

1989

# A Microcomputer-Based CIA System Designed to Compliment Traditional Instruction in Navy Technical Training

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A MICROCOMPUTER-BASED CAI SYSTEM DESIGNED  
TO COMPLEMENT TRADITIONAL INSTRUCTION  
IN NAVY TECHNICAL TRAINING

by

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A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Science

Nova University

May 2, 1989

I certify that I have read and am willing to sponsor this dissertation submitted by John Kaiser. In my opinion it conforms to acceptable standards and is fully adequate in scope and quality as a dissertation for the degree of Doctor of Science at Nova University.

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## ACKNOWLEDGEMENTS

This project could not have been completed without the help and encouragement of a number of people. I am grateful for the assistance of my advisors at Nova University, especially Dr. Thomas MacFarland, and Dr. George Fornshell who forced me to focus on the real issues and express myself in a way that could be understood by others. The staff of the Aviation Boatswain Mate School at the Naval Air Technical Training Center, Lakehurst, NJ assisted greatly by providing subject matter expertise and in reviewing the prototype program. Dr. Douglas Wetzel at the Navy Personnel Research and Development Center, helped to develop the idea that grew into the concept of the dissertation. He provided the LSCAI software and was always available to help as problems came up with its implementation. I would also like to thank Dr. Nancy Perry in the Chief of Naval Education and Training's Office of Training Technology Implementation for reviewing the concept of the project and providing valuable comment and support. My wife, Caro, who was often neglected over the past year while I was hard at work in my office, never failed in her support and was always there to provide encouragement when I needed it the most. To her I owe the greatest debt of gratitude.

## ABSTRACT

A prototype microcomputer-based CBI program was developed to provide review, structured self-study, and remediation to students undergoing initial skills training at the Naval Air Technical Training Center (NATTC), Lakehurst, NJ. The program demonstrates the capabilities of the authoring (LSAUT) and delivery (LSSTU) programs that are parts of the Language Skills Computer Aided Instruction (LSCAI) system developed by the Navy Personnel Research and Development Center and the University of Utah. A course of instruction at NATTC, Lakehurst was selected for this project on the basis of level of training, student throughput, attrition and setback rates, and category of learning objectives. Student and instructor evaluations of the program were conducted. A preliminary cost-effectiveness analysis is presented. Conclusions and recommendations include: (1) Development of the prototype program should be continued; (2) The LSCAI system should be considered for this type of application when learning objectives require the remembering of facts, especially the learning of technical vocabulary; (3) Use of microcomputer-based review, structured self-study and remediation can reduce the requirement for experienced instructors; (4) This type of CBI can be cost-effective when implemented on low-cost microcomputers using inexpensive software; (5) demonstration projects such as this should be encouraged and funded to facilitate the movement of technology from the laboratory to the classroom; (6) drill and practice type CBI that uses the capabilities of modern microcomputers can be challenging, interesting, and enjoyable and Navy development of systems that exploit these microcomputer capabilities should be continued; and (7) this type of review program should be considered for use on Navy ships to augment on-the-job training.

# TABLE OF CONTENTS

	Page
Acknowledgements . . . . .	ii
Abstract . . . . .	iii
List of Tables . . . . .	viii
List of Figures . . . . .	ix
 Chapter	
1. Introduction . . . . .	1
Statement of Problem . . . . .	1
Background . . . . .	4
Purpose . . . . .	9
Significance . . . . .	11
Definition of Terms . . . . .	13
2. Review of the Literature . . . . .	16
Use of Computers in Education and Training . . . . .	16
History of Computers in Education and Training . . . . .	16
Proliferation of Microcomputers . . . . .	18
Acceptance of Microcomputers for . . . . . Education and Training	21
Effectiveness of Computer-Based Instruction . . . . .	28
Viability of Drill and Practice as a Form . . . . . of CBI	31
Selective Application of CBI for Specific . . . . . Learning Objectives	34
CBI as an Adjunct to Traditional Instruction . . . . .	36
Navy Policies and Current CAI Initiatives . . . . .	37
Naval Education and Training Command Policies . . . . .	37
Current Navy CAI Initiatives . . . . .	38
Evaluation of Instructional Software . . . . .	43

