. THE FIELD TESTS MONITORED ADULT LEARNERS' PROGRESS THROUGH LESSONS SEQUENTIALLY ARRANGED IN FIVE STRANDS (STRUCTURAL ANALYSIS, VOCABULARY DEVELOPMENT, LITERAL COMPREHENSION, INTERPRETIVE COMPREHENSION, AND EVALUATIVE COMPREHENSION). THE DATA REVEALED THAT THE AVERAGE LEARNING TIME NECESSARY TO GENERATE A GAIN OF ONE FULL GRADE LEVEL IS 18.34 HOURS OF COMPUTER-BASED READING INSTRUCTION, EQUIVALENT TO APPROXIMATELY 120 HOURS OF REGULAR SCHOOL TIME. (RL).

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AN ED175423.
AU DIEM, RICHARD A.; FAIRWEATHER, PETER G.
TI AN EVALUATION OF THE EFFECTIVENESS OF A COMPUTER ASSISTED INSTRUCTIONAL PROGRAM IN BASIC LITERACY SKILLS IN A COUNTY JAIL.
SN BUREAU OF PRISONS (DEPT. OF JUSTICE), WASHINGTON, D.C. (BBB01427).
IS RIEJAN80.
YR 79.
AB THIS EVALUATION OF THE EFFECTIVENESS OF A COMPUTER ASSISTED INSTRUCTIONAL PROGRAM IN BASIC LITERACY SKILLS FOR INMATES IN A COUNTY JAIL COVERS THE FIRST YEAR OF THE PROGRAM. INSTRUCTIONAL MATERIALS USED WERE DEVELOPED BY CONTROL DATA CORPORATION FOR USE ON THE PLATO SYSTEM, AND CONSISTED OF LESSONS IN VOCABULARY, READING, SPELLING, ARITHMETIC COMPUTATION, AND ARITHMETIC PROBLEM SOLVING. THE REACTIONS OF BOTH THE PRISON POPULATION AND THE ADMINISTRATIVE STAFF OF THE BEXAR COUNTY DETENTION CENTER (SAN ANTONIO) AND THEIR INVOLVEMENT IN THE PROGRAM ARE DISCUSSED. ACHIEVEMENT GAINS OF

PRISONERS PARTICIPATING IN CAI ARE COMPARED WITH THOSE OF PRISONERS IN A TRADITIONAL INSTRUCTION GROUP, AND SOME SUGGESTIONS ARE OFFERED FOR MORE EFFECTIVE USE OF CAI BOTH FOR INMATES AND STAFF DEVELOPMENT COURSES. (RAO).

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AN ED171326.
AU SIMUTIS, ZITA M.
TI CAI AS AN ADJUNCT TO TEACH BASIC SKILLS.
IS RIEOCT79.
YR 79.
AB A STUDY WAS CONDUCTED TO DETERMINE THE INSTRUCTIONAL EFFECTIVENESS OF SUPPLEMENTARY COMPUTER ASSISTED INSTRUCTION (CAI) FOR HIGH SCHOOL EQUIVALENCY TRAINING IN THE MILITARY. THIRTY-TWO STUDENTS IN LANGUAGE ARTS CLASSES AND 32 STUDENTS IN MATHEMATICS CLASSES WERE RANDOMLY DIVIDED INTO TWO GROUPS: ONE RECEIVING TRADITIONAL INSTRUCTION AND THE OTHER TRADITIONAL INSTRUCTION SUPPLEMENTED BY CAI. STUDENTS WERE ARMY ENLISTED PERSONNEL, NONE OF WHOM WERE HIGH SCHOOL GRADUATES. A CAI CURRICULUM SPECIFICALLY TAILORED TO THE NEEDS OF THE STUDY WAS DEVELOPED FROM EXISTING LESSONS IN LANGUAGE ARTS AND MATHEMATICS AVAILABLE ON THE UNIVERSITY OF ILLINOIS PLATO SYSTEM. STUDENTS IN THE TRADITIONAL GROUP RECEIVED INSTRUCTION CONCURRENTLY IN THE SAME TOPICS AS THE TRADITIONAL WITH CAI GROUP. ON ALL MEASURES, SCORES FOR STUDENTS IN THE TRADITIONAL WITH CAI GROUP WERE HIGHER THAN FOR STUDENTS IN THE TRADITIONAL ONLY GROUP. THE RESEARCH INDICATED THAT CAI CAN SUCCESSFULLY BE IMPLEMENTED AT AN ARMY EDUCATION CENTER FOR USE WITH STUDENTS IN THE LOWER ABILITIES RANGE. (CMV).

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AN ED168644.
AU MUNRO, ALLEN; TOWNE, DOUGLAS M.
TI RESEARCH ON SELF-DIRECTED LEARNING TO MEET JOB PERFORMANCE REQUIREMENTS. FINAL REPORT.
SN ADVANCED RESEARCH PROJECTS AGENCY (DOD), WASHINGTON, D.C. (BB300141). OFFICE OF NAVAL RESEARCH, WASHINGTON, D.C. PSYCHOLOGICAL SCIENCES DIV. (BB300287).
IS RIEAUG79.
YR 79.
AB OVER A TWO-YEAR PERIOD, RESEARCH WAS CONDUCTED PRIMARILY IN TWO AREAS OF COGNITIVE STRATEGIES FOR ON-THE-JOB TRAINING (OJT). THE FIRST AREA WAS THE DEVELOPMENT AND TESTING OF A COMPUTER-BASED TRAINING SYSTEM TO IMPROVE SELECTIVITY IN TEXT PROCESSING IN ORDER TO IMPROVE PERFORMANCE DURING OJT. THE SECOND AREA WAS THE EXPLORATION OF TEXT-TYPE EFFECTS ON LEARNING FROM TEXT. PRELIMINARY RESULTS FROM THIS RESEARCH SUGGEST THAT LEARNING FROM TEXT MAY BE MEASURABLY IMPROVED THROUGH THE APPLICATION OF TEXT PROCESSING TECHNIQUES APPROPRIATE TO THE TYPE OF TEXT BEING READ. IN ADDITION TO PRODUCING COMPUTER PROGRAMS FOR TRAINING IN SELECTIVE TEXT PROCESSING, THE RESEARCH STAFF ALSO PRODUCED FOUR TECHNICAL REPORTS, TWO CHAPTERS IN BOOKS, AND THREE PAPERS FOR PROFESSIONAL MEETINGS. (AUTHOR/CSS).

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AN ED167641.
AU MALLORY, ALVA E. JR.; HOLDER, TODD.
TI A COMPREHENSIVE CAREER DEVELOPMENT EMPLOYABILITY, VOCATIONAL, AND COPING SKILLS TRAINING PROGRAM FOR YETP/SPEDY YOUTH IN THE GENESEE INTERMEDIATE SCHOOL DISTRICT. EXECUTIVE SUMMARY. (FINAL REPORT).
SN GCSP CETA CONSORTIUM, FLINT, MICH. (BBB16704).
IS RIEAUG79.
YR 78.
AB A CETA YOUTH PROJECT WAS DESIGNED TO PROVIDE TRAINING IN VOCATIONAL AWARENESS, SELF-AWARENESS, COPING SKILLS, JOB SKILLS, EMPLOYABILITY SKILLS, CAREER PLANNING, AND REMEDIAL READING. OVER 500 YOUTH BETWEEN 14-21 WERE INVOLVED AND MANY RECEIVED COMPUTER INTERACTIONAL CAREER TRAINING IN COORDINATION WITH AN INDIVIDUALIZED CAREER CLASS. SIGNIFICANT GAINS WERE REPORTED IN CAREER EXPLORATION, DECISION MAKING, AND CAREER PLANNING. SELF-REPORT DATA OF THE YOUTH CONFIRMED THAT THEY WERE DEFINITELY HELPED IN DECIDING WHAT THEY WANTED TO DO IN THEIR FUTURES. A 75% INCREASE IN THE LEVEL OF COPING SKILLS FOR SCHOOL AND WORK SETTINGS WAS FOUND AS A RESULT OF A SYSTEMATIC DELIVERY OF TWELVE ONE-HOUR MODULES. A SIMILAR GAIN WAS FOUND IN THE ABILITY OF YOUTH TO IDENTIFY JOB OPENINGS, DEVELOP RESUMES, AND TAKE INTERVIEWS. TWO HUNDRED OF THE 500 RECEIVED 90 HOURS OF VOCATIONAL TRAINING IN ONE OF EIGHT DIFFERENT PROGRAMS. INSTRUCTORS' RATINGS OF THEIR LEARNINGS INDICATED A MARKED IMPROVEMENT. AN INCREASE IN READING LEVELS RESULTED FROM THE APPLICATION OF REMEDIAL TRAINING CONDUCTED ON AN INDIVIDUAL BASIS AND AT A WORK SETTING AS OPPOSED TO AN ACADEMIC SETTING. WORK EXPERIENCES PROVIDED YOUTH WITH INCOME TO HELP KEEP THEM IN SCHOOL AND JOB EXPERIENCES, WHICH WILL HELP PREPARE THEM FOR FUTURE EMPLOYMENT. (THE COMPLEX MANAGEMENT SYSTEM OF THE PROJECT IS DESCRIBED, ALONG WITH RECOMMENDATIONS FOR IMPROVEMENTS. DATA TABLES ARE APPENDED.) (AUTHOR/CT).

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AN ED167114.
AU MASER, ARTHUR L.; AND OTHERS.
TI HIGHLINE PUBLIC SCHOOLS COMPUTER-ASSISTED INSTRUCTION PROJECT: A PROGRAM TO MEET DISADVANTAGED STUDENTS' INDIVIDUAL NEEDS FOR BASIC SKILL DEVELOPMENT: FINAL REPORT.
IS RIEJUL79.
YR 77.
AB THIS DESCRIPTION OF A COMPUTER-ASSISTED INSTRUCTION PROJECT, WHICH PROVIDES AN ALTERNATIVE APPROACH TO INDIVIDUAL INSTRUCTION IN BASIC SKILLS FOR ECONOMICALLY AND EDUCATIONALLY DISADVANTAGED STUDENTS AT THE SECONDARY LEVEL, INCLUDES THE RESULTS OF EVALUATIONS CONDUCTED AT THE END OF EACH OF THREE SCHOOL YEARS. INSTRUCTION IN PRIORITY AREAS--ARITHMETIC, LANGUAGE ARTS, AND READING--WAS ADMINISTERED TO STUDENTS SEVERELY DEFICIENT IN ONE OR MORE SKILL AREAS IN A DIFFERENT MANNER WITHIN EACH SCHOOL. MANAGEMENT AND STUDENT OUTCOME OBJECTIVES WERE EVALUATED BY WRITTEN DOCUMENTATION AND DATA ON STUDENT PRE- AND POSTTESTS. DATA INDICATE THAT STUDENT USE WAS EXCELLENT DURING THE 1974-1975 SCHOOL YEAR, OUTCOME OBJECTIVES WERE MET, AND RESPONSE BY STUDENTS, PARENTS, AND FACULTY WAS GENERALLY POSITIVE. MANAGEMENT AND STUDENT OUTCOME OBJECTIVES IN THE SECOND YEAR OF IMPLEMENTATION MET OR EXCEEDED EXPECTATIONS, STUDENT AND TEACHER INVOLVEMENT INCREASED REMARKABLY, AND STUDENT, PARENT, AND FACULTY ATTITUDES WERE ESPECIALLY POSITIVE. OBJECTIVE DATA FOR THE THIRD YEAR OF OPERATION PRODUCED THE MOST OUTSTANDING RESULTS, INDICATING THAT THE PROGRAM

WAS HIGHLY SUCCESSFUL AND THAT COMPUTER-ASSISTED INSTRUCTION IS A VIABLE METHOD OF BUILDING BASIC SKILLS WITH ELIGIBLE STUDENTS. (CWM).

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AN ED164773.
TI TEXAS TELECOMPUTER GRID/BILINGUAL CAREER EDUCATION DEMONSTRATION PROJECT. FINAL PROJECT PERFORMANCE REPORT.
SN OFFICE OF CAREER EDUCATION (DHEW/OE), WASHINGTON, D.C. (BBB10300).
IS RIEJUN79.
YR 76.
AB A DEMONSTRATION PROJECT WAS CONDUCTED IN 1975-76 AT THREE LOCATIONS IN TEXAS TO SHOW THE EFFECTIVENESS OF THE TEXAS TELECOMPUTER GRID (TTG) AS A TEACHING METHOD IN BILINGUAL CAREER EDUCATION. (TTG IS A SYSTEM DESIGNED TO CONNECT REGIONAL CONCENTRATIONS OF COMPUTER AND TELEVISION RESOURCES BY MICROWAVES TO TRANSMIT TELEVISED PROGRAMS, COMPUTER INFORMATION, AND FACE-TO-FACE CONVERSATIONS WITHOUT THE USE OF TELEPHONES.) A COURSE, ENTITLED "THE WORLD OF WORK: CAREER ORIENTATION FOR ADULTS," WAS DEVELOPED TO INCORPORATE THE BASIC SKILLS OF READING, WRITING, AND ARITHMETIC INTO THE TOPICS OF JOB CHOICE, SEARCH, AND TENURE. OF THE 218 ADULT STUDENTS WHO ENROLLED IN THE COURSE, THE 74% WHO PARTICIPATED IN THE EVALUATION STUDY WERE FOR THE MAJORITY SPANISH-SURNAMED. EXCEPT IN THE AREA OF AFFECTIVE DEVELOPMENT TOWARD CAREERS AND EDUCATION (WHICH REFLECTED LITTLE DIFFERENCE), TTG WAS FOUND TO BE MORE EFFECTIVE THAN CONVENTIONAL TEACHING METHODS, AND, IN GENERAL, TO BE A FLEXIBLE, VIABLE DELIVERY SYSTEM FOR BILINGUAL CAREER EDUCATION. FURTHER STUDY IS NEEDED TO EXPLORE (1) THE LEARNING STYLE OF SPANISH-SPEAKING ADULT STUDENTS, (2) THE APPLICATION OF TTG TO OTHER AREAS OF CAREER EDUCATION, AND (3) OTHER POSSIBLE USES OF TTG'S ABILITY TO SIMULATE FACE-TO-FACE CONVERSATIONS. (ELG).

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AN ED161425.
AU ANDERSON, RICK.
TI CAI AND DEVELOPMENTAL EDUCATION.
IS RIEMAR79.
YR 76.
AB THIS PAPER DISCUSSES THE PROBLEMS AND ACHIEVEMENTS OF COMPUTER ASSISTED INSTRUCTION (CAI) PROJECTS AT UNIVERSITY COLLEGE, UNIVERSITY OF CINCINNATI. THE MOST INTENSIVE USE OF CAI ON CAMPUS, THE CAI LAB, IS PART OF THE DEVELOPMENTAL EDUCATION CENTER'S EFFORT TO SERVE STUDENTS WHO LACK MASTERY OF BASIC COLLEGE-LEVEL SKILLS IN MATHEMATICS AND ENGLISH. THE CAI LAB SERVES AS RESOURCE TO FACULTY MEMBERS WANTING TO DEVELOP OR USE CAI UNITS. TWO AREAS IN PARTICULAR HAVE CAUSED PROBLEMS AND CONCERN: FINANCIAL DIFFICULTIES AND PROGRAM JUSTIFICATION. A COMPREHENSIVE REPORT ON ONE PARTICULAR COURSE, "IRREG" (IRREGULAR VERB FORMS), WAS PRODUCED AND IS PRESENTED HERE UNDER THE FOLLOWING HEADINGS: STUDENT EVALUATION AND ANALYSIS, AND SYSTEM PERFORMANCE (BASED ON THE CAI LAB LOG) AND ANALYSIS. (VT).

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AN ED150947.
AU HIMWICH, H. A. ED.

TI CRITIQUE AND SUMMARY OF THE CHANUTE AFB CBE PROJECT.
SN ADVANCED RESEARCH PROJECTS AGENCY (DOD), WASHINGTON, D.C. (BBB00287).
IS RIEJUL78.
YR 77.
AB CHANUTE AIR FORCE BASE WAS THE FIRST MILITARY TRAINING CENTER TO UNDERTAKE AN EXTENSIVE INVESTIGATION OF THE USE OF THE PLATO IV SYSTEM IN TECHNICAL TRAINING. THE SERVICE TEST WAS TO COMPARE A CONVENTIONALLY TAUGHT COURSE IN GENERAL VEHICLE MAINTENANCE WITH A COURSE TAUGHT WITH COMPUTER-BASED INSTRUCTIONAL MATERIALS. PART I OF THIS DOCUMENT IS THE FINAL REPORT OF THE PROJECT AND DISCUSSES SITE HISTORY AND MANAGEMENT EFFORTS. TOPICS INCLUDE THE RESEARCH AGREEMENT, SELECTION AND TRAINING OF PLATO AUTHORS, EVOLUTION OF THE PROJECT MANAGEMENT, LESSON DEVELOPMENT PROCEDURES, AND INSTRUCTIONAL SYSTEMS DEVELOPMENT (ISD) MANAGEMENT OF THE SERVICE TEST. WRITTEN BY PERSONNEL FROM THE COMPUTER-BASED EDUCATION RESEARCH LABORATORY OF THE UNIVERSITY OF ILLINOIS, WHO ACTED AS EVALUATION, INSTRUCTIONAL, AND PROGRAMMING CONSULTANTS FOR THE SERVICE TEST, PART II IS A CHAPTER-BY-CHAPTER CRITIQUE OF THE FINAL REPORT. (AUTHOR/JAB).

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AN ED147395.
TI AN ANALYSIS OF THE IMPACT OF COMPUTER ASSISTED INSTRUCTION ON A PROGRAM DESIGNED TO AMELIORATE THE EFFECTS OF RACIAL ISOLATION IN THE LOS NIETOS SCHOOL DISTRICT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEAPR78.
YR 77.
AB THE LOS NIETOS SCHOOL DISTRICT IN LOS ANGELES WAS THE FIRST SCHOOL IN THE UNITED STATES THAT HAD ITS BASIC SKILLS PROGRAM SUPPORTED THROUGH INTENSIVE USE OF COMPUTERS. THROUGH FUNDINGS UNDER THE EMERGENCY SCHOOL AID ACT (ESAA), THE PROGRAM IS EMBARKING ON ITS THIRD YEAR. THE SYSTEM INITIALLY SUPPORTED 17 TYPEWRITER-STYLE TERMINALS, BUT BEFORE THE END OF THE YEAR THE NUMBER WAS INCREASED TO 24. THE SYSTEM SUPPORTED THE FOLLOWING COURSES: ARITHMETIC PROFICIENCY TRAINING PROGRAM, ELEMENTARY READING SKILLS, AND WRITE. THE SYSTEM WAS AFFECTED BY SLOW RESPONSE TIME AND SOFTWARE PROBLEMS AND THE COURSES SHIFTED TO ELEMENTARY READING SKILLS (GRADES 3-6), ELEMENTARY ARITHMETIC (GRADES 1-7), AND ELEMENTARY LANGUAGE ARTS (GRADES 3-6). IN THE EVENING HOURS, THE SYSTEM WAS USED WITH ADULT READING, MATH, AND LANGUAGE SKILLS. COMPUTER ASSISTED INSTRUCTION (CAI), IT HAS BEEN SHOWN, IS AN EFFECTIVE MEDIUM FOR BUILDING INTERNAL CONTROL IN THE CHILD WHO BELIEVES THAT HIS LIFE IS CONTROLLED BY EXTERNAL FORCES. IT ALSO APPEARS THAT CAI IS A VALUABLE MEDIUM OF INSTRUCTION IN SCHOOL DISTRICTS THAT ARE IN THE PROCESS OF DESEGREGATION. TEACHERS HAVE REPORTED THAT PUPILS WHO HAVE BEEN THE MOST DIFFICULT TO HANDLE APPEAR TO BE PARTICULARLY ATTRACTED TO THE MEDIUM OF CAI. (AUTHOR/AM).

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AN ED147389.
TI EXCELLENCE IN SOCIAL ACHIEVEMENT, AFFECTIVE LEARNING, ACADEMIC GROWTH.
IS RIEAPR78.
YR 77.

AB THE LOS NIETOS BASIC SKILLS PROGRAM WAS THE FIRST PROGRAM OF COMPUTER ASSISTED INSTRUCTION FUNDED BY THE EMERGENCY SCHOOL AID ACT (ESAA). THE SYSTEM INITIALLY SUPPORTED 17 TYPEWRITER-STYLE TERMINALS, BUT THE NUMBER WAS LATER INCREASED TO 24. BECAUSE OF SOFTWARE PROBLEMS, THE SYSTEM CHANGED COMPANIES AND THE COURSES CHANGED TO THE FOLLOWING: ELEMENTARY READING SKILLS (GRADES 3-6), ELEMENTARY ARITHMETIC (GRADES 1-6), AND ELEMENTARY LANGUAGE ARTS (GRADES 3-6). IN THE EVENING HOURS, THE SYSTEM WAS USED WITH ADULT READING, MATH, AND LANGUAGE SKILLS. COMPUTER ASSISTED INSTRUCTION (CAI) TAKES OVER THE DRILL AND PRACTICE FUNCTION OF TEACHING. IN THE LOS NIETOS SCHOOL DISTRICT IN LOS ANGELES, CAI IS BEING IMPLEMENTED IN 5 SCHOOLS. TEACHERS HAVE REMARKED ON THE ENTHUSIASM OF THE CHILDREN TOWARD THE TERMINALS. IT SEEMS THAT PUPILS WHO HAVE BEEN THE MOST DIFFICULT TO HANDLE ARE PARTICULARLY ATTRACTED TO THIS MEDIUM. IT ALSO APPEARS THAT CAI IS A VALUABLE MEDIUM OF INSTRUCTION IN SCHOOL DISTRICTS THAT ARE IN THE PROCESS OF DESEGREGATION. (AUTHOR/AM).

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AN ED147344.
TI PROCEEDINGS OF THE ANNUAL CONFERENCE OF THE MILITARY TESTING ASSOCIATION (18TH, GULF SHORES, ALABAMA, OCTOBER 18-22, 1976).
IS RIEAPR78.
YR 76.
AB THE 75 PAPERS INCLUDED IN THESE CONFERENCE PROCEEDINGS DISCUSS TESTING CONDUCTED BY THE DIFFERENT BRANCES OF THE ARMED FORCES. THE IMPORTANCE OF RELATING NECESSARY JOB SKILLS TO THE SKILLS MEASURED BY THE TESTS ADMINISTERED TO THE JOB APPLICANTS IS EMPHASIZED. VARIOUS EVALUATION METHODS--INCLUDING PEER RATING, APTITUDE TESTING, ADAPTIVE TESTING, PERFORMANCE OR SKILL QUALIFICATION TESTING, COMPUTER ASSISTED TESTING, AND JOB KNOWLEDGE ANALYSIS--ARE USED FOR PERSONNEL SELECTION AND EVALAUTION REGARDING ADVANCEMENT. ADDITIONAL TOPICS DISCUSSED AT THE SYMPOSIUM INCLUDE: THE EVALUATION OF MILITARY TRAINING PROGRAMS, JOB SATISFACTION SURVEYS, IMPACT OF FEMALE PERSONNEL IN THE MILITARY, AND TEST CONSTRUCTION. THE BY-LAWS OF THE MILITARY TESTING ASSOCIATION ARE APPENDED. (GDC).

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AN ED146445.
AU FRANTZ, NEVIN R. JR.
TI THE DEVELOPMENT AND FIELD TESTING OF A COMPUTER-MANAGED DELIVERY SYSTEM FOR INDIVIDUALIZING INSTRUCTION IN MULTIOCCUPATIONAL PROGRAMS FOR VOCATIONAL EDUCATION. FINAL REPORT.
SN NATIONAL CENTER FOR EDUCATIONAL RESEARCH AND DEVELOPMENT (DHEW/OE), WASHINGTON, D.C. (BBB02778).
IS RIEAPR78.
YR 77.
AB A PROJECT WAS CONDUCTED TO DEVELOP AND FIELD TEST A COMPUTER BASED SYSTEM TO MANAGE AN INDIVIDUALIZED INSTRUCTIONAL APPROACH FOR MULTIOCCUPATIONAL PROGRAMS IN VOCATIONAL EDUCATION. A COMPUTER MANAGED SYSTEM WAS PREPARED WHICH SCHEDULED STUDENTS INDIVIDUALLY FOR A VARIETY OF INSTRUCTIONAL AREAS WITHIN AN OCCUPATIONAL CLUSTER. AN INDIVIDUALIZED INSTRUCTIONAL MODULE WAS DELIVERED, VIA A COMPUTER TERMINAL, WHICH TWENTY NINTH GRADE STUDENTS COMPLETED UNDER THE DIRECTION OF AN INSTRUCTOR. ACHIEVEMENT OF THE COGNITIVE INFORMATION FOR THIS MODULE WAS ACCOMPLISHED BY A POST-CHECK WHICH STUDENTS

RECEIVED FROM THE TERMINAL. FEEDBACK TO THE RESPONSES FOR THE POST-CHECK ITEMS WAS PROVIDED TO THE STUDENTS AND A RECORD OF THEIR STATUS WAS KEPT BY THE COMPUTER AND PROVIDED TO INSTRUCTORS WHEN NEEDED. THE RESULTS OF THE FIELD TEST INDICATED THAT A VIABLE COMPUTER MANAGED INSTRUCTIONAL SYSTEM FOR INDIVIDUALIZING INSTRUCTION IN A MULTIOCCUPATIONAL PROGRAM COULD BE DEVELOPED AND IMPLEMENTED SUCCESSFULLY. ADDITIONAL RESEARCH AND DEVELOPMENT SHOULD BE CONDUCTED TO DETERMINE THE EFFECTIVENESS AND EFFICIENCY OF THE APPROACH IN PROVIDING CAREER EXPLORATION EXPERIENCES AND JOB ENTRY COMPETENCIES FOR STUDENTS ENROLLED IN VOCATIONAL EDUCATION PROGRAMS AT THE SECONDARY SCHOOL LEVEL. APPENDIXES COMPRISE HALF OF THE THIRTY-TWO-PAGE REPORT AND CONTAIN SAMPLES OF THE COMPUTERIZED MATERIALS USED IN THE PROJECT. (AUTHOR/BL).

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AN ED144987.
TI TITLE I ESEA PROJECTS: DIGEST OF ANNUAL EVALUATIONS 1965-1976. REPORT NO. 7681.
IS RIEFEB78.
YR 76.
AB THE MAJOR PORTION OF THIS DIGEST CONSISTS OF BRIEF DESCRIPTIONS OF CURRENTLY FUNDED ELEMENTARY AND SECONDARY EDUCATION ACT, TITLE I PROJECTS IN THE PHILADELPHIA, PENNSYLVANIA PUBLIC SCHOOL SYSTEM, FROM 1965 THROUGH 1976. EACH DESCRIPTION INCLUDES FOUR SECTIONS: MANAGEMENT INFORMATION, PROJECT DESCRIPTION, EVALUATION TECHNIQUES AND MAJOR FINDINGS ON A YEAR-BY-YEAR BASIS THROUGH JANUARY 1976. PRELIMINARY FINDINGS ARE OFFERED FOR THE 1975-1976 SCHOOL YEAR. A LIST OF 41 PROJECTS NO LONGER FUNDED UNDER TITLE I APPEARS IN THE APPENDIX. (MV).

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AN ED128402.
TI PROCEEDINGS OF THE ANNUAL CONFERENCE OF THE MILITARY TESTING ASSOCIATION (17TH, FORT BENJAMIN HARRISON, INDIANA, SEPTEMBER 15-19, 1975).
IS RIEJAN77.
YR 75.
AB THE 62 PAPERS PRESENTED AT THE 1975 CONFERENCE OF THE MILITARY TESTING ASSOCIATION COVER ALMOST ALL AREAS OF MILITARY AND OCCUPATIONAL ASSESSMENT AND EVALUATION, AND ARE ARRANGED IN 19 "COMMON SUBJECT-MATTER GROUPINGS": SYMPOSIUM (ON APTITUDE TESTING), TRAINING EXTENSION COURSES, COMPUTERIZED TESTING, TASK VALIDATION AND QUALIFICATION STANDARDS, COMPUTER BASED TRAINING, TESTING/ASSESSMENT: ISSUES AND INNOVATIONS, SCREENING AND COUNSELING ENLISTEES, OCCUPATIONAL ANALYSIS AND TRAINING PROGRAMS, SKILL QUALIFICATION UNDER ENLISTED PERSONNEL MANAGEMENT SYSTEM (EPMS), RESEARCH AND MEASUREMENT METHODOLOGY, DEMONSTRATING OCCUPATIONAL COMPETENCY, USES OF OCCUPATIONAL ANALYSIS DATA, NON-COGNITIVE ASSESSMENT, TASK ANALYSIS TRAINING AND EVALUATION, ORGANIZATIONAL FACTORS IN PERFORMANCE, CRITERION REFERENCED MEASUREMENT, ASSESSING JOB AND GRADE REQUIREMENTS, AND MEASUREMENT AND PREDICTION. (BW).

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AN ED127950.
AU PARK, ROSEMARIE J.
TI TRAINING TEACHERS IN THE AREA OF ADULT LITERACY: A CASE STUDY APPROACH.
IS RIEJAN77.
YR 76.
AB TO ACQUAINT TEACHERS OF ADULT LITERACY WITH THE SPECIAL NEEDS OF ADULT LEARNERS, A SERIES OF COMPUTERIZED CASE STUDIES WAS DEVELOPED AS PART OF THREE TEACHER TRAINING COURSES. THE FIRST COURSE SENSITIZED TEACHERS TO THE LEARNING PROBLEMS OF CERTAIN TARGET POPULATIONS; THE SECOND INTRODUCED DIAGNOSTIC AND PRESCRIPTIVE TEACHING TECHNIQUES; AND THE THIRD FAMILIARIZED TEACHERS WITH EXISTING MATERIALS AND SUGGESTED TECHNIQUES FOR DEVELOPING ADDITIONAL MATERIALS. PARTICIPANTS TESTED THEIR SKILLS BY USING INTERACTIVE, COMPUTERIZED CASE SIMULATIONS. (EMH).

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AN ED124651.
AU NABORS, DONALD GENE.
TI A COMPARATIVE STUDY OF ACADEMIC ACHIEVEMENT AND PROBLEM-SOLVING ABILITIES OF BLACK PUPILS AT THE INTERMEDIATE LEVEL IN COMPUTER-SUPPORTED INSTRUCTION AND SELF-CONTAINED INSTRUCTIONAL PROGRAMS.
IS RIEOCT76.
YR 74.
AB THE PURPOSE OF THIS STUDY WAS TO MAKE COMPARISONS BETWEEN INTERMEDIATE GRADE BLACK PUPILS IN AN INDIVIDUALIZED, COMPUTER-SUPPORTED INSTRUCTIONAL PROGRAM AND INTERMEDIATE GRADE BLACK PUPILS WHO WERE IN A TRADITIONAL, SELF-CONTAINED CLASSROOM INSTRUCTIONAL PROGRAM. SPECIFICALLY, THE BASIC PROBLEM WAS THAT OF DETERMINING THE EXTENT TO WHICH AN INDIVIDUALIZED COMPUTER-SUPPORTED PROGRAM WITH INTERMEDIATE GRADE PUPILS IS EFFECTIVE AS A PROMOTER OF PROBLEM-SOLVING ABILITY. THE CHARACTERISTICS COMPARED WERE: OVER-ALL ACADEMIC ACHIEVEMENT, READING COMPREHENSION, AND GENERAL PROBLEM-SOLVING SKILLS AS EVIDENCED BY THE COOPERATIVE SEQUENTIAL TESTS OF EDUCATIONAL PROGRESS: SCIENCE, AND THE IOWA TESTS OF BASIC SKILLS. FIFTH BLACK INTERMEDIATE GRADE PUPILS FROM INTACT FIFTH AND SIXTH GRADE CLASSES WERE USED TO REPRESENT THE SAMPLE FROM A TRADITIONAL INSTRUCTIONAL PROGRAM. FIFTY BLACK INTERMEDIATE GRADE PUPILS FROM INTACT FIFTH AND SIXTH GRADE CLASSES WERE USED TO REPRESENT THE SAMPLE THAT WAS EXPOSED TO COMPUTER-SUPPORTED INSTRUCTION. STATISTICAL ANALYSES SHOWED THAT THERE WERE STATISTICAL DIFFERENCES BETWEEN THE TWO GROUPS IN PROBLEM SOLVING AT THE FIVE PERCENT LEVEL IN FAVOR OF THE COMPUTER-SUPPORTED GROUP. THERE WAS ALSO A SIGNIFICANT DIFFERENCE BETWEEN THE GROUPS ON THE VARIABLE OF OVER-ALL ACHIEVEMENT IN FAVOR OF THE COMPUTER-SUPPORTED GROUP. (AUTHOR/JM).

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AN ED113511.
AU BARAN, ANNA DESANTIS; GILLI, ANGELO C. SR.
TI SELECTED PAPERS OF JOSEPH T. IMPELLITTERI.
SO VOCATIONAL-TECHNICAL EDUCATION DEPARTMENTAL REPORT; V13 N7 JULY 1975 . JUL 75.
IS RIEMAR76.

YR 73.
AB THE COLLECTION OF SELECTED PAPERS OF JOSEPH T. IMPELLITTERI REPRINTS IN FULL, OR EXCERPTS FROM, 46 UNPUBLISHED POSITION AND CONFERENCE PAPERS, RESEARCH AND PROGRAM PROPOSALS, AND PROJECT REPORTS, AND FROM 20 PUBLISHED ARTICLES, CHAPTERS FROM EDITED COLLECTIONS, BULLETINS AND SPECIAL STUDIES WHICH IMPELLITTERI AUTHORED OR CO-AUTHORED. THE PAPERS ARE PRESENTED CHRONOLOGICALLY FOR THE YEARS 1963 TO 1972. THE PAPERS DEAL GENERALLY WITH THE FOLLOWING SUBJECTS: VOCATIONAL DEVELOPMENT, OCCUPATIONAL GUIDANCE (ESPECIALLY THAT WHICH IS COMPUTER ASSISTED), OCCUPATIONAL COMPETENCY ASSESSMENTS, INSTRUCTIONAL MEDIA, SELF-CONCEPTS OF VOCATIONAL STUDENTS, GRADUATE VOCATIONAL EDUCATION AT PENNSYLVANIA STATE UNIVERSITY, VOCATIONAL EDUCATION RESEARCH, AND PROFESSIONAL TEACHER EDUCATION. (JR).

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AN ED095307.
AU SMALL, HAZEL CHRISTINE.
TI EFFECTIVENESS OF REINFORCEMENT SCHEDULE IN RELATION TO CERTAIN ADULT CHARACTERISTICS USING COMPUTER ASSISTED INSTRUCTION. ADULT LEARNING RESOURCES PROJECT, RESEARCH MONOGRAPH NO. 3.
SN BUREAU OF ADULT, VOCATIONAL, AND TECHNICAL EDUCATION (DHEW/OE), WASHINGTON, D.C. (BBB01855).
IS RIEJAN75.
YR 70.
AB THE MONOGRAPH REPORTS THE PROBLEM, DESIGN, AND FINDINGS OF GRADUATE STUDENT RESEARCH DIRECTLY RELATED TO ADULT BASIC EDUCATION TEACHER TRAINING. THE OBJECTIVES OF THIS EXPERIMENT WERE TO ASSESS: (1) THE DEGREE OF RELATIONSHIP AMONG REINFORCEMENT, LEARNING, AND SELF-CONCEPT FOR ADULTS USING COMPUTER ASSISTED INSTRUCTION (CAI); (2) CHANGES IN LEARNER PERFORMANCE WITH CHANGES IN REINFORCEMENT SCHEDULE; AND (3) THE CONTRIBUTION OF SELF-CONCEPT TO CHANGES IN LEARNER PERFORMANCE WHEN REINFORCEMENT SCHEDULE IS VARIED. IT WAS CONCLUDED THAT THE SAMPLE OF ADULTS EXHIBITED SELF-CONCEPTS WHICH WERE SIGNIFICANTLY LOWER THAN HAD BEEN PREDICTED. DATA INDICATED SIGNIFICANT DIFFERENCES BETWEEN CORRELATIONS OF SELF-CONCEPT, TREATMENTS, AND ALL FOUR LEARNER PERFORMANCES: (1) ACHIEVEMENT, (2) TRIALS, (3) TIME, AND (4) ERRORS. AN EXAMINATION OF OVERALL CAI PERFORMANCE INDICATED THAT THOSE LEARNERS WITH THE LEAST ENABLING ABILITY REQUIRED MORE TRIALS BUT MADE MORE ACTUAL GAINS WITHOUT REGARD TO SELF-CONCEPT SCORES ON TREATMENT EFFECTS. HAVING INVESTIGATED A NUMBER OF VARIABLES AIDING IN THE DESIGN OF CAI MATERIALS AND PROGRAMS, PROBLEMS FOR FURTHER RESEARCH ARE SUGGESTED. A 30-PAGE BIBLIOGRAPHY AND APPENDIX CONCLUDES THE DOCUMENT. (AUTHOR/MW).

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AN EJ203438.
AU RIZZA, PETER J.; WALKER-HUNTER, PEGGY.
TI NEW TECHNOLOGY SOLVES AN OLD PROBLEM: FUNCTIONAL ILLITERACY.
SO AUDIOVISUAL INSTRUCTION; V24 N1 P22-23,63 JAN 1979. JAN79.
IS CIJOCT79.
YR 79.
AB FUNCTIONAL ILLITERATES FROM ADULT BASIC EDUCATION PROGRAMS, CORRECTIONAL INSTITUTIONS, AND FEDERAL OR CITY PROGRAMS SERVED AS SUBJECTS IN A TEST OF THE REMEDIAL INSTRUCTION EFFECTIVENESS OF THE

BASIC SKILLS LEARNING SYSTEM (BSLS) USING PLATO. RESULTS INDICATED THAT BSLS IS AN EFFECTIVE SYSTEM FOR IMPROVING BOTH READING AND COMPUTATIONAL SKILLS. (CMV).

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AN EJ179450.
AU PATRICK, JOHN; STAMMERS, ROBERT.
TI COMPUTER ASSISTED LEARNING AND OCCUPATIONAL TRAINING.
SJ BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY; 8; 3; 253-67. OCT 77.
IS CIJE1978.
YR 77.
AB INVESTIGATES THE POTENTIAL ROLE OF THE COMPUTER IN OCCUPATIONAL TRAINING. (AUTHOR).

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AN EJ102235.
AU FINCH, CURTIS R.
TI INDIVIDUALIZING INSTRUCTION: WHAT CAN YOU LEARN FROM RESEARCH.
SJ AMERICAN VOCATIONAL JOURNAL; 49; 6; 28-9. SEP 74.
YR 74.

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AN EJ031939.
AU SHERRON, RONALD H.
TI CURRICULUM RESEARCH FOR THE DISADVANTAGED ADULT.
SJ AUDIOVISUAL INSTRUCTION; 16; 1; 41-2. JAN '71.
IS CIJE1971.
YR 71.
AB A REPORT ON 'A DEVELOPMENTAL AND DEMONSTRATION PROJECT IN THE USE OF MODERN EDUCATIONAL TECHNOLOGY FOR THE INSTRUCTION OF UNDER-EDUCATED ADULTS'. (EDITOR).

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AN ED069786.
AU MITZEL, HAROLD E.; BRANDON, GEORGE L.
TI EXPERIMENTATION WITH COMPUTER-ASSISTED INSTRUCTION IN TECHNICAL EDUCATION. SEMI-ANNUAL PROGRESS REPORT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. BUREAU OF RESEARCH. (RMQ66004).
IS RIEAUG74.
YR 68.
AB A SERIES OF FIVE REPORTS IS PRESENTED WHICH DESCRIBES THE ACTIVITIES CARRIED OUT BY THE PENNSYLVANIA STATE UNIVERSITY GROUP ENGAGED IN RESEARCH IN COMPUTER-ASSISTED INSTRUCTION (CAI) IN VOCATIONAL-TECHNICAL EDUCATION. THE REPORTS COVER THE PERIOD JANUARY 1968-JUNE 1968 AND DEAL WITH: 1) PRIOR KNOWLEDGE AND INDIVIDUALIZED INSTRUCTION; 2) NUMERICAL AND VERBAL APTITUDE TESTS ADMINISTERED AT THE CAI STATION; 3) AN EXPERIMENTAL PROCEDURE FOR COURSE REVISION BASED ON STUDENTS' PAST PERFORMANCE; 4) THE DEVELOPMENT OF A GEOMETRIC DICTIONARY FOR THE IBM 1500 COMPUTER SYSTEM; AND 5) A PROCESSOR FOR MULTIPLE NUMERIC ENTRIES. ALSO PROVIDED IS A PREVIEW OF ACTIVITIES FOR FISCAL YEAR 1969. CURRICULUM DEVELOPMENT ACTIVITIES ARE DESCRIBED AS FOCUSING ON THE DEVELOPMENT OF

COMMUNICATIONS SKILLS FOR THE VOCATIONAL STUDENT AND THE CREATION OF CAI PHYSICS MATERIAL. RESEARCH EFFORTS ARE LISTED AS CENTERING UPON: 1) THE DEVELOPMENT OF A COMPUTER-BASED SEQUENTIAL INTELLIGENCE TEST; 2) ADAPTATION OF THE GENERAL APTITUDE TEST BATTERY TO ON-LINE PRESENTATION; AND 3) REPLICATION OF PRIOR STUDIES CONTRASTING THE EFFECTS OF GRADIENT AND FULL-RESPONSE FEEDBACK ON IMMEDIATE LEARNING AND RETENTION. (AUTHOR/PB).