Table of Contents - Continued

3.	Design Procedures and Methodology . . . . .	47
	Overview . . . . .	47
	Selection of a Course Unit . . . . .	52
	Authoring of CBT Courseware . . . . .	57
	Evaluation of Instructional Software . . . . .	58
	Cost-Effectiveness Analysis . . . . .	61
	Summary . . . . .	63
4.	Results . . . . .	65
	Selection of a Course Unit . . . . .	65
	Course Stability . . . . .	65
	Level of Training . . . . .	65
	Annual Throughput . . . . .	66
	Attrition and Setback Rates . . . . .	67
	CBI Benefit Analysis . . . . .	67
	Nature of Learning Objectives . . . . .	67
	Authoring Instructional Software . . . . .	70
	Authoring System . . . . .	70
	Prototype CBI Program . . . . .	71
	Introduction of Exercise Words . . . . .	73
	Hidden Multiple Choice . . . . .	74
	Visible Multiple Choice . . . . .	75
	Matching . . . . .	76
	Graphics Labeling . . . . .	78
	Cloze Paragraph (Fill in the Blanks) . . . . .	80
	Exercise Scoring . . . . .	82
	Evaluation of Instructional Software . . . . .	84
	Student Evaluation . . . . .	84

Table of Contents - Continued

Staff Evaluation . . . . .	86
Cost-Effectiveness Analysis . . . . .	87
5. Discussion, Implications, and Recommendations . . . . .	88
Selection of a Course Unit . . . . .	88
Course Stability . . . . .	90
Level of Training . . . . .	90
Throughput . . . . .	91
Attrition/Setback Rates . . . . .	91
Analysis of Learning Objectives . . . . .	92
Authoring of CBI Courseware . . . . .	93
Qualifications of the Courseware Developer . . . . .	96
Courseware Development Time . . . . .	97
Problems in Authoring Courseware . . . . .	98
Authoring System Capabilities . . . . .	99
Pilot Test of Courseware . . . . .	99
Student Evaluation . . . . .	100
Staff Evaluation . . . . .	102
Cost-Effectiveness Analysis . . . . .	103
Cost of Hardware . . . . .	105
Microcomputer Maintenance . . . . .	106
Cost of Software . . . . .	106
Cost of a Secure Facility (Computer Lab) . . . . .	106
Cost of Personnel to Staff Computer Lab . . . . .	107
Cost of Courseware Development . . . . .	107
Cost Savings Due to Reduced Attrition . . . . .	108
Cost Savings Due to Reduced Setbacks . . . . .	109



Table of Contents - Continued

Cost Savings Due to Less Review Time . . . . 109  
Needed in Class

Cost Savings from Reduced Need for . . . . 110  
Evening Review Periods

Conclusions and Recommendations . . . . . 110

References . . . . . 113

Appendixes

A. Authoring Tool Evaluation Form . . . . . 118

B. Student Software Questionnaire . . . . . 125

C. Instructor Software Evaluation Checklist . . . . . 127

Biographical Sketch . . . . . 129

Signature Page . . . . . 130

LIST OF TABLES

Table	Page
1. Plan of Action and Milestones (POA&M) for the Development of a Microcomputer-Based Review, Structured Self-Study and Remediation Program . . . .	50
2. NATTC, Lakehurst Course Information . . . . .	52
3. Benefit of CBI for NATTC, Lakehurst Courses Based on Training Level, Throughput, and Attrition/Setback Rates . . . . .	54
4. IQI Task/Content Matrix . . . . .	56
5. Level of Training of courses presented at NATTC, Lakehurst . . . . .	66
6. NATTC, Lakehurst Courses Rank Ordered by Planned Annual Throughput . . . . .	66
7. NATTC, Lakehurst Courses with Attrition or Setback Rates Greater than Zero . . . . .	67
8. Benefit of CBI for NATTC, Lakehurst Courses Based on Training Level, Throughput, and Attrition/Setback Rates . . . . .	68
9. Number and Percentage of PR Basic Course Learning Objectives in Each IQI Task/Content Category . . . . .	68
10. Number and Percentage of ABH A-1 Course Learning Objectives in Each IQI Task/Content Category . . . . .	69
11. Number and Percentage of ABF A-1 Course Learning Objectives in Each IQI Task/Content Category . . . . .	69
12. Courseware Development Time . . . . .	70
13. Student Evaluation Statements and Number of Evaluators who Agreed With Each of Them . . . . .	84
14. Costs and Cost Savings Resulting from Implementation of a Microcomputer-Based Review System . . . . .	87

# LIST OF FIGURES

Figure	Page
1. Main Menu Screen . . . . .	71
2. Exercise Introduction Screen . . . . .	72
3. Review Screen Containing Textual Material . . . . .	74
4. Review Screen Containing Both Text and Graphics . . . . .	75
5. Hidden Multiple Choice Screen . . . . .	76
6. Visible Multiple Choice Screen . . . . .	77
7. Visible Multiple Choice Screen With a Sentence Differentiating Between Often Confused Definitions . . . . .	77
8. Matching Screen . . . . .	78
9. Graphics Labeling Screen . . . . .	79
10. Graphics Labeling Screen That Prompts Student for a Second Try . . . . .	80
11. Cloze Paragraph Screen Before Filling in the Blanks . . . . .	81
12. Cloze Paragraph Screen with an Error After the First Try . . . . .	81
13. Cloze Paragraph Screen with an Error After the Second Try . . . . .	82
14. Score Summary Screen . . . . .	83

## Chapter 1

### INTRODUCTION

#### Statement of Problem

In spite of the wide availability of low-cost microcomputers throughout the Navy Training Command and study results recommending that computer-aided instruction be considered for certain training applications (Wetzel et al. 1987a, 27; Wetzel et al. 1987b, 21), little use is being made of microcomputers for the training of students. Navy policy states that interactive courseware is to be used whenever it is the most cost effective means of supporting instructors and enhancing the instructional process (CNET 1988b, 1). There has been a great deal of interest in using microcomputers in military training to improve instruction or to supplement limited instructor resources (Wetzel et al. 1987a, 1). The complexity of modern military equipment is placing increasing demands for technically trained personnel on the Navy training establishment. At the same time, the number of enlisted personnel authorized by the congress for the Navy has not kept pace with the growth in the number of ships. There are not enough experienced people, therefore, to increase the number of instructors to meet the increased training demands.

Computers have been used for some time to assist Navy instructional staffs in the management of instruction (Kearsley, 1983, 27). With the proliferation of microcomputers in the military, as well as the private sector, it was thought that the use of computer-based training (CBT) might be appropriate to augment the instructional staff in the delivery and management of instruction (Wetzel et al., 1987a, 1). Several evaluations of Computer-Based Instructional software indicate that they can improve effectiveness and efficiency for some kinds of training. It is realized, however, that computer-managed or assisted instruction is not a panacea and that not all instruction is appropriate for computer-aided instruction. Based on a survey that was conducted to determine the instructional delivery and course management techniques currently used in Navy technical courses and to assess the suitability of microcomputer support in such courses, Wetzel Van Kekerix and Wulfeck (1987a, 27) concluded that computer-based instruction (CBI) should be used for a number of specific applications and that learning objectives involving drill and practice, simulation, remembering facts, and the use of procedural steps occur frequently and are particularly amenable to computer-based instruction. Wetzel, Van Kekerix and Wulfeck (1987b, 21), in a companion study, analyzed instructional objectives in a large number of Navy courses and found that the high emphasis on training objectives for remembering facts and remembering procedural steps in Navy

schools should be supported with computer-based instruction involving drill and practice and simulation.

Although the potential for computer-based instruction (CBI) has been identified, little Navy training is being delivered by computer. Wetzel, et al. (1987a, 23) found that only 12.6 percent of all courses surveyed used some form of computer-based instruction, while 27 percent of the course managers could nominate at least one course module as being suitable for CBI. A number of reasons for the slow acceptance of computer-assisted instruction have been put forth (Leiblum 1982; Zemke 1984; Levin and Meister 1986; Schiffman 1986; Maloy and Perry 1986; Schofield and Verban 1988). Barriers to utilization of computers for the delivery of instruction include the cost and availability of hardware, a lack of learning theories to support the medium, cost and quality of available software, difficulty of programming, and lack of teacher training.