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AN ED089787.
AU MITZEL, HAROLD E.; BRANDON, GEORGE L.
TI EXPERIMENTATION WITH COMPUTER-ASSISTED INSTRUCTION IN TECHNICAL EDUCATION. SEMI-ANNUAL PROGRESS REPORT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. BUREAU OF RESEARCH. (RMQ66004).
IS RIEAUG74.
YR 66.
AB ACTIVITIES CONDUCTED DURING THE PERIOD JANUARY 1966-JUNE 1966 AS PART OF THE PENNSYLVANIA STATE UNIVERSITY COMPUTER-ASSISTED INSTRUCTION (CAI) PROJECT ARE REPORTED. THE OBJECTIVES OF THE PROJECT ARE DESCRIBED IN A PREVIOUS DOCUMENT (IR 000 511). THIS REPORT FIRST PROVIDES INFORMATION ON THE PHYSICAL FACILITIES AND EQUIPMENT USED IN THIS STAGE OF THE PROJECT. NEXT, THE DEVELOPMENT OF CAI COURSE MATERIALS FOR TECHNICAL EDUCATION IS DESCRIBED; A SUMMARY OF ALL COURSE MATERIALS DEVELOPED, TESTED AND REVISED IS GIVEN, FOLLOWED BY DETAILS ABOUT COURSE SEQUENCES IN ENGINEERING SCIENCE, TECHNICAL MATHEMATICS, NUMBER SEQUENCES, AND COMMUNICATIONS SKILLS (SPELLING). FOUR CATEGORIES OF RESEARCH ON CAI AND EDUCATIONAL VARIABLES ARE ALSO DISCUSSED. THESE INVOLVE: 1) FEEDBACK, PROMPTING, AND OVERT CORRECTION PROCEDURES IN NONBRANCHING CAI PROGRAMS; 2) THE EFFICIENCY OF TYPEWRITER INTERFACE; 3) DEFICITS IN INSTRUCTIONAL TIME RESULTING FROM THE TYPEWRITER INTERFACE; AND 4) THE EFFECTS OF ROTE RULE-LEARNING ON TRANSFER OF TRAINING. (AUTHOR/PB).

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AN ED089786.
AU MITZEL, HAROLD E.; BRANDON, GEORGE L.
TI EXPERIMENTATION WITH COMPUTER-ASSISTED INSTRUCTION IN TECHNICAL EDUCATION. SEMI-ANNUAL PROGRESS REPORT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. BUREAU OF RESEARCH. (RMQ66004).
IS RIEAUG74.
YR 65.
AB A REPORT IS GIVEN OF THE ACTIVITIES CARRIED OUT DURING THE FIRST SEVEN MONTHS OF A COMPUTER-ASSISTED INSTRUCTION (CAI) PROJECT AT PENNSYLVANIA STATE UNIVERSITY, BEGUN IN MAY 1965. THE PROJECT'S OBJECTIVES ARE LISTED AS: 1) TO DETERMINE HOW CAI CAN BE USED TO PRESENT CORE COURSES IN TECHNICAL EDUCATION; 2) TO PREPARE CAI MATERIALS IN TECHNICAL MATHEMATICS, ENGINEERING SCIENCE, AND COMMUNICATION SKILLS FOR POST-SECONDARY STUDENTS; 3) TO TRAIN INDIVIDUALS TO PREPARE CAI MATERIALS AND TO RESEARCH COMPUTER APPLICATIONS IN TECHNICAL EDUCATION; AND 4) TO DISSEMINATE INFORMATION ABOUT CAI. THE FIRST SECTION OF THE REPORT DEALS WITH THE PHYSICAL FACILITIES PROVIDED BY THE UNIVERSITY AND THE EQUIPMENT CONFIGURATION USED, WHILE THE FOLLOWING SEGMENT DESCRIBES THE INITIAL

COURSE DEVELOPMENT ACTIVITIES IN THE TECHNICAL EDUCATION SUBJECTS. BRIEF REPORTS OF RESEARCH FINDINGS ARE PRESENTED IN THE THIRD SECTION AND THE FINAL PART OF THE REPORT CONSISTS OF AN APPENDIX WHICH PROVIDES AN EVALUATIVE REVIEW OF CAI EFFORTS THROUGHOUT THE COUNTRY. (AUTHOR/PB).

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AN ED082463.
AU FRICK, FREDERICK C.
TI EDUCATIONAL TECHNOLOGY PROGRAM. QUARTERLY TECHNICAL SUMMARY, 1 DECEMBER 1972 THROUGH 28 FEBRUARY 1973.
SN AIR FORCE SYSTEMS COMMAND, WASHINGTON, D.C. (BBB02352).
IS RIEFEB74.
YR 73.
AB WORK ON THE LINCOLN TRAINING SYSTEM (LTS) CONDUCTED DURING THE PERIOD COVERED BY THIS REPORT FOCUSED UPON 1) APPLICATIONS RESEARCH FOR THE LTS AND 2) ON THE IMPLEMENTATION OF A SERIES OF EXPERIMENTAL DESIGN STUDIES. TEST RESULTS SHOWED THAT PAIRS OF STUDENTS COULD SHARE TERMINALS, WITH FEEDBACK AND REMEDIATION BASED ON ONLY ONE STUDENT'S RESPONSE, THUS PERMITTING MORE STUDENTS TO BE TRAINED AT LOWER COSTS. STUDENT DATA SUMMARIES FOR 1) THE EXACT PATH OF EACH STUDENT; 2) THE DISTRIBUTION OF FRAME TRANSFER AT EACH FRAME; AND 3) THE TIME PER FRAME, PROVED VALUABLE FOR LESSON ANALYSIS AND THE EVALUATION OF ALTERNATIVE INSTRUCTIONAL STRATEGIES. THE MICROFICHE SELECTOR/READER BREADBOARD WAS COMPLETED AND STUDIES WERE BEGUN INVOLVING ALTERNATIVE AUDIO READERS, X-Y POSITIONING SCHEMES, AND FICHE MANIPULATION SYSTEMS. DATA FROM THESE STUDIES WILL SERVE AS THE BASIS FOR DECISIONS REGARDING THE SUBSYSTEMS OF LTS-4. FINALLY, IT WAS DETERMINED THAT THE PROPOSED SELF-PROCESSOR FOR LTS-4 WAS CAPABLE OF COMPLETE REDUCTION OF THE RAW DATA STORED ON FILM, AND THAT THE FILM DATA CHANNEL MORE THAN ADEQUATELY MET THE SYSTEM'S REQUIREMENTS. (AUTHOR/PB).

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AN ED082461.
AU BUTMAN, ROBERT C.; FRICK, FREDERICK C.
TI THE LINCOLN TRAINING SYSTEM: A SUMMARY REPORT.
SN AIR FORCE SYSTEMS COMMAND, WASHINGTON, D.C. (BBB02352).
IS RIEFEB74.
YR 72.
AB THE CURRENT STATUS OF THE LINCOLN TRAINING SYSTEM (LTS) IS REPORTED. THIS DOCUMENT DESCRIBES LTS AS A COMPUTER SUPPORTED MICROFICHE SYSTEM WHICH: 1) PROVIDES RANDOM ACCESS TO VOICE QUALITY AUDIO AND TO GRAPHICS; 2) SUPPORTS STUDENT-CONTROLLED INTERACTIVE PROCESSES; AND 3) FUNCTIONS IN A VARIETY OF ENVIRONMENTS. THE REPORT OFFERS A DETAILED DESCRIPTION OF LTS-3, THE CURRENT EMBODIMENT OF THE SYSTEM CONCEPT OUTLINED ABOVE, DISCUSSING ITS MICROFICHE READER TERMINAL, AUDIO RECORDING, AUDIO READER, LOGICAL PROCESSOR, AND LESSONS. RESULTS OF THE FIELD TEST OF LTS-3 ARE GIVEN, THE MOST SIGNIFICANT OF WHICH INDICATE THAT A SYSTEM CAN BE DESIGNED WHICH IS COST EFFECTIVE, WHICH REDUCES TRAINING TIME WITHOUT ADVERSELY INFLUENCING TRAINING QUALITY, AND WHICH ENHANCES THE PERFORMANCE OF LOW ABILITY STUDENTS. FURTHER DEVELOPMENTS GROWING OUT OF THE LTS-3 PROJECT ARE ALSO TREATED. THESE HARDWARD MODIFICATIONS ARE EXPECTED TO RESULT IN LTS-4, A STREAMLINED AND SIGNIFICANTLY LESS EXPENSIVE VERSION OF THE

LTS, IN WHICH EACH LTS-4 CONSOLE WILL BE CAPABLE OF STAND-ALONE OPERATION AND SELF-CONTAINED COMPUTATIONAL POWER. (LB).

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ED062460.
FRICK, FREDERICK C.
EDUCATIONAL TECHNOLOGY PROGRAM. QUARTERLY TECHNICAL SUMMARY, 1 JUNE THROUGH 31 AUGUST 1972.
AIR FORCE SYSTEMS COMMAND, WASHINGTON, D.C. (BBB02352).
RIEFEB74.
72.
FIELD TRIALS OF THE LINCOLN TRAINING SYSTEM (LTS-3) AT KEESLER AIR FORCE BASE WERE COMPLETED. FIFTEEN LESSONS ON THE MATERIAL COVERED IN THE FIFTH WEEK OF AN ELECTRONICS COURSE WERE PREPARED AND USED. STUDENTS USING THE LTS-3 MATERIALS LEARNED SLIGHTLY BETTER THAN PUPILS WHO RECEIVED CONVENTIONAL INSTRUCTION, LOWER APTITUDE STUDENTS PERFORMED WELL, AND THERE WAS A 37% SAVINGS IN TIME. THUS, DESPITE HIGHER CAPITAL COSTS, OVERALL OPERATING EXPENSES CAN BE REDUCED, AND THE SYSTEM IS COST EFFECTIVE. THEREFORE, PLANNING FOR FULL ENGINEERING DEVELOPMENT AND OPERATIONAL TEST OF A PRODUCTION PROTOTYPE SYSTEM (LTS-4), IN WHICH THE NEW TRAINING MEDIUM WILL BE USED FOR AN ENTIRE COURSE OF INSTRUCTION, WAS UNDERTAKEN. EXTENSIVE DEVELOPMENT OF LESSON MATERIALS AND THE INSTALLATION OF MICROFICHE PRODUCTION FACILITIES AT KEESLER TECHNICAL TRAINING CENTER WERE RECOMMENDED. HARDWARE DEVELOPMENT ACTIVITIES DURING THE QUARTER INCLUDED: 1) MICROFICHE SELECTOR DEVELOPMENT, 2) AUDIO READER SYSTEM DEVELOPMENT, 3) AUDIO CHANNEL EXPERIMENTS, 4) DATA CHANNEL DEVELOPMENT, 5) A SURVEY OF HIGH-RESOLUTION FILMS, 6) THE ASSEMBLY OF A SYSTEM SELF-PROCESSOR, AND 7) THE DEVELOPMENT OF SELF-PROCESSOR SOFTWARE. (AUTHOR/LB).

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ED062184.
KRATOCHVIL, DANIEL W.
ARITHMETIC PROFICIENCY TRAINING PROGRAM DEVELOPED BY SCIENCE RESEARCH ASSOCIATES, INC. PRODUCT DEVELOPMENT REPORT NO. 11.
OFFICE OF PROGRAM PLANNING AND EVALUATION (DHEW/OE), WASHINGTON, D. C. (BBB02244).
RIEAUG72.
72.
THIS REPORT SUMMARIZES THE DEVELOPMENT OF A COMMERCIALLY AVAILABLE PROGRAM IN COMPUTATIONAL SKILLS WHICH MAKES EXTENSIVE USE OF COMPUTER CAPABILITIES. THE FIRST SECTION DESCRIBES THE ORGANIZATION, CONTENT, AND COST OF THE MATERIALS, AND THE PROCEDURES FOR USING THEM. THE KEY PERSONNEL, AND THE ORGANIZATIONAL AND FUNDING SOURCES ARE THEN NAMED. THREE PHASES IN THE DEVELOPMENT PROCESS ARE NEXT IDENTIFIED: (1) INFORMAL TRYOUTS, (2) PROGRAM DEVELOPMENT USING THE APL/360 PROGRAMMING LANGUAGE, AND (3) CONVERSION TO COURSEWRITER III LANGUAGE. FORMATIVE EVALUATION DURING THE SECOND PHASE AND SUMMATIVE EVALUATION AFTER THE THIRD PHASE ARE DESCRIBED IN SOME DETAIL. FINAL SECTIONS OF THE REPORT OUTLINE THE MARKETING PROCEDURES FOR THE PRODUCT, ITS DEGREE OF ADOPTION, POSSIBLE FUTURE DEVELOPMENTS, AND FOUR CRUCIAL DECISIONS IN ITS DEVELOPMENTAL HISTORY. (MM).

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AN ED059616.
AU MITZEL, HAROLD E.
TI EXPERIMENTATION WITH COMPUTER-ASSISTED INSTRUCTION IN VOCATIONAL-TECHNICAL EDUCATION, 1965-1970. FINAL REPORT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEJUN72.
YR 71.
AB A COMPUTER-ASSISTED INSTRUCTION (CAI) PROJECT FOCUSED PRIMARILY ON CURRICULUM DEVELOPMENT IN THREE TECHNICAL AREAS: SCIENCE, MATHEMATICS, AND COMMUNICATION SKILLS. THE PROJECT ALSO SOUGHT 1) TO DEVELOP SPECIFIC COURSE MATERIAL AND METHODS OF PRESENTATION; 2) TO PROVIDE EXPLANATIONS OF VARIOUS TECHNIQUES AND STRATEGIES FOR DEALING WITH COURSE DEVELOPMENT, WITH EMPHASIS ON THE EDUCATION OF VOCATIONAL EDUCATION TEACHERS; 3) TO EVALUATE AND ARTICULATE THE COMBINATION OF CAI WITH OTHER EDUCATIONAL STRATEGIES, AND 4) BY MEANS OF CAREFUL EXPERIMENTATION, TO DETERMINE OPTIMUM FORMATS FOR VOCATIONAL-TECHNICAL MATERIAL TAUGHT WITH COMPUTER ASSISTANCE. THE FOUR-YEAR PROJECT USED FIRST AN IBM 1410 COMPUTER AND THEN AN IBM 1500; PROGRAMS WERE IN THE COURSEWRITER LANGUAGE. IN THIS REPORT THE CURRICULUM MATERIAL IN MATHEMATICS, SPELLING, ENGINEERING SCIENCE, TESTING, AND OCCUPATIONAL GUIDANCE ARE PRESENTED IN SOME DETAIL, ALONG WITH THE SYSTEMS PROGRAMS FOR DISPLAY AND CODING, RESEARCH STUDIES INTO EDUCATIONAL STRATEGIES AND EQUIPMENT EVALUATION, AND THE FLOWCHARTS DEVELOPED BY THE PROJECT. THE DISSEMINATION ACTIVITIES OF THE PROJECT ARE SUMMARIZED. (JY).

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AN ED058589.
AU IMPELLITTERI, JOSEPH T.; FINCH, CURTIS R.
TI REVIEW AND SYNTHESIS OF RESEARCH ON INDIVIDUALIZING INSTRUCTION IN VOCATIONAL AND TECHNICAL EDUCATION.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEAPR72.
YR 71.
AB AN INTEGRATED FRAMEWORK FOR INDIVIDUALIZED INSTRUCTION IN VOCATIONAL AND TECHNICAL EDUCATION COULD CONSIST OF FIVE COMPONENTS, INCLUDING THE STUDENT, TEACHER, ENVIRONMENT, INSTRUCTIONAL CONTENT, AND MEDIATION. IN THIS REVIEW, RESEARCH AND DEVELOPMENT MATERIALS IDENTIFIED THROUGH A COMPUTER SEARCH OF MATERIALS IN THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC), ARE GROUPED ACCORDING TO THIS FRAMEWORK. SECTIONS ARE: (1) ISSUES IN THE DESIGN OF INDIVIDUALIZED INSTRUCTION, EMPHASIZING THE TEACHER COMPONENT, (2) STUDENT CHARACTERISTICS RESEARCH, EMPHASIZING THE STUDENT COMPONENT, (3) EDUCATIONAL TECHNOLOGY, EMPHASIZING THE MEDIATION COMPONENT, (4) INSTRUCTIONAL STRATEGIES, EMPHASIZING THE TEACHER COMPONENT, AND (5) INSTRUCTIONAL SYSTEMS APPROACHES, EMPHASIZING RESEARCH WHICH TAKES A MORE INTEGRATED APPROACH TO INDIVIDUALIZED INSTRUCTION. STUDIES RELATING TO THE INSTRUCTIONAL COMPONENT ARE LOCATED THROUGHOUT THE SECTIONS. IT WAS RECOMMENDED THAT COOPERATIVE EFFORTS OF PRACTITIONERS AND RESEARCHERS, INCLUDING DOCTORAL STUDENTS, ARE NEEDED TO IMPROVE THE CURRENT STATUS OF INDIVIDUALIZED INSTRUCTION. WE MUST ALSO ACKNOWLEDGE AND UTILIZE SELECTED IDEAS AND DEVICES INITIALLY DEVELOPED FOR MILITARY USE. (SB).

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AN ED055501.
AU ORNSTEIN, JACOB; AND OTHERS.
TI PROGRAMMED INSTRUCTION AND EDUCATIONAL TECHNOLOGY IN THE LANGUAGE TEACHING FIELD: NEW APPROACHES TO OLD PROBLEMS. LANGUAGE AND THE TEACHER: A SERIES IN APPLIED LINGUISTICS, VOLUME 9.
IS RIEFEB72.
YR 71.
AB SEEKING TO DETERMINE THE EXTENT TO WHICH EDUCATIONAL TECHNOLOGY IS REPRESENTED IN THE FIELD OF LANGUAGE INSTRUCTION, THIS STUDY PRESENTS A THREE-PART SURVEY OF HISTORICAL DEVELOPMENTS AND CURRENT PRACTICES IN THIS AREA. PART ONE EXAMINES THE DEVELOPMENT OF PROGRAMED INSTRUCTION IN THE LANGUAGE FIELD, WHILE FOCUSING ON RESEARCH AND DEVELOPMENT AT THE UNIVERSITY LEVEL, COMPUTER-ASSISTED INSTRUCTION, COMMERCIAL AND FEDERAL INVOLVEMENT, AND FOREIGN INTERESTS. ANOTHER MAJOR SECTION DEALS WITH PROGRAMED INSTRUCTION AND THEORIES OF LANGUAGE AND METHODOLOGY OF LANGUAGE TEACHING INCLUDING A REVIEW OF TRENDS IN LINGUISTIC THEORY, CRITICISM OF PROGRAMED INSTRUCTION, THE SYSTEMS APPROACH, AND THE FUTURE OF PROGRAMED LANGUAGE- LEARNING. THE FINAL SECTION DISCUSSES THE PRACTICAL COMPONENTS OF A PROGRAMED LANGUAGE COURSE INCLUDING: (1) "DESIGNED LEARNING," (2) STEP-INCREMENT, (3) REINFORCEMENT, (4) CONDITIONING AUDITORY ABILITY, (5) CONDITIONING FOR SOUND PRODUCTION, (6) FROM SOUND TO WRITING, (7) MORPHOLOGY, (8) DEVELOPING LINGUISTIC SKILLS, (9) APTITUDE, AND (10) ATTITUDE. A BIBLIOGRAPHY IS PROVIDED. (RL).

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AN ED046312.
AU TEN EYCK, R.
TI C.A.M. GERMAN LEVEL I.
IS RIEMAY71.
YR 70.
AB THE UNDERLYING THEORY OF COMPREHENSIVE ACHIEVEMENT MONITORING IS APPLIED AND ILLUSTRATED IN THIS GERMAN 1 LANGUAGE INSTRUCTION GUIDE. THIS COMPUTER-ORIENTED APPROACH TO INDIVIDUALIZING INSTRUCTION AND TO STUDENT EVALUATION MONITORS PROGRESS IN EVERY BASIC IDEA AND SKILL IN THE LANGUAGE COURSE. MATERIALS USED IN THIS COURSE INCLUDE ADVICE TO STUDENTS ON: (1) TAKING THE TESTS, (2) UNDERSTANDING C.A.M. RESULTS, (3) OBJECTIVES AND COMPUTER SCORING, (4) SAMPLE STUDENT EVALUATION REPORTS, (5) SAMPLE LEARNING PACKETS FOR THE TEXT "VERSTEHEN UND SPRECHEN", AND (6) LEARNING ACTIVITIES PACKAGES. TWELVE UNITS OF INSTRUCTIONAL MATERIALS ON DEVELOPING CONVERSATIONAL SKILLS ARE INCLUDED. (RL).

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AN ED045826.
TI VOCATIONAL-TECHNICAL EDUCATION IN HUMAN RESOURCE DEVELOPMENT IN FLORIDA: A STATEWIDE EVALUATION. RECOMMENDATIONS OF THE FLORIDA STATE ADVISORY COUNCIL ON VOCATIONAL AND TECHNICAL EDUCATION.
SN FLORIDA STATE DEPT. OF EDUCATION, TALLAHASSEE. (HWP26250).
IS RIEAPR71.
YR 70.
AB PRESENTED IN TWO SECTIONS, THIS REPORT CONSISTS OF RECOMMENDATIONS BASED ON GOALS SUGGESTED BY THE NATIONAL ADVISORY COUNCIL AND THE U. S. OFFICE OF EDUCATION, AND THE WORK OF A STUDY GROUP ORGANIZED AS APPENDIXES UNDER EACH OF THE SAME GOALS. THE SUMMARY OF THE

RECOMMENDATIONS REVEALED THAT THE MOST FREQUENTLY ENCOUNTERED PROBLEM WAS THE TENDENCY TO TREAT THE SYMPTOMS OF HUMAN DIFFERENCES WITHOUT CONSIDERING THE IMPLICATIONS FOR EDUCATION. OTHER MAJOR NEEDS ARE A TOTAL MANAGEMENT INFORMATION SYSTEM, AND COORDINATION BETWEEN THE MAJOR COLLEGES AND THE LOCAL COUNTY OPERATED VOCATIONAL CENTERS. (AUTHOR/JS).

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AN ED032776.
AU STOLUROW, LAWRENCE M.; KLARE, GEORGE R.
TI PROJECT CREATES. FIRST ANNUAL REPORT 1968-69.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEFEB70.
YR 69.
AB PROJECT CREATES STANDS FOR COMBINED RESOURCES FOR EDITING AUTOMATED TEACHING TO ENLIGHTEN STUDENTS, THE HARVARD UNIVERSITY COMPUTER-AIDED INSTRUCTION LABORATORY'S PART OF "A MULTI-AGENCY DEVELOPMENTAL ADULT BASIC EDUCATION PROGRAM". THE MAJOR EMPHASES OF PROJECT CREATES HAVE BEEN IN THE AREA OF PROGRAM AND PROCEDURE DEVELOPMENT FOR COMPUTER-AIDED REVISION OF INSTRUCTIONAL MATERIALS AND THE AREA OF COMPUTER INSTRUCTION OF READING AND LANGUAGE SKILLS. WORK HAS ALSO BEEN DONE ON ANALYTIC-GENERATIVE COMPUTER PROGRAMS TO AID EDITORS AND WRITERS IN TEXT REVISION, AND ON THE DEVELOPMENT OF NEW PROGRAMS FOR ADULT BASIC EDUCATION. THE COMPUTER AIDED INSTRUCTION TRAINING REPORTED WAS CARRIED OUT IN THE LEARNING CENTER ESTABLISHED IN THE ROXBURY SECTION OF BOSTON. THE FIRST TRAINING SESSION WAS STILL IN PROCESS WHEN THE REPORT WAS WRITTEN, AND DEFINITE TEST RESULTS WERE UNOBTAINABLE. HOWEVER, THE WORK DONE BY PROJECT CREATES PERSONNEL FROM THE INCEPTION OF THE PROGRAM TO THE TIME OF WRITING ARE COVERED IN DETAIL UNDER THE CATEGORIES: PERSONNEL, PUBLICATIONS, MEETINGS, AND RESEARCH AND DEVELOPMENT. AN APPENDIX CONTAINING MOST OF THE PUBLICATIONS, TECHNICAL REPORTS AND NOTES MENTIONED IN THE REPORT IS OBTAINABLE FROM SYRACUSE UNIVERSITY. A GLOSSARY OF ACRONYMS, PERSONNEL LIST, AND A SCHEMATIC DIAGRAM OF THE PROGRAM ARE INCLUDED. (SH).

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AN ED021988.
AU MCGREGOR, G.C.; REYNOLDS, ROBERT R.
TI IN SERVICE TRAINING IN COMPUTER ASSISTED INSTRUCTION FOR VOCATIONAL TEACHERS. FINAL REPORT.
SN OFFICE OF EDUCATION (DHEW), WASHINGTON, D.C. (RMQ66000).
IS RIEJAN69.
YR 66.
AB THIS PROJECT WAS THE THIRD IN A PROPOSED 5-PHASE PROJECT FOR DEVELOPING VOCATIONAL EDUCATION CURRICULUM FOR JUNIOR AND SENIOR HIGH SCHOOL STUDENTS. THIRTEEN VOCATIONAL EDUCATION TEACHERS PARTICIPATED DURING THE PERIOD FROM JULY 13 TO OCTOBER 15, 1966. A SPECIFIC OBJECTIVE FOR EACH PARTICIPANT WAS TO DEVELOP A 1-SEMESTER COURSE IN HIS PARTICULAR SUBJECT AREA WHICH WOULD BE USED IN ESTABLISHING A COMPUTER ASSISTED INSTRUCTION (CAI) CURRICULUM IN VOCATIONAL EDUCATION. THE OBJECTIVE OF COMPLETING A SEMESTER'S COURSE APPEARED TO HAVE BEEN TOO AMBITIOUS. FROM 50 TO 150 HOURS OF WORK WAS REQUIRED TO PRODUCE ONE 40-MINUTE CLASS LESSON. ONLY ONE TO ONE AND ONE HALF CLASS LESSONS COULD BE PREPARED SINCE THE PARTICIPANTS SPENT

15 HOURS IN PREPARATION EACH WEEK, OUTSIDE OF THE REQUIRED
OF 2 HOURS EACH EVENING ON MONDAY THROUGH THURSDAY, IN 6 WEEKS. THE
MOST IMPORTANT SINGLE IMPEDIMENT OF THE PROJECT WAS THE LACK OF
RELIABILITY OF THE CAI EQUIPMENT. RECOMMENDATIONS AND GUIDELINES FOR
FUTURE PROGRAMS ARE LISTED. A SAMPLE COURSE SECTION, "INTRODUCTION
TO DATA PROCESSING," FOR CAI INSTRUCTION IS INCLUDED IN THE APPENDIX.
(PS).

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AN ED020030.
AU RHODES, CHARLES W.
TI APPALACHIA TRIES A CO-OP.
IS COMRNPT.
YR 68.
AB EDUCATORS AT THE APPALACHIA EDUCATIONAL LABORATORY IN CHARLESTON,
WEST VIRGINIA, HAVE MODIFIED THE EDUCATIONAL PARK CONCEPT TO TAKE
ADVANTAGE OF SCHOOL CONSOLIDATION WHILE MAINTAINING A PERSONAL
RELATIONSHIP BETWEEN TEACHER AND PUPIL. AS PROPOSED, THE EDUCATIONAL
COOPERATIVE WOULD CONSIST OF A CENTRAL FACILITY, JOINTLY CONSTRUCTED
BY SMALLER SCHOOLS IN THE AREA CONCERNED. FROM THIS FACILITY,
TELEVISED LECTURES BY MASTER TEACHERS IN A WIDE RANGE OF SUBJECT
MATTER AREAS WOULD BE TRANSMITTED TO LOCAL SCHOOLS. A FLEET OF
MOBILE LABORATORIES WOULD BE SCHEDULED AND DISPATCHED FROM THE
CENTRAL FACILITY TO PARTICIPATING SCHOOLS. PROPOSED COMPONENTS OF A
CO-OP OF THIS SIZE INCLUDE EDUCATIONAL TELEVISION, MOBILE FACILITIES,
COMPUTER ASSISTED INSTRUCTION, SHARED COURSES, EARLY CHILDHOOD
EDUCATION, AND VOCATIONAL GUIDANCE. FIELD TESTS ARE BEING CONDUCTED
IN 6 APPALACHIAN STATES, EACH CONCENTRATING ON A SINGLE PHASE OF THE
PROPOSED CO-OP. EVALUATION HAS ALSO BEEN UNDERTAKEN ON AN
INTERACTION ANALYSIS TECHNIQUE DESIGNED TO AID IN-SERVICE TEACHERS IN
DETERMINING THE DEGREE OF FREEDOM A STUDENT MAY BE ALLOWED IN
EXPRESSING HIMSELF, WHILE PERMITTING CONTROL BY THE TEACHER. THIS
ARTICLE APPEARS IN "EDUCATION NEWS," VOL. 2, NO. 10, MAY 27, 1968,
PAGE 12. (JA).

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AN ED019757.
AU HIRSCH, WERNER Z.
TI PLANNING EDUCATION TODAY FOR TOMORROW.
IS COMRNPT.
YR 68.
AB IN THREE AREAS OF RESPONSIBILITY--POLICY CONSIDERATION, PROGRAM
FORMULATION, AND PROGRAM ADMINISTRATION--EDUCATIONAL PLANNERS ARE
RELATIVELY UNPREPARED TO MAKE DECISIONS AFFECTING URBAN EDUCATION IN
BOTH THE IMMEDIATE AND THE DISTANT FUTURE. THESE THREE FUNDAMENTAL
RESPONSIBILITIES INVOLVE IDENTIFYING EDUCATIONAL OBJECTIVES,
OPPORTUNITIES, AND PROBLEMS AND SOLUTIONS, FORMULATING EDUCATIONAL
PROGRAMS TO MEET THE NEEDS THAT HAVE BEEN RECOGNIZED, AND EFFECTIVELY
ADMINISTERING THE RESULTANT PROGRAMS. THE ESTABLISHMENT OF A
METROPOLITAN EDUCATION OUTLOOK STATION IS PROPOSED AS AN
INTER-INSTITUTIONAL PLANNING CENTER TO OFFER LOCAL UNITS UNIFIED
INFORMATION AND A COMMON SOURCE OF EXPERT ADVICE. VARIOUS WAYS TO
PLAN AND UTILIZE SUCH A FACILITY ARE OUTLINED, INCLUDING SIMULATION
TECHNIQUES, BENEFIT-COST ANALYSIS, AND PROGRAM BUDGETING. POTENTIAL

PROBLEMS WHICH SUCH A FACILITY COULD HELP TO SOLVE INCLUDE TIME-ENERGY EXPENDITURE FOR THE INCREASING PROPORTION OF OLDER ADULTS, POOR UTILIZATION OF INTELLECTUAL TALENT, THE BEST USE OF COMPUTERIZED INFORMATION SYSTEMS, AND VOCATIONAL TRAINING FOR THE TECHNOLOGICALLY DISPLACED WORKER. THIS ARTICLE APPEARED IN "URBAN AFFAIRS QUARTERLY," VOLUME II, NUMBER 1, SEPTEMBER, 1966. (JK).

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AN ED019575.
AU POder, WILLIAM H. ; HAND, SAM E.
TI FRONTIERS IN ADULT BASIC EDUCATION, A COMPILATION OF SELECTED PAPERS AND GROUP REPORTS PRESENTED AT THE SOUTHEASTERN REGION INSTITUTE FOR TEACHER-TRAINERS IN ADULT BASIC EDUCATION (FLORIDA STATE UNIVERSITY, AUGUST 1-26, 1966).
IS CONREPT.
YR 66.
AB SELECTED PAPERS AND GROUP REPORTS FROM A FLORIDA STATE UNIVERSITY TRAINING INSTITUTE ARE PRESENTED ON PSYCHOLOGICAL AND SOCIOLOGICAL DIMENSIONS OF POVERTY AND ILLITERACY, ADULT BASIC EDUCATION METHODS AND OBJECTIVES, PRINCIPLES OF ADULT LEARNING AND BEHAVIOR CHANGE, AND RELATED CONCERNS IN TEACHER TRAINING AND PROGRAM DEVELOPMENT. SPECIFIC PROBLEM AREAS IDENTIFIED BY TEACHER TRAINERS, THE OVERALL PROBLEM OF IDENTIFYING WITH AND MOTIVATING THE UNDEREDUCATED, ADULT CENTERED COUNSELING, CURRICULUM PLANNING, AND READING INSTRUCTION, EVALUATION OF INSTRUCTIONAL MATERIALS, ENLISTMENT OF COMMUNITY SUPPORT, LONG RANGE EFFECTS OF EARLY CULTURAL DEPRIVATION, AND STRATEGIES AND SUGGESTIONS FOR TRAINING INDIGENOUS NONPROFESSIONALS ARE AMONG THE MAJOR TOPICS CONSIDERED. TWO TABLES, CHAPTER NOTES AND REFERENCES, APPENDIXES, AND A MODEL OF THE LEARNING PROCESS ARE ALSO INCLUDED. (LY).

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AN ED015559.
AU MCCLELLAND, WILLIAM A.
TI TRAINING RESEARCH UTILIZING MAN-COMPUTER INTERACTIONS, PROMISE AND REALITY.
IS CONREPT.
YR 67.
AB THE PAPER WAS PRESENTED AS PART OF THE AVIONICS PANEL PROGRAM ON NATURAL AND ARTIFICIAL LOGIC PROCESSORS, SPONSORED BY THE ADVISORY GROUP FOR AERONAUTICAL RESEARCH AND DEVELOPMENT, NATO. SEVERAL CONCEPTUAL PROPOSITIONS IN REGARD TO MAN AND THE COMPUTER ARE OFFERED. THE NATURE OF TRAINING RESEARCH IS EXAMINED. THERE IS ALSO A BRIEF CATEGORIZATION OF HUMAN BEHAVIOR TO SUGGEST SOME OF THE USES AND SOME OF THE DIFFICULTIES IN THE UTILIZATION OF COMPUTERS IN TRAINING RESEARCH. THE ROLE OF THE TRAINING RESEARCH PSYCHOLOGIST DEALING WITH LARGE GROUPS OF PEOPLE IN MASS INSTRUCTION IN A MILITARY SETTING IS DISCUSSED, AS IS THE IMPORTANCE OF THE COMPUTER FOR DATA PROCESSING AND AS A TOOL FOR SIMULATING COMPLEX BEHAVIOR. THIS DOCUMENT, AD-654-618, IS AVAILABLE FROM THE CLEARINGHOUSE FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION, SPRINGFIELD, VA. 22151. MICROFICHE $0.65. HARDCOPY $3.00. (AUTHOR).

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AN ED014030.
AU WALLIS, D. ; AND OTHERS.
TI PROGRAMMED INSTRUCTION IN THE BRITISH ARMED FORCES, A REPORT ON RESEARCH AND DEVELOPMENT.
IS CURRENT.
YR 67.
AB THE BRITISH ARMED SERVICES HAVE APPLIED PROGRAMING IN SCHOLASTIC SUBJECTS. A MARKED IMPROVEMENT IN THE TECHNOLOGY OF TRAINING HAS RESULTED IN THE DEVELOPMENT OF A MORE SYSTEMATIC DERIVATION OF TRAINING OBJECTIVES, CLOSER ASSESSMENT OF KNOWLEDGE AND ABILITY OF POTENTIAL STUDENTS, AND MORE ACCURATE SPECIFICATION OF CONTENTS, METHODS, AND MATERIALS FOR TRAINING EFFICIENCY IN TERMS OF PERFORMANCE STANDARDS AND COST EFFECTIVENESS. ADAPTIVE TEACHING MACHINE SYSTEMS ARE SUCCESSFUL IN INSTRUCTION OF KEYBOARD AND RADAR SKILLS, FAULT FINDING AND GENERAL COMPREHENSION, WHILE COMPUTER-BASED INSTRUCTION SYSTEMS ARE UTILIZED IN ACQUISITION OF KNOWLEDGE. WIDESPREAD USE OF PROGRAMING WOULD IMPROVE TRAINING BY REDUCING DEMANDS ON INSTRUCTORS AND INSTRUCTION TIME, INCREASING KNOWLEDGE AND PROFICIENCY, AND THE NUMBER OF TRAINED PERSONNEL. FUTURE MILITARY RESEARCH MUST DEAL WITH SUCH PROBLEMS AS--DEVELOPING NEW PROGRAMING STYLES AND DEVICES AND MORE SUITABLE CRITERIA FOR JUDGING PROGRAM EFFECTIVENESS, AND EVALUATING THE ROLE OF THE INSTRUCTOR. (THE DOCUMENT INCLUDES A FOLD-OUT TABLE OF CLASSIFICATION OF TRAINING AREAS AND INSTRUCTIONAL METHODS.) THIS DOCUMENT IS AVAILABLE FROM HER MAJESTY'S STATIONERY OFFICE, LONDON, ENGLAND. (PT).

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AU JACOBS, T.O. ; AND OTHERS.
TI U.S. ARMY HUMAN FACTORS RESEARCH AND DEVELOPMENT ANNUAL CONFERENCE, INDIVIDUAL AND SMALL-UNIT TRAINING FOR COMBAT OPERATIONS (12TH, FORT BENNING, GEORGIA, OCTOBER 1966).
IS CURRENT.
YR 67.
AB RESEARCH IN THE AREA OF MILITARY TRAINING AND TRAINING METHODS WAS REVIEWED AND ASSESSED FOR (1) ITS RELEVANCE TO MODERN COMBAT OPERATIONS (IDENTIFICATION OF COMBAT TASKS, DEVELOPMENT OF SKILL TRAINING, AND EVALUATION) AND (2) ITS EFFICIENCY (REDUCED COST AND TIME AND INCREASED TRAINEE PROFICIENCY, OR BOTH). CASES OF EFFECTIVE RESEARCH IN USE OF WEAPONS (TRAINFIRE AND RIFLEMAN SERIES), LAND NAVIGATION, AND OPERATION AS SQUAD MEMBER AND LEADER WERE CITED. PROGRESSIVE STEPS WERE ESTABLISHED FOR TRAINING IMPROVEMENT AND INCLUDED SUCH ACTIVITIES AS--ANALYSIS OF TRAINING OBJECTIVES, LITERATURE AND PSYCHOLOGICAL LEARNING FACTORS, AND DETERMINATION OF ESSENTIAL SUBJECTS, SKILLS, AND PERFORMANCES. IMPROVED PROGRAMS RESULTED IN ELIMINATION OF LECTURES, MORE INDIVIDUALIZED INSTRUCTION APPROPRIATE PLACEMENT OF INSTRUCTION, AND REALIZATION OF THE IMPORTANCE OF GROUP PRACTICE AND FEEDBACK. AFTER DETAILED REPORTS OF PROGRAMED INSTRUCTION, EDUCATIONAL TELEVISION, AND COMPUTER ASSISTED INSTRUCTION, THE CONCLUSION WAS REACHED THAT LEARNING EFFECTIVENESS DEPENDED UPON ATTAINMENT OF REALISTIC TRAINING OBJECTIVES AND TYPE OF MEDIA WAS DETERMINED BY ECONOMIC FEASIBILITY. A FINAL PAPER DEALT WITH INDIVIDUALIZED INSTRUCTION. (THIS DOCUMENT, AD-653-845, IS AVAILABLE FROM THE CLEARINGHOUSE FOR FEDERAL SCIENTIFIC AND TECHNICAL INFORMATION, SPRINGFIELD, VA. 22151. MICROFICHE $0.65, HARDCOPY $3.00) (AUTHOR/LY).

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Journal of Educational Psychology
1983, Vol 75 No 1 19-26

0022-0663/83/7501-0019$00.75

Effects of Computer-Based Teaching On Secondary School Students

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This article used quantitative techniques, or *meta-analysis*, to integrate findings from 51 independent evaluations of computer-based teaching in Grades 6 through 12. The analysis showed that computer-based teaching raised students' scores on final examinations by approximately .32 standard deviations, or from the 50th to the 63rd percentile. Computer-based instruction also had smaller, positive effects on scores on follow-up examinations given to students several months after the completion of instruction. In addition, students who were taught on computers developed very positive attitudes toward the computer and positive attitudes toward the courses they were taking. Finally, the computer reduced substantially the amount of time that students needed for learning.

Programs for computer-based teaching have come a long way in the 20 years since they were first developed. Today's programs come in a variety of sophisticated shapes and sizes and show few traces of their origins in B. F. Skinner's modest, fill-in-the-blanks teaching machines. The programs tutor and drill students, diagnose learning difficulties, prescribe remedies for problems, keep records of student progress, and present material in print and diagram form. In their own way, they do nearly everything that good teachers do.

Pioneers in the area believed from the start that CBI would bring great benefits to students and teachers (Gerard, 1967). Among the benefits expected for learners were better, more comfortable, and faster learning, since students would learn at their own pace and at their own convenience; opportunities to work with vastly richer materials and more sophisticated problems; personalized tutoring; and automatic measurement of progress. Benefits for teachers were to include less drudgery and repetition, greater ease in updating instructional materials, more accurate appraisal and documentation of student progress, and more time for meaningful contact with learners.

Has computer-based instruction produced such benefits? Soon after its introduction, educational researchers started to design evaluation studies to answer this question. In a typical study, a researcher divided a class of students into an experimental and a control group. Students in the experimental group received part of their instruction at computer terminals, whereas those in the control group received their instruction by conventional teaching methods. At the end of the experiment, the researcher compared responses of the two groups on a common examination or on a course evaluation form.

Although these evaluation studies produced potentially valuable information on the effects of computer-based teaching, the message from the studies was not immediately clear. One problem was that each evaluation report was published separately. The total picture was therefore not easy to see. Another more serious problem was that studies were never exact replications of one another. The studies differed in experimental designs, settings, and in the types of computer applications they investigated. And, worst of all, evaluation results differed from one investigation to another. Findings from different studies were never exactly the same.