The selection of the Zenith 248 as the Navy standard microcomputer in 1984 and a contract with Zenith that was entered into jointly by the U.S Navy and U.S. Air Force resulted in the wide availability of very capable microcomputers at relatively low cost. The Navy's Low Cost Microcomputer Training Systems project (DCNO (MPT) 1986, 62; NPRDC 1987) addressed the problems of excessive CBI development time and costs, the requirement for programming expertise and the standardization of previously developed CBI on widely available computers. The resulting Computer-Based Educational Software System (CBESS)

provided a set of CBI authoring and delivery programs that are transportable to a wide range of computer systems.

In spite of the progress made in solving some of the problems identified above, the use of microcomputers for training has continued to be slow to develop. Several authors point to a lack of planning for CBI implementation as the most important reason. Maloy and Perry (1986, 25) describe the problem as one of communication between the research community and the trainers. Training technology implementers who are aware of the capabilities being developed in the laboratory and, at the same time are aware of real world implementation requirements must facilitate the flow of information in both directions. They have to establish demonstration projects that show the capabilities of new technology, conduct cost-benefit analyses and assist in implementation of the new technology. Cassanova (1989, 44) agrees that differing perspectives of practicing educators and researchers must be recognized and deliberately addressed if we are to integrate research and practice in education.

#### Background

Prior to 1977, computer applications in education were the domain of large projects that had the funds necessary for expensive computers. The introduction of microcomputers at that time made it possible for a wide range of smaller institutions,

and even individuals to start using them for educational purposes. Since that time there has been phenomenal growth in the educational use of computers.

Administrative uses were the first applications of computers in education, both for central office and classroom administration. Computer applications were later developed for the actual delivery of instruction. The various kinds of educational applications include tutorial instruction, drills, simulations, instructional games, tests, problem-solving environments, teaching tools, games, intelligent computer-assisted instruction (ICAI), and computer-controlled video (Alessi and Trollip 1985, 50-56).

Some of the specific objectives of computer-based training are increased control, reduced resource requirements, individualization, timeliness and availability, reduced training time, improved job performance, convenience, change agent, increased learning satisfaction, and reduced development time (Kearsley 1983, 2). Computer-based training, is not appropriate for all training situations, however. Kearsley (1983, 18) proposes a "CBT Benefits Checklist" that can be used to determine whether computer-based training should be used for a particular training situation. He (Kearsley 1983, 18) says:

No matter how appealing the idea may be, if CBT does not meet a real training need or organizational goal, it is almost certain to flounder somewhere along the way. In other words, if the training application being analyzed results in all "no" answers in [the CBT Benefits Checklist], then you should abandon the idea



of CBT and consider a more suitable training medium or approach.

In a later book, in which he described artificial intelligence applications for instruction, Kearsley (1987,v) says that over the years, he has become increasingly disenchanted with the value of computer-assisted instruction programs. He feels that most of our current attempts to use computers for instruction are too simplistic, and that more sophisticated instructional software is needed to employ the kind of teaching strategies and subject-matter knowledge possessed by good teachers. He initiated a research program to get intelligent computer-assisted instruction (ICAI) into the real world. An important part of that program was implementing ICAI programs on commonly available personal computers.

Wetzel, Van Kekerix, and Wulfeck (1987a, viii), in a study to assess how appropriate and acceptable microcomputer support would be for instructional delivery and course management, concluded that computer-based instruction (CBI) should be used for a number of training delivery applications. They (Wetzel, Van Kekerix, and Wulfeck 1987a, viii) pointed out, however, that:

While improvements resulting from easing clerical or administrative tedium are easy to foresee, the value of CBI applications in delivering instruction requires scrutiny. Rather than computerizing entire curricula, a more rational path is to identify selected CBI applications that do offer an improvement.