Reviews were therefore written to bring

This research was supported by the National Science Foundation Grant No. 79-20742. Opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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the separately published studies together and to find the common threads among their results. The reviews that appeared were of two basic types: box-score reviews and meta-analyses. Box-score reviews usually reported the proportion of studies favorable and unfavorable toward computer-based instruction, and often provided narrative comments about the studies as well. Reviewers using Glass's meta-analysis (Glass, McGaw, & Smith, 1981) took a more quantitative approach to their task. Meta-analysts used (a) objective procedures to locate studies; (b) quantitative or quasi-quantitative techniques to describe study features and outcomes; and (c) statistical methods to summarize overall findings and to explore relationships between study features and outcomes.

Reviewers using box-score and narrative methods usually concluded that computer-based teaching was effective in raising student achievement, especially in elementary schools. Vinsonhaler and Bass's review (1972), for example, reported that results from 10 independent studies showed a substantial advantage for computer-augmented instruction. Elementary school children who received computer-supported drill and practice generally showed performance gains of 1 to 8 months over children who received only traditional instruction. Jamison, Suppes, and Wells (1974) also concluded that computer-based teaching, when used as a supplement to regular instruction at the elementary level, improved achievement scores, particularly for disadvantaged students. At the secondary and college level, these reviewers concluded, computer-based teaching was at least as effective as traditional instruction and sometimes resulted in substantial savings in student time. According to Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975), computer-assisted instruction often produced better results than did conventional teaching on end-of-course examinations, but not on retention examinations. These reviewers also noted that computer-based teaching reduced the time it took students to learn.

Hartley (1977), who was the first to apply meta-analysis to findings on computer-based instruction, focused on mathematics education in elementary and secondary schools. She reported that the average effect of computer-based instruction in this area was to raise student achievement by .41 standard deviations, or from the 50th percentile to the 66th percentile. Hartley also reported that the effects produced by computer-based teaching were not so large as those produced by programs of peer and cross-age tutoring, but they were far larger than effects produced by programmed instruction or the use of individual learning packets. Finally, Hartley noted that although correlations between study features and outcomes were not generally high, a few study features significantly affected study outcomes. She pointed out, for example, that elementary students fared better with computer-based teaching than did secondary students.

Burns and Bozeman (1981), like Hartley, used meta-analysis to integrate findings on computer-assisted mathematics instruction in elementary and secondary schools. These reviewers found overall effect sizes of .45 for computer-based tutorial instruction and .34 for drill and practice. They found virtually no evidence of a relationship between experimental design features and study outcomes. Kulik, Kulik, and Cohen (1980) used meta-analysis to reach conclusions about the effectiveness of computer-based college teaching. They found that computer-based instruction raised the examination scores of college students by approximately .25 standard deviations. Computer-based teaching also had a moderate effect on the attitudes of students toward instruction and toward the subjects they were studying. Finally, Kulik et al. (1980) reported that computer-based instruction reduced substantially the amount of time needed for instruction.

Kulik (1981), reviewing evidence from his own quantitative synthesis of findings and from Hartley (1977), concluded that the effectiveness of computer-based teaching is a function of instructional level, at least in mathematics education. Hartley found that computer-based teaching raised examination scores in mathematics by approximately .4 standard deviations at the elementary level and by approximately .3 standard deviations at the high school level, and Kulik reported that computer-based teaching raised examination scores by only .1 standard deviation in mathematics education at the college level. Kulik suggested that at the lower levels of instruction, learners need the stimulation and guidance provided by a highly reactive teaching medium. At the upper levels of instruction, a highly reactive instructional medium may not only be unnecessary but may even get in the way. College learners apparently profit from working by themselves on problems before receiving individual evaluations and prescriptions for further work.

This article uses meta-analysis to shed further light on the effectiveness of computer-based teaching. Its specific focus is computer-based instruction in Grades 6–12. The article is meant to answer the sorts of questions commonly asked by meta-analysts: How effective is computer-based teaching? Is it especially effective for certain types of outcomes or certain types of students? Under which conditions does it appear to be most effective?

Method

This section describes the procedures used in locating studies, coding study features, and quantifying outcomes of studies The procedures described here are similar to those used in other meta-analytic studies by Kulik and his associates (e g., Kulik, Kulik, & Cohen, 1979a, 1979b, 1980).

Sources of Data

The first step in this meta-analysis was to collect a large number of studies that examined effects of CBI on secondary school children.[1] We began the collection process by computer searching three databases through Lockheed's DIALOG Online Information Service: ERIC, a data base on educational materials from the Educational Resources Information Center, consisting of two files, *Research in Education* and *Current Index to Journals in Education*; *Comprehensive Dissertation Abstracts*; and *Psychological Abstracts*. We developed special sets of key words for the three different data bases The bibliographies in articles located through the computer searches provided a second source of studies for the meta-analysis

In all, these bibliographic searches yielded a total of 51 studies that met the guidelines for inclusion in our final pool of studies These guidelines were of three sorts. First, the studies had to take place in actual classrooms in Grades 6-12 Studies carried out at higher or lower grade levels and studies describing laboratory analogues of classroom teaching did not meet this guideline. Second, studies had to report on measured outcomes in both CBI and and control classes. Studies without control groups and studies with anecdotal reports of outcomes failed to meet this criterion And third, studies had to be free from crippling methodological flaws. Excluded from the pool of useable studies were those in which treatment and control groups differed greatly in aptitude and those in which a criterion test was unfairly "taught" to one of the comparison groups.

In addition, we established guidelines to ensure that each study was counted only once in our analysis When several papers described the same study, we used the most complete report for the analysis When the same instructional outcome was measured with several instruments in a single paper, we pooled the results from the instruments to obtain a composite measure. Finally, when a single paper reported findings separately for different school subjects, we pooled results from the various subjects to obtain a composite result These guidelines kept studies with more detailed analyses (i e, many test scores and many subgroups) from having a disproportionate influence on overall results.

Characteristics of Studies

The next step in the meta-analysis was to develop variables and categories for describing features of the studies The first of these variables covered type of computer application, and had five categories: drill and practice, tutoring, computer-managed teaching, simulation, and programming the computer to solve problems. In drill-and-practice studies, brief lessons were administered to the student at a computer terminal as follow-up exercises to a teacher's presentations. In tutoring studies, the computer program provided the presentation as well as the practice. In studies of computer-managed teaching, the computer evaluated student performance, diagnosed weaknesses, and guided students to appropriate instructional resources. In simulation studies, students explored relationships among variables in models simulating aspects of social or physical reality. Finally, in the programming studies, students programmed the computer to solve problems in the fields they were studying.

Two other variables were needed to describe differences in the use of the computer. The first of these variables indicated whether the computer served as a supplement to or substitute for conventional teaching. In studies in which the computer served as a substitute, it replaced teacher presentations, readings, assignments, or some combination of these. In studies where the computer served as a supplement, it did not replace regular course elements, but instead served as an additional resource for students. Another variable indicated the duration of the study. In some studies the computer was used in instruction for a full semester or even longer, whereas in other studies the computer was used for only a single unit, sometimes for as little as a week or two of instruction.

Studies differed not only in their use of the computer but also in other features To describe these additional

[1] A complete list of studies used in the analysis described in this article is available from James A. Kulik, Center for Research on Learning and Teaching, The University of Michigan, 109 East Madison Street, Ann Arbor, Michigan 48109

features, we defined 11 more variables Five of these variables covered aspects of the experimental design of the studies random versus nonrandom assignment of students to comparison groups, control for teacher effects by using the same teacher for both experimental and control groups, control for historical effects by use of concurrent experimental and control groups, control for scoring bias through use of objective examinations, and control of author bias through use of commercial or standardized examinations. Three other variables described features of the course settings, including class level of students, subject matter, and average ability level of students. One variable indicated whether course materials were produced commercially or locally. And finally, two variables described publication features of the study: the manner of publication of the study and the year of publication.

Two of the study features initially selected for coding—control for historical effects and control for scoring bias—proved to be of little use because studies showed almost no variation on these features. In almost all studies, experimental and control groups were taught during the same semesters, and objective examinations were used as the criterion of student achievement Because there was little variation in these features, they could not possibly explain observed variation in study outcomes. These variables were therefore dropped from the analysis at an early point, leaving 12 variables that might explain variation in study outcomes.

Study Outcomes

The 51 studies contained findings on effects of CBI in six major areas: final examination performance, performance on retention examinations, attitude toward subject matter taught in the experiment, attitude toward computers, attitude toward instruction, and time to learn. Examination outcomes were based on tests administered to students in both CBI and control classes Attitudes toward computers, subject matter and instruction were based on self-report responses to questionnaire items or scales. Student learning times were recorded in minutes.

To quantify outcomes in each of these areas, we used the Effect Size (*ES*), defined as the difference between the means of two groups divided by the standard deviation of the control group (Glass, McGaw, & Smith, 1981) For studies that reported means and standard deviations for both experimental and control groups, we calculated *ES* from the measurements provided. For less fully reported studies, we calculated *ES* from statistics such as t and F, using procedures described by Glass, McGaw, and Smith (1981).

To make our study more similar to traditional reviews, we also examined the direction and significance of differences in instructional outcomes in CBI and control classes. On the basis of results, we classified each outcome on the following 4-point scale: 1 = difference favored conventional teaching and statistically significant, 2 = difference favored conventional teaching but not statistically significant; 3 = difference favored CBI but not statistically significant; and 4 = difference favored CBI and statistically significant.

In our previous meta-analyses of research on college-level programmed, audiotutorial, and computer-based instruction (Kulik, Cohen, & Ebeling, 1980, Kulik et al., 1979b, 1980), we reported that different measures of effect size agreed remarkably well when applied to the same data set. This also turned out to be the case in the present analysis. For 34 of the studies with data on achievement outcomes, for example, we were able to calculate both *ES*s and scores on the 4-point scale reflecting direction and significance of observed differences The correlation between the two indices was .77. Because correlations between indices were generally so high, we were able to write regression equations for "plugging" effect-size measures for cases with some missing data. For example, when a study did not give any indication of within-group variances but did report the direction and significance of the difference between experimental and control means, we were able to use the score on the 4-point scale to estimate *ES* with a high degree of accuracy.

Results

This section describes the effects of CBI on student achievement on final examinations and retention examinations; on student attitudes toward subject matter, computers, and instruction; and on amount of time students needed to learn.

Final Examinations

In 39 of the 48 studies with results from final examinations, students from the CBI class received the better examination scores; in the 9 other studies, students from the conventional class got the better scores. A total of 25 of the studies reported a statistically significant difference in results from the teaching approaches. Results of 23 of these studies favored CBI, and results of 2 studies favored conventional instruction. The box-score results therefore strongly favored CBI.

By using the index of effect size *ES*, we were able to describe the influence of CBI with greater precision. The average *ES* in the 48 studies was .32; the standard deviation of *ES* was .42; and its standard error was .061. This average *ES* implies that in a typical class, performance of CBI students was raised by .32 standard deviations. To interpret this effect more fully, it is useful to refer to areas of the standard normal curve. Using this guideline, we see that students from CBI classes performed at the 63rd percentile on their examinations, whereas students who received only conventional in-

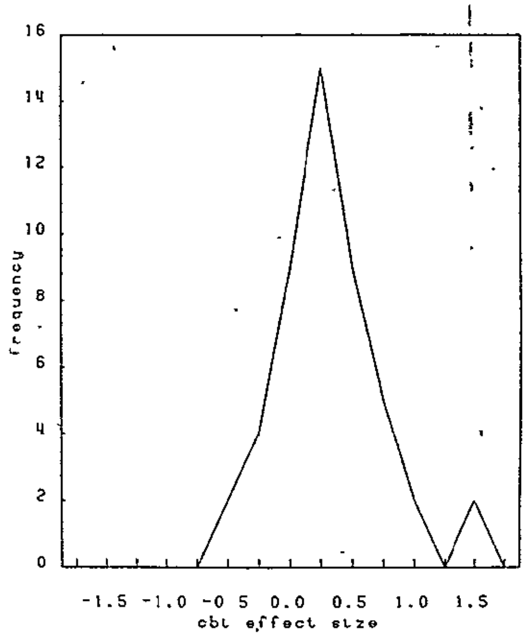

Figure 1. Distribution of effect sizes for 48 comparative studies of student achievement in computer-based and conventional classes (cbi = computer-based instruction)

struction performed at the 50th percentile on the same examinations. Or put in another way, 63% of the students from CBI classes outperformed the average student from the control classes.

Although the effect of CBI was moderate in the typical study, the size of effect varied from study to study (Figure 1). Effects of CBI ranged in size from high positive (e.g., an increase in achievement scores of approximately 1.5 standard deviations in two studies) to moderate negative (e.g., a decrease in achievement of approximately .5 standard deviations in two other studies). It seemed possible that this variation in study outcome might be systematic, and we therefore decided to carry out further analyses to determine whether different types of studies were producing different results.

Further analysis of the data, however, did not disclose any strong relationships between study features and final examination scores. Only two of the features listed in Table 1 had effects on examination scores that reached borderline levels of statistical significance. These features were year of publication and duration of the study. Effects on final examinations tended to be somewhat higher in more recent studies ($r = .27$, $p < .10$). Effects were also greater in studies of shorter duration ($r = .29$, $p < .10$).

Table 1
Means and Standard Errors of Achievement Effect Sizes for Different Categories of Studies

Coding categories	Number of studies	Effect size *M*	Effect size *SE*
Use of computer			
Managing	11	.33	12
Tutoring	11	36	.18
Simulation	5	.49	.33
Programming	8	.20	.08
Drill & practice	11	.27	11
Implementation			
Supplement	14	21	.10
Substitute	33	36	.08
Random assignment of subjects			
No	26	.34	.07
Yes	18	.32	.12
Control for instructor effect			
Different instructor	24	.30	.08
Same instructor	16	.28	.10
Control for author bias in test			
Local test	18	.33	.13
Commercial test	29	31	.06
Duration in weeks			
4 weeks or less	8	56	.26
5–8 weeks	16	.30	.02
More than 8 weeks	18	.20	.08
Average ability of students			
Low	11	45	13
Middle	8	39	.15
High	4	.13	.16
Grade level			
6–8	12	.29	.11
9–12	32	.34	.08
Subject matter			
Mathematics	27	.24	08
Science	11	.31	.15
Other	10	.50	.15
Source of publication			
Unpublished	13	21	.11
Dissertation	24	.30	.09
Published	11	.47	.15
Year of publication			
Before 1970	6	.27	.08
1970–1974	31	.27	.08
1975–1979	10	.46	.16
Production of materials			
Local	34	.33	.08
Commercial	10	.29	.14

Retention Examinations

The five studies with follow-up examinations investigated retention over intervals ranging from 2 to 6 months. In 4 of the studies, retention examination scores were higher in the CBI class, but none of these 4 retention effects was large enough to be considered statistically significant. In the remaining study, retention examination scores were significantly higher in the control class. The average *ES* of .17 favored CBI; the standard error of *ES* was .16.

Attitudes Toward Subject Matter

Ten studies reported results on students' attitudes toward the subject matter that they were being taught. In 8 of these studies, student attitudes were more positive in classrooms using CBI. Only 3 of the 10 studies, however, reported an effect large enough to be considered statistically reliable. In 2 of the 3 studies, the effects favored CBI. The average *ES* was .12, a very small effect; the standard error of *ES* was .094. Because the total number of studies of student attitudes was so small, we did not attempt to compare attitudinal results in different subgroups of studies.

Attitudes Toward Computers

Four studies reported results on student attitudes toward computers. In each of the 4 studies, student attitudes toward computers were more positive in the CBI class, and in 3 of the studies, attitudes were significantly more positive among students who used CBI. The average *ES* was .61, and the standard error was .21.

Attitudes Toward Instruction

Another four studies reported on student ratings of the quality of instruction in CBI and conventional classes. In each of the studies, the students from the CBI classes expressed more favorable ratings, but none of the differences between classes was statistically significant. The average *ES* in these studies was .19, with a standard error of .050. This effect is a very small one at best.

Time to Learn

Only two studies contained comparative data on the amount of time students took to learn. In 1 of the studies (Hughes, 1973) students spent 135 minutes on instruction and study when taught with computers, and 220 minutes when taught in a conventional manner. The 39% savings in time was equivalent to an *ES* of .78. In the other study (Lunetta, 1972), students spent 90 minutes on instruction and study when taught with computers, and 745 minutes when taught conventionally. The 88% savings in time was obviously great, but we were unable to calculate Glass's *ES* for this effect because Lunetta did not report within-group variances.

Discussion

Our analysis showed that computer-based teaching raised final examination scores by approximately .32 standard deviations, or from the 50th to the 63rd percentile. Computer-based teaching also raised scores on follow-up examinations given several months after the completion of instruction, but these retention effects were not as clear as the immediate effects of computer-based teaching. In addition, students who were taught on computers developed very positive attitudes towards the computer and also gave favorable ratings to the computer-based courses they were taking. Finally, the computer reduced substantially the amount of time that students needed for learning.

These findings were consistent with predictions from Kulik's (1981) model describing effects of instructional technology on school learning. The model suggested that computer-based teaching would be more effective at the secondary level than it has been at the college level, and this is exactly what we found. Most of the findings from this meta-analysis were also consistent with findings reported in other reviews. Earlier box-score and meta-analytic reviews, for example, also reported moderate size effects on final examination scores from computer-based teaching, and a number of the reviews (Edwards et al, 1975; Jamison, Suppes, & Wells, 1974; Kulik et al., 1980) also stressed the potential importance of the computer in saving instructional time.

A few of our findings, however, introduce a new note into reviews of effectiveness of computer-based instruction. Edwards et al. (1975) once suggested, for example, that computer-based teaching has negative effects on retention of learning. We found, on the other hand, that effects on retention measures were basically positive, but not so clear as effects on measures of immediate performance. Our findings on attitudes also came as a small surprise. Other reviewers overlooked attitudinal effects of computer-based teaching. We found that the computer had an important positive effect on student attitudes.

Like other meta-analysts working in this area, we found that features of studies were not strongly related to study outcomes. None of the relationships between study features and outcomes that we investigated, in fact, could be considered clearly statistically significant with the number of studies available to us. Nonetheless, the few small correlations of borderline significance that we found were interesting because they confirmed findings from earlier meta-analyses. Particularly worth noting were the relationships between outcomes and these features: year of publication of studies, manner of publication, and study duration.

First, more recent studies reported stronger effects of computer-based teaching on student achievement. A significant tendency for more recent studies to produce stronger results has been noted several times in the past in meta-analyses on instructional technology. Hartley (1977), for example, noted this tendency in studies of programmed instruction at the elementary and secondary level, and Kulik (1981) noted the same effect in two separate meta-analyses of findings on programmed instruction at the secondary and college levels. It seems unlikely that the stronger effects reported in more recent studies can be attributed to a switch in recent years to better research designs. None of the meta-analyses showed great improvements in research methodology over time, and they all reported little relationship between research design features and study outcomes. It seems more likely that instructional technology has simply been used more appropriately in recent years.

Second, studies published in journals reported somewhat stronger effects than did dissertation studies. Although the difference was not statistically significant, journal effects were .17 standard deviations higher than dissertation effects. This result is very similar to those from other meta-analyses. Kulik (1981), summarizing findings from 3 other meta-analyses conducted at the University of Michigan, reported that journal effects in these studies averaged .16 standard deviations higher than dissertation effects, and Smith (1980), summarizing results from 12 University of Colorado meta-analyses, also reported that journal effects averaged .16 standard deviations higher than dissertation effects. It is possible that the quality of studies conducted by graduate students is lower than the quality of studies from more established researchers, and so dissertation research may underestimate the true size of experimental effects. But it is also possible that studies with significant results may more often be accepted for journal publication, and published research may therefore overestimate the true size of effects.

Third, studies that were shorter in duration produced stronger effects than did studies of longer duration. Cohen, Kulik, and Kulik (1982) reported a similar result for programs of cross-age and peer tutoring in elementary and secondary schools: stronger effects from shorter studies. Although the smaller effects reported in longer studies may actually show that experimental effects decrease in potency with extended use—too much of a good thing—it is also possible that shorter studies are better controlled and more likely to estimate true effects.

Hints of other relationships between study features and outcomes appeared in our results. The effects of computer-based teaching seemed especially clear in studies of disadvantaged and low aptitude students, for example, whereas effects appeared to be much smaller in studies of talented students. This is exactly what the review of Jamison, Suppes, and Wells (1974) would lead us to expect. But the relationship was far from statistically significant with the number of studies currently available. The reliability of this and other relationships hinted at in our results must therefore be investigated in further analyses.

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Received January 22, 1982

Project Report Number 20

COMPUTER-ASSISTED INSTRUCTION AND COMPENSATORY EDUCATION: THE ETS/LAUSD STUDY

THE EXECUTIVE SUMMARY AND POLICY IMPLICATIONS

June 1982

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The Program on Teaching and Learning, U. S. National Institute of Education, funded this work through Contract 0400-78-0065 to the Educational Testing Service, Princeton, New Jersey

Executive Summary and Policy Implications

School systems for years have sought compensatory education techniques with three essential characteristics: effectiveness, replicability at different locations, and costs within typical per-student Title I allocations. Computer-assisted instruction (CAI) appeared to offer promise as one solution to the challenge of compensatory education. Early work indicated that its costs fell well within per-pupil Title I allocations[1] and that use of the mathematics curriculum over a period of one year improved student performance in mathematics.[2] Since the curriculums were available for use with minicomputers or large mainframe computers, replicability of the drill-and-practice material could also be assured. If CAI curriculums could be conclusively shown, over several years, to provide a pedagogically effective intervention, then state and local educational authorities could be assured of having at least one demonstrably satisfactory compensatory intervention at their disposal.

The present study was designed to answer questions about the effectiveness of three CAI curriculums -- mathematics, reading, and language arts -- when used for one year and over several years. The study produced these findings:

- With only 10 minutes per day of mathematics CAI, students made significant gains in their computation skills compared to control students.
- With 20 minutes of mathematics CAI, students doubled gains in computational skills.
- During a second and third year of mathematics CAI, students increased their gains significantly.
- Smaller but consistently positive results were obtained in the first year of reading and language skills with 10 minutes of CAI daily.
- Reading and language skills were maintained -- but not increased -- with additional years of CAI.

- According to an independent comparative analysis, the benefits from mathematics CAI were about equivalent to the benefits from equal amounts (in minutes) of tutoring.

- As used in this study, one 10-minute session of CAI daily throughout the school year was estimated to cost $130.

Features of the Study

Funded by the National Institute of Education, Educational Testing Service (ETS) in conjunction with the Los Angeles Unified School District (LAUSD) conducted a four-year study of CAI for compensatory education. Four elementary schools were each equipped with CAI labs using terminals and printers operated by a minicomputer. Labs in the larger Title I schools contained 32 terminals; labs in the smaller schools contained 16 terminals. Half of the students in each school attended the CAI lab for 10 to 20 minutes a day over four years. Students signed on to the computer which greeted them, presented questions, gave feedback on student responses, provided answers when necessary, and tallied students' scores for presentation at the end of each session. Computer-assisted instruction was provided by drill-and-practice curriculums in mathematics, reading and language arts leased from Computer Curriculum Corporation 1070 ARASTRADERO ROAD in Palo Alto, California. 94304 800-227-8224 or 415-494-8450

The CAI Curriculums

A brief description of the composition of the drill-and-practice CAI curriculums is given below:

Mathematics Strands: Grades 1-6

1. number concepts
2. horizontal addition
3. vertical addition
4. horizontal subtraction
5. vertical subtraction
6. equations
7. measurement
8. horizontal multiplication
9. laws of arithmetic
10. vertical multiplication
11. division
12. fractions
13. decimals
14. negative numbers

Reading: Grades 3-6

1. word attack
2. vocabulary
3. literal comprehension
4. interpretive comprehension
5. work-study skills

A newer reading-for-comprehension curriculum containing a 6th component on paragraphs was used for one year only.

Language Arts: Grades 3-6

1. principal parts
2. verb usage
3. subject-verb agreement
4. pronoun usage
5. contractions, possessives, negatives
6. modifiers
7. sentence structure

Each of the curriculums was designed to reinforce skills which students had already been taught in the classroom. The computer program adapted its delivery of each strand of the CAI curriculum to the performance level of each student and moved the student along at the individual's own rate of progress.

Procedures and Measures

In order to measure CAI effectiveness independent of other factors, students in four schools were randomly assigned to the CAI curriculums. In subsequent years students assigned to CAI maintained those assignments and incoming students at three grade levels were randomly assigned. Over four years this resulted in 12 separate one-year studies and three longitudinal studies. Students in experimental classrooms in grades 3-6 received equal amounts of CAI time although they were assigned to different curriculums. The study provided control students from within classrooms (taking alternate CAI curriculums), from other non-CAI schools, and from other years.

Students were tested each fall and spring with both standardized tests -- the Iowa Tests of Basic Skills (ITBS) and the Comprehensive Tests of Basic Skills (CTBS) -- and curriculum specific tests (CSTs). The CSTs for each grade level were composed of 100-120 questions taken directly from each of the CAI curriculums. For either type of test, the CAI treatment effect was obtained by a regression analysis which determined the difference in performance between experimental and control groups after adjustments had been made for pretest scores, sex, ethnicity and specific classroom variables. For purposes of this summary, the CAI treatment effects were translated into equivalent percentile scores which can be compared with the fiftieth percentile average for the control students.

Effectiveness

Mathematics

On standardized tests of mathematics computation, the math CAI students showed significant progress. (See Table 1.) They performed at the 64th percentile of their within-class control groups at the end of only one year, at the 71st percentile by the end of two years, and at the 76th percentile at the end of three years. On the CSTs they increased from the 79th percentile in year 1, to the 82nd percentile in year 2, to the 89th percentile by the end of year 3. There is no doubt that the mathematics CAI curriculum improved students' computational skills.

Although mathematics CAI students in grades 1 and 2 showed superior performance in mathematics concepts and applications, in the upper grade levels their performance was not significantly different from the performance of reading CAI students. This is not surprising since the CAI curriculum was designed to give drill-and-practice in mathematics computation.

Table 1

Mean Performance Level in Percentiles for Students Receiving CAI in Mathematics

	CST	Standardized Test (CTBS)			
		Computation	Concepts		Applications
Duration	Grades 1-6	Grades 1-6	Grades 1-2	Grades 3-6	Grades 3-6
1 year (12 studies)....	79*	64*	63*	49	51
2 years (6 studies)....	82*	71*	69	55	55
3 years (3 studies)....	89*	76*	--	54	60

*p < .01

Reading

Because CAI reading assignments were made only in grades 4 to 6, there were fewer studies of the CAI reading curriculum. In addition, attrition rates were high. Some students could not read at the required third-grade level and others did not speak English. Nevertheless, students who used the CAI reading curriculum for one year showed significant improvement in performance on reading tests. (See Table 2.) After the initial improvement, however, results were not impressive.

Language Arts

There was a relatively poor match between the materials in the language subtests of the CTBS and the CAI language arts curriculum. Although the data are not impressive, the small consistent effect in language mechanics is real. The CST results show gains in one year maintained over three years with the use of the CAI curriculums.

Students using the reading and language arts CAI curriculums did not show the pattern of increasing performance over time evident with use of the mathematics CAI curriculum. Whether a consistent pattern in reading and language arts failed to emerge because of some quality of the curriculum, the effects of the bottoming-out and topping-out phenomena on the research design, a mismatch between the curriculums and the standardized tests, or some other factor is not immediately obvious.

Total Program Effectiveness

Each of the CAI curriculums demonstrated its capability of improving the test scores of students requiring compensatory education as well as students performing at grade level. The success with mathematics CAI was very encouraging. Although the reading and language arts CAI curriculums were less successful in longitudinal studies, broader based curriculums might improve the long-term effects. Overall, the results from this study extend the knowledge gained from other research on computer-assisted instruction.

Table 2

Mean Performance Level in Percentiles for Students Receiving CAI in Reading

	CST	Standardized Test	
		Vocabulary	Comprehension
Duration	Grades 4-6	Grades 4-6	Grades 4-6
1 year (7 studies)....	65*	60*	59*
2 years (3 studies)....	70*	57	50
3 years (1 study)......	66*	72	41

*p < .01

Table 3

Mean Performance Level in Percentiles for Students

Receiving CAI in Language Arts

	CST	Standardized Test		
		Spelling	Mechanics	Expression
Duration	Grades 3-6	Grades 3-6	Grades 3-6	Grades 3-6
1 year (9 studies)....	76*	56	59*	54
2 years (4 studies)....	78*	52	61	52
3 years (2 studies)....	77*	56	60	59

*p < .01

Other Research on CAI Effectiveness

Early surveys of CAI studies[3,4,5] concluded that computer-assisted instruction was effective in raising student achievement, especially in elementary schools. Results from the PLATO project[6] showed that the PLATO Elementary Mathematics Curriculum produced large achievement gains in mathematics for students in grade 4, although the PLATO Elementary Reading Curriculum failed at that time to produce gains in reading. Four recent doctoral dissertations reported gains with the use of reading CAI.[7,8,9,10] A Title I study[11] using the CCC Reading and Language Arts Curriculums and the Hewlett-Packard Mathematics CAI Curriculum found that drill-and-practice in basic skills in conjunction with good teaching was useful in raising levels of student performance.

Several recent studies used meta-analysis -- combining results from several studies -- to evaluate computer-assisted instruction. Hartley[12] used meta-analysis in a survey of mathematics CAI use in elementary and secondary schools. She found, on the average, that CAI raised student performance from the 50th percentile to the 66th percentile. She also found that gains for elementary students were greater than gains for students in secondary school. Burns and Bozeman[13] confirmed Hartley's finding on CAI mathematics studies, but found overall treatment effects for computer-based tutorial instruction slightly higher than those for drill-and-practice CAI. Kulik[14] supported Hartley's finding that CAI effectiveness is tied to educational level -- at least for mathematics. Although CAI has been found to be effective at all levels, the gains observed in elementary grades were the highest, and the gains observed in college were the lowest.

The findings of the current study are consistent with the findings of other researchers. The current study extends those findings to show increased gains in mathematics computation skills with 20 minutes of mathematics CAI daily rather than 10 minutes and with additional years of drill-and-practice in mathematics CAI. Gains in reading or language arts tend to be maintained beyond one year by continued use of the CAI curriculums.

The success of CAI in this study may be related to the successful practices identified in other instructional effectiveness studies: mastery learning,[15] high academic learning time with a high probability of success in responding,[16] direct instruction,[17] adaptability and consistency of instruction,[18] an orderly atmosphere with expectation of success in basic skills,[19] and use of drill with equal opportunity for responses from all students.[20] The advantage of the computer for drill-and-practice activities lies primarily in the computer's efficient use of time. For only 10 to 20 minutes daily, truly individualized drill-and-practice can be used to instruct students at their own ability levels, to provide immediate feedback to each response, to move students ahead on the basis of their mastery of subject matter, to keep records of each student's placement in each strand of each curriculum, and to do all of these with demonstrable effectiveness over a period of years.

Replicablility

Replicability within the study's sites was demonstrated by fairly consistent results over the four years of the study. Although school environment and personnel affect the CAI program, the drill-and-practice curriculums themselves achieved consistent results with students across schools and across years. The major inconsistency was the unsuitability of the reading and language arts curriculums for some elementary school students. Some students in grade 4 were unable to use the curriculums because they could not read at a third-grade level, and a few were sufficiently skilled in reading and language arts that they completed the courses before the end of grade 6. The mathematics curriculum, on the other hand, was used by students from kindergarten to sixth grade and only two girls exhausted the course materials after having 20 minutes per day of instruction from grade 2 through grade 5.

The compensatory intervention used in this study was designed to be replicable in other sites. To the extent that components of other programs matched components of the program used in this study, the results should be similar. Key components of this program were:

- CAI drill-and-practice curriculums: Mathematics Strands, Reading, and Language Arts.
- A pull-out program of instruction in a CAI lab monitored by a CAI coordinator.
- Daily 10- to 20-minute periods of CAI for each student.

Cost[21]

The per-pupil cost of the CAI program was within Title I allocations for 1977-78. It cost about $100,000 a year to provide a classroom, personnel, and equipment for operating a CAI laboratory. Although some costs would vary according to the equipment used, the cost analysis in this study provides a framework that others can use to estimate what their own costs might be. Slightly more than one-third of the cost was for facilities and equipment, an equivalent amount was spent on personnel, and the remainder went for curriculum rental, maintenance contracts and supplies. One 10-minute session of CAI daily throughout the school year was estimated to cost about $130 if a CCC-17 minicomputer was used to operate 32 terminals. Up to three 10-minute sessions of drill-and-practice, in the same or different curriculums, could be provided daily for each disadvantaged child at the 1977-78 level of Title I expenditure.

The cost-effectiveness of CAI vs. other interventions could not be determined within the constraints of the project, although the study provides some groundwork for such comparisons. The effectiveness of CAI was compared to the effectiveness of other interventions such as reduction in class size, tutoring, instructional television, and electronic calculators.[22] Although the effectiveness of the mathematics CAI curriculum appeared to approximate the effectiveness of tutoring, the costs of interventions other than CAI were not immediately available for comparison. The method to be used in conducting a cost-effectiveness analysis of educational interventions is contained in the final report.[23]

Other Issues

The Acceptance of CAI in the Schools

In addition to effectiveness, replicability, and cost, educational administrators may be concerned about the acceptance of computer-assisted instruction by school personnel. Although initial acceptance by teachers was less than wholehearted, by the end of the first full year most teachers were convinced of the value of CAI and supported it fully. The CAI coordinators who managed the CAI labs were most enthusiastic about the help that CAI gave in improving students' skills. Principals enjoyed bringing visitors to the CAI labs, and parents filled the labs at every opportunity. Students enjoyed the CAI program as well, although they sometimes complained of their assignments to specific curriculums:

> CAI is real boring, but I guess it would be better if I had reading or language, but I'm stuck with math.

Only 10 to 13 percent of students had any negative comment, however. Most were strongly supportive:

> Computers is an exciting event, everybody is working and trying hard to get one hundred percent. It feels like we're a great big family, just doing our jobs, so I like computers...
>
> I think the CAI program is fantastic. I think the program should be spread throughout every school system in America.

The overall acceptance of the CAI program in Los Angeles was excellent. In 1982, two years after the government support for the project ended, the Los Angeles Unified School District is supporting the continued operation of the CAI labs.

CAI and Microcomputers

Computer-assisted instruction as used in this study has been shown to be a viable intervention for compensatory education. A review of the literature confirms CAI's effectiveness. One cannot generalize from these results, however, to say that all CAI would achieve similar results. In this study alone, there were differences among the mathematics, reading, and language arts curriculums in the length and breadth of coverage, accessibility by students of different ability levels, and effectiveness over periods of one year or more. With the advent of microcomputers, even greater differences may be expected among the myriad smaller CAI programs developed by hundreds of different authors. Little work has been done as yet in the evaluation of microcomputer use in the schools. The present study was designed as a prototype and a first step toward systematic evaluation of the effectiveness of CAI. Future work applying the methodology of this study to alternate delivery systems will provide an increasingly useful base of information for intelligent decision making.

For Additional Information

For those who wish more information on the CAI study, the Final Report will soon be available through the ERIC system. The report is composed of seven parts, the topics of which are listed below:

Part 1 - Overview of the Final Report

Part 2 - A Descriptive Study

Part 3 - The CAI Curriculums: Placement, Time, and Rate of Progress

Part 4 - The Effectiveness of CAI

Part 5 - Longitudinal Patterns of Student Attitudes in a Computer-Assisted Instruction Curriculum

Part 6 - Assessment of the Effectiveness of Computer-Assisted Instruction in the ETS-Los Angeles Study and a Comparison of CAI with Several Intervention Strategies

Part 7 - A. An Evaluation of the Costs of Computer-Assisted Instruction

B. Towards a Meta Cost-Effectiveness Analysis of Educational Interventions

Parts 3, 4, 5, and 6 of the report are fairly technical reports of the CAI research. Part 2, which includes comments and illustrative materials appended by the CAI coordinators, may be useful for school personnel who are about to establish a CAI lab. Part 7 may be useful for administrators concerned with the costs of CAI.

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IDA PAPER P-1375

COST-EFFECTIVENESS OF COMPUTER-BASED INSTRUCTION IN MILITARY TRAINING

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April 1979

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Contract DAHC15 73 C 0200
Task T-134

DOCUMENT RESUME

ED 195 227 IR 008 847

AUTHOR Orlansky, Jesse; String, Joseph
TITLE Cost-Effectiveness of Computer-Based Instruction in Military Training.
SPONS AGENCY Institute for Defense Analysis, Arlington, Va.
REPORT NO IDA-P-P-1375
PUB DATE Apr 79
CONTRACT DAHC15-73-C-0200
NOTE 215p.: Tables may not be legible due to size of print.

EDRS PRICE MF01/PC09 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; *Computer Managed Instruction; *Conventional Instruction; *Cost Effectiveness; Educational Attitudes; *Individualized Instruction; Instructional Materials; *Military Training

ABSTRACT

This comparison of the cost effectiveness of conventional, individualized, computer-assisted (CAI) and computer-managed instruction (CMI) for military training is based on data drawn from experiments of limited duration with relatively few students. All findings are confounded by effects that may be due to either CAI or CMI in comparison to conventional instruction, or to the revisions in course materials needed to modify a course from conventional to computer-based instruction. Analysis of these data indicate that, while CAI and CMI save about 30 percent (median) of the time required by students to complete the same courses given by conventional instruction, student attrition appears to increase with CAI or CMI as compared to conventional instruction; changes in student quality may account for this increase. It was concluded that students prefer CAI or CMI to conventional instruction, attitudes of instructors are unfavorable to CAI and CMI, individualized instruction (without computer support) saves student time, and little additional student time is saved when the same courses are given by CAI or CMI. Cost savings attributed to CAI and CMI are based on estimates of pay and allowances of students for time saved by these methods. (Author/MER)

ABSTRACT

The cost and effectiveness of computer-based instruction for military training are evaluated on the basis of about 30 studies conducted since 1968. Four methods of instruction are distinguished and compared:

Conventional Instruction: group-paced lectures, and discussions.

Individualized Instruction: self-paced (without computer support).

Computer-Assisted Instruction (CAI): computer stores and provides instructional materials to students individually via interactive terminals; computer tests and guides students; self-paced.

Computer-Managed Instruction (CMI): instructional materials and tests provided away from computer; computer scores the tests and guides students; self-paced.

Much of the data come from experiments of limited duration and with relatively few students; by contrast, some CMI systems have been used for 4 years. All findings are confounded by effects that may be due either to CAI or CMI, in comparison to conventional instruction, or to the revisions in course materials needed to modify a course from conventional to CAI or CMI instruction.

CAI and CMI save about 30 percent (median) of the time required by students to complete the same courses given by conventional instruction; CAI and CMI cannot be compared directly because different courses were used in each study. Student attrition appears to increase with CAI and CMI compared with

conventional instruction, but changes in student quality may also account for this increase. Students prefer CAI or CMI to conventional instruction; attitudes of instructors, considered in only a few studies, are unfavorable to CAI and CMI. Individualized instruction (without computer support) also saves student time; little additional student time is saved when the same courses are given by CAI or CMI.

Direct comparisons of the cost and effectiveness of different methods of instruction are not now possible because only incomplete cost data were found. So-called cost savings attributed to CAI and CMI are based on estimates of pay and allowances of students for the time saved by these methods of instruction; allowances are seldom made for the costs of the CAI or CMI equipment and courseware, instructors, and other costs incremental to computer-based instruction.

WHERE CAI IS EFFECTIVE A SUMMARY OF THE RESEARCH

CAI seems to be effective—particularly with certain students, in some situations.

BY GLENN FISHER

Glenn Fisher is a school computer specialist in Alameda County, CA

OVERVIEW: AFTER 20 years of tug-of-war debate, most researchers appear ready to conclude that, yes, CAI is effective under certain conditions. Essentially, the research shows that CAI is effective when the following conditions are met:

- When it is aimed at specific student-body groups;
- When it is fully integrated into the regular classroom curriculum;
- When certain subject areas are selected; and
- When the proper setting and scheduling is established.

This article summarizes findings such as these, drawn from a range of studies conducted over the course of those two decades of research. (The research surveys used to prepare this article are listed on page 84.)

Three Significant Factors for CAI Effectiveness: How Subject Area, Student Achievement Range, and Setting Appear to Affect CAI Outcomes

FACTORS	MOST EFFECTIVE	MODERATELY EFFECTIVE	LESS EFFECTIVE
Subject Area	Science Foreign Language	Math	Reading Language Arts
Achievement Range	Low Achievers High Achievers	Middle Achievers	
CAI in Curriculum	Supplements Curriculum		No Teacher Input

Research to date shows that CAI appears most effective when it's integrated with regular science and foreign language instruction, and used with either low or high achieving students. These findings may have been colored, however, by the historically weak quality of much reading/language arts software, compared to material in the maths and sciences

CONDITIONS NECESSARY FOR EFFECTIVE CAI

Targeted Student Population: CAI is significantly more effective at raising achievement among low-achieving and high-achieving students than it is for students of average achievement. This holds whether the "disadvantage" causing the low achievement is physical (according to studies done with mentally handicapped students) or social (according to studies looking at performance levels between ethnic groups). One study reported that the greatest pre/post test gains were for the lowest-achieving students. Several studies have monitored students moving from the bottom quartile to above the fiftieth percentile on standardized tests.

This finding of differential effects probably has the most far-reaching implications for the use of computers of any of the factors discussed here. It implies that CAI should possibly be targeted at specific groups of students—not provided wholesale to the entire student population.

Integrated with Classroom Instruction: CAI used as a supplement to regular classroom instruction was found consistently effective. One study found it to be the most effective instructional method for boys, compared to any traditional instructional strategy.

In situations where the computer is being used by the teacher in his or her own classroom, that integration may take place as a matter of course. In cases where the instructor of the regular curriculum is not the computer instructor (for example, when computers are grouped in a central lab), this research finding reinforces the need for communication between the two educators.

Selection of particular subject areas: CAI was shown to be almost always effective in the areas of science and foreign language. It was also usually effective in math, and less effective in reading and language arts. These findings seem accurate regardless of age, computer type, and type of test used to measure achievement.

Establishment of proper setting and scheduling: The scheduling of computer time was also shown to be an important factor in the effectiveness of CAI, though more research needs to be done to determine exactly how. One study found the number of sessions was more important than the total time spent at the computer, while another found just the opposite. Research on learning, however, tells us that frequent short sessions are better for memorizing material than infrequent long ones. The short daily session may also provide a more effective supplement to instruction taking place in the classroom.

There seems no question that students complete material faster on computers than off—occasionally as much as 40 percent. This finding was consistent among virtually all of the studies I've seen, regardless of age of student, subject area, and type of computer used.

SOFTWARE vs. SETTING

There is one variable at work in all CAI research, of course, that is quite difficult to measure. That is the quality and appropriateness of the CAI software program being used. Perhaps because it is so difficult to measure, the impact of this variable on all of the findings described above is as yet unclear. Most studies appear to have focused on the questions of setting, student group, and subject area.

One study I encountered, however, did look specifically at what made software effective by comparing a program with extensive graphics, sound, and animation, with another program featuring text only.

(Continued on page 84)

RESEARCH

(Continued from page 82)

When low-achieving students seemed to learn more from the plain version, the researchers concluded that graphics may have served only to distract the students, and draw them away from the real lesson at hand.

AFFECTIVE RESULTS

All studies that looked at student attitudes report a significant positive change, improved attendance, increased motivation, and lengthened attention span. In some cases, (especially with special education students) researchers found that these changes were transferred to other tasks in the classroom.

Another finding with educationally disadvantaged students was that "passive" students, who saw school as a series of events outside their control, became more "active," and began to feel they had some control over events. The individual nature of computer use, researchers concluded, seems to encourage independence, where more traditional tutoring situations may foster dependence.

The implications of these findings are enormous. Rather than focusing narrowly on subject area drill, CAI could be viewed as part of an intervention strategy to change anti-social behaviors and outlooks. There is now a pilot program underway using computers as part of an intervention strategy to change anti-social behaviors among mildly mentally retarded students. While this smacks of *1984*, it is important to remember that students respond to the computer as a device which gives them control, and they appear to view it clearly, and positively, in that manner.

Conclusion: CAI is an effective use of computers—for certain students, in some subject areas, as a supplemental activity. Besides increasing student achievement, it also changes student attitudes and behaviors, apparently in positive ways. Used wisely, it can be a powerful and effective tool to help students gain control of their own education, both in achievement and attitude.

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Forman, Denyse, "Search of the Literature," *The Computing Teacher,* January 82, V. 9 #5, pp. 37–51. If you're only going to read one, this is it, since it covers virtually every area of research on computer use in schools, and summarizes results.

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Burns, Patricia, and Bozeman, William, "CAI and Math Achievement: Is There a Relationship?" *Educational Technology* (Englewood Cliffs, NJ), October 81, pp. 32–39. Survey of previous research, and meta-analysis for trends in rigorously done studies of math CAI. Because of the technique and rigor of the survey, this probably is the most definitive statement of the effectiveness of math CAI.

Dence, Marie, "Toward Defining the Role of CAI: A Review," *Educational Technology,* November 1980. This early study focused mainly on time-shared, large computer-based CAI, but conclusions are clearly drawn and consistent with later research. **EL**

THE COMPUTER AS SANDCASTLE
(TR-20)
Jeanne Bamberger
April 1983, 6 pages

This paper, presented at the 1983 AERA meetings, explores how the computer may serve as a "hall of mirrors" by helping us to know in a formal way what we already know in other, more intuitive ways. This view of "conversational learning" with materials as one builds or invents things is exemplified for the domain of music, and a Logo drum programming experience that helps us to understand rhythm in new ways is described.

COMPUTERS FOR COMPOSING
(TR-21)
Janet H. Kane
April 1983, 11 pages

Case studies are reviewed in this paper, presented at the 1983 AERA meetings, of eighth grade children using word processors in a writing minicourse. Writing with and without computers are compared, and six ways in which the technology may be used to support students' writing are characterized.

CHAMELEON IN THE CLASSROOM: DEVELOPING ROLES FOR COMPUTERS
(TR-22)
April 1983, 62 pages

This is a collection of papers presented at the 1983 AERA Symposium entitled "Chameleon in the Classroom." It includes Technical Reports 12-15 and 20-21, an introduction by Karen Sheingold, and discussions by Joseph Glick and James A. Levin.

CLASSROOM SOFTWARE FOR THE INFORMATION AGE
(TR-23)
Karen Sheingold, Jan Hawkins, and D. Midian Kurland
November 1983, 12 pages

The future of microcomputer technology in classrooms hinges on appropriately-designed software and on how teachers are able to incorporate it into their classrooms. Five criteria for software selection are set forth as a basis for decision-making by publishers, software developers and school personnel. By these criteria, it is argued, tool software, such as word processors and database management systems, holds significant educational potential.

Computer Enhanced Collaborative Learning: A New Technology for Education

BY G. CHRISTIAN JERNSTEDT

The Tension Between Intelligent Resources: People and Computers

Sit down with a group of educators today and you are likely to find conversation focused on one of two intelligent resources actively involved in the teaching of students: people and computers. Often the conversation will be directed towards the difficulties one resource has working with the other in the classroom. Part of the difficulty lies with a tension between the technological approach, with its emphasis on the practical, logical and scientific and the humanistic approach, with its emphasis on human interests, values, and self-realization. As one writer has observed, there is "a basic divergence in point of view between the tough-minded empiricism of the product-oriented programming fraternity and the tender-minded idealism irrespective-of-evidence of the process-oriented educational philosophers."[1]

This divergence of view between the humanistic and technological perspectives can be rather extreme:

> "Our fears conjure up images of mindless children performing inane tasks to the mechanical rhythm of the machine's relentless 'bleep, bleep.'"[2]
>
> "Skills are minimized in favor of vague achievements — educating for democracy, educating the whole child, educating for life, and so on."[3]

In teaching, there is a tension between the technological approach and the humanistic approach.

Computers and Other Technology

During much of their history, primary and secondary schools, as well as colleges and universities, have employed large-group instruction as their primary mode of teaching. Since the basic model of the university developed in the twelfth century, the lecture has been the dominant mode of instruction in the university. In American primary and secondary schools the small groups of the one-room schoolhouse were most common until about the middle of the nineteenth century. By then the philosophy of universal education contributed to ever increasing numbers of students, and the schoolhouse evolved into the large, bureaucratic "educational institution." The size of the school age population and the growing domination of the industrial model in society moved the focus in schools to the large group and the processing of large numbers of students as student bodies.

By the turn of the century, however, the awareness of a need to return to a more personalized or individualized educational philosophy began to emerge. That no two students are alike was one fact that a majority of educators could agree upon. In the 1920's the notion of using machines to help individualize education was introduced with Sidney Pressey's "apparatus which gives tests and scores — and teaches."[4]

Forty years later, in the 1960's, two branches of the individualized instruction movement emerged. On the one hand were the teacher-focused methods that stressed active learning, clear goals, material broken into units, extensive feedback and evaluation for the student, and student regulated pacing through the material. These methods of individualizing instruction apparently were highly effective due to their frequent testing of performance, immediate feedback, and requirement that work be redone until mastered.[5]

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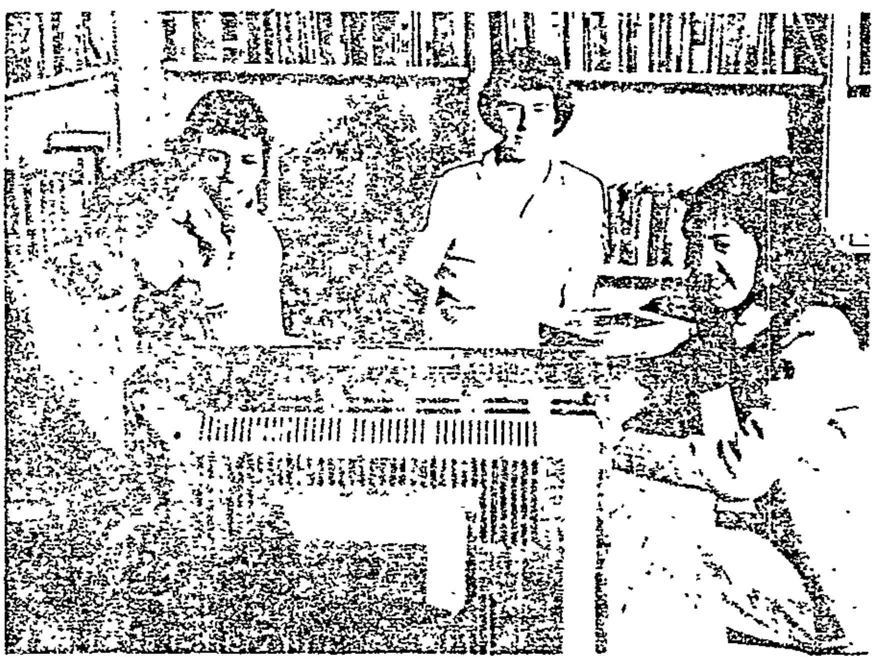
On the other hand emerged a focus on individualizing instruction with the use of machines, in particular, computers. Today, with their requirement of active engagement on the part of the student and with their graphics and other sensory outputs, feedback and allowance for student self-pacing and timing, computers are seen as a solution to the individualization needs.[6]

The impact of computers in education at present is principally in saving time for teachers and students and in raising attitudes and achievement in learning.[7] But changes are coming. Computer aided instruction has not brought the revolution it was predicted to bring. Neither have the other technologies of providing individual instruction brought their predicted revolutions in learning. The problem lies not with computers or technology *per se*. The problem rests with using these technologies as a replacement for teachers and group learning.

> "If society is to continue to benefit from knowledge and if we are to expand the frontiers of knowledge, we must devise new and better ways to expand human capacity, multiply human reasoning abilities, and overcome or compensate for human limitations."[8]

Peers influence academic achievement and intellectual self-esteem.



People and Interpersonal Relationships

At about the same time that teaching methods and educational technology turned towards the goal of individualization, educators became more aware of the impact of human relationships in the classroom. Between the 1930's and the 1970's educational researchers focused their attention on the adult-student interaction in the learning process. Nearly all research on interpersonal relations in education involved parent-child or teacher-student relations.[9] It became clear that teachers can have a profound impact on their students' development, both cognitively and affectively.[10]

But teachers are in the minority in the classroom. There are far more peers than teachers as potential interactants with a student in school. The research on these peer interactions in the classroom is rather recent. From that research we know that peers have an impact on socialization, social behavior, attitudes, beliefs and self-image. It is also clear that peer interactions can be an excellent predictor of emotional state in later life.[11] These effects, however, are not instructional effects. We must ask what influence peer interactions can have on academic learning in the classroom. The answer is that peers influence academic achievement cognitive problem solving skills and intellectual self-esteem. It also appears that intellectual peer interactions influence psychological health and the liking of others and that all of these influences come from group interactions as well as from dyadic relationships.[12]

The Goal: Integrating The Resources of People and Computers

We have traced the evolution of two contributions to the learning process in the classroom. With individualized instruction, and especially computers, the technologists have created an efficient, effective, but impersonal process. In contrast, the humanists have contributed, through interpersonal interactions, a personal, supportive, but relatively inefficient process. Successful combinations of interpersonal relations and computer aided learning have not been accomplished. Those educators focused on technology, whether the translation of existing materials to computer routines or the understanding of individualized instruction methods, have missed the interpersonal. For example, even the latest criteria for evaluating computer based learning materials do not mention the possibility of interpersonal interactions as part of the learning process.[13] Conversely, human relations oriented educators have treated machines as near anathema.

We know enough now to change this state. We can bring the two cultures together to create new ways of learning that use the best features of each of these intelligent resources. We must, as we begin the synthesis, first understand what each resource can provide and what each needs to function most effectively in supporting student learning. The goal will be the creation of a synergetic combination of computer and person, which might be called computer enhanced collaborative learning (CECL).

Employing the Computer Resource

One of the most important findings from the literature on technological methods of teaching has been the importance of the degree of student activity during learning. The quality of learning increases in direct proportion to the degree of activity of the learner.[14] With CECL, therefore, the student must be required to take an active role in the learning process. Each student must respond as frequently as possible in as many different appropriate manners as possible.

What better use of computers in the classroom than the enhancing of intellectual collaboration among learners.

A second major finding is the importance of the amount of study time that the student spends in direct contact with the material to be learned. The more time the student spends academically engaged, the higher will be his or her final level of achievement.[15] This one measure of learner activity predicts achievement better than almost all other variables. Interestingly, the computer is one of the most effective devices for producing high attention to task. With its visual and other sensory feedback and with its ability to provide immediate response to the student, the computer can and does demand an especially high level of engagement from the student. Further, as is evident from time-shared systems, the computer can do this for groups of individuals simultaneously, with ease.

The third important finding for the computer side of the goal is the significance of direct instruction. An educational process that provides academic focus and is expert-directed, sequenced and structured is called direct instruction. Such instruction produces highly positive effects in the classroom.[16] The computer is an ideal means of providing direct instruction to students. When materials are carefully selected in advance and when a lesson is based on parameters of student performance, instruction (especially by computer) can double achievement found with less direct methods.[17] Furthermore, the complex branching procedures that are often associated with computer based learning, but which are enormously expensive to create, are not absolutely necessary. Relatively fixed drills can produce more learning than branching drills, especially for more difficult materials.[18]

Employing the Human Resource

As previously described the greatest potential for interaction in the classroom lies with relationships between students Even if preferred, there is simply not enough time for extensive dyadic interactions between student and teacher, and a methodology based on such interaction would be impractical. The focus of interpersonal relations, for academic goals, should therefore be on peer relationships For small groups there are three goal orientations that have been examined, cooperative, competitive and individualistic. These goal orientations are created by making the evaluation of a student's performance dependent on the performance of the entire group, dependent on how many other students the individual was able to perform better than, or independent of other students' performances

The differences between cooperative groups and independent learning have been examined in more than 122 studies. It is clear that in both academic achievement and productivity, cooperative goal orientation is significantly better than individualistic For all age groups and for all subject matters studied, this effect is so strong that it overwhelms other potential mediating variables [19]

When cooperative groups are compared with competitive ones, a similar result obtains. Across all ages, subject matters and nearly all academic tasks, cooperative goal orientation is superior to competitive If intergroup competition is added to groups with intragroup cooperation, they perform better than purely competitive groups. However, cooperative groups without intergroup competition are superior to cooperative groups with intergroup competition.[20]

Several other variables are also of concern. It appears that the optimal group size is between 4 and 6 persons Ability grouping does not seem to be a major variable and heterogeneous groupings of students seem to do somewhat better than other groupings [21] Finally, one difficulty with peer groups is that they seem to need a supervisor or task director to maintain high task engagement times [22]

The quality of learning increases in direct proportion to the activity of the learner.

The Integrated Resources at Work: CECL in the Classroom

The computer enhanced collaborative learning technique is now available on an inexpensive computer system described elsewhere.[23] Basically, the system uses a personal computer and a set of small hand-held response modules that give each student direct access to the computer Students are guided through material presented on a display screen by a sophisticated software package. Individual responses are recorded for each student and displayed to the group At the start of the learning session the group is told that their evaluation will be based on the overall performance of the group They are also told that cooperating, by sharing strategies and other such information, *after* each student has answered a question, should help them learn faster and better No teacher intervention occurs during the lesson.

What ensues is a true intellectual collaboration. As the computer proceeds through the lesson by asking a series of structured questions, it pauses to allow conversation after all students have answered the current question. The group then jointly determines when the next question should appear With these procedures the intellectual conversation is not only easy to encourage, it is also difficult to prevent!

The Effect of the Integrated Resource

How does this new educational environment actually affect students? To answer this question, a series of carefully controlled experiments was conducted [24] The results were then tested across different ages of students and with a variety of subject matters. The computer enhanced collaborative groups were compared both to individuals and to groups in which either the computer or the collaboration was removed

The differences between computer enhanced collaborative groups and conventional lecture-discussion classes were dramatic.

The results of one study are indicated in Figure 1. With CECL the time required of the teacher dropped to 18% of what it was for the lecture method. Simultaneously, the time on task of the students doubled when compared to students in the lecture-discussion situation. Finally, the academic achievement of the computer enhanced collaborative students rose 22% above that of the other students.

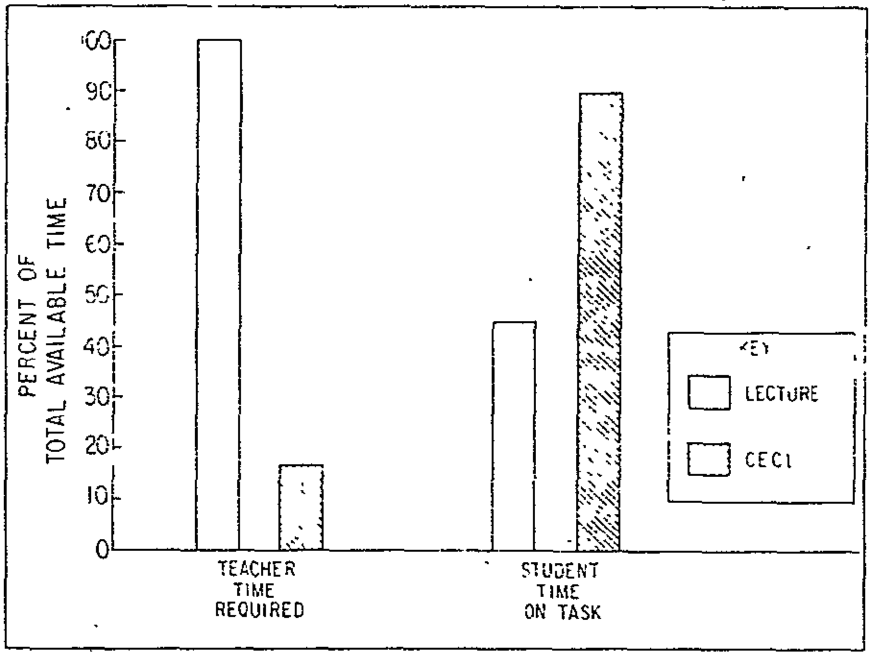


Figure 1. Teacher time and student time on task with lectures and with computer enhanced collaborative learning

When the same computer lessons were used, but with the collaboration between students prevented, learning was not as effective. This conventional computer aided learning was about as successful as the lecture method. These results are compatible with those found by other researchers in related areas.[5] Compared to students working alone at the computer, the collaborative students have achieved test scores as much as 42% higher.

When different goal orientations are presented to groups working on the computer, we find that the cooperative orientations produce significantly better achievement than do the competitive or individualistic, in line with previously described studies without the computer.

What Produces The Effect?

We must now ask what aspects of the CECL seem responsible for the increases in learning that we have observed. Three causes seem most evident: the directed nature of the computer programs, the increased time on task with the computer and the verbal interaction of the students.

As described previously, expert-directed learning is generally better than self-directed learning. A well designed computer program provides just such expert direction. Certainly some of the effectiveness of computer enhanced collaboration rests with the design of teaching techniques used in the software. Moreover, in addition to its obvious effect on each individual student, the computer direction seems to set a focus on the concepts that aids the group in discussing appropriate strategies and other aspects of learning the material.

The increased effectiveness of the computer enhanced collaboration appears to be due also to the very large increases in student time on task that occur. Since

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Step 4, Figure 3, establishes a set of design criteria, input from the teaching institution. They will be of the following sorts: least cost, shortest course length, graduation of the most students per unit time, or maximum use of communication media. The user would assign each criterion an order of importance or a weight.

Once the criteria have been specified, the actual system design can begin (Step 5, Figure 4). The direct inputs to the design will be the strategies of instruction, the Lesson Analysis and the design criteria. Characteristics of the learner population, the stated general policy and the general features of the course of study also enter into the design process indirectly.

At present, we see the design process as having four main components: First, each learning event is linked to the strategy of instruction that has been chosen for that particular type of event. Second, student flow through the course is simulated by a flow and scheduling model. Third, a set of criteria is used to select specific media systems. (The Lesson Analysis only identifies the class of media [for example, motion-visual] that might be used for a particular lesson. What precise form the media system should take [for example, silent film] will be specified by the strategies of instruction and other criteria which are being developed.) Fourth, a set of criteria is used to assign personnel. Although there will be instances where a certain number of people will be required to carry out a particular task, such as monitoring for safety, other personnel requirements will be harder to identify—such as determining the number of students that can feasibly be assigned to a teacher in a classroom. This component still has to be worked out. The final step will be a cost analysis to determine the time-dependent dollar requirements for the system.

As noted above, the outputs of the design process will be: course length, student flow and time-dependent requirements for resources; all are useful for the planner. He can then compare the requirements for resources with resources he expects to be available to the school, to determine whether the system is economically feasible; he can also compare the outputs with requirements for general policy and other inputs to determine whether they satisfy what he wanted. If not, he can change some of the initial specifications such as the strategies of instruction or the design criteria. Possibly he would want to change the learner population, the course of study or even the general policy.

Although these tools compose a closely interrelated set of elements in system design, several are useful in their own right. For example, the decision process for setting instructional strategy contains a comprehensive checklist of considerations in instructional system design that can be used without the computer program if so desired. Similarly, the Lesson Analysis helps the user look at his subject matter in a methodical and systematic manner. The work has been directed toward very general applications so that it will be of use not only to Air Force organizations such as the Air Training Command and the Air Force Academy but to educational institutions in the public sector as well. □

A Summary of Ten Major Studies on CAI Drill and Practice

John F. Vinsonhaler
and Ronald K. Bass

This article summarizes the results of ten independent studies of CAI drill and practice, involving over 30 separate experiments with about 10,000 subjects within the content areas of language arts and mathematics.

The results indicate a substantial advantage for CAI augmentation of traditional classroom instruction, where standardized achievement tests are used as the criteria for educational performance. Generally, CAI groups show performance gains of one to eight months over groups receiving traditional instruction.

The authors conclude that the results establish the effectiveness of CAI within the limits imposed by their survey. They suggest that CAI evaluation research should place greater emphasis upon analytic studies and studies comparing CAI with other modes of nonconventional instruction. The present report is based upon a more complete summary (Vinsonhaler and Bass, 1971).

Introduction

Reviewers of educational research all too frequently encounter that familiar phrase "no significant difference" between experimental and control subjects. The evaluation research in CAI has been no exception. As noted by one reviewer, " . . . the most common finding in studies that compare traditional instruction with CAI or programmed instruction is that no significant difference among treatments is obtained" (Silberman and Filep, 1968, page 384). In the judgment of the present authors, this generalization does not hold for CAI drill and practice. On the contrary, in the controlled studies applying drill and practice to language arts and mathematics, there seems to be rather strong evidence for the effectiveness of CAI over traditional instruction where effectiveness is measured by standardized achievement tests. What remains in question is the long-term educational significance of this finding.

In accordance with Mark Twain's scientific dictum, "First get your facts straight—then pervert them," the authors shall present an objective review of several major studies of CAI and then offer personal judgments on the educational significance of the studies. Before proceeding with the review, briefly consider the scope of this survey of CAI evaluation. The particular studies included all meet the three major criteria stated below.

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the percentage of time spent on academic tasks in the typical classroom has been reported to be about 45%, time on task becomes a very important determinant of the outcome of regularly used computer based learning [26] A technique that can double time on task during the academic work can contribute greatly to the achievement of the students. This increased time on task seems due, in part, to the effectiveness of the visual display in maintaining attention to the lesson materials. Not only is the material visually structured, but it is also in a form that is quite familiar to a generation of students raised with television, both of which help ease the learning task.

Obviously the verbal communication of the students is the crucial determinant of the success of this method Students engaged in cooperative, verbal learning show better categorizing, problem solving, strategy behaviors, explaining and a host of other cognitive skills than do students learning in other situations [27] The focus of this effect seems to be the mutual tutoring that occurs during the learning session Despite the skepticism occasionally expressed about the value of learning by tutoring peers or being tutored by peers, the data argue for the real effectiveness of this activity [28] Not only does such tutoring lead to higher performance on examinations, but it also results in more positive attitudes towards the subject matter [29] Coupled with computer guidance, such learning apparently may also help students discover the cognitive strategies that are most effective for themselves.[30]

The Future

William James, in commenting on the union of the technological perspectives of psychology and the humanistic perspectives of teaching, wrote.

"You make a great, a very great mistake, if you think that psychology, being the science of the mind's laws, is something from which you can deduce definite programs and schemes and methods of instruction for immediate schoolroom use. Psychology is a science, and teaching is an art; and sciences never generate arts directly out of themselves. An intermediary inventive mind must make the application, by using its originality."[31]

Analogously, we might conclude that insofar as computers behave scientifically and student peers artistically, their union can bring a much needed creative strength to education. With computer enhanced collaborative learning we find significant improvements in the learning process as it occurs in the classroom:

- The teacher, who never has enough time to carry out all the teaching and interpersonal activities he or she needs to, gains major blocks of time.
- The student can double his or her efficiency during learning
- The quality of what is learned is better
- The attitudes of students are more positive towards what they are learning and the process of learning itself.
- And the cost of this process is a fraction of the cost of more conventional methods

Perhaps most importantly we must not forget the impact that technology can have on culture. Our methods of using technology shape our culture in powerful ways with long term impacts. Is our educational future one in which individuals sit in isolation in front of computer terminals? Or, will we allow our humanistic understandings to release a potential for collaborative interaction and bring life to our technology. What better use of computers could we imagine in the classroom than to bring us together. By enhancing an intellectual collaboration among learners, the computer may reach its highest educational potential.

Editor's Note: The system mentioned is a product of Active Systems, Inc., P.O. Box A 187 Hanover, NH 03755, Telephone (603) 643-2381. Please contact them directly if information is desired.

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[illegible] Sample [illegible] Coles [illegible] Shear [illegible] The effect of mode of learning and cooperation on performance Hanover NH Dartmouth College (Senior Honors Thesis) 1982
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As may be seen from the criteria, the present review is concerned with "summative" evaluation involving the comparative experimental control model (Bloom *et al.*, 1971). The survey is not claimed to be exhaustive, but does include most of the major studies presently available in the field.

A. *CAI Drill and Practice Programs in Language Arts and Mathematics*

All studies used a mode of CAI described as drill and practice. Drill and practice systems may be defined as CAI systems designed to assist a learner in the maintenance and improvement of a skill. By contrast, tutorial systems are designed to assist a learner in the *acquisition* of a skill.

B. *Evaluation Criterion—Standardized Tests in Mathematics or Language Arts*

All studies in the present review concerned methods for improving the performance of students in mathematics and language arts—as measured by standardized tests. In all studies, performance was determined by an average gain score—the difference between pretest and posttest scores. The unit of measurement was grade-year equivalent. The specific tests used in the various studies included, principally, the Stanford Achievement Test (SAT) for Mathematics and Language Arts and the Metropolitan Achievement Test (MAT).

C. *Experimental Method—CAI and Traditional Instruction Versus Traditional Instruction*

In the studies reviewed, a basic experimental group/control group design was used. In all studies, the experimental group received traditional instruction augmented by CAI drill and practice for five to fifteen minutes per day. In most studies, the control group received traditional instruction without any special assistance; however, some studies controlled for the obvious possibility of a Hawthorne effect by providing CAI experience for control subjects. In most studies, control and experimental groups were selected randomly as a class. Subjects were matched on standard ability and achievement measures either individually or as a class. The training period for instruction ranged from three months to ten months. The model training period was seven months.

Results

The results for CAI drill and practice evaluation are presented as follows. First, studies included in the survey are summarized; second, results are given for language arts; and third, results are summarized for mathematics. Again we should emphasize that our survey is not exhaustive, but does attempt to cover most of the major evaluative projects. A more complete analysis of results is available in another publication (Vinsonhaler and Bass, 1971).

Studies Included in Survey

As shown in Figure 1, only three major studies, with five comparisons, are included in our review of language arts. However, it should be noted that all studies are comparable with respect to CAI programs and experimental design. Further, one of the studies included a representative national sample of 180(elementary school children. Seven major studies, with 34 separate comparison experiments, are included in this review of CAI drill and practice evaluations for mathematics. The studies were performed in California, Michigan, Mississippi and New York. The number of subjects ranged from less than two hundred to several thousand.

Results for Language Arts

Figure 2 summarizes the results of CAI drill and practice studies in language arts by comparing the mean performance of experimental and control groups. The horizontal axis of the figure indicates the grade level of subjects at the beginning of each study and the study identification from the previous figure. The vertical axis plots the difference obtained by subtracting the control group average gain score from that of the experimental group. Obviously, the differences would be expected to be zero, under the null hypothesis of no difference between CAI/traditional instruction and traditional instruction. As shown in the figure, all differences are positive, ranging from *one tenth to four tenths of a school year* in favor of CAI groups.

Results for Mathematics

Figure 3 shows the average gain scores for groups receiving both CAI and traditional instruction versus groups receiving only traditional instruction. The horizontal axis indicates the study identification from the previous figure and the grade level of the subjects at the beginning of the experiment. The vertical axis shows the difference in mean gain scores, i.e., the mean gain of the control groups subtracted from the mean gain score of the experimental groups. Under the assumption of no difference in treatments, the expected value is zero. As may be seen, most comparisons show an advantage for CAI plus traditional instruction. In a majority of cases, the differences are statistically significant. Perhaps more importantly, the differences favoring CAI are replicated in most of the independent studies.

The only striking exceptions to the CAI performance advantage were observed in the Waterford 1968-69 study at the fifth grade level and in the New York 1969-70 study at the sixth grade level. The Waterford investigators attributed their reversal to the use of the Iowa Test of Basic Skills as the criterion. They felt that the Iowa Test measured concepts rather than the mathematical skills which their CAI programs were intended to develop. The subsequent Waterford 1969-70 study supported this argument since it showed significant gain on the SAT for the group receiving CAI.

The New York investigators attributed their reversals and the generally poor CAI gains to two possible causes. First, they suggested that the students in the second year might not have completed enough of the drill and practice items. Most of their students completed less than half of the exercises. Second, since a majority of their subjects had used the programs in the first year, the researchers suggested that the drop in gain

Figure 1

Studies Included in the Survey

Field	Identification of Study	Year	Grade(s)	Subjects	Length of Study	Test Used	Reference for Study
Language Arts	[1]California East Palo Alto	1970	1	88	10 Mos.	Stanford Ach./ Metropolitan Readiness Test	Fletcher & Atkinson (1971)
	[2]Michigan Waterford Indicom	1969	4*	68	4 Mos.	Stanford Achievement	Wilson & Fitzgibbons (1970)
	[3]New York Harcourt Brace	69-70	4, 5, 6	1800 (National Sample)	5 Mos.	Stanford Achievement	Harcourt Brace (1971)
Mathematics	[1]California	66-67	4-6**	182	9 Mos.	Stanford Achievement	Suppes and Morningstar (1969)
	[2]California	67-68	1-6	665	7 Mos.	Stanford Achievement	Suppes and Morningstar (1969)
	[3]Mississippi	67-68	1-6	515	3 Mos.	Stanford Achievement	Suppes and Morningstar (1969)
	[4]New York	68-69	2-6	3000	5 Mos.	Metropolitan Achievement	Weiner *et al.* (1969)
	[5]New York	69-70	2-6	3534	10 Mos.	Metropolitan Achievement	Abramson *et al.* (1971)
	[6]Waterford	68-69	3-6	391	9 Mos.	Iowa Test of Basic Skills	Scrivens (1970)
	[7]Waterford	69-70	2-6	335	9 Mos.	Stanford Achievement	Arnold (1970)

*Includes Grades 4 and 5, but primarily 4th.

**Two experiments were conducted together in California in 1966-67. Only one, however, is included in this report. The other study had a confounding variable of two teachers (in the control group) giving their students an additional 25 minutes per day classroom instruction and practice in arithmetic.

during the second year could also be due to the loss of a novelty effect of CAI that was present in the first year study.

Conclusions

The effectiveness of CAI over traditional instruction seems to be a reasonably well-established fact in drill and practice for both mathematics and language arts, when performance is measured by SAT- and MAT-type tests. In the field of elementary education, there appears to be little reason to doubt that CAI plus traditional classroom instruction is usually more effective than traditional instruction alone in developing skills—at least during the first year or two. What remains in doubt is the advantage of CAI over other, less expensive methods for augmenting traditional instruction and the long-term effects of CAI. There are indications that the effects obtained with CAI might be obtained through less expensive means. For example, one of the studies reported by Suppes and Morningstar (1969) suggests that an additional 30 minutes of ordinary classroom drill and practice can accomplish the same results as a 15-minute CAI program. Another possibility is programmed instruction. Studies have shown that CAI may actually prove inferior to programmed instruction under certain circumstances. For example, Dick and Latta (1969) compared the performance of eighth grade students on CAI and PI presentations of mathematics concepts. The results favored PI over CAI on all measures.

In the field of drill and practice for mathematics and language arts, what we now need are studies which compare CAI with other nontraditional methods of instruction and which attempt to identify the under-

Figure 2

Language Arts Results. Difference in Gain Scores for Groups Receiving CAI and Traditional Instruction Versus Those Receiving Traditional Instruction Only

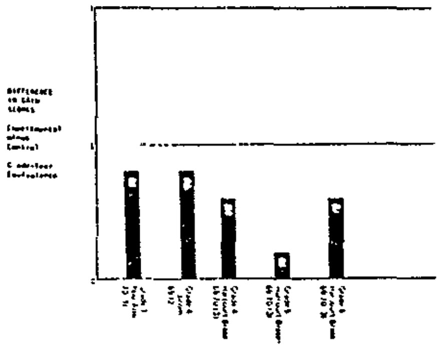
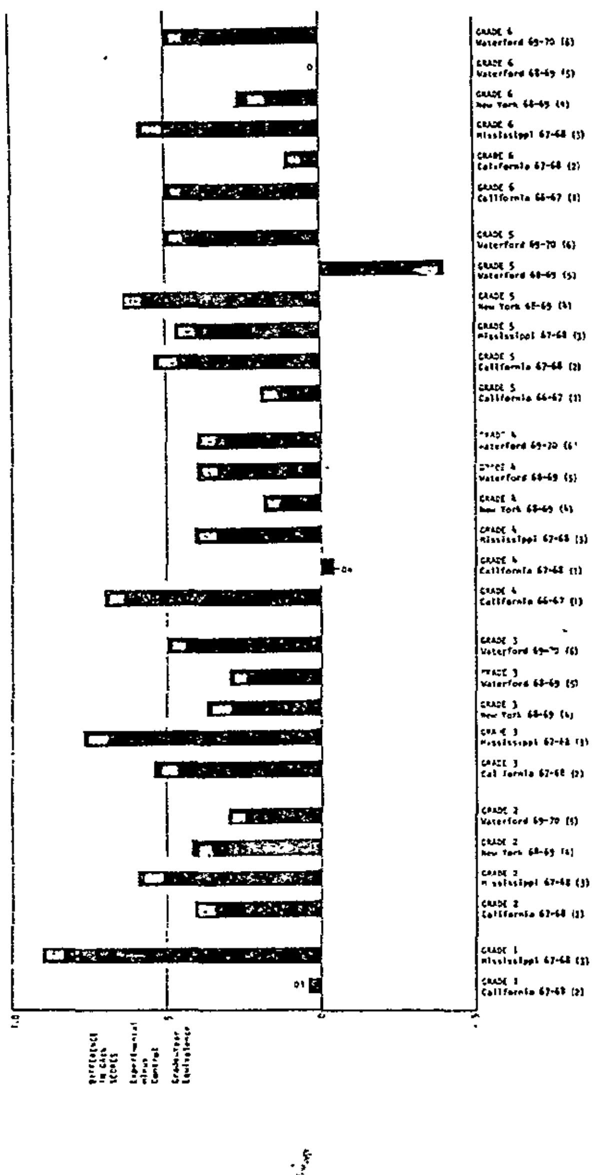


Figure 3

Mathematics Results. Difference in Gain Scores for Groups Receiving CAI and Traditional Instruction Versus Those Receiving Traditional Instruction Only



lying bases fo... CAI effects. With regard to the latter, we presently do not even know the major sources of the advantage of CAI over traditional instruction. The advantage could be due to direct effects of CAI experiences; to "novelty" effects which decline over a period of years; to changes induced by CAI in teacher behavior (additional classroom drill); or to changes in student behavior (voluntary additional practice). Research studies have established that CAI is effective; we must now consider the more sophisticated question—"How does CAI improve instruction?"

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Review of Educational Research
Winter 1980, Vol. 50, No. 4, Pp. 525–544

Effectiveness of Computer-based College Teaching: A Meta-analysis of Findings

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This review used Glass' (1976) meta analytic techniques to integrate findings from 59 independent evaluations of computer based college teaching. The meta-analysis showed that computer-based instruction made small but significant contributions to the course achievement of college students and also produced positive, but again small, effects on the attitudes of students toward instruction and toward the subject matter they were studying. Computer assisted instruction also reduced substantially the amount of time needed for instruction. In general, the meta-analysis found little relationship between study findings and design features of the experiments, settings for the studies, or manner and date of publication of the findings.

The dream of a computer revolution in college teaching is now almost two decades old. Soon after the computer industry started using computers in personnel training in the late 1950's, farsighted educators began dreaming about a computer age in higher education. They envisioned college classrooms in which computers would serve as infinitely patient tutors, scrupulous examiners, and tireless schedulers of instruction. Teachers in these imagined classrooms would be free to work individually with their students. Students would be free to follow their own paths and schedules in learning.

Government agencies, private foundations, and commercial organizations have tried for more than a decade to make this vision become a reality. Since 1965, for example, the United States Office of Education and the National Science Foundation have funded hundreds of computer projects in education. The Exxon Foundation, the Sloan Foundation, and other private agencies also made awards to numerous colleges for development of computer-based approaches to teaching and learning. Finally, research and development units of computer corporations poured millions of dollars into the creation of hardware and software for computer-assisted instruction.

Not everyone shared the vision of a benign computer revolution, however. To some critics, computers were expensive gadgets that increased the cost and complexity of instruction without increasing its quality. Others worried that rigidly programmed machines might force all learners into the same mold and stifle idiosyncrasy. Finally, some educators feared that computer requirements would ultimately affect the choice

This study was supported by National Science Foundation Grant SED 77-18566.

of instructional content. Teachers using computers in instruction, they warned, might be tempted to teach only those things that could be taught easily by machine.

Systematic comparisons of outcomes of computer-based and conventional teaching were clearly needed to help guide educational policy, and in the late 1960's evaluations of computer-based teaching began appearing in print. In a typical evaluation study, a researcher divided a class of students into an experimental and a control group. Members of the experimental group received part of their instruction at computer terminals, whereas students in the control group received their instruction by conventional teaching methods. At the end of the experiment, the researcher compared responses of the two groups on a common examination or on a course evaluation form. Teachers and researchers carried out such studies many times and in many different settings.

Reviewers of these evaluation studies generally supported the effectiveness of computer-based teaching as a supplement to conventional instruction in elementary schools. Vinsonhaler and Bass (1972), for example, summarized results from 10 independent studies of computer-supported drill and practice, involving more than 30 separate experiments with about 10,000 subjects. Results indicated a substantial advantage for computer-augmented instruction. Elementary school children who received computer-assisted instruction generally showed performance gains of 1–8 months over children who received only traditional instruction. In a more recent review, Edwards, Norton, Taylor, Weiss, and Dusseldorp (1975) also concluded that normal instruction supplemented by computer-based teaching was more effective than normal instruction alone. Most of the studies that these authors reviewed were carried out in elementary schools, and results of some of these studies were, in the words of the authors, "quite remarkable." In their broad overview of effectiveness of instructional media, Jamison, Suppes, and Wells (1974) also concluded that computer-assisted instruction was effective as a supplement to regular instruction at the elementary school level. Finally, Hartley's (1977) research synthesis showed that computer-assisted instruction was one of the most effective ways of teaching mathematics at the elementary and secondary levels.

It has proved harder to show the educational advantage of computer-based instruction at higher levels of education. Jamison et al. (1974), for example, reviewed nearly a dozen small-scale studies of computer-based instruction in college classrooms. Most of these studies were carried out in courses operated as part of research and development projects in computer-assisted instruction. The results of the studies defied easy summary. At the college level, Jamison and his colleagues were therefore able to draw only the conservative conclusion that computer-assisted instruction was about as effective as traditional instruction when used as a replacement. Jamison and his colleagues pointed out that it is broadly correct to conclude that, at the college level, most alternative methods of instruction are equally effective.

In the late 1960's, the National Science Foundation began backing two systems of computer-assisted instruction on a scale sufficient to permit a realistic evaluation of the potential of the computer in college teaching. Ultimately, the National Science Foundation invested more than $14 million in the development of these systems, called PLATO (Programmed Logic for Automatic Teaching Operators) and TICCIT (Time-shared, Interactive, Computer-Controlled, Information Television). The PLATO system is a large educational and computing network based at the University of Illinois that supports nearly 1,000 terminals at dispersed locations and provides

each site with access to a central library of lessons (Bitzer & Skaperdas, 1971). The TICCIT system developed by the Mitre Corporation of Bedford, Massachusetts, supports small, local instructional computing facilities (Stetton, 1971). In the TICCIT system, lessons are displayed on a color-television screen connected to the student's keyboard and a local computer. One TICCIT system can serve 128 terminals.