In their companion study, Wetzel, Van Kekerix, and Wulfeck (1987b, 20) concluded that most courses have many types of

learning objectives, some of which are better adapted to CBI than others. They felt that CBI should be integrated with conventional classroom and laboratory instruction in selected applications that offer some form of improvement for specific training objectives or course components. CBI should be used as a tool or aid for the instructor, rather than replacing the instructor. Specific situations suitable for selective application of CBI include supplementing instructor resources, laboratories, and trainers with excessive wait times and presentation of introductory or familiarization materials, tasks requiring high levels of practice, dynamic graphic representations of difficult concepts, and simulated procedures training for equipment operation and maintenance. Specific recommendations for the Navy education and training community were made (Wetzel et al. 1987b, 21):

1. Selection and introduction of CAI and CMI into specific Navy schools should be based on the nature of the training objectives, the level of training to be provided, and the availability of laboratory equipment and trainees.

2. The high emphasis on training objectives for remembering facts and using procedural steps in Navy schools should be supported with computer-based instruction involving drill and practice and simulation.

3. CAI should be considered for selected training modules judged to benefit from conversion, rather than for all types of curricula. Situations suitable for application of CBI include supplementing instructor resources, laboratories, and trainers with excessive wait times and presentation of introductory or familiarization materials, tasks requiring high levels of practice, dynamic graphic representations of different concepts, and simulated procedures training for equipment operation and maintenance.

4. Recent initiatives to move some shore-based training to shipboard sites should be supported where appropriate with standard computer-aided instructional delivery and management packages.

5. Continuing work should be supported to develop guidelines as to when CBI is appropriate and to develop technical aids for CBI authors so that they can develop quality CBI for their students. Many CBI capabilities can be provided by the Computer-Based Educational Software System (CBESS) on Navy standard microcomputers.

Some other researchers have also recognized that certain types of CAI are more applicable to some learning situations than others. Bell (1985, 37), for example, in discussing the evaluation of microcomputer-based instructional software suggests that one approach is to identify the skills each type of software can teach, and then select an instructional theory that addresses the identified skill. Merrill, et al. (1986, 11) propose using Gagne's Learning Outcomes to choose a particular type of CAI application.

Wetzel, Van Kekerix and Wulfeck (1987b) used portions of the Instructional Quality Inventory (IQI), previously developed at NPRDC (Wulfeck, et al., 1978; Ellis et al., 1979) and described in the Handbook for Testing In Navy Schools (Ellis and Wulfeck, 1982), to classify lesson objectives by Content Type and Task Level. Content Types include FACT, CATEGORY, PROCEDURE, RULE, and PRINCIPLE. Task Level describes whether the student must REMEMBER the content or USE it. If it is a USE task, it is further classified as AIDED if a memory aid is given, or UNAIDED if a memory aid is not. Generalizations were

made about what kinds of CBI are applicable to the IQI content levels.

Wetzel, Van Kekerix, and Wulfeck (1987b, 16) note that while CBI authoring systems or languages provide a general facility for creating CBI without the need to know how to program, they may be unable to handle many specific applications that require complex databases or special presentation formats. The Computer Based Educational Software System (CBESS) programs contain elements to handle specific learning strategies.

### Purpose

Although Navy policy is to use interactive courseware when it is the most cost-effective means of supporting scarce instructor assets, little use is being made of widely available low-cost microcomputers to deliver instruction in Navy schools. The purpose of this dissertation is to demonstrate that available CBI systems can be used effectively to augment traditional classroom/laboratory instruction by providing students with a vehicle for review, structured self-study and remediation. Traditional instruction in most Navy schools is presented in a lecture format by an instructor using an overhead projector, a chalkboard, and a few training films. Classroom sessions are augmented by laboratory periods during which students view training aids or actual pieces of equipment. Some hands-on practice may be allowed in the laboratory. Material covered is reviewed briefly at the end of each classroom period