With support from the National Science Foundation, researchers at the Educational Testing Service recently carried out a major evaluation of these two systems (Alderman, 1978, Murphy & Appel, 1977). The evaluation was based on field tests of the TICCIT system in two community colleges in Arizona and Virginia and tests of the PLATO system in five community colleges in Illinois. The evaluators of PLATO reported that both students and teachers reacted favorably to this computer-teaching system, but that PLATO had no significant impact on student achievement. The evaluators of TICCIT reported that this system resulted in an improvement in student achievement, but students in TICCIT classes were more likely to drop out than those in conventionally taught classes. The evaluators concluded that neither PLATO nor TICCIT had reached the potential so long claimed for computer based instruction.

The evaluation of PLATO and TICCIT gave educators an additional perspective on computer-based college teaching. The evaluation demonstrated that institutions of higher education would accept computer-based instruction as an additional resource for promoting student learning. But the conditions of the Educational Testing Service evaluation limited the settings to which its findings could be generalized. Although the evaluation was large in scale, it had many special characteristics. It was carried out in community colleges only. The evaluation focused on large-audience, lower level courses. Teachers involved in the study were recruited for participation; computer-based instruction was not an indigenous development at the colleges. Finally, PLATO and TICCIT were but two of many approaches to computer-based college teaching.

The purpose of this article is to provide an objective synthesis of findings from numerous studies of the effectiveness of computer-based teaching at the college level. The article is meant to integrate results from the PLATO and TICCIT evaluation and from more than 50 other independent studies of computer based and conventional teaching. The approach used in this investigation has been called "meta-analysis," or the analysis of analyses. The term was first used by Glass (1976) to describe the statistical analysis of a large collection of results from individual studies for the purpose of integrating findings. Researchers carrying out a meta-analysis locate studies of an issue by clearly specified procedures. They characterize features of the studies and study outcomes in quantitative or semiquantitative ways. Finally, meta-analysts use multivariate techniques to describe findings and relate characteristics of the studies to outcomes.

This method was developed initially for handling the difficulties posed by the wealth and diversity of findings in the social sciences. When studies of an issue run into the hundreds, and findings are diverse, reviewers often see what they wish in the collected results. The use of quantitative methods and statistical tools somewhat constrains a reviewer's fancy. By applying to a collection of results the same objective methods that researchers use in analyzing results from an individual study, the meta-analyst is able to draw reliable, reproducible, and general conclusions. Meta-analysis is especially helpful in the social sciences when researchers are interested in formulating ecological rather than individual generalizations—generalizations about the effectiveness of an approach in a population of settings rather than generalizations about effectiveness for a population of individuals in a single setting.

Methods

This section describes the procedures used in locating studies, coding study features, and quantifying outcomes of the studies.

Locating Studies

The first step in this meta-analysis was to collect a large number of studies that compared effects of computer-based instruction (CBI) and conventional teaching. The primary sources for these studies were eight library data bases computer-searched through Lockheed's DIALOG Online Information Service. The data bases included (a) *Compendex*, the machine-readable version of the *Engineering Index*; (b) *Comprehensive Dissertation Abstracts*; (c) *ERIC*, a data base on educational materials from the Educational Resources Information Center, consisting of the two files *Research in Education* and *Current Index to Journals in Education*; (d) *Inspec*, an on-line file corresponding to the printed *Physics Abstracts, Electric & Electronic Abstracts*, and *Computer and Control Abstracts*; (e) *NTIS*, the data base of the National Technical Information Service, consisting of reports on government-sponsored research, development, and engineering; (f) *Psychological Abstracts*; (g) *Scisearch*, a multidisciplinary index comprised of all the records published in *Science Citation Index*; and (h) *Social Scisearch*, a multidisciplinary data base containing the records published in the *Social Science Citation Index*. We developed a special set of key words for each computer search to take into account the distinctive features of the different data bases. The bibliographies in articles located through computer searches provided a second source of studies for meta-analysis.

In all, our bibliographic searches yielded over 500 titles Most of the articles, however, failed in one way or another to meet the criteria established for the analysis. We reduced the initial pool of 500 titles to 180 potentially useful documents on the basis of information about the articles contained in titles or abstracts. We obtained copies of these 180 documents and read them in full. A total of 59 of the 180 reports contained data useful to the meta-analysis, and these 59 reports provided all the data used in our study.

In reducing the initial pool of 500 titles to a final group of 59, we used a set of explicit guidelines. To be included in our final sample, studies had to satisfy three criteria. First, the studies had to take place in actual college classrooms. We did not include in our analysis studies carried out at the elementary or secondary levels, nor did we include studies describing laboratory analogues of college teaching. Second, studies had to report on quantitatively measured outcomes in both computer-based and conventional classes. We excluded studies without control groups and studies with anecdotal reports of outcomes from our analysis. Third, studies had to be free from crippling methodological flaws. Our analysis did not include data from studies in which treatment and control groups were clearly different in aptitude. Nor did it include data from studies in which a criterion test was unfairly "taught" to one of the comparison groups.

In addition, we established guidelines to ensure that each comparison was counted only once in our analysis. When several papers reported the same comparison, we used the most complete report for our analysis. When the same comparison was carried out in the same course at the same institution for two or more terms, we used the data from the most recent term. When an instructional outcome was measured on several instruments in a single paper, we pooled the results from the instruments to obtain a composite measure. Finally, when a single paper reported on a number of courses, we pooled results from the various courses to obtain a composite result. These guidelines maximized independence among comparisons and prevented a few major research efforts from having an undue influence on overall results.

Describing Characteristics of Studies

The 59 studies located for use in the meta-analysis described four major types of applications of the computer to instruction tutoring, computer-managed teaching, simulation, and programming the computer to solve problems In tutoring studies, the computer presented instruction directly to students. In studies of computer-managed teaching, the computer evaluated student performance, diagnosed weaknesses, and guided students to appropriate instructional resources. In simulation studies, students explored relationships among variables in models simulating aspects of social or physical reality. Finally, in the programming studies, students programmed the computer to solve problems in the academic field they were studying.

The 59 applications of the computer to instruction also varied along two other dimensions. In some studies, the computer substituted for conventional teaching replacing lectures, recitation sections, conventional readings, or problem assignments or some combination of these. In other studies, the computer supplemented regular instruction Instead of replacing regular course elements, the computer simply served as an additional resource for students. Finally, in some studies the computer was used for instruction for the full duration of a course, whereas in other studies the computer was used only for a unit of instruction, usually for a week or two during a course. Table I lists 57 of the 59 studies according to type of computer application, use as a substitute or a supplement in teaching, and use in a unit or a full term of teaching. The two studies not listed in the table (Culp, 1971; Tsai & Pohl, 1977) contained data from two or more different applications of the computer to teaching, and these studies could not be placed into single cells of the table.

Studies differed not only in their use of the computer but also in other features To describe these features, we defined 13 additional variables Table II lists these variables, the coding categories for each, and the number of comparisons in each category. The first five variables in the table describe aspects of the experimental design of the studies (Bracht & Glass, 1968; Campbell & Stanley, 1963). The next six variables describe features of the course setting, including class level, field of the course, and level of the institution in which the course was offered Classification of fields was based on Biglan (1973), and categorization of institutional level was based on the Carnegie taxonomy of institutions of higher education (Carnegie Commission on Higher Education, 1976). The last two variables describe publication features of the studies.

The purpose of coding the studies in this fashion was twofold. First, the classification helped us to determine areas in which computer-based instruction was studied extensively and areas in which it was relatively unstudied. Second, the classification

TABLE I

Comparative Effectiveness Studies on Computer-based Instruction

Type of use	Substitute		Supplement	
	Unit	Full	Unit	Full
Tutorial	Ibrahim (1970) Meyer & Beaton (1974) Proctor (1968) Ward & Ballew (1972)	Alderman (1978) Arsenty & Kieffer (1971) Axeen (1967) Broh (1975) Cartwright, Cartwright, & Robine (1972) Castleberry, Culp, & Lagowski (1973) Culp, Stotter, & Gilbert (1973) Emery & Enger (1972) Hamm (1975) Homeyer (1970) LeCuyer (1977) Lee (1973) Lorber (1970) Montanelli (1977) Morrison & Adams (1968) Murphy & Appel (1977) Ozarowski (1973) Paden, Dalgaard, & Barr (1977) Romaniuk (1978) Skavaril (1974) Suppes & Morningstar (1969) Vaughn (1978)	None	Byers (1973) Castleberry & Lagowski (1970) Grandey (1970) Liu (1975) Skavaril, Birky, Duhrkopf, & Knight (1976)
Managed	Cunningham & Fuller (1973)	Gallagher (1970) Kromhout, Edwards, & Schwarz (1969) Lawler (1971) Roll & Pasen (1977) Torop (1975) Weiss (1971) Wood (1976)	None	Anderson, Anderson, Dalgaard, Paden, Biddle, Surber, & Alessi (1975) Henry & Ramsett (1978) Jones & Sorlie (1976) Kelley (1972) Smith (1976)
Simulation	Coombs (1976) Green & Mink (1973) Roe & Aiken (1976)	Cox (1974) Hsiao (1973) Mancuso (1975) Steinkamp (1977)	None	Dudley, Elledge, & Mukherjee (1974)
Programming	None	Bell (1970) Deloatch (1977) Fiedler (1969)	None	DeBoer (1973) Holoien (1970)

TABLE II

Categories for Describing Studies and Number of Studies in Each Category

Coding categories	Number
Methodological features	
Random assignment of comparison groups	
No	41
Yes	18
Control for instructor effect	
Different instructors	15
Same instructor	35
Control for historical effect	
Different semesters	3
Same semester	54
Control for scoring bias in criterion	
Nonobjective test	8
Objective test	55
Control for author bias in criterion	
Instructor-developed test	29
Commercial standardized test	9
Ecological conditions	
Duration of treatment	
Fraction of semester	20
Whole semester	38
Course level	
Introductory	42
Other	17
Content emphasis on "hard" discipline	
Soft	26
Hard	31
Content emphasis on "pure" knowledge	
Applied	20
Pure	38
Content emphasis on "life" studies	
Nonlife	40
Life	18
University setting	
Comprehensive, liberal arts, or community-college	15
Doctorate-granting institution	41
Publication features	
Source of study	
Unpublished	30
Published	29
Study year	
1967–69	6
1970–72	17
1973–75	18
1976–78	18

helped us to determine how properties of studies affected the principal findings. With carefully described studies, we were able to answer such questions as: "Is computer-based teaching as effective in 2- and 4-year colleges as it is in research universities?" and "Do studies using true experimental designs and studies using quasi-experimental designs produce the same results?"

Quantifying Outcomes

The outcomes described in the 59 studies were of five major types: student achievement, correlation between aptitude and achievement, course completion, student attitudes, and instructional time. First, we described the effect of CBI on achievement as measured on a unit or a final examination. As our basic index of achievement effect, we used d, defined as the difference between the means of two groups divided by the standard deviation common to the two populations (Cohen, 1977). For studies that reported means and standard deviations for both experimental and control groups, we calculated d from the means and the pooled standard deviation, using standard formulas for the pooled standard deviation. For less fully reported studies, we calculated d from statistics such as t and F, using procedures described by McGaw and Glass (in press). To add to the interpretability of our results, we also expressed differences between CBI and conventional classes in concrete terms. We calculated the difference in percentage scores on examinations by subtracting the average examination score (expressed as a percentage) in the conventional class from the average in the CBI class.

Second, we examined the effect of CBI on the correlation between student aptitude and achievement in college courses. A number of researchers have suggested that the aptitude achievement correlation will be higher in conventional classes than in computer based classes. In conventional classes in which all students receive the same amount and kind of instruction, aptitude plays a strong role in determining achievement. But in computer-based, individualized classes, students should receive the amount and kind of instruction they need, and aptitude should play less of a role in determining performance. Student aptitude can be measured in various ways: standardized aptitude measures, instructor prepared pretests, or student grade-point average on entry to a course. To quantify CBI effect on the aptitude-achievement correlation, we calculated q (Cohen, 1977) by transforming correlations using Fisher's Z transformation and then subtracting Z for the conventional class from the Z for the CBI class.

Third, we measured the effect of CBI on course completion. We first calculated withdrawal rates for CBI and conventional classes, where withdrawal rate was defined as the proportion of students initially enrolled who failed to complete a course in a term. We then used Cohen's (1977) procedures for determining h, the index of effect size when proportions are being compared. Calculation of h involved arcsine transformation of proportions and then subtraction of the transformed value for the conventional group from the transformed value for the CBI group.

Fourth, we quantified CBI effects on student attitudes. Quantifying effects in this domain presented some special difficulties. To measure student attitudes, most researchers examined the degree of endorsement of items on questionnaires. Different investigators, however, used different rating scales to measure attitudes. We had to decide when differently phrased items should be considered equivalent. We first

developed two lists of model-rating items to cover two major attitudes: overall attitude toward the course that the students were taking and their attitude toward the general subject that they were studying. We included in our analysis results on any item that appeared in one of our lists. Our basic index of effect size was d, calculated from the difference in average scale scores of CBI and conventional groups on items in our lists. To add to interpretability of our results on attitudes, we also converted rating results to scores on a 5-point scale (where 5 represented the most favorable attitude and 1 the least favorable attitude) and calculated the difference between ratings for CBI and conventional classes.

The fifth outcome that we described was time required for instruction. A number of reviewers have suggested that CBI reduces the amount of time needed to teach students. We therefore paid close attention to the studies that compared the number of hours per week spent in instruction in CBI and conventional classes. We again used d as our index of CBI effect on instructional time. As an aid in interpretation, we also calculated the average number of hours per week spent in instruction in CBI and conventional classes.

To make our study more similar to traditional reviews, we also examined the direction and significance of differences in outcomes of computer-based and conventional teaching. On the basis of results, we classified each outcome on the following 4-point scale: 1 = difference favored conventional instruction and statistically significant; 2 = difference favored conventional instruction but not statistically significant; 3 = difference favored CBI but not statistically significant, and 4 = difference favored CBI and statistically significant.

In our previous meta-analyses of research on programmed and audiotutorial instruction (Kulik, Kulik, & Cohen, 1979b; Kulik, Cohen, & Ebeling, in press), we reported that different effect-size measures agreed remarkably well when applied to the same data set. This also turned out to be the case in the present analysis. For 30 of the studies with data on achievement outcome, for example, we were able to calculate both d and examination differences in percentage points. The correlation between the two indexes was .94. The correlation between effect sizes as measured by d and by scores on the 4-point scale reflecting direction and significance of differences was .77. Because these correlations were so high, we were able to write regression equations for "plugging" missing data on specific effect-size measures. If, for example, a study did not report final examination averages in percentage terms but did report data from which d could be calculated, we were able to use d to predict the number of percentage points separating experimental and control groups on the examination.

In our previous research, we also reported negligible correlations between effect sizes for different types of outcomes. In our meta-analyses of research on programmed and audiotutorial instruction, for example, correlations between effect sizes on achievement, course withdrawal, and student satisfaction were nonsignificant. Most of the studies collected for this article reported only a single outcome. In the few studies that reported multiple outcomes, there was no indication of predictability from one type of effect to another. The correlation between the effect on achievement and on course completion was small and insignificant, for example, as was the correlation between effect on achievement and on student attitudes.

Results

In this section we describe results of statistical analyses comparing effects of computer-based and conventional teaching. We describe the findings in five areas: (a) achievement, (b) aptitude-achievement correlation, (c) course completion, (d) student ratings, and (e) instructional time.

Student Achievement

A total of 54 of the 59 studies located for this meta-analysis looked at examination performance of students in CBI and conventional classes. In 37 of the 54 studies, CBI examination performance was superior to examination performance in a conventional class; 17 studies favored conventional instruction. Fourteen of the 54 comparisons reported statistically significant differences between teaching methods. Results of 13 of these studies favored CBI, and results of one study favored conventional instruction. If no overall generalization about the effect of CBI was possible, one would expect about half the cases to favor CBI and half to favor conventional teaching. Instead, a clear majority of studies favored CBI. We were therefore able to reject the null hypothesis of no effect of CBI on student achievement.

Continuous measures of effect size permit a more exact description of the influence of CBI on examination performance. The average examination score was 60.6 percent in the typical CBI class; the average was 57.6 percent in the typical conventional class. Examinations from computer-based and conventional classes therefore differed by 3.0 percentage points, the standard deviation of this difference was 6.5. It is statistically very unlikely ($p < .01$) that a difference of this size would occur if there were no overall difference in effectiveness of computer-based and conventional teaching.

The average d in the 54 studies was .25. Thus, the effect of CBI in a typical class was to raise student achievement by about one-quarter of a standard deviation unit. This implies that a typical student in a CBI class was performing at the 60th percentile on examinations, whereas the typical control student performed at the 50th percentile. Cohen (1977) described effects of this magnitude as small. With $d = .2$, for example, treatment-group membership accounts for only 1 percent of the variance in a trait, and treatment effects are ordinarily too small to be observed without special measuring procedures. When group averages are separated by a half standard deviation ($d = .5$), the effect is said to be medium in size. When $d = .8$, effects are large.

Although the effect of CBI in the typical study was small, effect sizes varied from study to study. Figure 1 presents a distribution of effect sizes for the 54 studies. The figure shows that nearly one-quarter of the studies reported a medium or large effect in favor of CBI, nearly three-quarters of the studies found small or trivial effects, and very few studies (less than 5 percent) reported moderate or large effects favoring conventional instruction.

We also wanted to know whether the studies that reported large effects differed systematically from those reporting small effects. We therefore examined the relation between achievement-effect sizes and study characteristics. Table III presents the correlation between study characteristics and achievement-effect size. The table shows that only one variable—use of a control for instructor effect—was significantly related to effect size. The average effect size d was .13 for those studies in which a

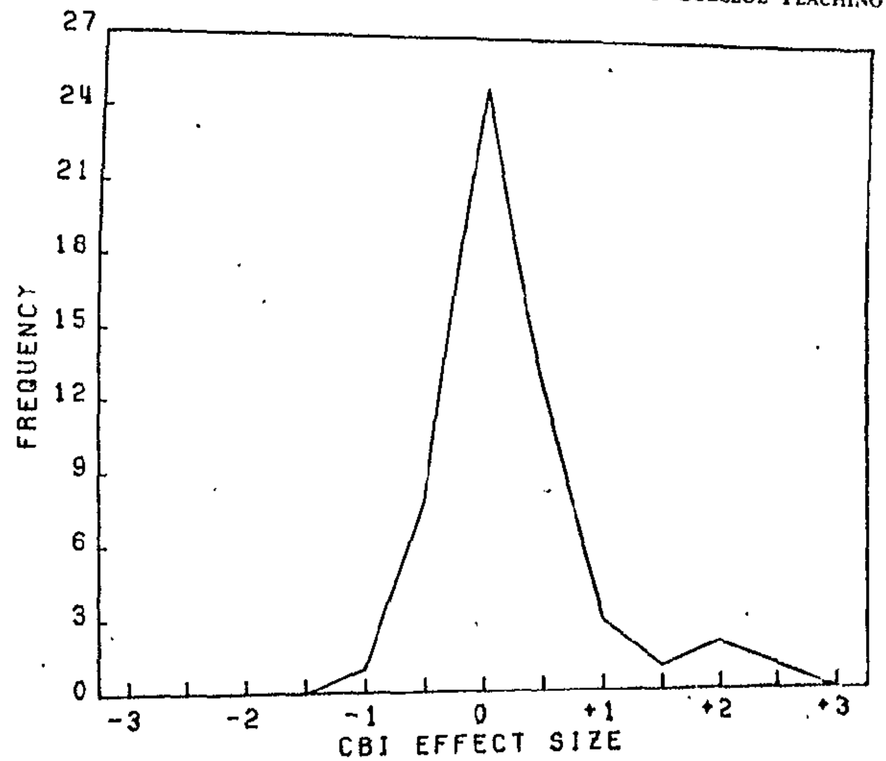

FIGURE 1. Distribution of achievement effect sizes for 54 studies.

single teacher gave both computer-based and conventional sections of a course. Effects were larger when different teachers gave the two sections. The average effect size was .51 when different teachers gave computer-based and conventional sections of a course.

Other study features were less highly related to effect size. Correlations between effect size and the remaining variables were low in magnitude, and none could be considered significantly different from zero. To investigate the possibility that a combination of variables might predict effect sizes more accurately than a single predictor, we also carried out a stepwise multiple regression analysis with generous limits for inclusion of predictor variables. Results of this analysis were clear-cut. Once instructor control was taken into account, none of the variables was significantly related to effect size.

Aptitude-Achievement Correlation

Seven studies reported aptitude-achievement correlations separately for CBI and conventional classes. We first examined the direction and significance of differences

TABLE III

Correlations of Study Characteristics with CBI Effect on Achievement

Study characteristic	Correlation with effect size
Use of computer for managing	04
Use of computer for tutoring	.17
Use of computer for simulation	−.18
Use of computer for programming	−.14
Extent of use	.15
Implementation	−.10
Random assignment of comparison groups	.08
Control for instructor effect	−.27*
Control for historical effect	.02
Control for scoring bias in criterion	.11
Control for author bias in criterion	12
Duration of treatment	−.08
Course level	.07
Content emphasis on "hard" discipline	−.18
Content emphasis on "pure" knowledge	.09
Content emphasis on "life" studies	.16
University setting	.01
Source of study	−.05
Study year	−.12

* $p < .05$.

in aptitude-achievement correlations in these studies. For three of the studies, the correlation between aptitude and achievement was higher in the CBI section; for the other four studies, the correlation was higher in the conventional section. Only one study reported a significant difference in the aptitude-achievement correlations found in CBI and conventional classes, and in that study the correlation was higher in the conventional class. Second, we examined the average aptitude-achievement correlation in the two kinds of classes. The average correlation coefficient in the CBI classes was .41, and the average correlation in the conventional classes was .51. Finally, we determined the average *q*, the index of size of difference in correlation coefficients. The average *q* was .12, a small value. It seems safe to conclude that CBI has at best a small effect on the correlation between aptitude and achievement in college courses.

Course Completion

Only 13 of the 59 studies in our collection examined the effect of CBI on course completion. In seven studies withdrawal rate was higher in the CBI section, and in six studies withdrawal rate was higher in the conventional section. The difference in withdrawal rates was statistically significant in only three studies. In one of these cases, withdrawal rate was significantly higher in the CBI class, and in two cases it was significantly higher in the conventional class. Under a null hypothesis of no overall effect of CBI on course completion, one would expect withdrawal rates to be higher in CBI classes about half the time. The results obtained do not differ significantly from this expectation.

We were able to perform a more sensitive test of the effect of CBI on course withdrawal by treating withdrawal rate as a continuous variable. Even with this procedure, however, we could not reject the hypothesis of no difference in course withdrawals as a function of teaching method. The average CBI withdrawal rate was 26.9 percent; the average rate in the conventional classes was 27.6 percent. Finally, we also expressed the average effect size as *h* (Cohen's measure of size of effect for comparisons of proportions). For these withdrawal data, average *h* equaled .005, a trivial value

Student Attitudes

Only 11 of the 59 studies contained results from quantitative comparisons of student attitudes toward instruction in computer-based and conventional classes. CBI ratings were higher than conventional ratings in eight of the studies, and conventional ratings were higher in the remaining three studies. Four studies showed a statistically reliable difference in favor of computer-based teaching, and one study showed a statistically reliable difference in favor of conventional teaching. On a 5-point scale from 1 (the lowest rating) to 5 (the highest rating), the average rating of course quality was 3.77 in the CBI classes and 3.50 in the conventional classes. This difference in ratings is probably best considered a small one. It corresponded to a *d* of .24.

Computer-based teaching also had a small effect on student attitudes toward the subject matter in these courses. Seven of the studies in our collection examined effects on student attitudes toward subject matter. In five studies the CBI classes had more favorable attitudes, and in two studies the conventional classes expressed more favorable attitudes toward the subject matter. In two studies there was a statistically reliable difference between CBI and conventional students in their attitude toward subject matter, and both of these studies reported more favorable attitudes on the part of the CBI students. In general, however, CBI effects on subject matter attitudes were small. The average *d* for the seven studies with relevant data was .18.

Instructional Time

Eight investigators collected data on the amount of time spent in instruction of students in CBI and conventional classes. Each of the eight investigators found that the computer produced a substantial saving in instructional time. In all of the cases in which investigators performed statistical tests, the differences in instructional time between CBI and conventional classes were statistically significant. On the average the conventional approach required 3.5 hours of instructional time per week, and the computer-based approach required about 2.25 hours. This is a substantial and highly significant difference between methods. There appears to be little doubt that students can be taught with computers in less time than with conventional methods of college teaching.

Discussion

This meta-analysis showed that for the most part the computer has made a small but significant contribution to the effectiveness of college teaching. In the typical implementation, computer-based instruction raised examination scores by about 3 percentage points, or about one-quarter standard deviation. Thus, the typical student in a computer-based class scored at the 60th percentile on an achievement examination over course material, whereas the typical student in a conventional class scored at the 50th percentile. The boost that computer-based teaching gave to student achievement was about as noticeable in high- and low-aptitude students as it was in average students; computer-based instruction did not seriously reduce the expected correlation (about .5) between aptitude and achievement in college classrooms. Computer-based teaching also had small and positive effects on attitudes of college students toward instruction and toward the subject matter that they were taught. College students tended to like their courses somewhat more and become more interested in the subject of these courses when instruction was computer based.

In individual studies, there were notable exceptions to the general rule of small effects of the computer on student performance and attitudes In a few applications, the introduction of computer-based instruction into a college classroom dramatically influenced student examination performance; class averages on final examinations rose by 15–20 percentage points in these cases. In a few cases, the computer also had strong positive effects on student attitudes. Studies like those by Cartwright, Cartwright, and Robine (1972), Grandey (1970), and Roll and Pasen (1977) are potentially important because these investigators reported unusually strong, positive effects of computer-based instruction.

The most dramatic finding in this meta-analysis, however, is related to instructional time. In every study in which computer-based instruction substituted for conventional teaching, the computer did its job quickly—on the average in about two-thirds the time required by conventional teaching methods. It is clear that the computer can function satisfactorily in college courses and at the same time reduce time spent in instruction.

Overall, however, the accomplishments of computer-based instruction at the college level must still be considered modest. The present results, for example, are not so impressive as those for computer-supplemented instruction in elementary schools. The studies reviewed by Edwards et al. (1975) and by Vinsonhaler and Bass (1972) were unanimous about the effectiveness of supplemental computer-assisted instruction at the elementary level, and Hartley's (1977) meta-analysis also reported differences at the elementary school level of at least one-half standard deviation between students whose classes received supplemental CBI and students who did not receive computer-supplemented instruction. Nor are the results of computer-based teaching as impressive as results for other applications of instructional technology at the college level. Keller's Personalized System of Instruction, for example, has produced much more dramatic results in college classrooms (Kulik, Kulik, & Cohen, 1979a). Numerous studies have reported that Keller's teaching method makes a substantial contribution to examination performance and also contributes dramatically to ratings of instruction. The effects of computer-based teaching were smaller and comparable in size to those reported in studies of programmed instruction (Kulik et al., in press) or of Postlethwait's audiotutorial approach to teaching (Kulik et al, 1979b).

In general, we found little relationship between design features of experiments and experimental outcomes. For the most part, design features of experiments did not influence outcomes. Quasi-experimental studies and true experiments produced similar results. Experiments with controls for historical effects yielded the same results as experiments without historical controls. Nor did settings influence findings

in any substantial way. Findings were similar in "hard" and "soft" disciplines, in pure and applied areas, and in life studies and other content areas. Findings were also the same for courses at different levels.

We were especially surprised to find no relationship between publication features and findings reported in the studies. In our meta-analysis of research on Postlethwait's audiotutorial approach (Kulik et al., 1979b), we reported that findings in published studies were stronger than those in unpublished studies and dissertations—a relationship reported in a number of meta-analyses (Peterson, 1979; Rosenthal, 1976). In our meta-analysis of research on programmed instruction (Kulik et al., in press), we reported that study year was related to size of effect; more recent studies produced results more favorable to programmed instruction. Other meta-analysts have also reported time trends in results (Hall, 1978). For computer-based teaching, however, neither variable—nature of publication or study year was significantly related to study outcome

Only one variable predicted study outcome in our meta-analysis and that was use of a design that controlled for instructor effects In studies in which different teachers taught computer-based and conventional sections of a course, examination differences were more clear-cut and favored computer based teaching. In studies in which a single teacher taught both experimental and control classes, differences were less pronounced. We found a similar relationship between this research design feature and experimental outcomes in our meta-analysis of research on Keller's Personalized System of Instruction (Kulik et al., 1979a). It seems possible that involvement of teachers in innovative approaches to instruction may have a general effect on the quality of their teaching. Outlining objectives, constructing lessons, and preparing evaluation materials (requirements in both computer-based and personalized instruction) may help teachers do a good job in their conventional teaching assignments

Two points should be kept in mind by readers forming an overall evaluation of computer-based college teaching on the basis of our meta analysis. The first point concerns the weighting that we gave to different studies in the analysis. Our meta-analysis gave equal weight to each independent study that we located, where "study" was defined as a set of results described in a single report or publication. If we had weighted studies according to the number of students, classes, or comparisons described in them, our results would have been different. The findings from the ETS evaluation of PLATO and TICCIT (Alderman, 1978; Murphy & Appel, 1977) would have carried as much weight as the results of all the other investigators combined, and the unique ETS findings—elevated withdrawal rates and neutral-to-negative student attitudes to computer-based courses—would have had a far greater influence in our findings.

The other point concerns the very nature of meta-analysis. This method provides a way of determining major themes in reported research findings. In this meta-analysis, we looked at student outcomes that were frequently studied: student learning, student attitudes, student course completion, instructional time, and the correlation between aptitude and achievement. We did not examine less direct, more subtle, or even unique outcomes of computer-based teaching. We do not know, therefore, whether computer-based teaching helped students develop a sense of confidence with computers, whether it contributed to faculty development, or whether it provided the groundwork for future innovations far more effective than anything now imagined. Furthermore, the effectiveness research that we examined was conducted during the time period 1967 through 1978. The picture we drew is of the past, not the future. Developments in computer technology have been occurring so swiftly that no one can predict with confidence what the next year, much less the next decade, will bring in computer-based college teaching.

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Review of Educational Research
Winter, 1980, Vol. 50, No. 4, Pp. 545–595

Student-Faculty Informal Contact and College Outcomes

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This paper is a critical review and synthesis of the research on the association between student-faculty informal, nonclass contact and various outcomes of college. Relevant investigations are summarized according to sample characteristics, independent and dependent variables, statistical or design controls, and findings. A synthesis of the results indicates that, with the influence of student preenrollment traits held constant, significant positive associations exist between extent and quality of student-faculty informal contact and students' educational aspirations, their attitudes toward college, their academic achievement, intellectual and personal development, and their institutional persistence. Methodological problems and issues in the existing body of evidence are discussed, and directions for future research are suggested. A conceptual model to guide future inquiry in the area is offered and discussed briefly

Theoretical Perspective

One of the more persistent assumptions in American higher education has been that of the educational impact of close student-faculty interactions beyond the classroom. Indeed, so strongly and widely held is this assumption that frequent informal contact between faculty and students has often been viewed as a desirable educational end in and of itself Much of the ferment and unrest experienced by academic institutions in the late 1960's and early 1970's has been explained as a reaction to the growing impersonalism of the multiversity and the lack of communication and nonclassroom contact between faculty and student cultures (e g. Mayhew, 1969; Taylor, 1971).

Furthermore, many of the indictments of higher education during this period were based on a philosophical stance which emphasized the importance of college impacts beyond the transmission of facts and knowledge (e g, acculturation to the world of ideas, inculcation of certain attitudes and personality orientations, development of interpersonal skills, promotion of critical thinking and problem-solving ability, development of a sense of self and career identity, and clarification of personal values). Inherent in this developmental education perspective is the belief that close

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An earlier version of this paper was presented at the annual meeting of the American Educational Research Association, Boston, April 1980. I wish to thank the New Hampshire College and University Consortium for their support of the initial research for this paper. Sincerest thanks are also due to Joseph Durzo, Susanna Pflaum, William Schubert, and Patrick Terenzini for their insightful criticisms of earlier drafts of the manuscript.

Search of the Literature

from *Instructional Use of Microcomputers: A Report on B.C.'s Pilot Project*, prepared for the Ministry of Education by Denyse Forman, published by British Columbia's Ministry of Education, September, 1981.

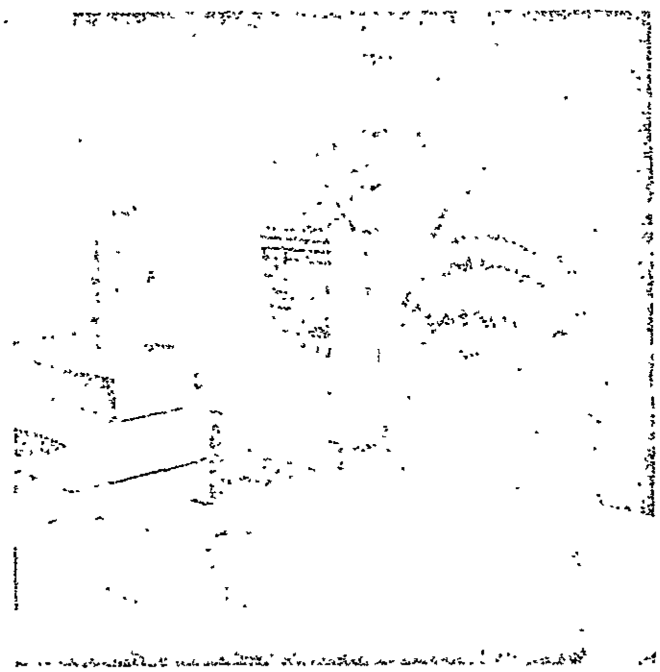
.. Note: Denyse Forman has been a Research Associate for JEM Research; Victoria, British Columbia since ... ,efore that she developed expertise in many disciplines, teaching at several small rural schools in Manitoba. .. wrote up this search because· "We know that most educators don't have time to do a search of the ..re, and we believe that investigating relevant literature is a desirable starting point for making decisions about ..er education. Reporting this search gives educators a head start."

..arch of the literature reveals that most educators .. agree with Splittgerber[45] that the instructional ..tion of microcomputers can generally be divided ..o broad categories, namely, computer managed ..tion (CMI) and computer assisted instruction

.. latter, CAI, is defined as a teaching process ..tly involving the computer in the presentation ..structional materials in an interactive mode to ..de and control the individualized learning en..ment for each individualized student. These in..ive modes are usually subdivided into drill-..practice tutorial, simulation and gaming, and ..lem-solving . . .

..ontrast, CMI is defined as an instructional ..agement system utilizing the computer to direct ..entire instructional process, including perhaps ..as well as traditional forms of instruction which ..not require the computer such as lectures and ..p activities. CMI has some or all of the following ..cteristics organizing curricula and student .. monitoring student progress, diagnosing and ..ribing, evaluating learning outcomes, and pro.. planning information for teachers (Splitt.., p. 20)

..definition of CAI has been further refined by ..ers and Sprecher[..] to distinguish between ad.. and primary, simplistic and complex CAI. ..ing to these researchers, adjunct CAI refers to a .. or series of programs which supplements the .. situation whereas primary CAI describes pro..which provide instruction of a substitute or stand ..ately. Simplistic CAI can be developed by using ..dern programming languages but complex CAI .. authoring which permits such features as the .. use of graphics and large scale calculations. ..er, for the purposes of this discussion, the ..I and CAI will be used interchangeably to in.. broad range of possible applications of com.. education. The remainder of this section of the report will review the current literature regarding the use of computers in education.



Denyse Forman

THE EFFECT OF CAI ON ACHIEVEMENT

Arguing against the need to prove over and over again that CAI "works," Eisele[18] points out that there is "little likelihood that sufficient evidence will ever exist that will assure educators—with any noticeable degree of confidence—that any *delivery system* will perform adequately if the criterion is stated in replicable learner performance" (Eisele, p. 1).

Similarly, Gleason[21] observes that few serious researchers are now interested in comparative studies, i.e., studies which attempt to compare the results of computer assisted instruction with the results of other strategies because of the extreme difficulty of controlling the number of significant variables in any learning situation (Gleason, p. 16).

Aiken and Braun[1] argue that although the trend has been to use statistical techniques to measure the effectiveness of CAI materials, they feel that attitudinal studies would appear to be a more promising approach. They point out that "statistical results have been meaningful only as measures of *performance;* other methods will have to be considered if we are to have meaningful measures of *learning*" (Aiken and Braun, p. 14).

"... there are a number of well designed and tightly controlled studies from which some generalized conclusions can be drawn regarding the effectiveness of CAI in the learning process."

However, although researchers caution against placing too much emphasis on statistical results, decision makers are demanding proof that CAI is effective, often without fully understanding what they mean by "effective."

As Chambers and Sprecher[11] point out,

> To some effectiveness means the amount of learning that takes place initially. To others it means the degree of retention of learning, or at the very least, whether or not an individual stays in or drops out of a learning experience. Still others are concerned with the learner's change in attitude toward the computer as an instructional medium or simply as a helpful tool in the culture. Finally, owing to the fact that CAI is in its infancy, some are simply concerned with transportability of materials and/or acceptance of the materials for use by others (Chambers and Sprecher, p. 335).

To further complicate the issue, the number of methodologically sound evaluations of the effectiveness of computer assisted instruction are rare and conclusive results are difficult to find.

However, there are a number of well designed and tightly controlled studies from which some generalized conclusions can be drawn regarding the effectiveness of CAI in the learning process:

1. The use of CAI either improved learning or showed no difference when compared to traditional classroom approaches.[9,16,17,20,23,29,34,41,50]
2. The effect on achievement occurred regardless of the type of CAI used, the type of computer system, the age range of the students, or the type of instrument used to make the measurements (Hallworth and Brebner, p. 175).
3. When CAI and traditional instruction a[re com]pared, equal or better achievement using [CAI is] obtained in less time.[16,17,20,29,34,42]
4. Students have a positive attitude towards C[AI, fre]quently accompanied by increased mo[tivation,] attention span, and attendance in course[s (Hall]worth and Brebner, p. 178).

In addition to the above consistencies, a nu[mber of] other interesting and significant factors relatin[g to the] effectiveness of CAI are reported in the literatu[re:]

1. Tutorial and drill modes seem to be more e[ffective] for low-ability students than for middle o[r high-]ability students;[9,16,17,20,26,42]
2. Many reluctant learners become active [and in]terested learners when involved in compu[ter-sup]ported programs,[20,26]
3. The bulk of the studies showing CAI to be e[ffective] have concerned the use of adjunct CAI in [which] the classroom teacher was readily availab[le;]
4. Poor attitudes on the part of instructors [and ad]ministrators have resulted in overt sabota[ge of the] computer learning process,[14]
5. Foreign languages and science are two [areas in] which CAI programs consistently hav[e been] shown to be effective;[17]
6. CAI is helpful to students reviewing materi[al with] which they had prior familiarity;[17] and
7. Retention rates may be lower than for tra[ditional] means.[45]

Although a number of fundamental quest[ions re]garding the effectiveness of CAI have been an[swered,] an increasing number of researchers are argu[ing that] there are many more complex questions that s[till need] to be explored and that more subjective, less [quanti]tative approaches are going to have to be used.[18,21,31,42]

The types of questions that educators and [admin]istrators are currently asking of the research a[re con]cisely summarized by Gleason[21]:

1. What are the most effective CAI strategie[s? What] type of feedback is most effective? How o[ften? At] what point in the program? What types of [student] interaction are most productive? Which [instruc]tional paradigms are most effective in the [various] content areas?
2. What are the interactions of individual [learning] styles in CAI? How much cognitive compl[exity can] the learner manage? What concept-learn[ing stra]tegies are most appropriate for which [types of] learners?
3. What are the effects of individual learner [charac]teristics such as memory span, percept[ual and] sensory preferences, intelligence, mo[tivation,] etc.?
4. Which hardware configurations are most [effective] and efficient in various types of program[s?]

...ch-sensitive screens? Videodisc? Light pens?

...hat affective characteristics of the learner are im-...tant? Motivation? Persistence? Delayed gratifi-...tion? Locus of control? Etc.

...hat are the most effective strategies for program ...velopment?

...hat are the most effective strategies for inte-...ting CAI with other instructional activities? ...eason, p. 16)

... answers to these questions will provide further ...ation regarding the development of courseware ... integration of instructional technology into the ...em. In the meantime, educators can continue to ...d implement computer programs on the basis of ... that have been completed. As Paden[41] points

...f the profession is serious about improving in-...uction, these experiments provide tips galore: use ... computer to improve study habits, to highlight ...portant concepts, to process data, to "individu-...e" instruction, to give examinations, to provide ...ompt feedback to students, to keep records, and ...add pizzazz to content instruction. Some of this ... improve performance. Some of it will improve ...dent attitudes. Other aspects will reduce the ...gery of teaching for the instructor (Paden, p. ...

... also cautions, as does a search of the literature ...ectiveness of CAI, that expectations of greatly ... performance from CAI presented as an addi-... conventional instruction seem unrealistic.

...e expresses a similar opinion in regard to the ...tive current and future use of CAI in the in-...al setting. She points out that current studies in ...titude-Treatment Interactions) are attempting to ... ways to measure individual student character-... determine which approaches will benefit stu-... th specific characteristics. Educators have ... identify the student characteristics such as re-...se, initial levels of achievement, and prior fa-... with subject matter as characteristics that re-...well to CAI, and Dence suggests that further ... in areas such as locus of control, split-brain ... cognitive style, anxiety level, and personality ... assist educators in designing courseware and ... recommendations for the effective use of ...ucational settings. She adds that "where signi-...ferences are found between CAI and tradi-...truction, it is imperative to identify and quan-...those differences occurred." (Dence, p. 54) ...ncludes,

...e results of direct research will have a great im-... on the use of CAI by extending the interpreta-...and applicability of prior findings. CAI can then ...ed in those situations where the indication is ... will enhance learning for individual students or groups of students. More traditional methods of instruction can be retained for those situations where they are the most effective (Dence, p. 54).

THE COST EFFECTIVENESS OF CAI

Kearsley[29] has pointed out that although CAI may be perceived as instructionally effective, educators may be reluctant to use it if they perceive it as being prohibitively expensive. Economically, the debate over the uses of CMI and CAI focuses on 1) the relative advantages that the computer has over traditional, perhaps less expensive instructional methods; 2) whether, in fact, less expensive means are available to effect the same instructional gains as the computer; and 3) whether technological advances have reduced the costs to a point where school districts can implement computer based instruction (Splittgerber, p. 21).

Cost estimates for CAI are highly variable and are difficult to establish with any degree of accuracy, particularly as CAI can be delivered on a variety of timeshare or microcomputer hardware systems. There have been a number of studies which have assessed the cost effectiveness of timeshare systems,[6,7,8,11,23,29] but studies providing information regarding inexpensive microcomputers and commercially available courseware are difficult to find.

However, regardless of whether CAI is being delivered via timeshare or microcomputer technology, the hardware purchase and maintenance costs, the courseware purchase and courseware development costs, and the cost of the provision of training and support services to educators must be taken into consideration in any estimate of the cost effectiveness of CAI over traditional instructional methods.

More specifically, estimates of cost effectiveness need to consider hardware purchase and maintenance costs as amortized over the number of years of use the system is intended to provide and as distributed over the number of students who will be using the system.

Similarly, courseware acquisition and development costs are dependent on a number of factors which influence any estimate of the overall cost effectiveness of CAI. For example, software development and acquisition costs are reduced in proportion to the number of students using the courseware, particularly if the courseware is being provided for handicapped or remote students who have traditionally been more expensive to educate than regular students. Costs are also reduced if the courseware is simple in design and if it has a long lifespan uninterrupted by updates or revisions. Whenever possible, it is generally more cost effective to purchase commercially available courseware than to develop it.

In addition, any decision regarding the cost effectiveness of CAI must take into consideration whether the courseware and the costs are being incurred to replace, or to add to regular instruction.

These variables have made it difficult to assess the cost effectiveness of CAI, particularly with the newer microcomputer technology.

It has been estimated that a very adequate stand alone system costing $5,000 to $6,000 and used for 1500 hours throughout a school year will cost 50 cents an hour. Courseware development cost estimates range from 50 cents to $750 per student hour.[11,23]

"... in a period of run-away inflation on a nearly global basis, the per character cost of computer technology has been reduced a thousand fold, the reliability increased twenty fold, and the accessibility increased by a like magnitude."

Courseware acquisition costs are highly variable, ranging from $3.00 for a single program to $600 for a series of programs that can be used by an entire elementary school, but 50 cents an hour would be a generous estimate. Therefore, whether courseware is acquired or developed, the cost of CAI using a microcomputer hardware system can be estimated at $1.00 a student hour. Hallworth and Brebner[23] estimate that time-sharing computer cost is between 66 cents to $1.00 per student hour. They point out that when 16 bit microprocessor systems become available, with multi-user software using hard disks, these should support up to at least 16 users on a school CAI system and it may be reasonably expected that for this number of users, and possibly for a smaller number this system will reduce the cost per student hour to 20 cents or less. With the overall cost of education per student hour for the Calgary Board of Education being $2.22 with $5.56 for special education students.[23] CAI, whether on time-share or a microcomputer system, compares very favourably.

Norris[39] has pointed out that traditional instructional costs have been increasing at the rate of 13% a year for the past three years while CAI costs have been decreasing at 5% per year, coupled with a 10% improvement in performance. Hirschbuhl[26] also points out that "in a period of run-away inflation on a nearly global basis, the per character cost of computer technology has been reduced a thousand fold, the reliability increased twenty fold, and the accessibility increased by a like magnitude," (Hirschbuhl, p. 62). He estimates that by 1990, computer industry hardware will become 32 times as cost effective as present day hardware. It can be safely assumed that, as hardware capabilities increase and costs decrease, CAI will become more and more cost effective.

In addition, the hidden benefits must be considered. Braun[8] reports that in a computer program in th... trict of Columbia in which 700 students were inv... there was an increase in student attendance at ... cost saving to the public of $30,710. Extrapolating to the entire student population, Braun argues th... productivity gain would be on the order of $1 ... per year. Similarly, based on a study on attitu... community college system in Ontario, Braun es... that by using CAI mathematics the province's ... gain or cost-productivity gain index per year wo... $9,600,000. He concludes that "the value of th... studies is that they demonstrate that the use of th... puter to aid instruction *can* result in a substantial ... the use of the tax dollar for education" (Braun, p...

It has also been pointed out that hardware ori... purchased for CAI has been doing double dut... ministration, guidance, record keeping and ... functions; that truancy and vandalism were redu... schools where CAI was being used with disadva... students, that by using the computer, educatio... stitutions can offer more flexible scheduling and ... course alternatives; that curricula can be more ... to the pace of change; that instructor costs are sa... providing distance and continuing education; an... new knowledge can be brought into education ... sooner.[8,11 23 29 39]

The hidden costs include maintenance costs for ... ware, the inevitable higher costs for coursewa... velopment which are anticipated to account fo... 90% of total costs by 1990,[23] and the cost of ... mechanism to introduce and integrate CAI into ... structional setting in a manner which guarant... benefits which have been shown to be possib...

If the cost estimates of CAL are adjusted to ... the hidden costs of software, courseware, m... maintenance and support, they may well be... than traditional per-student-hour costs. They... however, be weighted for their cost effect... Deltak, Inc. compared their industrial train... grams and found that a five-day instructor led ... of 10 students was more costly than a comp... hanced, learner-paced multi-media approach ... of $1,120/$680.[42] That is, traditional training ... more expensive than CAL.

Kearsley, in his article "The Cost of CAI. A M... Assumption," concluded:

> The fact that CAI results in a higher per ... hour cost is based upon a fairly dubious as... that the instructional effec... veness of CAI is ... as traditional instruction. This is most certa... valid premise. Almost all comparative studi... have shown that it reduces the time requ... subject by 25-50 percent while still resulti... same end performance. CAI permits a very ... monitoring and evaluation of student per... and instructional effectiveness which is ... impossible in traditional instruction. CAI ... mits certain kinds of instruction which cou... done by any traditional means (e.g., medi...

...ons of dying patients). Students are overwhel-...gly positive about CAI, and they express strong ...rences for this mode of instruction across all ...ects. Thus, an hour's worth of CAI may be in-...tionally equivalent to two hours or more of tra-...onal instruction. If we accept this, then cost es-...ates which show CAI as costing the same as or ...hly more than traditional instruction in fact give ...t the edge.[21]

...s used as a substitute or replacement for tra-... methods, particularly when considering the ...on of special students, CAI can be cost saving. ... at the present time, CAI is used today mainly ...plement to regular instruction either in en-...t or remediation and as such, its costs must be ...ed as add-ons to traditional instruction. Con-...the benefits, educators must ask whether the ...xpense is worth it.

FURTHER CONSIDERATIONS

...on to the effect that CAI reportedly has on ...ent and education costs, a search of the li-...reveals that researchers have identified a num-...er factors that can be identified as advantages

...advantages include the computer's ability to ...ize the instructional process;[31] to simulate ...ns not possible at all without a computer;[11,29,34] ...students informed of their progress through im-...feedback and achievement summaries;[3] to ...immediate and systematized reinforcement; to ...nstruction that has been systemmatically pre-...equenced, tested and revised;[34] and to allow ...to review previous instruction, request special ...to continue on to enrichment activities.[34] ...ition, researchers argue that because the com-...olves the individual actively in the instruc-...ocess, learning is facilitated;[11] and that CAI ...teacher to devote more time to the personal, ...considerations of their students, a factor which ...identified by Chambers as being the most sig-... in the development of creative abilities, ...g to students.[17]

...als for introducing computers into the ...on the basis of cost effectiveness and instruc-...ents is a potent argument, particularly in light ...c's perception in Canada and the U.S. that ...ional system is both costly and unsatis-

...ntifies a number of factors which indicate ...dissatisfaction with the education system in ...These factors include the significant increase ...ber of dropouts, an increase in the numbers ...s who are performing below their grade ...acceptably high levels of youth unem-... a continuing decline in the education of ...ts in the sciences and the spiralling costs of ...or the education of the handicapped, the

Coming Attractions

NCCE Announces Computers in Education Conference

The annual Computers in Education Conference will be held on March 12 & 13, 1982 at Seattle Pacific University, Seattle, WA. The program will include talks, workshops and exhibits with emphasis on the use of the microcomputer in K-12 classrooms of various disciplines. For further information, contact Tony Jongejan, Everett High School, 2416 Colby, Everett, WA 98201.

National Society of Data Educators Convention Scheduled

April 15, 1982
Washington, D.C.

This year's convention will be held at the Holiday Inn, Thomas Circle (Massachusetts Avenue and 14th Street). A block of rooms has been reserved at the Holiday Inn—Connecticut Avenue (across the street from the Washington Hilton where the NBEA Convention will be held) for persons attending the SDE Convention. Convention rates are as follows: Single, $45: Double, $53; Triple, $61; and Quad, $69. Room reservations should be made directly with the hotel by calling 202/332-9300.

Your registration fee of $20 covers registration charges plus a luncheon and coffee break. The first meeting will begin at 9:00 a.m. on April 15, 1982.

Persons desiring to present papers during the convention should send a brief summary of their presentations to Dr. Richard Bassler, Center for Technology and Administration, College of Public Affairs, The American University, Washington, D.C. 20016. Dr. Bassler will serve as Convention Program Chairman.

For information or registration, write: Dr. Lloyd Brooks, Department of Office Administration, Fogelman College of Business Administration and Economics, Memphis, TN 38152, 901/454-2762

...nd the learning disabled.
...ers the arguments of Dr. Dustin Heuston of ...as further rationale for the immediate and ...ead introduction of the computer into the pre-...ucational system. In "Technology and the Edu-...l Delivery System," Heuston points out that

...e current U.S. educational system is insensitive ...dditional investment and cannot be improved ...ut the dramatic change producible with new ...hnologies
...e current educational delivery system provides ...out 15 seconds of personal attention per hour ...ereas with computers that proportion could ...ch almost 100%.
...ter expensive and extensive efforts at improve-...nt, the present educational system has reached ...maximum effectiveness.

Braun and Heuston argue that the only effective ...of increasing the productivity of the present ...ional system is through the introduction of tech-... into the instructional process, and as Braun ... out, computers will move into homes and ...whether or not anyone does anything to ensure ...ective use.
...tgerber[35] summarizes:

...pporters forecast an imminent breakthrough in ...use of computers, due primarily to decreasing ...ts and increased availability of minicomputers, ...rricula and software improvements, the trend to-...d accountability; the requirement for improved ...ool productivity; and the expansion and per-...alization of instruction (Splittgerber, p. 25).

THE COMPUTER LITERACY ARGUMENT

...haps the most powerful argument for the im-...iate and widespread introduction of computers in-... school system is Luehrmann's argument[32] that ...bility to use computers is as basic and necessary ...person's formal education as reading, writing, and ...metic" (Luehrmann, p. 98). He contends that ...uting plays such a crucial role in everyday life ...n his nation's technological future that "the ...ral public's ignorance of the subject constitutes a ...nal crisis (Luehrmann, p. 98).

"... computers will soon be everywhere and students who have not been exposed to them will be at a decided disadvantage when competing with those who have."

...e requirements for living and working in what has been called The Age of Information have been clea... described by Andrew Molnar[36] who argues that "if w... are to continue to benefit from the expanding frontie... of knowledge, we must devise new ways to expa... human capacity and reasoning . . . and we must crea... new intellectual tools to extend human capacity ... reason."

In his presentation, "Education for Citizenship in ... Computer-Based Society," Daniel Watt[31] points ... that although in the past only a small percentage of th... population ever had direct contact with computers, ... the future, as the nation's economy becomes more de...pendent on information processing and high tec...nology, "we can expect the overwhelming majority ... our working population to have significant interactio... with computers as part of their daily work" (Watt, p. 2... He insists that "only public schools can help insure th... all citizens have equal access to the opportunity ... computer literacy education, and only the pub... schools in our society have the responsibility for th... education of citizens who can make effective decisio... about the impact of technology on society" (Watt, ... 6)

The important point being made is that compute... will soon be everywhere and students who have n... been exposed to them will be at a decided disadva...tage when competing with those who have; and so...ciety generally will be at a disadvantage when co...fronting issues that have to do with the impact of co...puters on the individual and on society. In short, o... students must become computer literate.

The definition of computer literacy has been evolvin... as educators and researchers have become mo... knowledgeable about what it means to be literate a... as computers extend further and further into society.

Initially, when computer literacy was identified ... 1977 as one of the Ten Basic Skills by the Americ... Council of Supervisors of Mathematics, computer ...teracy was generally described as what students shou... know about the uses of computers and what co...puters can and cannot do.[40]

The Human Resources Research Organizatio... (HumRRO) defined computer literacy as what a pers... needs to know and to do with computers in order ... function competently in our society.[38] The Univers... of Oregon advised that computer literacy referred ... the non-technical and low-technical aspects of th... social, vocational, and educational implications ... computers.[38]

However, it is generally believed that these defi...tions no longer suggest adequate goals and objective... for a computer literacy program. As David Moursu... points out, computer literacy initially tended to mea... level of understanding at which the student could ta... about but could not actually work with a computer. However, this level of understanding is now co...sidered to be computer awareness rather than litera...

Luehrmann[32] argues that computer literacy mu... mean the ability to *do* computing and not merely ...

...cognize,' 'identify,' or ...out computing that have ...eacher. Further, he state ...oper to inculcate belief... ...at do not arise out of dir... ...of that subject" (Lueh... Based on an interpretati... ...literacy and following a... ...at it means to be literate ...uter literacy as "that col... ...ques and relationships t... ...n comfortably as a proc... ...nted society" (Watt, p... He further divides the c... ...o four distinct but inte... ...ganized, include:

1. The ability to control... achieve a variety of p... fessional goals;
2. The ability to use a ... computer applications ... professional contexts;
3. The ability to underst... social and psychologi... individuals, on groups ... society as a whole; an...
4. The ability to make us... computer programmi... tions as part of an ... tegies for informatio... and problem solving (...

Watt concludes that "the ...ajor commitment in this ... ...ous consequences for ... ...blic and the future of p... 37).

IMPEDIMENTS TO ...

If the evidence for the ... ...troduction of computers ... ...erwhelming, why is there ...al and potential use of ... ...arch of the literature reve... ...factors which researche... ...pediments to the explor... ...e computer in education...

1. Insufficient funding fr... to support the original ... ware, courseware, and ... support services for t... the technology into th... [37,45]
2. The primitive state of ... confusing diversity of l... tems.[31,29]
3. CAI materials that are ... undocumented, and ...

... identify,' or 'be aware' of alleged facts ... puting that have been supplied by a book or ... further, he states that "it is intellectually im... ...culate beliefs and values about a subject ... arise out of direct experience with the con... subject" (Luehrmann, p. 6).

...an interpretation of the common meaning and following a traditional understanding of ... ...s to be literate, Daniel Watt[50] defines com... ...s as "that collection of skills, knowledge, ...relationships that allows a person to func... ...ably as a productive citizen of a computer ...ciety" (Watt, p. 26).

... divides the concept of computer literacy ... ...nct but interrelated areas which, sum... ...lude:

...ty to control and program a computer to ... a variety of personal, academic and pro... ...goals:

...ty to use a variety of preprogrammed ...er applications in personal, academic and ...onal contexts;

...ty to understand the growing economic, ...d psychological impact of computers on ...als, on groups within our society, and on ... as a whole; and

...ty to make use of ideas from the world of ...er programming and computer applica... ...part of an individual's collection of stra... ...or information retrieval, communication ...em solving (Watt, p. 27).

...adds that "the failure of schools to make a ...tment in this area now can have disas... ...quences for both the education of the ... the future of public education" (Watt, p.

...IMPEDIMENTS TO IMPLEMENTATION

...ce for the widespread and immediate ... computers into the school system is so ... why is there such a gap between the ac... ...ntial use of computers in education? A ... literature reveals that there are a number ... ...h researchers have identified as being ...to the exploration of the full potential of ... in education:

...funding from the appropriate sources ... the original purchase of hardware, soft... ...courseware, and to establish the necessary ... services for the successful integration of ...ology into the educational system.[11,29,33]

...the state of the art in which there is a ... diversity of languages and hardware sys...

... that are poorly constructed, largely ..., and able to run only on the equipment for which they were written.[11,29]

4. Lack of knowledge among educators as to how to effectively use CAI materials and the computer in the learning situation, particularly at the moment when limited financial resources restrict the number of systems available per classroom.[11,29,37]
5. The attitude among teachers, familiar with and comfortable using tried and tested methods, that the computer is not a tool but an intelligent machine destined to replace them as teachers.[11,14,29,45,48]

In order of importance, Chambers and Bork[13] found the impediments to the implementation of computer assisted instruction to be 1) funding; 2) lack of knowledge about computer assisted instruction and computers in general; 3) attitudes of faculty; and 4) the need for more and better computer assisted instruction modules (Chambers & Bork, p. 28).

In addition to the above impediments to the implementation of computer assisted instruction, critics cite the lack of information about the effectiveness of CAI, the tremendous financial commitment to a technological innovation that is new, untried and uncomfortably similar to educational television, depersonalization of the educational process, and lack of support from teachers and teacher's organizations as reasons why it is advisable to adopt a wait-and-see attitude.

POTENTIAL, ACTUAL, AND PROJECTED USES OF THE COMPUTER IN EDUCATION

A search of the literature reveals that there are various applications which have been identified as being reasonable and effective uses of the computer in education. As described and envisioned by such researchers as Bork, Franklin, Haugo, and Watts, these applications include the following:

1. *Administrative applications* which include such activities as keeping track of accounting, payroll, inventory and employee records and of attendance, grades and student records. The computer has also been used in administration in class time tabling and in simulating models to forecast the implications of decisions and changes in the educational environment.[6,24,49,52]

2. *Curriculum planning applications* such as the resource information file which was developed and is being used in Alaska to provide teachers with information on available educational resources.[49]

3. *Professional development applications* which not only provide teachers with new skills and an understanding of the uses of computers in education, but could also provide highly informative and imaginative professional development courses in other areas of education.[52]

4. *Library applications* which involve the computer in maintaining records of holdings, managing intra-

and inter-library loans, and enabling users to search files for relevant titles and information.[52]

5. *Research applications* which enable a school or d. trict to analyze data collected on a regular basis or for special purposes.[52]

6. *Guidance and special services applications* which include computer administration and scoring of selected standardized tests, provision of guidance and career information using a computer, and the administration of tests and the analysis of data to assist special education personnel with the diagnosis and remediation of learning problems.[52]

7. *Testing applications* which include computer assistance in the construction, administration, scoring, and evaluation and analysis of test results.[6,52]

8. *Instructional aid applications* which are described by Watts[52] as the use of the computer in the same manner that any audio-visual device or piece of laboratory equipment may be used to demonstrate or illustrate concepts or to allow students to manipulate parameters without having to duplicate a real world situation.

9. *Instructional management applications* which assist the teacher in providing individualized or small group instruction by using the computer to manage the student's learning experiences and to monitor and assess progress.[1,6,24,45,52]

"... approximately 90% of all school districts responding are now using the computer in support of the instructional process."

10. *Computer assisted instruction applications* which involve the computer in taking over a central part of the instruction of the student[1,6,24,45,52] and which can include a number of different modes of interaction with the student:

  a. Drill and practice programs take advantage of the computer's tireless patience and ability to provide immediate feedback and reinforcement to prescribe, provide and monitor potentially very complex drill and practice activities which can be tailored to a student's individual needs.

  b. Tutorial programs, depending on the capabilities and the storage capacity of the computer system, are dialogues between the learner and the designer of the educational program. The computer acts as a 'tutor' to teach the student concepts and skills. The worst of such programs are simply page turners which present passages of text and then ask the student to question on what they have just rea type of tutorial, called 'dialog,' lead learner through a series of carefu questions to some new understanding edge of the topic at hand.

  c. Simulations or controllable worlds are in which the computer can be used to or generate environments for the learn he can change variables and explore in a manner that might have been to sive, too restricted by time limitation, gerous or too impossible to allow the explore in the real world.

11. *Computer awareness and literacy app* which involve the computer in preparing to understand and to be able to use com our future computer oriented society.

12. *Computer science applications* which teaching students about computer arc operations, programming and application

Chambers and Bork[13] selected a sample school districts which closely approximated population of U S. public school districts to current and projected use of the computer public secondary/elementary schools, wi emphasis on the use of the computer in c assisted instruction (figure 1).

It was found that approximately 90% of

FIGURE 1

TRENDS
(U S. EXPERIENCE)

	% of Sc Districts S
1. Districts Using Computers	1980 - 90 1985 - 94
2. Instructional Usage	1970 - 13 1980 - 71 1985 - 87
3. CAL	1980 - 54 1985 - 74
4. Application Priority	1. Math 2. Science 3. Langua 4. Busines
5. Emphasis Shift 'Drill and Practice —> Tutorial —> Simulatio	

Source: ACM Report on CAL
Chambers/Bork 1980

...s responding are now using the computer in sup... the instructional process. Most computers are ...d or owned by districts and large computers are ...n evidence than are micros and minis which the ...found to be equal in popularity. It was also found ...e most popular applications in order of usage are ...aching of computer languages, computer assisted ...ng, data processing applications, using the com... as an instructional aid, and using it for guidance ...ounselling applications (Chambers & Bork, p. 11). ...omputer assisted instruction applications, the ...minant use is in drill and practice, although it was ...that simulations are also receiving a good deal of ...t the secondary level, predominant use is occur... in Mathematics, Natural Science, Business and ...age Arts (Chambers & Bork, p. 15).

...mbers and Bork's study showed a dramatic ... from the past. From an estimated 13% in 1970, ...ctional computer usage has leaped to 74% in ...ith the type of instructional usage changing from ...minantly problem solving and the acquisition of ...ills, to a much heavier emphasis on computer ...d instruction. They also found that while the ... of instructional computer usage in the schools ...creased significantly, the richness and diversity of ...had not increased proportionately. They attribute this to the industry's concentration on providing hardware to the schools while not being able to provide adequate and satisfactory courseware to support the use of the hardware, and to the lack of adequately trained staff to enable effective use of the computer in CAI.

For the period 1980-1985, 94% of the districts surveyed anticipated using the computer with 87% of this percentage indicating that they would be using the computer to provide support for instruction. Types of instructional usage were projected to continue as in the past with 74% of the districts indicating that they would be providing computer assisted instruction. It was also anticipated that tutorials would assume greater usage with drill and practice receiving less. Chambers & Bork suggest that this shift in emphasis will perhaps move towards simulation by 1990. In support of Chambers and Bork's findings is Hirschbuhl's table which projects increased levels of acceptance and utilization areas for CAI by 1990 (Figure 2).

Watts[52] points out that there are schools in which a dozen applications of the computer in education are already to be found and he concludes, "the challenge is there for all schools to successfully introduce computers and to develop their potential in education" (Watts, p. 22).

FIGURE 2

LEVELS OF ACCEPTANCE AND UTILIZATION AREAS FOR CAI

	HOME PRESCHOOL	SECONDARY SCHOOLS	HIGHER EDUCATION	INDUSTRY	COMMUNITY INST.
...ANCE	Zero	Widely dispersed emerging	Widespread	High level limited implementation	On the horizon
...ATION	None	Basic skills (heavy)	Skill and survey type instruction (moderate)	Testing and training drills (light) Basic skills and conditioning programs (light)	Vocabulary and procedural info in health areas
...ANCE	Widespread	Widespread	Universal	Heavy	Broad by social and health institutions
...ATION	Heavy use for concept development	Universal for skill development and high level concept development	Extensive for entry level courses and high level professional development and continuing education	Heavy in specific training skills and management development	Heavy use by health industry for upgrading diagnostic skill Heavy use for rehabilitation and deterrent programs in criminal justice

...Hirschbuhl
...ducation J Techn... ... 1978), p. 62.

FUTURE TRENDS AND RECOMMENDATIONS

A search of the literature indicates that most educators and researchers are cautiously optimistic about the future of computers in education.

As discussed earlier, the major impediments to the widespread introduction of computers into the education system are:

1. Insufficient funding to purchase hardware and courseware;
2. Insufficient and inadequate courseware that has been designed to run only on one system,
3. The confusing diversity of hardware systems and languages;
4. Lack of knowledge among educators as to how to effectively use the computer in an educational setting; and
5. The concern of teachers that the computer is either too difficult for them to learn to use or that it is destined to replace them in their job.

Although Chambers and Bork report that "it is predicted that by 1985 the current major problems in the use of computer assisted learning will have been reduced to the level that the hardware problem has now reached in 1980" (Chambers & Bork), at the moment, the above impediments must still be considered major concerns

It is generally agreed that hardware barriers have been or shortly will be resolved and cost reductions will help eliminate funding problems and permit the cost effective use of CAI [2,3,10,11,26,29,31,39] In support of this prediction, Gleason[21] reports that a recent study by the National Science Foundation estimated that there are already 200,000 microcomputers in American elementary and secondary schools and projects one million units by 1985.

It is also generally agreed that the technology for instructional use in educational settings will likely include mini- and microcomputers capable of standing alone or networked and incorporating a touch sensitive input device, image projection, colour printing device, voice input and output, interactive television, videodisc systems and satellite communication. According to the research, videodisc technology will play an increasingly significant role in creative and effective innovations in education.

A number of researchers—Atkinson, Bunderson, Hirschbuhl—predict distributed networks with large shared databases which would enable individuals to use stand-alone microcomputers or access larger databases or communicate with other users.

Hirschbuhl[26] argues that, "the power of interactive visual, sound, computer simulation, control, and change of variables along with the mind extending ability of computer prediction offer teaching capabilities never before realized" (Hirschbuhl, pp. 52-53). He envisions brain waves used as input to Computer Assisted Dialogue CBE systems, laser libraries for the visually handicapped, talking computers to provide books for the blind, listening computers that understand unconstrained natural speech, in short, innovations that will have far-reaching implications for education

Although it is generally accepted that hardware is going to be the most easily solvable problem in implementing CAI in the future, it is still considered absolutely essential that 1) educators continue to monitor new hardware products and their potential usefulness to CAI, and that 2) wherever there is a central organization planning the activities of a group of computer using educators, there should be uniformity of hardware and cost reducing bulk purchase arrangements with manufacturers

Although Atkinson[2] believes that "by 1990, the use of computer-assisted instruction will be so cheap and its applications so broad that it will be viewed as an educational necessity" (Atkinson, p. 60), Bitzer points out that "the next steps in producing useful educational computer technology are far more difficult and include some of the most difficult applications of the computer" (Bitzer, p. 61).

He agrees that limited applications that can take advantage of increased low-cost technical capabilities are already available but argues that hundreds of unconnected stand-alone systems are not going to provide an educational system consisting of high quality materials organized in an overall educationally efficient manner (Bitzer, p. 61). He believes that the most difficult questions must still be answered and that we cannot afford to underestimate how much those answers are going to cost.

The first of these problems is the continuing diversity of hardware systems with their differences in languages and their limitations in only running the courseware that has been written for that system. Although researchers believe that this will continue to be a problem, Attala[3] argues that hardware advances in the development of microprogrammable chips containing compilers for several kinds of authoring languages, of replaceable read-only memory chips for the modification of system software will "solve the problem of transferability that has hindered for so long the propagation and popularity of CAI" (Attala ... Chambers and Sprecher[11] recommend the development of a nationwide, standard high-level CAI language for complex CAI development which incorporates authoring aides, computational capability, graphics capability, multisensory input/output controls, and prescribed documentation standards. They believe such a language should be easy to use and should be capable of running on large, mini-, and microcomputers. Because the development of such a language would be in the national interest, they argue it should be funded by the federal government with the impetus coming from the educational sector, possibly incorporating a cooperative venture with the private sector.

The second major impediment, and considered ...

...ne to be the most serious, is the lack of a sufficient ...ty of high quality courseware. The problem of ...ability of software and courseware which restricts ... market, the copyright problem, the tremendous ...unt of time required to develop materials, and the ...d for experienced and qualified educational and ...puter professionals are factors working against a ...tion to this problem. As discussed above, the prob... of the portability of courseware could possibly be ...ed through the development of a standard CAI lan...ge or through hardware advances which may also ...e the copyright problem.

...ut the problems associated with the amount of time ...eded to develop materials and the difficulty in find... qualified and experienced instructional designers ... computer programmers still exist. Gleason[21] warns ...ators that contrary to what they may have been ..., courseware development is not easy:

> It involves careful specification of objectives, selection of programming strategies, detailed analysis of content structure and sequence, development of pretests and posttests, preliminary drafts, revisions, trials, validation, and documentation. This is a very time-consuming and expensive process, well beyond the capability and resources of individuals and even small groups of teachers (Gleason, p. 12).

...e points out that at the present time there is no com...hensive, systematic or effective organization to pre... good programs, and although there are thousands ... programs being written, "most are virtually devoid ... any instructional value and in most cases are acting ... deterrents to widespread acceptance of CAI" (Glea...n, p. 12).

...hambers and Sprecher[11] found that the majority of ...rseware that is available has largely been written in ...achine dependent language and is undocumented ... therefore difficult to share. They report that in ...e ABC's of CAI" project,[47] over 4000 CAI programs ...tten in BASIC were reviewed, and about 3-4 percent ... found to be acceptable by faculty in the fields ...cerned (Chambers & Sprecher, p. 338). In short, ... are in agreement with Bork who argues that, "The ...ion that computer-based materials can be produced ... anybody, completely by themselves, is an archaic ...cept" (Bork, p. 20).

... team approach employing two or three content ...specialists, an instructional design specialist, and a ...puter programmer has been suggested as the only ...ble way of ensuring the development of course...e that will be acceptable to faculty and students. ...ther, it has been found that direct financial reward ... not a motivator in involving faculty in developing ...terials. Rather, as Chambers and Sprecher report, ...dies have shown that recognition and acceptance by ...'s peers for courseware development and sharing ...ch materials, release time, and acceptance of ...rseware development by peers and by adminis...tors as equivalent to research publications for promotion and tenure, appeared to be the most in... incentives in involving faculty members in dev... courseware (Chambers and Sprecher, p. 339).

Hallworth and Brebner, in their report to the ...ment of Education in Alberta,[23] support the ide... development of courseware. They argue that ... a need for a coordinated effort within the Prov... build effective CAI curricula with many grou... tributing and exchanging materials, but with n... cation of effort on any topic because of the ...tionally large numbers of work hours involved ...worth and Brebner, p. 215) and they believe ... only way this can be done is through the lea... and support of the Department of Education ... recommend that the Department:

1. Facilitate the development of courseware by ... of teachers and other persons having exp... in CAI, by appropriate financing including, ample, release time for teachers,
2. Monitor such courseware development to ... continuity of curricula and prevent duplicat... effort;
3. Set up mechanisms for disseminating infor... on developments;
4. Set up a mechanism for facilitating excha... courseware, both within and outside the Pro... and
5. Retain all rights within the public domain ...worth & Brebner, pp. 215-216)

There is also evidence that the major publish... educational materials are becoming increasing... terested in developing CAI materials and with the ... sources, experience and organization it will ...

> *"... if teachers and educational organizations constantly monitor what is commercially available and continually evaluate its applicability to the curriculum, they will be in a position to use what is acceptable in the commercial market and to be able to determine areas where support is needed for local development."*

be long before there is a substantial number of acc... able CAI programs commercially available. In add... there are large number of small companies and ... ganizations which have entered the courseware ... velopment market. A number of these have ...

vived a second year in the market, but many are on a second major revision of their materials and have shown themselves to be very willing to listen to the suggestions of teachers and to modify their programs to bring them in line with teachers' expectations. Not only has the quantity of commercially available programs increased dramatically over the past two years, but the quality has improved to such an extent that what was considered to be good a year ago is now considered to be average or below average. New benchmarks in quality are constantly being set and the rest of the market gradually works to that standard until a new level is set.

Thus, if teachers and educational organizations constantly monitor what is commercially available and continually evaluate its applicability to the curriculum, they will be in a position to use what is acceptable in the commercial market and to be able to determine areas where support is needed for local development. Dence[17] has argued for the importance of doing more studies on areas where CAI has an advantage over traditional instruction and why it is more effective, and the results of these studies can be used to help educators plan courseware development efforts. This opinion is supported by researchers who argue against "financing an army of CAI authors. A better way, they say, would be to find the areas in which CAI is most effective, and then devise some effective tool for creating and testing good courseware addressed to those areas (Sugarman, p. 29). This argument seems to be supported by the fact that of the approximately 16,000 hours of CAI related materials created for Plato, requiring from 500-800 thousand hours of writing, only 4000 hours are used regularly (Sugarman, p. 29).

"... teachers' lack of knowledge about CAI and computers was considered to be a major impediment to the implementation of CAI in the schools, second only to funding."

It would seem that, in the future, a combination of public and private resources will be concentrating on the courseware development problem. By constantly monitoring and evaluating what is commercially available, educators can direct their efforts only to those areas that are not being adequately addressed by the marketplace; and by concentrating their efforts on areas where the research has demonstrated that CAI is more effective and more cost effective than traditional instruction, educators can avoid the time and expense wasted in developing courseware that could have been purchased more cheaply than developed or that is not effective in the instructional setting.

The need for organizations that will provid- pendent evaluations of programs and professio- vice as to the quality of commercially availab- grams is argued throughout the literature and - flection of teachers' need for support in this ne- intimidating area of education. As Aiken and B- argue, "teacher acceptance is the biggest ch- facing us today" (Aiken & Braun, p. 13).

This appears to be corroborated by Chamb- Bork's study[13] which found that teachers' l- knowledge about CAI and computers was cons- to be a major impediment to the implementat- CAI in the schools, second only to funding. Sim- Hallworth and Brebner argue that "CAI will no- ceed in any environment where it does not ha- full understanding and backing of teachers" (Hal- & Brebner, p. 216); and Clement[14] reports that attitudes on the part of instructors have actua- sulted in covert and in some cases overt sabotage- computer-aided learning process (Clement, p- Teachers need information and knowledge an- needs teachers in order to be successful.

Clement believes that "changing most instructo- tudes is a matter of educating them on the adju- value of the computer in the learning process" ment, p. 30), and he suggests pointing out th- computer is capable of taking over the routi- formation giving and drill and practice tasks, ar- clerical tasks while freeing the teacher to fa- learning through one-to-one and small-group actions.

Hallworth and Brebner[3] argue for the importa- educating teachers and providing information, a- gest that demonstration projects, sponsored an- ported by the Ministry of Education and in coop- with an established research center, be set - teachers who are already knowledgeable abo- and who can demonstrate the benefits to teachers. They also recommend that the Minist- only financially support and publicize the de- stration projects and provide encouragement an- professional status for teachers who demonstrat- petence in CAI, but they should also require th- teachers have some knowledge of the use of com- in education. They encourage the Ministry to computer literacy courses available to teache- number of different levels and recommend tha- courses be made compulsory.

Aiken and Braun[1] recommend that courses an- grams be provided for students training to be te- and point out that a way must be found to re- thousands of teachers who are already in the - system. They recommend the approach that the - have taken in training a small nucleus of teache- are then used to teach others. However, they that whatever method is used, it is going to be - sive and a slow process that may require the video tape and videodisk as cost-reducing -

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(Aiken & Braun, p. 13).

...erson[25] is more specific. He argues that all ...s and educational administrators should com... minimum of two courses in computer science as ... requirement for certification. He adds that all ...ary teachers should complete one additional ... covering the use of CAI materials for the ele... student, and secondary teachers should com... additional computer science courses cover... use of computer-oriented materials and CAI ma... designed for the secondary student and the de... of computer-related materials. Adminis... according to Henderson, should be required to ... additional courses relating to the use of the ...ter in school operations and planning (Hen... pp. 41-42).

CONCLUSION

...ch of the literature regarding the instructional ...omputers has revealed that for the most part, ...s are generally optimistic about the future of ...puter in education. They feel that the hardware ... are being dealt with and that future advances ... can only result in what ... should term ... However, it is also ... accepted that the problem of ensuring an ... supply of quality courseware and of training ... how to use the computer in an effective man... to impede the ... integration ... into the school system. It is ...ally accepted that solving these problems is ... be expensive.

...research can be more specific, it seems rea... that the resources of institutions, schools and ... should concentrate their efforts on areas ... has proven itself to be both effective and ... In their recommendations to the Alberta ... of Education, Hallworth and Brebner ... that:

... those students who will benefit most from CAI ... for whom the patience and repetitiveness ... computer are of ... assistance in their learn... those who require individual attention, those ... some reason, have failed to learn in the regu... into a conventional ... those who feel inade... and inferior and do not seek help from a ... for fear of displaying their ignorance, those ... not have ready access to schools, and those ... subjects in which the computational and ... processing power of the computer en... learning (Hallworth & Brebner, p. 218).

... argue that CAI must be given time to ... course ... hands ... In this way, they believe ... should naturally find their place in the ... system."

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Computer-Assisted Instruction and Mathematics Achievement: Is There a Relationship?

Patricia Knight Burns and
William C. Bozeman

Educators, in both private and public sectors, have demonstrated an increased interest during the past few years in the role of computer technology as applied to educational/training processes. This interest has been, to a great extent, a function of the emerging technologies associated with low-cost, personal computers, the recognition of the need for better means of individualizing education, and an appreciation of the many ways computer support can improve the instructional and management responsibilities requisite within a total instructional system.

Only a short time ago, the use of computers in education would have been important to only a relatively few persons involved in research and development activities. Educational computing seemed far-removed from the real world of practice. Now computer support is available to even the smallest of schools and school districts, colleges, and organizations.

This availability has raised a host of questions regarding application of the technology. While many of these questions have been and continue to be of concern to researchers and scientists, they were of limited significance to practitioners. Today, educators at all levels—from classroom personnel to executives charged with policy formulation—are voicing an expression beyond simple curiosity about educational computing. They require and demand information related to the effectiveness and efficiency of computer-based education (CBE) systems.

Early advocates of computer support for the instructional process offered the promise of greater student achievement, more efficient use of human and material resources, improved attitudes toward the learning process, and an enhancement of education in general. Were these empty promises, never to be realized, or have they been fulfilled? It is toward a partial answer to this question that this article is addressed.

CBE research and development pose the problems associated with any educational effort. The management functions associated with instruction via CBE systems (e.g., diagnosis, planning, reporting, maintenance, scheduling, etc.) are present as in any conventional pedagogical structure. In addition, the advances in hardware and delivery systems serve to complicate the situation even more. Also, as with general educational research and development, there is the problem of making some sense of the plethora of information that amasses as efforts continue from year to year (Nadler and Bozeman, 1981).

This latter area, i.e., the scarcity of some synthesis of the work which has been accomplished in CBE, is particularly troublesome. While there have been many excellent CBE projects over the past 20 years, there has been limited success in the development of documents which report a synthesis and interpretation of the various independent efforts.

Knowledge Synthesis

Before proceeding further, it may be of some benefit to examine why a synthesis of information/knowledge about CBE is particularly important at this time. The educational community, as both a producer and consumer of knowledge, requires information upon which it can base intelligent decisions. This decision/policy-making process has, as its principal purpose, the delivery of effective educational programs. Effectiveness measures (including, but not limited to, quality, reliability, efficacy, etc.) must be clearly articulated and communicated if the decision process and/or policy formulation can even begin. This communication must be presented in language which practitioners can understand. If this is not accomplished, even the best efforts toward synthesis and dissemination of research findings will be doomed to failure.

The process of synthesis and dissemination of knowledge and research is, of course, an old problem and has puzzled persons across the theory-research-practice continuum for many years. The problems are not unique to education but exist in almost every imaginable area. Practitioners continue to ask the same questions, whether they are concerned with new agricultural products or the latest medical advancement. This question is usually of the form "How do we know this

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advancement (product, invention, etc.) works any better than what we are presently using?"

The diffusion of knowledge derived from research is difficult enough. CBE research dissemination is made even more difficult because the practitioner must not only understand the research evidence and jargon, but he or she must also understand something about the associated computer technology and its language.

Perhaps this difficulty is best addressed for our practitioner by looking back briefly to the.history and evolution of computer applications to instruction.

Evolution of Computer-Assisted Instruction

One of the earlier and most prominent applications within the area of computer-based education was computer-assisted instruction (CAI). Among the first users of CAI were members of the computer industry who, in the late 1950s, used computer-based instruction to train their own personnel (Suppes and Macken, 1978). Coincidentally, educators' interest focused on programmed instruction as a means toward individualized instruction. Educational CAI was an almost natural combination of emerging computer technology and the programmed instruction movement (Schoen and Hunt, 1977). The availability of federal funds to education in the early 1960s provided an additional stimulus that was needed (Atkinson and Wilson, 1969).

Following the lead of IBM, computer corporations ventured into the field of instructional computing throughout the 1960s. Notable among these were Digital Equipment, Control Data, and Hewlett-Packard. Numerous enterprises were undertaken in conjunction with major university educational research and development specialists. Frequently funded by the National Science Foundation or the United States Office of Education, these·cooperative endeavors combined the corporate contribution of technical hardware/software expertise with the philosophical and pedagogical expertise of the educational theorist relative to learner control and instructional hierarchies. Paramount among the significant CAI models to emerge from these efforts was the Stanford Project.