and an extensive review is provided at the end of each phase of instruction. Additionally, instructors hold review sessions in the evening for students who are having difficulty or who desire extra help. The system presented here uses the same teaching methods that the experienced instructor uses in the classroom to review material that has been covered. Students, many of whom do not have good study habits on their own, will use the system in the evening to review material, thereby reducing the requirement for review time in class and instructor involvement in the evening. It will show that the availability of low-cost microcomputers and courseware developed and delivered using Computer-Based Educational Software System (CBESS) products, such as the Language Skills CAI (LSCAI) program, reduce the costs of this kind of CBI system to a level at which such use may be cost effective. An extension of the Low-Cost Microcomputer Training Project of the Navy Personnel Research and Development Center, San Diego, CA, the dissertation describes a demonstration project that will provide information about development costs and difficulties in using the LSCAI authoring and delivery programs, as well as describing the capabilities and limitations of the resulting courseware. Finally, the project supports the philosophy of the Training Technology Implementation office on the staff of the Chief of Naval Education and Training in that it provides a bridge between the research and instructional communities, demonstrating a use of the technology while, at the same time, providing feedback as to its effectiveness.

## Significance

The Navy's need for skilled technical personnel is increasing (Wetzel, Van Kekerix and Wulfeck 1987b, vii). Equipment is becoming more complex and the size of the fleet has increased over the past several years. The number of Navy enlisted personnel allowed by the congress has not kept pace with the growth of the fleet. Much pressure has been placed on the training establishment to reduce the number instructors so that those currently involved with training people can be reassigned to the fleet. If some of the workload traditionally required of instructors can be eliminated or transferred to less experienced personnel with the assistance of low-cost microcomputers, that pressure will be relieved. Much has already been accomplished in reducing instructor workload by using microcomputers in the management of training. Little has been done to help them with actual instruction. The use of microcomputers to provide review, structured self-study and remediation could reduce instructor requirements considerably.

This dissertation is intended to demonstrate that, with the use of the Computer-Based Educational Software System, Navy trainers can develop CAI that will have that capability. The final report will be submitted to the Navy Personnel Research and Development Center for publication as a Technical Report and distribution throughout the Navy Technical Training Command. It is expected that Navy trainers will be encouraged to use the CBESS system to increase the use of Navy standard microcomputers

to improve their instructional productivity and reduce the requirement for experienced instructors.

The most significant results of the dissertation may be the demonstration that microcomputer-based review, structured self-study and remediation can be effective, and that with widely available low-cost microcomputers and inexpensive courseware, drill and practice applications that supplement normal classroom instruction can be cost-effective. Here-to-fore, the high cost of computer hardware and software required that CBI replace whole courses of instruction to be cost-effective. This project will show that it is now possible to augment instruction with drill and practice that uses the full power of a low-cost microcomputer to present high resolution graphics and dynamically produce exercises from information contained in knowledge bases that are separate from the delivery system. While many of the modern approaches to CAI such as simulation and Intelligent CAI are not amenable to the highly structured behavioral learning theory embedded in the Navy's Instructional Systems Development system, this dissertation will show that effective and interesting CAI can be designed to support certain types of behavioral learning objectives.

Maloy and Perry (1986, 25) discussed a role for a new class of professionals who are familiar with both the research and instructional communities and who can focus, full time, on the implementation process. This dissertation shows how these "implementers" can act as a bridge between the researchers and instructors, demonstrating new technology, feeding back inform-

ation on problems and needs of instructors, and articulating the cost-effectiveness of technology in light of real world implementation difficulties.

While the CAI module developed for this project is intended to support instruction at the Naval Air Technical Training Center at Lakehurst, NJ in teaching initial skills, it may be useful as a vehicle for refresher training for personnel already assigned to the fleet. This would support Navy initiatives in strategic homeporting, which requires training to be distributed across the country rather than concentrated in a few geographic locations. It could also result in the movement of some shore-based training to on-board ships, another Navy goal.

#### Definition of Terms

CAI. See Computer-Aided Instruction

CBESS. See Computer-Based Educational Software System.