Initiated under the direction of Patrick Suppes at the Institute for Mathematical Studies in the Social Sciences at Stanford University, the Stanford computer-assisted instruction project was among the earliest CAI endeavors in the area of public school education. Begun in 1963, its original aim centered on the development of a small tutorial system intended to provide instruction in elementary mathematics and language arts. Phase two of this endeavor was directed toward the development and implementation of a CAI program in initial reading and mathematics for culturally disadvantaged students. By the end of the second year of operation, approximately 400 students had received daily instruction in either reading or mathematics under computer control (Suppes, Jerman, and Brian, 1968).

Concurrently, a second CAI system, known as the Stanford Drill-and-Practice System, was designed by the Stanford group. During the 1967-1968 school year, approximately 3,000 students received daily lessons in initial reading, arithmetic, and spelling in numerous geographically proximate schools as well as in the distant locations of McComb, Mississippi, and Morehead, Kentucky (Suppes and Morningstar, 1972).

In addition to the Stanford Project, other pioneer CAI efforts which impacted on the state-of-the-art of the technology in the field of education were several. The Individual Communication (INDICOM) system distinguished itself as the first public school CAI project in the Midwest. Originally launched in 1967 in the Waterford, Michigan School District, INDICOM featured teacher-authored CAI curriculum packages in 11 content areas within the broader curricular domains of mathematics and language arts for grades kindergarten through 12. A systems approach to curriculum creation accommodated behavioral objectives specification, instructional sequencing, and procedures for evaluating model effectiveness.

The PLATO (Programmed Logic for Automatic Teaching Operations) system originated in 1960 in the Coordinated Science Laboratory at the University of Illinois. Over the course of a seven-year developmental phase, the feasibility of effectively utilizing this computer-based teaching system toward the goal of automating individual instruction was explored. During this time, approximately 300 programs were written for the system to demonstrate its flexibility for teaching as well as for educational research. In 1967, the University of Illinois founded the Computer-based Education Research Laboratory for the PLATO project, which began work toward refinement of the teaching system in use at that time (PLATO III) and aimed toward the development of the large-scale computer-based PLATO IV educational system (Lyman, 1972).

The PLATO IV system, which continues to be operational, supports several hundred terminals at dispersed locations. Each terminal site is provided access to a central lesson library. The powerful and relatively facile PLATO author language, TUTOR, accommodates simultaneous system time sharing by students and teacher-authors as lesson material

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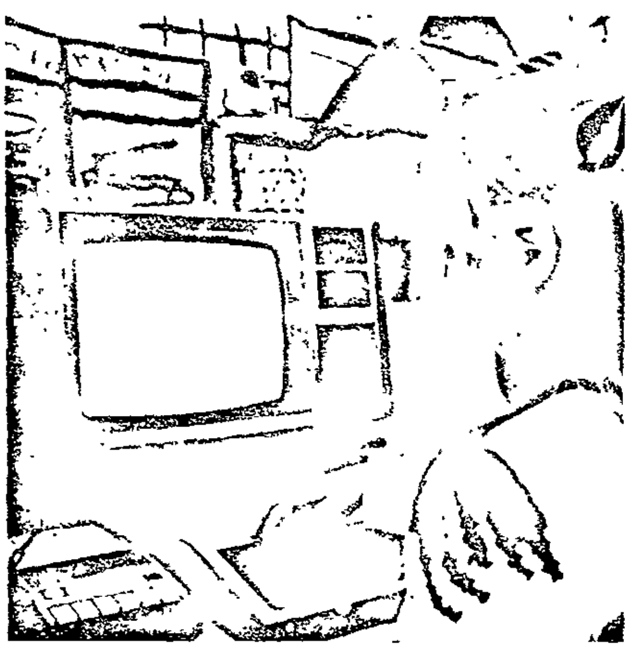

Texas Instruments

continues to proliferate. Efforts at the elementary and secondary school levels have been concentrated in the areas of mathematics and language arts. PLATO now services over 4,000 students per semester.

The University of Pittsburgh has been active in the field of CAI since the late 1960s in the form of its Project Solo. The original Project Solo and the Soloworks Lab Project which followed attempted to test the feasibility of deliberately reorganizing a segment of secondary school mathematics around computer-based laboratories intended to preserve the best features of both student-controlled computing and modern math curricula and to integrate mathematics and other disciplines (Dwyer, 1974). The Soloworks endeavor is organized around five labs, which serve as vehicles for content organization. Overall project focus is toward skill development/problem-solving proficiency in the areas of computer programming, model creation, and simulation design. Soloworks makes particular attempt to apply relevant mathematics concepts to the fields of music and the sciences.

The TURTLE CAI project, developed in the early 1970s at the Massachusetts Institute of Technology under the direction of Seymour Papert, deserves mention in that it was characterized by a unique philosophy which stressed creative functions as opposed to rote aspects of subject matter. The basic tenet of Papert's approach centered on belief in the need to provide learning environments in which students can experientially deal with mental models. The significance of Papert's work is that it demonstrates that today's curriculum greatly underestimates the capacity of children to deal with complexity and arbitrarily postpones the introduction of problem-solving skills to a point so late in the curriculum that most children lose interest or become so dependent on guidance that they never do master these skills (Molnar, 1978).

Corporate involvement in CAI has historically taken the form of hardware/software contributions. Each computer corporation markets a unique trade-marked line of CAI courseware, generally affording a local programming option to those customers who prefer to create and program curriculum unique to their specific needs. Specia author-language features are offered in conjunctior with several systems. One of the numerous corpor ations actively involved in the CAI movement i Computer Curriculum Corporation (CCC). Th formation of CCC in 1967 can be characterized a a direct outgrowth of the Stanford endeavor, a individuals under whose direction the Stanfor Project had pioneered realized the acute need fc curricularly relevant and sequentially develope CAI drill-and-practice courseware materials. CC offers a variety of courseware for elementa through adult-level students, primarily in the are of mathematics, reading, and language arts. CC curricular programs have been utilized nationwi for purposes of basic skill development/maintenance primarily with the culturally and/or academically disadvantaged.

With recent advances in microcomputer technology, corporations whose primary marketing goals relate specifically to microcomputer production and support services in the areas of both instructional and personal computing have gained prominence. Predictions relative to the impact of microcomputers on educational computer networks vary. Some technologists have argued that the microcomputer has the potential to rapidly render mainframe-based computer networks obsolete. Others suggest that microcomputers and mainframes should be viewed as complementary computing climates. Whatever the verdict, there is reason to believe that computer technology in general will continue to flourish in the schools.

CAI Effectiveness

Definitive data relative to the pedagogical effectiveness of CAI as an instructional medium have remained elusive. In a study of factors precluding more pervasive utilization of computer technology for instructional purposes, Anastasio (1972) found the lack of evidence of CAI effectiveness to be among the most critical. Additional years of research efforts have failed to alleviate the dilemma (Avner, Moore, and Smith, 1980).

Published studies comparing the effectiveness of CAI to traditional instruction report conflicting and inconclusive results. The studies, however, generally conclude that an instructional program supplemented with CAI is at least as effective as, and frequently more effective than, a program utilizing only traditional instructional methods (Magidson, 1978). Research in the area of CAI effectiveness has typically investigated one or more of five criterion variables: student achievement, student attitude toward CAI and toward subject matter, time savings relative to unit completion and/or mastery learning, learning retention, and cost factors.

Because an abundance of CAI effectiveness studies exists and because individual studies have failed to produce conclusive evidence of effectiveness, various researchers have attempted to narratively review the research literature in an attempt to formulate conclusions and/or to establish a more broadly based case for CAI. These endeavors, also, have resulted in conflicting and inconclusive findings.

Grayson (1970) summarized the research aimed at determining the relative effectiveness of CAI as follows:

> While many studies have been conducted, very few have dealt with large numbers of students over a long period of time, even in a loosely controlled situation. In many of them, the Hawthorne effect of novelty may be the overwhelming factor. (p. 3)

In a review of the literature relative to the effectiveness of alternative instructional media, Jamison *et al.* (1974) concluded:

> . . . no simple uniform conclusions can be drawn about the effectiveness of CAI . . . . CAI attempts to improve the quality of instruction by providing for its individualization along one or more dimensions. Nonetheless, findings of no significant difference dominate the research literature in this area.
>
> Though there are often no significant differences in achievement, some studies do report a saving in student time, and this is an index of success. When small amounts of CAI are used as a supplement to regular classroom instruction (as with elementary school drill-and-practice programs), substantial evidence suggests that it leads to an improvement in achievement, particularly for slower students. Models exist that relate the amount of achievement gain to the number of CAI sessions a student receives. (p. 56)

Results of a review of research literature on CAI effectiveness on the criteria of student achievement, time compression, and learning retention compiled by Edwards *et al.* (1975) are paraphrased as follows:

1. All studies reviewed have shown normal instruction supplemented by CAI to be more effective than normal instruction alone.
2. When CAI was substituted, in whole or in part, for traditional instruction, 45 percent of the studies demonstrated greater achievement gains by CAI students, while 40 percent found little or no difference; 15 percent showed mixed results.
3. Based on available evidence, it cannot be concluded that any given CAI mode is more effective relative to student achievement than other modes.
4. CAI has been shown to be equally effective relative to student achievement when compared with other nontraditional instructional methods.
5. All studies showed that it took less time for students to learn through CAI than through other methods.
6. There is some evidence that learning retention levels of CAI students may not be as high as those of traditionally taught students.

Thomas (1979), in a comprehensive review of secondary level CAI research relevant to each of the cited criterion variables, concluded:

> The studies reviewed paint a positive picture for computer-assisted instruction. In the past years, proponents hoped to see great achievement gains for CAI courses, spoke of very low costs and high retention, and did not mention time at all. Today, CAI as a medium has 'settled down.' Achievement gains over other more traditional methods are the norm, but mere equivalence with good instruction is also attained. Retention is equal to that obtained in traditional instruction. The technology fosters generally favorable attitudes toward computers and often toward the subject being taught. Perhaps the most valuable finding in the long run is that many CAI students gain mastery status in a shortened period of time. (p. 111)

These contradictory outcomes appeared to signal the need for synthesis of the CAI effectiveness literature by other than narrative means. The research subsequently summarized was aimed toward providing a quantitative integration of the outcomes of individual research efforts and utilized the research integration methodology known as *meta-analysis*.

Meta-Analysis: An Overview

The technique of meta-analysis, a unique approach to the integration of findings of experimental studies, has been developed by Glass (1976, 1978) and by McGaw and Glass (1980). Meta-analysis is a term intended to suggest the analysis of analyses, and employs a common measure of treatment effectiveness, termed "effect size," to obtain a quantitative synthesis of research outcomes (Glass, 1978).

Effect size is defined as the mean difference on the outcome variable between treated and untreated subjects divided by the within-group standard deviation. Where the within-group standard deviations are not homogeneous, the most reasonable procedure is to use the control group standard deviation for effect size standardization purposes (McGaw and Glass, 1980). The concept of mean effect size, derived on the basis of aggregated data, is ultimately utilized to determine the broad-based effectiveness of a given treatment relative to a control group.

Calculation of effect size can prove problematic in cases in which the experiment does not include a control or in which data relative to treatment and control group means and standard deviations are not available. McGaw and Glass (1980) have outlined procedures for converting to the effect size metric statistical information reported in the form of the t statistic, covariance adjusted means, and F statistics derived from multiple regression analysis or analysis of variance.

For purposes of this study, the meta-analysis model appeared to offer advantages over other quantitative approaches to research synthesis. In addition to alleviating the need for access to original data, the procedure accommodates a large and potentially powerful data base and provides a system of refined quantification of research design variables, affording the possibility of discrete analyses based on these quantifications.

Study Description

This study was specifically aimed toward the analysis and integration of research findings relative to the pedagogical effectiveness of computer-assisted mathematics instruction in elementary and secondary schools. Student achievement served as the outcome criterion. In order to establish a framework within which to pursue the investigation, six criteria for inclusion of an individual research effort in the research synthesis were determined:

1. The study was one in which CAI was utilized in conjunction with mathematics instruction.
2. The study was one in which CAI was utilized as a supplement to, rather than as a replacement for, traditional classroom instruction.
3. The study was one which was conducted at the elementary and/or secondary school level(s).
4. The study was one in which respective performances of a treatment and control group were compared or in which data relative to control group predicted performance were available.
5. The study was one in which the outcome variable was a measure of student achievement.
6. The study was one in which the CAI supplementary program employed was of drill/practice or tutorial mode.

In an effort to provide a more refined examination of the CAI effectiveness issue, specific questions addressed were formulated so as (1) to facilitate scrutiny of outcomes on the basis of particular subject characteristics, and (2) to allow assessment of the impact of potentially confounding design features inherent in various original research models.

The sample pertinent to the investigation comprised 40 studies which met the pre-established inclusion criteria. Incorporated study findings yielded 397 drill/practice- and 151 tutorial-related effect size measures. Data relative to each incorporated study finding were quantified in such a way as to afford differentiation of subject, study, and design characteristics. Subject variables included grade level, student ability level, and, where appropriate, sex of subjects. Study variables comprised source of findings and year of experimentation. Design variables considered were sample size, sampling procedure, outcome evaluation instrumentation, specific cognitive skill measured, treatment conditions, homogeneity of variance, and the potential for the presence of a Hawthorne or novelty effect.

Respective mean effect sizes were tested for statistical significance by means of the t-statistic deduced as the ratio of a given mean effect size to the standard error of the mean of the effect sizes under consideration. In an attempt to mitigate the impact of incorporation of potentially dependent effect size measures on a given standard error and on the corresponding t value, the null hypothesis, stating that the mean effect size was zero, was rejected only in instances in which the probability of committing Type I error was less than or equal to 0.01. An analysis of variance model was employed in an attempt to assess the strength of association between effect size measures and observable research design features.

Study Outcomes

Outcomes of this study are delineated according to pertinent subject variables in Table 1. Overall mean effect sizes of .3388 and .4453 for drill/practice and tutorial modes, respectively, were each significant at the .01 level. Data in Table 2 provide a summary of the strength of association measures between effect size and study characteristics/design features for drill/practice and tutorial mode data. It is noted that caution must be exercised in the interpretation of those findings in which a small number of studies and effect sizes contributed to the calculation of a given mean effect size measure.

Primary findings were the following:

1. A mathematics instructional program supplemented with either drill/practice or tutorial computer-assisted instruction was significantly more effective in fostering student achievement than a program utilizing only traditional instructional methods.
2. CAI drill/practice programs were significantly more effective in promoting increased student achievement at both the elementary and secondary instructional levels and among highly achieving and disadvantaged students as well as among students whose distinct ability levels had not been differentiated by the original researchers. The achievement of average level students was not significantly enhanced by supplementary drill/practice CAI.
3. Instructional plans accommodating supplementary drill/practice CAI were significantly more effective in stimulating greater achievement gains among boys at the intermediate grade level than were instructional plans employing only traditional pedagogical models. It was not demonstrated that a basis existed to support an analogous conclusion relative to achievement among intermediate level girls.
4. Tutorial CAI-supplemented instruction was significantly more effective in promoting increased mathematics achievement among students at both the elementary and secondary instructional levels, among disadvantaged students, and with respect to instances in which study summaries did not report findings pertaining to particular student ability levels.
5. There was virtually no evidence to suggest the existence of a relationship between experimental design features and study outcomes (Burns, 1981).

Conclusions and Implications

As indicated earlier, the principal focus of this effort was to address practitioner questions related to the effectiveness of computer-assisted instruction. While no ultimate final answers related to CAI effectiveness or guarantors of success can be presented, *the analysis and synthesis of many studies do point to a significant enhancement of learning in instructional environments supplemented by CAI, at least in one curricular area—mathematics.* This conclusion must, however, be accompanied by a caveat—that the effectiveness of CAI or any instructional support system will be influenced by a host of variables, some uncontrollable. Failure to consider the mitigating effects of such variables will lead to a wide variance in levels of success.

On a positive note, the research does indicate that the promises offered by persons involved in early development of CAI systems may not be empty. A carefully structured pedagogical system supported by CAI does offer considerable opportunity for enhancement of the learning process as compared to a traditional system which does not include computer support.

This research clearly points to other issues which must be addressed by both researchers and practitioners. One issue concerns the impact of CAI on attitude toward learning, on mastery learning time, and on learning retention. Additional research with respect to these dimensions of the learning process is certainly essential. A second issue relates to the apparent lack of confidence displayed by educa-

Table 1

Effect Size as a Function of Subject Variables in Drill/Practice and Tutorial Studies

Subject Variables	Number of Studies	Number of Effect Sizes	Mean Effect Size	t
Drill/Practice				
Grade Level				
Elementary	29	343	.3544	11.36*
Secondary	11	54	.2403	6.19*
Ability Level				
All	13	176	.3789	7.33*
High	5	18	.3160	3.74*
Average	3	10	.1396	.91
High/Average	1	6	.4671	2.08
Disadvantaged	23	187	.3099	10.51*
Sex of Subjects**				
Male	5	23	.4179	4.66*
Female	5	23	.1714	2.14
TOTAL	35	397	.3388	12.28*
Tutorial				
Grade Level				
Elementary	4	124	.4288	6.71*
Secondary	5	27	.5214	5.67*
Ability Level				
All	5	132	.4354	7.02*
High	1	4	.2849	3.09
Average	1	4	.5845	3.33
Disadvantaged	5	11	.5723	5.57*
TOTAL	9	151	.4453	8.11*

*Significant at the .01 level.
**All studies involved intermediate level students.

tional practitioners toward research outcomes as they pertain to instructional alternatives. The development of adequate vehicles through which research-based knowledge can be disseminated, interpreted, and efficiently utilized toward the design, development, and implementation of effectual instructional models would appear to warrant a high degree of priority within the educational community. □

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Table 2

Strength of Association Between Effect Size and Study Characteristics/Design Features

	Drill/Practice: R^2	Tutorial: R^2
Study Characteristics		
Source of Findings	.0029	.0033
Year of Experimentation	.0004	.0000
Design Features		
Sample Size	.0076	.0032
Treatment Conditions		
Weeks of treatment	.0006	.0006
Hours of treatment	.0049	.0004
Number of treatments	.0000	.0152
Sampling Procedure	.0001	.0033
Evaluation Instrument Type	.0135	.0719
Cognitive Skill Evaluated	.0019	.0367
Homogeneity of Variance	.0000	.0028
Novelty Effect	.0029	.0012

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RESEARCH REPORT

a. Citation
Jamison, Dean, Suppes, Patrick, & Wells, Stuart (1974, Winter). The effectiveness of alternative instructional media: A survey. Review of Educational Research, 44, (1), 1-67.

b. Purposes or Goals of the Study
The stated purpose of the study was to provide an overview of the effectiveness of alternative instructional media. The authors reviewed existing research studies on traditional classroom instruction (TI), instructional radio (IR), instructional television (IT), programmed instruction (PI), and computer assisted instruction (CAI). Effectiveness was defined as a significant increase in as standardized test score.

c. Specific Hypotheses (if stated)
In general, the hypotheses were that the augmenting traditional instruction with an alternative educational technology would result in increased student achievement on standardized test scores. The authors described only one piece of research where they actually cited the hypotheses. This research compared a CAI with a TI course on computer programming (Homeyer, 1970). The four hypotheses tested in this study were:

"H1. The CAI group can complete course instruction significantly faster than the lecture group."
(Note: This hypothesis was accepted.)

"H2. The CAI group makes significantly fewer personal visits to the instructor."
(Note: This hypothesis was rejected.)

"H3. There is no significant difference between CAI and lecture groups with respect to mean scores on examinations."
(Note: This hypothesis was accepted.)

"H4. There is no significant difference between the CAI and lecture groups with respect to mean grades on computer programs written."
(Note: This hypothesis was accepted.)

d. Methodology (Sample, Instrumentation, Design, etc.)
In general the research studies used an experimental design that consisted of an experimental and a control group with pre- and post-tests. There was quite a bit variation in how students got into either a control or an experimental group. In some cases they were randomly assigned, in some cases it was a matter of volunteering,

and in some cases they were matched on some variable such as achievement test scores. No examples of instrumentation were provided in the overview. Many of the studies used the database provided by the Equality of Educational Opportunity Survey and regression analysis.

e. Main Results
Almost any augmentation of traditional methods resulted in improved effectiveness or a savings in time.

f. Conclusions & Suggestions for Further Research

- In the section reviewing determinants of students' scholastic achievement in a traditional classroom setting, the research results were inconsistent. Teachers verbal ability and small classes in elementary school seem to improve student performance.

- Instructional radio supplemented with appropriate printed material was about as effective as traditional instruction.

- If instructional television was used to simulate traditional instruction methods, it can be as effective for all grade levels and subject matters.

- At the elementary school level, CAI was an effective supplement to regular instruction, particularly for disadvantaged students. Some studies reported a savings in time, though there may be no siginificant increase in achievement.

- Further research suggestions included the following: 1) Examine savings in time over longer periods; 2) Evaluate technologies influence on student motivation; 3) Evaluate whether students receiving individualized instruction in elementary school prefer more traditional instructional forms as they get older, and 4) Examine more imaginative uses of new media.

g. Shortcomings
The authors noted a variety of weaknesses which included: small samples, teachers changing the treatment, and the effects of self-selection in volunteer situations.

The major shortcoming I find with the research is that CAI has been put to more imaginative uses uses since 1974. It would be valuable to know the effectivess of some of the new discovery CAI methods.

-- KATHE CONRAD

ofComputer-Based Instruction
Vol. 6, No. 4, 115-118.

ACTIVE EXTERNAL CONTROL: A BASIS FOR SUPERIORITY OF CBI[1]

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A recurring problem in justifying the selection of Computer Based Instruction (CBI) over other, less-costly, alternatives is the almost total lack of unambiguous evidence for unique advantages in instructional effectiveness for this medium.

Active, individualized control over student interaction is one feature of CBI which is not readily available from alternative media. Such active control provides a means of ensuring cognitive processing of information to be learned. While instructional design theory holds that active processing should yield more effective learning, there are few well-controlled studies showing that CBI can in fact provide better learning under realistic conditions while using this potential advantage. This study sought to provide evidence in support of such an advantage for CBI. During two semesters, almost 700 university students in a chemistry laboratory course were given CBI materials in one of two forms, each identical in content and in use of dynamic graphics. One form ("interactive") required student interaction of a type feasible only by use of active control like that provided by CBI. The other ("passive") allowed self-pacing similar to that of many alternatives to CBI. Laboratory performance was significantly better ($p = .029$) for students who used the "interactive" form.

A recurring problem in justifying the selection of puter Based Instruction (CBI) over other, less-y, alternatives is the almost total lack of unam-ous evidence for unique advantages in in-tional effectiveness for this medium. Many of the uctional approaches used by Computer Based uction (CBI) to provide superior instruction can implemented on less costly media. For example, rammed texts can provide the time-savings that lt from self-paced instruction, while film can ide animation that enhances a student's per-ion of difficult relationships (Lumsdaine, Sulzer, pstein, 1969). Studies which contrast CBI with room instruction are seldom of value in justifying use of CBI even when superior learning is found the CBI condition. The superiority can often be bed to use of instructional approaches, such as acing, which could be provided just as well by other than CBI. The potential for true iority of CBI can only be demonstrated when an uctional approach unique to (or most eco-ically provided by) CBI is shown to produce better ing than instructional approaches supported by ative media (Avner, 1978). Unfortunately, studies directed toward such demonstrations sometimes appear to be so obvious or superficial that few workers have been interested in pursuing them. The result has been a multitude of studies that document the ability of a group or a person to produce superior learning by using CBI, but few studies that clearly document that the superior learning was due to use of a characteristic unique to CBI.

The fact that CBI, like a human tutor, can provide active control over the progress of the student suggests one basis for a true potential superiority of CBI over competing media. One application of the capability of active control is in pacing of the presentation of material. Steinberg's (1977) review of the effects of student control in CBI showed that learning tended to be more efficient when the computer rather than the student controlled course flow. These findings support a series of cross-media studies conducted by Dare, Hill, Hall, & Wofford (1975) who tested mastery learning materials prepared by the same experienced instructor for two forms of self-pacing (augmented programmed text and CBI) against group-paced classroom instruction. Students learned mastery under all conditions. Both forms of self-pacing led to significant time-savings over classroom instruction. In addition, the active management provided by CBI made possible a significant savings of time for CBI

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uction over appropriate alternative forms of self-... For example, in a course in Evaluation and ...ing Materials Development, the CBI students ... only about 60% as much time as students using ...ard self-paced materials. This difference was ...ly significant ($F(1,138) = 32.2$, $p < .0005$, 42.8% ...population variance is estimated to be accounted ...by effects of media). In this situation, and in many ...s where computer routing shows time savings ...r student-controlled routing, savings have often ... found to result from the ability of an active ...trol element like a computer to route students ...ptly to new material as soon as mastery is ...nstrated. Learning is thus made more efficient by ...mizing the time that a student might spend on ...rial already adequately learned.

Another way an external control element might ...ance individualized instruction is by increasing the ...ty of learning. Learning is substantially more ...ly to occur when a student actively processes in...mation being learned (Bugelski, 1977). Homework ...lems and study questions are among the ...niques often used by teachers to increase a ...ent's interaction with material. However, a ...ent with poor learning habits or low motivation ...still skim over or ignore materials when such ...aches are incorporated in most media. Only ...ctional sequences which use an active control ...ent such as a human instructor or a computer ...e a chance to prevent the sort of passive progress ...ugh materials which often leads to poor learning. ... will question the ability of CBI to provide an ...active learning environment. The question is: can ...actually demonstrate a significant learning ad...tage for CBI over alternative media that is solely ...to application of this special feature. As indicated ...er, few existing CBI studies give unambiguous ...ers on this point. While studies made with other ...ia (e.g. Gropper & Lumsdaine, 1961) have ...ested advantages for instruction which insures ...ent interaction, results have often been in...lusive. Preliminary studies using CBI in university ...ratory instruction (Chabay & Smith, 1977) were ...what more promising. These preliminary studies ...to a series of experiments by Moore (1978). We will ...ribe here a portion of the outcomes of these last ...riments that impact on the documentation of a ... advantage of CBI over other media. Other ...s (such as details of design or application of the ...rials in the specific setting involved) are covered ...where (Moore, Smith & Avner, 1980).

Moore's studies examined the utility of CBI-...rated student interaction on learning under ...rimentally controlled conditions in a realistic ...ing situation. Instruction was directed toward increasing the understanding of principles behind laboratory experiments to be performed by students in university chemistry courses. The university laboratory setting permitted inclusion of tasks that ranged in complexity from rote procedure-learning to advanced concept learning. It additionally provided an instance in which potential cost-savings might occur. Students who have a full understanding of the principles behind processes and procedures carried out in the chemistry laboratory should be both more efficient in use of limited laboratory resources and less likely to make errors that might endanger themselves or costly equipment.

METHOD

Subjects

Laboratory sections for a University of Illinois class in introductory chemistry which used CBI as a normal part of instruction were randomly assigned to an experimental and a control group. Assignments were made on a quota basis to preserve balance between instructors and section meeting times (the only non-chance variables which affected student choices of section during registration). Intact sections were used to minimize chances that subjects would notice that different CBI programs were being used. This procedure was followed for two semesters (involving almost 700 students and 30 laboratory sections) to provide replication both within and between classes. The sample sizes involved assured that statistical tests at alpha = .05 would be able to detect experimental effects of greater than .5 standard deviation units at least 90% of the time.

Materials

Two sets of CBI materials were designed for each laboratory project included in the study. Both sets of materials included the same information on the laboratory procedure that the student was to carry out (usually using identical displays). A wide variety of instructional techniques, including animation, simulation, modeling, and direct text presentation was used. The sole difference was that one set of materials required that the student give responses during the lesson that demonstrated understanding of the content being taught while the other set allowed students to step through the material simply by pressing a key. Students using the material that required accurate responses were not allowed to continue unless their responses were correct. The processes being taught had multiple correct paths to solution, however, so that it would not be economically feasible to pre-program

...orrect alternative approach. Only an active ...element such as a computer which would be ...infer correct responses from a general model of ...ess involved could economically support such ...tion. Both sets were presented by a PLATO IV ...stem to control for potential effects of self- ...animation, or novelty of medium.

...ance

...criterion of laboratory performance was the ...e or absence of specific types of errors in ...ory work by students. A standard list of errors ...eloped by experienced instructors for each ...ory situation. Interjudge reliability for a typical ...ry session during actual data collection was ...e spent by students in control and treatment ...was also kept for selected laboratory and CBI ... For laboratory sessions, time was kept as a ...f the normal administration of the laboratory ...me for CBI sessions was kept automatically by ...mputer as a normal part of student data ...on.

...ure

...ng laboratory sessions, observers unobtrusively ...subjects on the error scale designed for that ...lar session. Laboratories normally contained ...s from both conditions, and observers did not ... which students had been exposed to which ...nt. Since one error in procedure might generate ...others before being corrected, errors for a given ... cannot be considered to be independent. For ...son, students were scored for analysis purposes ...ing made either no observable errors or as ... made one or more observable errors. To check ... possibility that the materials that required ... interaction might be affecting performance for ...eason other than superior learning of the in- ... instructional content (e.g., practice in an- ... questions or following directions), some ...ory sessions were designed to require only ...al, rule-following behavior while other ... demanded an understanding of the concepts ... Data on time spent in the laboratory and ...nt on CBI materials were collected for each

RESULTS

...mance of students under the same conditions ...sistent across laboratory sections and classes. ...d data for the major experimental conditions ...n in Table I for two representative laboratory

Table 1. Percentage of Students with No Errors During Laboratory Session.

Understanding Required	Instructional Approach Interactive CBI	Passive CBI
Low (follow instructions)[a]	69% (n = 26)	77% (n = 26)
High (decisions required)[b]	57% (n = 42)	30% (n = 57)

[a] $p = .400$ (binomial test)
[b] $p = .029$ (binomial test)

sessions. The laboratory session requiring simple instruction-following was an acid-base titration, while the session requiring decision-making on the part of the student involved use of an analytical balance. Similar results were seen for other sessions under these conditions. In sessions requiring only instruction-following, most students made no observable errors, and there were no significant differences in errors between students who received pre-laboratory instruction by interactive or by passive approaches. However, in sessions where the student had to make decisions requiring an understanding of principles behind the experiment, students following the interactive approach showed significantly better performance.

Students who had used the interactive CBI materials took less time to complete accompanying laboratories (e.g., $p = .0237$ that the observed savings were due to chance alone for an experiment on the relative activity of the halogens). This savings in the laboratory was, however, almost always offset by an equivalent increase in relative time spent in the interactive CBI materials.

DISCUSSIONS AND CONCLUSIONS

Generalizability of the findings reported here is aided by the fact that they occurred under conditions that would tend to obscure minor effects. Intact classes rather than selected groups were the basic experimental unit. Hence, most of the sources of random variation normally present in realistic instructional settings were present. In addition, university students are more likely than other students to have learning habits which allow them to make effective use of non-interactive materials (e.g. books). Thus, we would expect any advantages in favor of interactive materials to be smaller for this group than for most other student populations. Despite the presence of such sources of extraneous variance and such leveling factors, the interactive versions of the materials resulted in significantly better performance by students.

Such results support prior studies showing superiority for active learning. More important from the viewpoint of CBI as a medium, the studies document superior learning for students who used an application of CBI which could not normally be duplicated by other media. Furthermore, in the application described, CBI also showed a potential for resource savings that could prove cost-effective in an academic environment.

These findings, together with earlier documented time-savings for CBI-controlled course routing, provide a basis for choosing CBI over alternative individualized media. At the same time, they show the absolute necessity for evaluating CBI against appropriate alternative media rather than simply against classroom instruction. The mere fact that CBI is used (or even that it is superior to classroom instruction) does not mean that the instructional designer has made appropriate use of the unique characteristics of CBI. Unfortunately, much of current CBI material bears a closer resemblance to the "passive" than to the "interactive" materials prepared by Moore. Only where the computer is used to structure the learning situation in dynamic response to a constantly updated assessment of the student's knowledge will the advantages described here for CBI be anything more than potentials.

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How Effective Is CAI? A Review of the Research

JUDITH EDWARDS, SHIRLEY NORTON, SANDRA TAYLOR, MARTHA WEISS, RALPH DUSSELDORP

What happens when computer-assisted instruction is substituted, in whole or in part, for traditional instruction? Several researchers have found conflicting answers to this and other questions.

FOR the purpose of this review, computer assisted instruction (CAI) is defined as the use of the computer for direct instruction of students. This includes four modes (drill-and-practice, problem-solving, simulation, and tutorial) but does not include computer managed instruction or the teaching of computer science. Only studies are included in which effectiveness was measured by student achievement as a result of CAI as compared with achievement resulting from other methods of instruction.

CAI as a Supplement to Traditional Instruction. CAI is commonly provided to students in addition to normal, classroom instruction. As shown in Figure 1, when that is the case, all studies have shown normal instruction supplemented by CAI to be more effective than normal instruction alone.

In some cases the results were quite remarkable. In the Suppes (31) study, for example, third grade students in California and Mississippi whose normal instruction was supplemented with CAI gained, respectively, 2.28 and 2.03 grade levels in computational ability in one year. Arnold (3) and Scrivens (29) found that after one year the differences in achievement between students whose arithmetic instruction was supplemented by CAI drill and practice and students who received normal instruction were only .3 grade levels for grade two, .5 for grade three, .4 for grade four, and .5 for grades five and six (all favoring the CAI students). Fletcher and Atkinson (13) found that students who received supplementary CAI instruction in reading scored, at the end of a year, an average of .6 grade levels higher on a standardized test than students who received normal classroom instruction only. Wilson and Fitzgibbon (32) reported that a group of fourth and fifth graders made an average of seven months growth in reading

Study	Mode	Subject	Grade Level	Results *
Arnold	Drill & Practice	Arithmetic	3-6	+
Crawford	Drill & Practice	Arithmetic	7	+
Martin	Drill & Practice	Arithmetic	3-4	+
Scrivens	Drill & Practice	Arithmetic	3-6	+
Suppes	Drill & Practice	Arithmotic	2-6	+
Fletcher and Atkinson	Tutorial	Reading	1	+
Bitter	Problem Solving	Calculus	College	+
Culp	Simulation	Chemistry	College	+
Lagowski	Mixed	Chemistry	College	+

* In this and subsequent figures, a + indicates that the students involved in CAI achieved more than non CAI students A − indicates that the CAI studies did less well, while an = indicates the same level of achievement.

Figure 1. Studies That Involved CAI as a Supplement to Traditional Instruction

skills during four months as a result of having their normal instruction supplemented with CAI.

CAI as a Substitute for Traditional Instruction. As shown in Figure 2, when CAI was substituted, in whole or in part, for traditional instruction, nine studies showed that the CAI students achieved more than the non-CAI students, while eight studies found little or no difference. Three of the studies (1, 18, 33) showed mixed results.

Effectiveness of Different Modes of CAI
Figure 3 shows the results of studies of the effectiveness of CAI categorized according to the various modes.

As shown in Figure 3, from the evidence available it cannot be concluded that any mode of CAI is consistently more effective than other modes. Each mode of CAI has been shown to be more effective than traditional instruction in some studies but no more effective in other studies.

Comparison with Other Nontraditional Methods of Instruction. Figure 4 lists three studies in which the effectiveness of CAI has been compared with other nontraditional methods of instruction. CAI has been shown to be equally effective when compared with individual tutoring, language laboratory, and

media such as prog
filmstrips.

Compression c
have shown that ev
always result in g
time it takes stude
Those studies are s
As shown in
time to learn was

Study	Mode
Abramson	Drill & Practice
Street	Drill & Practice
Wilson	Drill & Practice
Cole	Drill & Practice
Adams	Drill & Practice
Morrison	Drill & Practice
Atkinson	Tutorial
Morgan	Tutorial
Lorber	Tutorial
Cropley	Tutorial
Proctor	Tutorial
Johnson	Problem Solving
Katz	Problem Solving
Wing	Simulation
Lunetta	Simulation
Culp	Simulation
Hollen	Simulation
Diamond	Mixed
Diamond	Mixed
Cartwright	Mixed

* These three studies

Figure 2. Studie
Substitute for

Study
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Morrison
Street

Figure 4. Stud

Study
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Proctor
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Wing
Lunetta
Hollen
Cartwright

* A − indicates tha

Figure 5.

media such as programmed instruction and filmstrips.

Compression of Time. Several studies have shown that even though CAI does not always result in greater achievement, the time it takes students to learn is reduced. Those studies are shown in Figure 5.

As shown in Figure 5, when student time to learn was measured, all studies showed that it took less time for students to learn through CAI than through other methods. Krupp (20) showed that adults learning computer programming through CAI took from five to 10 hours to reach the

Study	Mode	Subject	Grade Level	Results
Abramson	Drill & Practice	Arithmetic	2-6	+, =*
Street	Drill & Practice	Arithmetic	3-7	=
Wilson	Drill & Practice	English	4-5	+
Cole	Drill & Practice	General Math.	High School	+
Adams	Drill & Practice	German	College	+
Morrison	Drill & Practice	German	College	=
Atkinson	Tutorial	Reading	1	+
Morgan	Tutorial	Algebra	High School	+
Lorber	Tutorial	Tests & Measurement	College	+
Cropley	Tutorial	Fortran	College	=
Proctor	Tutorial	Curriculum	College	=
Johnson	Problem Solving	Mathematics	7-9	=
Katz	Problem Solving	Algebra	High School	+, =*
Wing	Simulation	Economics	6	+, =*
Lunetta	Simulation	Physics	High School	+
Culp	Simulation	Chemistry	College	=
Hollen	Simulation	Chemistry	College	=
Diamond	Mixed	Biology	7-10	+
Diamond	Mixed	Reading	7-10	=
Cartwright	Mixed	Education	College	+

* These three studies produced mixed results.

Figure 2. Studies That Involved CAI as a Substitute for Traditional Instruction

Mode	Study	Subject	Grade Level	Results
Drill & Practice	Arnold	Arithmetic	3-6	+
	Martin	Arithmetic	3-4	+
	Scrivens	Arithmetic	3-6	+
	Suppes	Arithmetic	2-6	+
	Crawford	Arithmetic	7	+
	Gipson	Arithmetic	7	=, +
	Abramson	Arithmetic	2-6	=, +
	Street	Arithmetic	3-7	=
	Cole	Gen Math.	High School	+
	Wilson	English	4-5	+
	Adams	German	College	+
	Morrison	German	College	=
Tutorial	Atkinson	Reading	Intermediate	+
	Fletcher and Suppes	Reading	Intermediate	+
	Morgan	Algebra	High School	+
	Cropley	Fortran	College	=
	Krupp	Computer Prog.	Adult	=
	Lorber	Testing	College	+
	Proctor	Curriculum	College	=
	Sango	Elections	Adult	=
Problem Solving	Johnson	Mathematics	7-9	=
	Katz	Algebra	High School	+, =
	Bitter	Calculus	College	+
Simulation	Wing	Economics	6	+, =
	Lunetta	Physics	High School	+
	Culp	Chemistry	College	+
	Culp and Castleberry	Chemistry	College	=
	Hollen	Chemistry	College	=
Mixed	Diamond	Biology	7-10	+
	Diamond	Reading	7-10	=
	Lagowski	Chemistry	College	+
	Cartwright	Education	College	+

Figure 3. Effectiveness of CAI According to Mode

Study	Mode	Subject	Grade Level	Comparison	Results
Culp	Simulation	Chemistry	College	Tutoring	=
Morrison	Drill & Practice	German	College	Lang. Lab.	=
Street	Drill & Practice	Arithmetic	3-7	P.I., Films	=

Figure 4. Studies Comparing Effectiveness of CAI with Other Nontraditional Methods of Instruction.

Study	Mode	Subject	Grade Level	Results: Achievement	Results: Time *
Kockler	Tutorial	Mathematics	College	=	–
Lorber	Tutorial	Testing	College	+	–
Proctor	Tutorial	Curriculum	College	=	–
Krupp	Tutorial	Computer Programming	Adult	=	–
Sango	Tutorial	Electronics	Adult	=	–
Wing	Simulation	Electronics	6	=	–
Lunetta	Simulation	Physics	High School	+	–
Hollen	Simulation	Chemistry	College	=	–
Cartwright	Mixed	Education	College	+	–

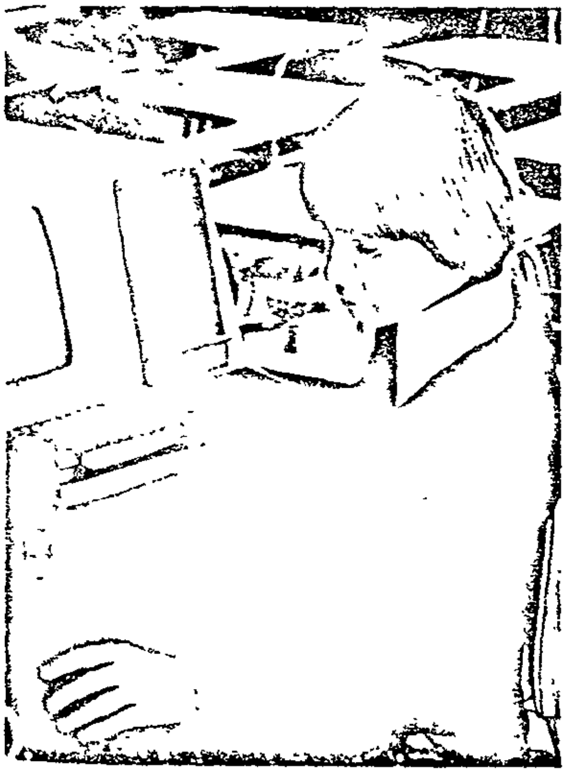
* A – indicates that less time was required by CAI students.

Figure 5. Studies That Separated the Time Required for Students to Learn Through CAI Compared with Other Methods of Instruction

same level of proficiency as students who spent from 24 to 30 hours in traditional instruction. Lunetta and Blick (23) compared computer simulation of high school physics experiments with traditional laboratory experiments and found that the CAI students learned more in one eighth the time.

Retention. Even though students may learn more or may learn more quickly through CAI, there is some evidence that they may not retain as much as traditionally taught students. As shown in Figure 6, although one study showed retention to be equal, two studies showed that students who learned through traditional methods retained more of what they had learned than students who learned through CAI.

Effectiveness According to Ability Level. Only two studies reported results according to ability level of students. Both Martin (24) and Suppes (31) found CAI drill and practice in arithmetic to be relatively more effective for low ability students than for average or high ability students.



Study	Mode	Subject	Grade Level	Results *
Wing	Simulation	Economics	6	−
Lunetta	Simulation	Physics	High School	−
Proctor	Tutorial	Curriculum	College	=

* A − indicates that the CAI students retained material less well than the non CAI students.

Figure 6. Studies That Compared Retention of Material Learned Through CAI with Retention of Material Learned Through Other Methods

Study	Mode	Subject	Grade Level	Results
Martin	Drill & Practice	Arithmetic	3 - 4	Low +
Suppes	Drill & Practice	Arithmetic	2 - 6	Low +

Figure 7. Studies That Compared the Effect of CAI on Students of Different Abilities

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—JUDITH EDWARDS, SHIRLEY NORTON, SANDRA TAYLOR, *and* MARTHA WEISS *were all Research Assistants, University of Iowa, Iowa City, at the time this review was compiled; and* RALPH DUSSELDORP, *Professor of Education and Chairman of the Division of Educational Administration, University of Iowa, Iowa City.*

rating scales may be enhanced by the development and utilization of specific scoring criteria and (3) the construct validity of the LC construct received little support from the quantitative analyses conducted in the present study.

PROGRAMMED REVIEW TESTS IN A PSI COURSE

Order No. 8019976

McSWEEN, TERRY EDWARD, PH.D. *Western Michigan University*, 1980 73pp.

Two experiments demonstrated that carefully programmed review tests can result in 90% mastery of course objectives. Introductory psychology students participated in two group comparisons of the effectiveness of review tests versus no review tests. Review tests were programmed in that difficult items were repeated on several review tests. In both studies, students taking review quizzes outperformed students not taking review quizzes on final examinations. In addition, students not taking review quizzes were more likely to drop the course.

THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON STUDENT SELF CONCEPT, LOCUS OF CONTROL LEVEL OF ASPIRATION, AND READING ACHIEVEMENT

Order No. 8019116

MRAVETZ, PATRICIA JO, PH D *The University of Akron*, 1980. 175pp.

The effects of a computer-assisted instructional (CAI) program in reading on the attitudinal variables of: (1) self concept; (2) locus of control; and (3) level of aspiration were examined. A separate subscale measuring reading self concept was developed from the self concept instruments. The subjects were thirty (30) rural Caucasian junior high school students who were one or more reading grade levels below actual grade level. Twenty (20) subjects were in the experimental group with little or no exposure to CAI; the control group subjects (10) were instructed in the Reading Center without CAI. Both groups had the same teacher. Results indicated that there was no significant difference in the self concept and reading self concepts. Although both groups' scores increased, the experimental group's scores gained proportionately higher. Differences in feelings of locus of control in reading were statistically significant, due to a negative shift in the control group. Level of aspiration, measured in November, 1979, January, 1980, and February, 1980, indicated a shift toward the development of more realistic learning choices. Differences in reading achievement were statistically significant, suggesting that based on this achievement, the impact of CAI may encourage attitudes of individual responsibility and realistic decisions for learning.

THE LONGITUDINAL EFFECTS OF TRAINING IN EMPATHIC RESPONSE IN PRESERVICE TEACHER EDUCATION

Order No. 8020383

OSMUS, KYRA JONES, ED D *Memphis State University*, 1980. 71pp. Major Professor: Dr. Carlton H. Bowyer

The purpose of the study was to examine the longitudinal effects of training in empathic response in preservice teacher education. The subjects were volunteers who had been undergraduates in the College of Education at Memphis State University. The experimental group consisted of 16 subjects who, two years previously, participated in a Systematic Human Relations Training workshop which was taught as part of a combined section of two core courses. At that time they received training in empathic response. The control group consisted of 16 subjects who were also enrolled two years previously, in two sections of a core course, but received no training in empathic response.

The subjects in the present study were interviewed individually and were measured by three instruments. The first was a paper and pencil multiple choice instrument which measured recognition of empathic response. The second instrument was an audiotape stimulus which elicited verbal responses which were rated on a 4-point empathy scale. The third instrument was a self-report measure which required that the subject relate an incident during which he had helped or taught someone something. The incidences were rated for empathy on a 7-point scale.

Analysis of the data produced the following results. Hypothesis One predicted that subjects trained in empathic response and tested two years previously on the paper and pencil measure would still score higher on a delayed posttest of that measure than they did when pretested. The data supported the first part of the hypothesis. Hypothesis One also predicted that control subjects who did not receive training would not score higher on the same delayed posttest when they did when pretested two years previously. The data did not support the second part of the hypothesis. Hypothesis Two predicted that subjects who received training in empathic response would score higher on a delayed posttest of the paper and pencil measure than would control subjects. The data supported the hypothesis. Hypothesis Three predicted that experimental subjects would score higher than control subjects on the self-report measure. No significant differences were found, and the hypothesis was not supported. Hypothesis Five predicted that all three empathy measures would be positively correlated. A significant positive correlation was found only between the paper and pencil test and the audiotape stimulus, so the hypothesis received only partial support. Hypothesis Six predicted that subjects would respond with a higher level of empathy to stimulus statements on the audiotape when the statements were presented by members of their own sex. The experimental subjects did not respond to difference in sex of the presenters on the audiotape. However, subjects in the control group were more empathic when the presenter on the audiotape was female. Hypothesis Six received only partial support.

The results of the study demonstrated that the training program in empathic response was still effective after a two-year span. The results suggest that when such a program is included in a college curriculum several years prior to graduation, the effects of the program are retained long enough to be useful in a professional role following graduation.

PARENT EDUCATION AS A MEANS OF FOSTERING MORAL DEVELOPMENT IN BEGINNING PRIMARY AGE CHILDREN

Order No. 8020095

PEMBROKE, EILEEN, PH.D. *Loyola University of Chicago*, 1980. 132pp.

Current theory in the field of moral education has been influenced as a result of Kohlberg's 25 years of research in this area. He and other researchers have shown that a certain level of cognitive development, the ability to understand another's perspective and exposure to higher stages of reasoning are necessary conditions for development of moral reasoning. In the present study, an attempt was made to provide these conditions in children's daily lives by teaching parents communication skills which would establish these conditions if practiced at home. The 8 week parent education program involved teaching parents active listening skills, skills to use when confronting a problem, and skills to use for mutual decision making.

Self-concept and social reasoning in the areas of justice and authority were measured for the 5 to 8 year old children of the parents who volunteered to participate in the program. Parents were randomly assigned to experimental and control conditions.

The primary purpose of this investigation was to determine (1) whether self-concept was associated with level of social reasoning, (2) whether parent participation in the program increased children's levels of social reasoning, and (3) whether parent participation in the program significantly improved children's self-concepts. In addition, the relationship of age and sex to level of reasoning was investigated. The short-term reliability of Damon's authority and justice interviews, used to measure social reasoning, was also established.

The results of the statistical analyses showed that some self-concept variables (i e social interest, minority identification, identification with friends) were related to age, but not to level of reasoning on the authority and justice interviews. Participation in the parent education program did not significantly alter children's self-concepts or their levels of reasoning in the areas of justice and authority. Certain tests approaching significance showed a tendency for children in the experimental group to change more in their reasoning concerning issues of authority than children in the control group. This tendency was not seen with reasoning in the area of justice. Also, a tendency for more change in reasoning on the authority interview was seen for 8 year old children. As in Damon's studies (1977), no differences in reasoning were found between males and females. Level of reasoning was found to increase with age which supports the developmental nature of the variables being measured.

The justice and authority interviews were found to have adequate reliability in relation to other projective and personality measures. Change occurred in reasoning in both upward and downward directions over one month's time, which tends to contradict the "invariant sequence of stages" concept.

Finally, parent's verbal behavior but not attitude changed as a result of the experimental manipulation. This lack of change in attitude may be a major factor in the lack of significant change in children's self-concept and level of social reasoning.

Pearson product-moment correlations and analysis of variance were used to analyze the hypotheses. This study did not find any evidence of sex-role stereotyping among counselor education students. It did find, however, that female counselor education students have more liberal attitudes toward the rights and roles of women in society, than have male counselor education students. In addition, a significant relationship was found between age and amount of quarter hours completed and scores on the Attitudes Toward Women Scale. Several possible factors may have been responsible for this. Those that were reviewed included (1) current changing attitudes toward women, (2) length of counselor education program, (3) geographic differences, and (4) racial differences.

THE EFFECTIVENESS OF AN INDIVIDUALIZED, COMPUTER-ASSISTED INSTRUCTIONAL PROGRAM (PLAN) WITH STUDENTS FROM A LOW SOCIO-ECONOMIC COMMUNITY Order No. 7920969

WILKINSON, John H., Ph.D. St. John's University, 1979. 90pp. Director: Thomas N. Grant

Modern education has been criticized for the lack of individualization in most school programs, the failure of too many students to learn adequately, the tremendous cost of education, and the failure of too many school programs to address the affective aspects of students' personalities. In an attempt to answer this criticism, John C. Flanagan, Ph.D. and his associates developed an individualized, computer-assisted instructional program known as PLAN.

The purpose of this study was to determine if PLAN would affect (1) student achievement scores as measured by various subtests of the SRA Achievement series, and (2) student self-esteem as measured by Coopersmith's Self-Esteem Inventory (SEI). The study was carried out over a three year period in a parochial junior high school in an "inner city" section of New York City. Students were enrolled in either the PLAN or a traditional program. Students were Black or Hispanic. There were 84 males and 111 females. 95 students were in PLAN and 100 in the traditional program. Analysis of Covariance was used because an initial difference in IQ was found between the PLAN and traditional groups.

The hypotheses stated that no significant differences would be found between the scores on the mathematics, reading, social studies, language-arts, and science subtests of the SRA Achievement Test for PLAN and traditional students nor would a significant difference be found on the Coopersmith Self-Esteem Inventory. However, significant differences were found on the mathematics, reading, and social studies subtests. In each case the PLAN students scored significantly higher than their traditional counterparts.

The results of this study indicate that PLAN is at least a limited success. It also shows that "disadvantaged" students can benefit from it. Can PLAN help those students who are poorer readers than the students in this study? Reading was an important criterion for selecting the PLAN students who were used in this study. Another area that needs clarification is the relationship between self-esteem and achievement. In this study student self-esteem scores were not significantly different because of the educational program, although it had been assumed that participation in an individualized program would raise self-esteem.

An area that was not specifically investigated in this study was cost effectiveness. If PLAN is ever to be considered as a viable alternative to other programs cost effectiveness must be taken into account.

A STUDY TO DETERMINE THE EFFECTS OF CERTAIN METHODS OF BEHAVIORAL COUNSELING ON THE FREQUENCY OF DISRUPTIVE ACTS OF SCHOOL BUS PASSENGERS Order No. 7916288

WILLIAMS, Nathaniel Brown, Ed.D. University of Virginia, 1978. 56pp. Chairman: Dr. Richard L. Beard

An attempt was made to affect the behavior of school bus passengers in rural, racially mixed, Charles City County, Virginia by using behavioral counseling techniques based on the social learning theory. The study was conducted as two experiments.

Experiment One involved twenty-four subjects who were enrolled in the Charles City Middle School which contains the sixth and seventh grades. The subjects were identified as being prone to commit disruptive acts as school bus passengers. The subjects were randomly assigned to two treatment groups and one control group. Each group consisted of eight subjects. Treatment for Group I was ten sessions, approximately forty-five minutes each, of individual counseling. Treatment for Group II consisted of eight, approximately fifty minute sessions of group counseling which were structured by the investigator. Subjects in Group III received no treatment. Empirical evidence supported the hypothesis that individual and group counseling would influence positively the number of disruptive acts committed by the subjects as school bus passengers. The hypothesis that the effects of individual and group counseling procedures on the number of disruptive acts committed by the subjects as bus passengers would vary was not substantiated.

The subjects for Experiment Two were eight female bus drivers and four male drivers who discharged bus passengers at the pre-school, the elementary and secondary schools of Charles City County. Two of the male drivers were high school students. One male driver and one female driver were employed by the county as teachers. Several drivers worked for the county as school cafeteria employees. The subjects were randomly assigned to a treatment and a control group. Treatment for the experimental group in Experiment Two consisted of four, one hour sessions in which skills in behavior management were presented. The control group received no treatment.

School bus passengers who have been identified as being liable to commit disruptive acts on a school bus appeared to respond favorably to behavioral counseling. The absence of any referrals to the principal of any of the experimental subjects in this investigation supports this idea when compared with the referrals of subjects in the control group.

With training the unique abilities of drivers, counselors, principals, parents and bus passengers may aid in the orderly transportation of students. The relationship of the driver to the passenger is an influential factor in a passenger's behavior pattern. Counseling disruptive students could serve to make transportation a positive aspect of education instead of another part of the problem.

The investigator feels that the findings of this study may be employed under circumstances similar to those in Charles City County, Virginia. The investigator also believes that modifications may be applied which would make a program of behavioral counseling effective in larger or smaller school districts. Further research is needed in the area of skill training for bus drivers. Investigations into the effects of behavioral counseling in other localities and under other circumstances are needed.

It is suggested that future investigators of disruptive school bus passengers give particular attention to the use of referrals as a measure of school bus passenger disruption. It is also suggested that longer periods of treatment might result in a positive influence when used with bus drivers.

Development in Young Children, focused on psycho-analytic interpretation of the same records. Detailed interpretation reinforces the central import of both books; emotions need early freedom or they act as later killers. This exciting proof of psychological needs secured Isaacs a world-wide reputation among more radical educators and fellow child analysts.

Later books did not add a scholarly contribution. Nursery Years, one of the first child care books, brought her views to a larger audience and made parents more sensitive to the fact that early years are crucial and the dangers of rigid discipline are life scarring. Despite the present disaffection with Freudian views, Isaacs is still recognized as champion of children's rights to an education that places self before conventional measurements and proscriptions.

Order No. 77-22,483, 402 pages.

RELATION BETWEEN COMPUTER–ASSISTED INSTRUCTION AND READING ACHIEVEMENT AMONG FOURTH, FIFTH, AND SIXTH GRADE STUDENTS

LITMAN, George Howard, Ed.D.
Northern Illinois University, 1977

The general purpose of the study was to determine the effect that participation in a drill-and-practice computer-assisted instruction (CAI) program had on reading achievement. Specifically, this study sought to reaffirm the current theory that there was a positive relationship between CAI participation and reading achievement at the end of the year of instruction as well as two years after instruction. Previous studies had shown this relationship existed at the end of the year of instruction but longer term results were not available.

The Iowa Test of Basic Skills (ITBS) reading achievement scores at the end of the year of instruction and two years after instruction of students in the middle grades who participated in CAI were compared to ITBS reading achievement scores of similar students not participating in CAI. These raw scores were converted to z scores before the comparison since the students took a variety of levels of the ITBS. A factorial covariance procedure was used to allow the simultaneous comparison of scores of male and female; fourth, fifth, and sixth grade; CAI and non-CAI participants.

In the analysis of covariance procedures of reading achievement scores at the end of the year of instruction, statistically significant F values were found on the instruction method and sex main effects as well as the instruction method and grade level interaction. In the analysis of covariance procedures of the reading achievement scores two years after instruction, statistically significant F values were found for the instruction method and grade level main effects as well as the instruction method and sex interaction. It was concluded that fourth and fifth grade CAI participants scored higher on the test of reading achievement at the end of the year of instruction than did non-CAI participating students. It was also concluded that male CAI participants scored higher on the test of reading achievement two years after the year of instruction than did male non-CAI participants.

Additionally, the effectiveness of CAI as a viable instructional technique was promoted for three reasons. The increased reading achievement scores of CAI participants was not only statistically significant but when converted to grade equivalent scores was apparently important and desirable. This increased achievement of CAI participants was obtained at relatively low cost. Finally, this achievement was accomplished by middle grade students who have been considered as hopelessly unsuccessful in special reading programs.

Order No. 77-20,883, 79 pages.

EFFECTS OF TWO HUMAN DEVELOPMENT COURSE MODELS AT A COMMUNITY COLLEGE

MALONEY, Michael Joseph, Ph.D.
Loyola University of Chicago, 1977

The Problem

The literature indicates that Human Development course models are being offered extensively at the community college level, but does not describe the instructional models in depth. This study, therefore, attempted to bridge the practice/theory gap by describing the course content, methods, and learning outcomes of two Human Development course models taught at Oakton Community College in Morton Grove, Illinois.

The Purpose

The specific purpose of this study was to analyze changes in selected attitudes, values, and certain interpersonal characteristics of students enrolled in two Human Development course models at Oakton Community College in Morton Grove, Illinois. The research of Anna Miller-Tiedeman and Gerard Egan was presented as the educational bases upon which these Human Development courses were structured. Inferences were also made as to the possible causes for differences between both models and changes within both models after instruction.

The Hypotheses

The testing direction was to reject the null hypotheses at the .05 level of significance. 1. There will be no significant differences after instruction in students' attitudes and values between Model I and Model II. 2. There will be no significant differences after instruction in students' interpersonal behavior between Model I and Model II. 3. There will be no significant changes after instruction in students' attitudes, values, and interpersonal behavior within Model I: Decision Making. 4. There will be no significant changes after instruction in students' attitudes, values, and interpersonal behavior within Model II: Community Formation.

The Instruments

The Personal Orientation Inventory (P.O.I.) and the Fundamental Interpersonal Relations Orientation-Behavior questionnaire (FIRO-B) were used.

The Procedure

The Human Development course instructors emphasized learning experiences and teaching techniques pertinent to each instructional model. In Model I: Decision Making, these instructional elements were based on the research of Anna Miller-Tiedeman. Model II: Community Formation, was based on the research of Gerard Egan. Each model contained six course sections of fifteen students and met three hours a week for sixteen weeks.

The Findings

For Model I the mean P.O.I. scores of Self-Actualizing Value, Nature of Man, and Synergy regressed significantly ($p < .05$). The Acceptance of Aggression mean value remained stable while Spontaneity increased nonsignificantly towards self-actualization. The other seven P.O.I. variables disclosed nonsignificant regression towards lesser affirmation of self-actualizing attitudes and values. For Model II five mean scores increased significantly toward self-actualization:

framework that interrelates the influence of internal and external factors as they affect organizational change. Malinowski's functional theory of institutions is offered as a possible framework. Its usefulness is explored by applying it to the problems of center implementation in Florida and to the advent of teacher centers in American education.

THE EFFECTS OF NONVERBAL COMMUNICATION ON CLASSROOM CLIMATE AND ACHIEVEMENT

Order No. 7804941

WILLIAMS, Narvie Danese Hill, Ph.D. Georgia State University - School of Education, 1977. 136pp.

Purpose

This study was concerned with the effect of certain modalities of nonverbal communication of classroom teachers on student perception of classroom climate and relationships of this perception to achievement. The modalities chosen were eye contact, proximity-tactility and proximity only. The effectiveness of these modalities was compared, in combination (eye contact, proximity-tactility, proximity only) and individually, with the effectiveness of a traditional teaching method on climate and achievement. The relationship of organizational climate and worker productivity has been highlighted in the classic Hawthorne studies and the works of Chris Argyris, among others. The observation and measurement of classroom climate, while rooted in the research of H. H. Anderson (1939), reached what is perhaps its most extensive development under Ned Flanders (1967). Flanders, and some of his predecessors, have focused generally on the nature of the verbal communication occurring in the classroom as an indication of climate. The nonverbal component of communication was all but ignored until Charles Galloway (1962) applied the concept to education. The main thrust of research on nonverbal communication in the classroom has been on raising the awareness level of teaching of their own nonverbal behavior and that of their students. This study attempted to move beyond the awareness level to the testing of specific nonverbal behaviors of teachers on learning.

Methods and Procedures

The subjects of this study were 150 sixth grade students of a middle school in the Atlanta Public Schools randomly assigned to three experimenter-teachers. Each teacher had five groups of ten students each. A unit on study skills was taught to all groups using one treatment per group. The treatments were the use of all nonverbal modalities (Treatment One), the use of eye contact (Treatment Two), the use of proximity-tactility (Treatment Three), the use of proximity only (Treatment Four), and the use of a traditional teaching method (Treatment Five). Treatments 1, 2, 3, and 4 were experimental groups with treatment 5 the control group. Comparisons were made between the means of treatments 1 and 5; 1, 2, 3, 4, and 5; and between 2, 3, and 4 relative to classroom climate and achievement. Data were gathered by means of student responses at five minute intervals on electric response boxes attached to each students desk, by a student awareness questionnaire, by a criterion referenced pre and post test, and by a student attitude toward study skills and teachers inventory. A post study conference was held with subjects to clarify certain results of the data.

Results

A one-way analysis of variance revealed significance of difference between the effect of the combined modalities and the traditional teaching method on student perception of positive classroom climate ($p < .05$). The Newman Kuel procedure revealed significant differences between the means of all nonverbal modalities and the traditional teaching method on students perception of positive classroom climate. No significant difference was found between the means of all treatments on achievement.

Conclusions

The results of the data indicated a direct relationship between teachers use of nonverbal communication and students perception of positive classroom climate. Eye contact was perceived as threatening and embarrassing due to established associations with the intent of the teacher's gaze. Tactility was not desired while proximity was perceived as showing interest in student welfare. The failure of the treatments to affect achievement could be due to the lack of feedback from the pretest, or the fact that school was closing and new learning activities were not relevant. Further research should be conducted with the same and other modalities associated with varied variables. Skill in effective usage of nonverbal communication should become a part of pre and inservice teacher training.

EDUCATION, TEACHING MACHINES

COMPUTER-ASSISTED INSTRUCTION AND READING ACHIEVEMENT OF URBAN THIRD AND FOURTH GRADERS

Order No. 7804582

ANELLI, Catherine Mary, Ed.D. Rutgers University The State University of New Jersey (New Brunswick), 1977. 118pp. Chairperson: Martin Kling

The purpose of this study was to investigate the effects of various time schedules on the attention span and performance of computer-assisted instruction (CAI) users. Specifically, this study attempted to investigate the nature of the relationship between the time spent on CAI and reading improvement, performance, and attitudes.

The subjects for this study included 121 third and fourth grade boys and girls who were attending three elementary schools in Newark, New Jersey. These children received reading instruction on the computer in either twenty or forty minute time periods. The effect of these various time periods, as well as the effect of the total amount of CAI received by these children was measured by posttest scores on the Stanford Achievement Test (SAT) and by grade changes on the CAI program.

There were three levels in the treatment and each treatment level involved participants who had received less than four hours CAI or four or more hours CAI. Each treatment level involved both boys and girls and thus a total of twelve cells was created. The SAT Total pretest score and the CAI initial grade level score were used as covariates to permit comparison of treatment levels on a more equal basis.

Data resulting from this study were analyzed with the aid of the Statistical Package for the Social Sciences (SPSS), 1975 An analysis of variance with the covariates, SAT and CAI pretest scores, was used with the default and Option 9 to yield classic and regression analyses.

Neither total CAI time nor length or frequency of CAI sessions appeared to affect reading achievement as measured by the SAT. Students receiving three to four hours CAI during a three month period made the greatest progress though the CAI program in proportion to the time spent. Girls in all treatment levels made the most progress in the CAI program. The finding that girls made more progress in the CAI program than did boys may be explained by the possibility that girls were inclined to adjust their responses to the requirements of the CAI program rather than to respond according to inner convictions.

Findings reported in previous studies that CAI can be used improve performance of disadvantaged children and minimize sex differences in achievement were not found in this study. While subjects in this study also seemed enthusiastic about CAI, students were less enthusiastic after seven or eight hours accumulated machine time. Because the CAI drill material was less effective than its proponents anticipated, program modification should be undertaken to provide students with more complex reading tasks and to present material which is interesting enough to survive the effects of student habituation.

EDUCATION, TESTS AND MEASUREMENTS

THE DEVELOPMENT OF AN INSTRUMENT FOR EVALUATING FILMS FOR USE IN HIGH SCHOOL AND COMMUNITY COLLEGE TEACHING Order No. 7806668

BARNES, Richard Verle, Ed.D. The University of Florida, 1977. 106pp. Chairman: C. Glen Hass

The purpose of this study was the development of a comprehensive film evaluation instrument which might be used by high school and community college teachers in selecting entertainment films for classroom use. Guiding concepts in developing the study were the four bases of curriculum and instruction as identified by Hass, Bondi and Wiles: Social Forces; Human Development; Learning; and Knowledge.

A preliminary instrument of 70 items and six open-ended questions was designed and offered to evalutors in a pilot study. The instrument was structured around Hass et al's., four bases of curriculum and instruction and additional categories of Art, Entertainment, and General.

Subjects in the pilot study were 10 high school and community college teachers who used the instrument to evaluate a film and who evaluated the importance of each item on a scale of one to five. From the pilot study, ten items and one open-ended question were eliminated from the instrument.

Evaluators in the field test were 168 high school and community college teachers and other educators from Florida, Georgia, South Carolina, and Tennessee. Teachers who served comprised eight different academic areas identified by the investigator prior to the execution of the study. A total of 308 potential evaluators were invited to participate, with 192 evaluators returning responses. From the 192 responses obtained, 24 were eliminated from the final data analysis, primarily because of incomplete instrument responses. Thus a total of 168 evaluators' responses, obtained by mail and personal contact, were used in the validation study. Interviews were conducted with selected respondents, specifically soliciting constructive comments about the instrument and instrument items.

Internal reliability was determined by a two-way analysis of variance as recommended by Kerlinger, and was estimated to be .984. A factor analysis of the data was also run. The initial factor method was the principal axis solution, which identified 12 major factors. The factor analysis was run again, rotating 12 factors to varimax criterion, with nine factors retained in the final instrument revision. Labels were assigned to each factor. Overall, the factor analysis, along with the analysis of mean ratings by the evaluators, resulted in the elimination of 25 items, leaving a final instrument of 35 items. Instrument structure remained essentially the same, with the categories of Art, Entertainment, and General being consolidated into new categories of Aesthetics and Communication.

The major conclusion in this study is that the instrument might be useful to teachers in evaluating films, but further refinement and development needs to be done in order to assure that the instrument is useable for purposes other than experimental purposes.

A CASE STUDY OF AN EVALUATION STUDY: THE IMPACT OF FORMATIVE EVALUATION UPON MULTIPLE LEVELS OF DECISION MAKERS Order No. 7806456

BEHNKE, Grant James, Ed.D. University of California, Los Angeles, 1977. 255pp. Chairman: Professor W. James Popham

There are many factors which influence program modification decisions of project practitioners. The problems which educational evaluators commonly encounter while attempting to provide useful information to decision makers have been described by numerous evaluation theorists. There are, however, few case studies which illustrate these problems. This investigation provides a case study of an evaluation dealing with an innovative project in its initial year of operation.

The primary purpose of the evaluation study of the innovative project, Project TELEMATH, was to illustrate the systematic collection of formative evaluation data which were provided to multiple levels of decision makers. A secondary purpose of this investigation, having a more generalized significance, was to illustrate instances of the possible impact of the evaluation data upon the decision makers and to correlate these situations with the relevant contemporary literature.

The students involved in the evaluation study, and the decision makers of the case study of the evaluation, were the students and adults associated with the implementation of Project TELEMATH. Approximately 400 students in six elementary schools participated in the TELEMATH project during the 1976-1977 school year. The decision makers were classified into six levels for the purpose of the case study. These levels were: (1) Teachers, (2) Site Management, (3) Project Management, (4) Upper Management, (5) The Board of Education, and (6) State Department of Education officials.

Ongoing anecdotal documentation of pre-project planning and the formative evaluation data provided to project-related persons was maintained during the first year of Project TELEMATH's operation--from funding notification through the writing of the application for the continuation of funding. These records included written memos, a mock evaluation report, implementation and progress evaluation reports, statistical summaries, management forms, etc. These were among the data provided to the various decision audiences by the project evaluator.

Anecdotal records were maintained for resulting decisions and the apparent actions of the decision makers. These records included descriptions of the levels of decision makers involved, their reactions to the formative data provided, their actions or inactions as a result of the data provided, and a description of other environmental factors which appeared to play a significant role in the decisions and resulting actions.

An extensive review of literature is provided in this investigation which is divided into two major sections: (1) A review of factors which influence the utility of evaluation--factors generally acknowledged as within the scope of influence of the evaluator, and (2) A review of conditions which limit the utilization of evaluation--conditions generally beyond the influence of the evaluator.

A set of 14 key situations was gleaned from the anecdotal records which were collected through the first year of Project TELEMATH's implementation. Each key situation was analyzed with the emphasis of the analysis placed upon highlighting the correlation of the situation with the evaluation literature.

Situations are illustrated in which the disparate needs of different levels of decision makers were exhibited. Other situations in which one level of decision making differed from another level are illustrated. Outside factors (e.g., political, social, economic) played a more significant role upon decisions than did the formative evaluation data in many instances. All of the key situations analyzed illustrated many factors which were described in the literature.

The situations cited and illustrated in the case study of the evaluation of Project TELEMATH should assist novice

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Abstracts of Technical Report Series
November 1983

ISSUES RELATED TO THE IMPLEMENTATION OF COMPUTER TECHNOLOGY IN SCHOOLS: A CROSS-SECTIONAL STUDY
(TR-1)
Karen Sheingold
February 1981, 18 pages

This exploratory, multidisciplinary study identifies a research agenda for the educational implementation and impact of microcomputers in schools. Three geographically distinct school districts with a diversity of microcomputer applications at both elementary and secondary levels were studied. While each system was unique in its pattern of microcomputer use and the goals served by the technology, cross-site trends emerged which raise important issues for future research: (1) differential access to microcomputers; (2) the emergence of new roles in response to microcomputers; (3) the lack of integration of microcomputers into elementary classrooms and curricula; (4) the inadequate quantity and quality of software; (5) the inadequate preparation of teachers for using microcomputers; and (6) the lack of knowledge of effects and outcomes.

STUDY OF ISSUES RELATED TO THE IMPLEMENTATION OF COMPUTER TECHNOLOGY IN SCHOOLS
(TR-2)
Karen Sheingold, Janet Kane, Mari Endreweit, and Karen Billings
July 1981, 137 pages

This paper is a complete report of the research findings presented in TR-1.

MICROCOMPUTERS IN SCHOOLS: IMPACT ON THE SOCIAL LIFE OF ELEMENTARY CLASSROOMS
(TR-3)
Jan Hawkins, Karen Sheingold, Maryl Gearhart, and Chana Berger
1982

[No longer available as a technical report. Published in Journal of Applied Developmental Psychology, 1982, 3, 361-373.]

Two studies are reported which examined some possible social effects of the use of microcomputers in elementary school classrooms where children were learning to program in Logo. First, the task-related interaction that children engaged in with each other was observed and recorded in two classrooms (8- to 9-year-olds and 10- to 11-year-olds) as the children worked on both computer and noncomputer tasks. The children in both classrooms were significantly more likely to collaborate with each other when they worked with computers, as compared with their interactions in other classroom tasks. The second study examined children's perceptions of their peers as resources for help with a variety of classroom tasks; it was in the computer context that children more consistently identified certain of their peers as resources for help.

WHAT IS PLANNING DEVELOPMENT THE DEVELOPMENT OF?
(TR-4)
Roy D. Pea
Spring 1982

[No longer available as a technical report. Published in D. Forbes & M. T. Greenberg (Eds.), New Directions for Child Development: Children's Planning Strategies. San Francisco: Jossey-Bass, 1982, pp. 5-27.]

This paper provides a developmental perspective on planning abilities, synthesizing findings from developmental psychology, cognitive science, and artificial intelligence, and is preliminary to the studies of transfer of planning skills from programming (see TR-16). It is argued that making a developmental perspective on planning activities explicit may be necessary, not only for the formulation of a developmental psychology of planning, but for the development of planning skills by individuals. A report of clinical interview studies with school-aged children reveals that they have some knowledge about planning, but focus very little on the central revisionary quality of plan construction and plan execution.

LOGO RESEARCH AT BANK STREET COLLEGE
(TR-5)
Jan Jewson (Hawkins) and Roy D. Pea
Spring 1982

[No longer available as a technical report. Published in Byte, August 1982, 332-333.]

Ongoing studies of cognitive development and social collaboration in relation to learning Logo programming at Bank Street College of Education are described.

FLEXIBLE USE OF COMPUTERS IN CLASSROOMS
(TR-6)
Jan Hawkins
November 1982, 8 pages

With the increasing attention to the importance of microcomputers in schools, there is a major concern about how new teachers can best be prepared to use the technology effectively. This paper presents a perspective on teacher training, based on our classroom research with three different types of software. It concludes that teachers should be made aware of the options available for using the computer as a tool in their curricula, and how to make critical choices for integrating it with their teaching goals.

PROSPECTS AND CHALLENGES FOR USING MICROCOMPUTERS IN SCHOOLS
(TR-7)
Roy D. Pea
November 1982, 24 pages

This paper, prepared as an address for educator groups, provides a theoretical perspective for thinking about problems and prospects for integrating microcomputer uses in school activities. Six major aspects of the perspective are defined: (1) the computer as general-purpose symbolic device; (2) the importance of developmental studies of children's understanding; (3) the importance of teachers and instruction; (4) the need to make computer-based learning purposive; (5) the aim of meeting educational goals effectively; and (6) the guidance of computer use by educational values. Current innovative uses of school computer technologies are discussed in terms of this perspective.

EDUCATIONAL SOFTWARE TOOLS: DESIGNING A TEXT EDITOR FOR CHILDREN
(TR-8)
D. Midian Kurland
January 1983, 9 pages

An overview of the design process that led to the creation of the Bank Street Writer word processing program is reported. The design of this program is taken as a starting point for a general discussion of desirable features and design characteristics for good educational software. Specific points are covered about how to design educational tools, and what features these tools and their manuals should have.

ON THE COGNITIVE EFFECTS OF LEARNING COMPUTER PROGRAMMING
(TR-9)
Roy D. Pea and D. Midian Kurland
October 1983, 56 pages

[Revised version to appear in New Ideas in Psychology, 1983, 1 (3), published by Pergamon Press.]

This paper provides an historical and empirical critique of the claim that learning to program will promote the development of general higher mental functions. A developmental perspective on learning to program is provided which incorporates cognitive science studies of mental activities involved in programming, and highlights the importance of programming contexts, instructional contexts, and a student's relevant background knowledge and reasoning skills for the task of learning to program. Different levels of programming skill development and types of transfer outcomes expected from each are described.

CHILDREN'S MENTAL MODELS OF RECURSIVE LOGO PROGRAMS
(TR-10)
D. Midian Kurland and Roy D. Pea
February 1983, 9 pages

[In Proceedings of the Fifth Annual Cognitive Science Society, May 1983, Rochester, New York.]

A study is reported in which children with a year of Logo programming were asked to think out loud about the function of some Logo recursive programs, and then to predict, by hand-simulation of the programs, what the graphics turtle would draw when the program was executed. A prevalent but incorrect "looping" mental model of Logo recursion persisted, even in the face of contradictions between program effects and the children's predictions. The report concludes with a brief discussion of the need to teach program control structures, such as recursion, rather than expecting children to discover them on their own.

THE MICROGENESIS OF PLANNING PROCESSES IN A CHORE-SCHEDULING TASK
(TR-11)
Roy D. Pea and Jan Hawkins
March 1983, 55 pages

[Revised version to appear in S. L. Friedman, E. K. Scholnick, & R. R. Cocking (Eds.), Blueprints for Thinking: The Development of Social and Cognitive Planning Skills. New York: Cambridge University Press, 1984.]

This chapter provides a detailed empirical account of 8- to 9-year-olds' and 11- to 12-year-olds' performances on a chore-scheduling task developed to assess the dynamics of planning processes. Children were given multiple opportunities to construct the shortest path for accomplishing a series of classroom chores. Careful examination of the processes and products of planning activities across different trials--specifically, think-aloud protocols, strategies for problem solution, and route efficiency--revealed considerable developmental progress within sessions for both younger and older children, and robust age differences (e.g., older children engaged in significantly more higher-level decision making during planning processes).

LOGO PROGRAMMING AND PROBLEM SOLVING
(TR-12)
Roy D. Pea
April 1983, 9 pages

This paper, presented at the 1983 AERA meetings in Montreal, discusses a program of longitudinal developmental studies on learning to program in Logo by 8- to 12-year-olds. Findings from studies of the children's level of programming expertise, think-aloud studies of children's understanding of flow of control, and transfer studies of planning skill beyond the programming domain are reviewed. Although children were deeply engaged in programming projects, knowledge gains were modest and transfer of planning skill was absent. The discussion highlights the importance of guided instruction in programming microworlds and thinking skills, in addition to discovery learning.

LEARNING LOGO TOGETHER: THE SOCIAL CONTEXT
(TR-13)
Jan Hawkins
April 1983, 10 pages

The issue of the effectiveness of collaborative activity as a learning context has a long history in education and psychology. The impact of microcomputers on the social organization of classrooms in terms of the amount and type of collaborative learning was the focus of a series of studies conducted in two classrooms working with Logo. The assumptions concerning the possible impact of collaborative work, and the potential of computers for influencing this activity are outlined. Two of the studies in the research program are briefly reviewed: (1) an observational study indicating that more collaborative work occurred among children working with microcomputers than with other classroom tasks; and (2) an interview study concerning children's views of the social organization of classroom work.

RESEARCH AND DESIGN ISSUES CONCERNING THE DEVELOPMENT OF EDUCATIONAL SOFTWARE FOR CHILDREN
(TR-14)
Cynthia A. Char
April 1983, 5 pages

This paper, presented at the 1983 AERA meetings, discusses formative research efforts surrounding the development of some innovative science and mathematics software at Bank Street College. To assess the appeal of the software and its comprehensibility and usefulness, researchers conducted a classroom fieldtest in 13 elementary school classrooms. Seven measures were used, including classroom observations, student and teacher interviews, and written forms assessing students' and teachers' interest in and understanding of the software. Considerable differences in software implementation in classrooms were observed--both quantitative (e.g., the amount of time each student used the software), and qualitative (e.g., the degree and type of teacher involvement in the software experience). Research findings also pointed to the importance of studying the classroom learning context, and the significant impact of teacher and classroom variables upon software use.

SOFTWARE IN THE CLASSROOM: ISSUES IN THE DESIGN OF EFFECTIVE SOFTWARE TOOLS
(TR-15)
D. Midian Kurland
April 1983, 10 pages

This paper, presented at the 1983 AERA meetings, calls attention to the fact that, while there are few software tools developed specifically for the educational market, many excellent programs designed for businesses do exist and can be readily adapted to the needs of the classroom. The classroom computer can be used by students as a tool rather than as a tutor or electronic page turner and scorekeeper. However, learning to use and train others to use a tool designed for a different environment places an added burden on the teacher. The paper concludes that there is a need for research and development to help bridge this gap between the potential power of software tools for educational purposes and the current uses of software in schools.

LOGO PROGRAMMING AND THE DEVELOPMENT OF PLANNING SKILLS
(TR-16)
Roy D. Pea and D. Midian Kurland

[Not available until December 1983, approximately 60 pages]

Findings are presented from two separate year-long longitudinal studies of the development of planning skills among school-aged children in relation to learning Logo programming, and a theoretical context is provided for predictions of greater improvement by the programming groups. In the first year, experimental and control groups were administered a classroom chore-scheduling planning task; process and product measures of planning skill revealed no benefits for students doing Logo programming. In the second year, a microcomputer version of this task was implemented in which students gave commands to a robot to carry out the chores, and similar assessments of planning performances were collected on-line. Again, learning to program did not differentiate experimental from control group performances. Further tests of the programming transfer hypothesis are proposed.

TR-17 [Not assigned]

ON THE COGNITIVE PREREQUISITES OF LEARNING COMPUTER PROGRAMMING
(TR-18)
Roy D. Pea and D. Midian Kurland
June 1983, 91 pages

This NIE report is an extensive critical review of literature germane to the question of whether or not there are cognitive prerequisites for learning to program. Work from the fields of human factors, cognitive science, software psychology, and developmental psychology is framed in terms of a developmental perspective of programming knowledge acquisition. Candidate areas of probable prerequisites (e.g., conditional reasoning, procedural reasoning) are reviewed. The authors argue that the prerequisites question cannot be separated from the goals of programming, and that developmental analysis of the specific cognitive subtasks of programming (problem understanding, planning, code writing, comprehension, and debugging) and how they vary for different types of programming (e.g., applications versus game programming) will be required. (Includes 36-page bibliography.)

STRUCTURED INTERVIEWS ON CHILDREN'S CONCEPTIONS OF COMPUTERS
(TR-19)

[Not available until December 1983, approximately 30 pages.]

This paper discusses in-depth structured interviews with 8- to 9-year-old and 11- to 12-year-old students conducted before and after a year-long discovery-learning exposure to Logo in the classroom. The interviews explored children's conceptions of what computers are used for, the parts of the computer and how they work, the computer's role in problem solving, what people must know to use computers, and the relation between computer operations and human thinking processes.