CBI. See Computer-Based Instruction

CBT. See Computer-Based Training

CMI. See Computer-Managed Instruction

CNET. Chief of Naval Education and Training located in Pensacola, FL. Responsible for the Navy Education and Training Command

Computer-Aided Instruction (CAI). The use of the computer for actual instruction. For the purposes of this paper, includes both Computer-Assisted Instruction (drill and practice, tutorial, and socratic instructional strategies) and Computer-Assisted Learning (simulation, games, database, and programming instructional strategies)

Computer-Assisted Instruction. Use of the computer for actual instruction using drill and practice, tutorial, and socratic instructional strategies. Often used interchangeably with Computer-Aided Instruction



Computer-Based Educational Software System (CBESS). The beginning of a core library of Navy CBI software. Developed by NPRDC and the University of Utah, CBESS contains authoring and delivery systems for specific CBI packages tailored to memorizing factual databases, learning technical vocabularies, and solving equipment troubleshooting problems

Computer-Based Instruction (CBI). Synonymous with Computer-Aided Instruction (CAI)

Computer-Based Training (CBT). Use of computers for training and training management and administration. Often used interchangeably with Computer-Aided Instruction

Computer-Managed Instruction (CMI). Use of computers for training management, including registering, scheduling, testing, and reporting student progress

Courseware. Computer software used to present courses of instruction or other instructional material

Drill and Practice. Refers to those CBI systems that are designed to exercise previously learned material

ICW. See Interactive Courseware

Instructional Quality Inventory (IQI). A scheme to classify learning objectives and test items according to what the student must do (TASK) and the type of information the student must learn (CONTENT)

Instructional Systems Development (ISD). A systematic approach to the development of instructional systems as used by the U.S. Navy. It integrates the processes of development, implementation, and evaluation proceeding from an analysis of job task inventories to a selection of tasks to be trained, the identification of skills and knowledges required, the development of training objectives, the design and development of training materials, the conduct of courses, and the evaluation of courses and course materials. Detailed standard requirements are contained in MIL-STD-001379C (NAVY) which supersedes various other standards

Interactive Courseware (ICW). Computer-based instruction, with or without the use of video-disk, that supports the learning process.

IQI. See Instructional Quality Inventory

ISD. See Instructional Systems Development

LSCAI. Language Skills Computer-Aided Instruction. A CBESS program that provides learning and testing exercises for technical vocabulary and reading skill.

Low Cost Microcomputer Training Systems Project. A research and development project being conducted by Douglas Wetzell, Ph.D and Wallace Wulfeck, Ph.D at the Navy Personnel Research and Development Center (NPRDC), San Diego, CA. It is intended to facilitate improved training productivity at acceptable costs by producing software for a CBI system and guidelines for microcomputer applications in Navy education and training

Microcomputer. Family of small computers, often referred to as personal or desktop computers. Operation is based on a microcomputer integrated circuit chip

Navy Personnel Research and Development Center (NPRDC). The U.S. Navy's research and development laboratory for manpower, personnel, and training projects and studies. Located in San Diego, CA

NPRDC. See Navy Personnel Research and Development Center

Navy Technical Training Command. The portion of the Navy Training Command that falls under the command of the Chief of Naval Technical Training. Provides Recruit Training and initial and advanced technical skill training

Navy Education and Training Command. The Navy training establishment that falls under the command of the Chief of Naval Education and Training. Provides most schoolhouse training in the Navy including flight training, technical skill training, recruit training and fleet training

Navy Integrated Training Resources and Administration System (NITRAS). An ADP system maintained by the Chief of Naval Education and Training to centrally manage Navy training.

OP-01. Office code for the office of the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) located in Washington, DC

R&D. Research and Development. Research normally applies to basic research while development applies to the application of research in the development of methodologies and systems

Remediation. Review or presentation of material that students should already have learned, but have not for some reason or another. For the purposes of this project remediation refers to review of technical skills that students have not mastered prior to taking an examination. In the literature, remediation often refers to reteaching of basic skills such as English and arithmetic

Strategic homeporting. The stationing of Navy ships at a number of coastal cities rather than basing them at relatively few large Naval complexes. Dispersing the ships across many home ports reduces their vulnerability to wartime attack, but increases logistics problems.

## Chapter 2

### REVIEW OF THE LITERATURE

#### Use of Computers in Education and Training

##### History of Computers in Education and Training.

A number of authors have reviewed the history of the use of computers in training and education. Bell (1985, 36) marks the beginning of the "classroom technology" revolution in the United States at about 25 years ago with the introduction of the teaching machine and programmed instruction. Kearsley and Seidel (1985, 62-64) see two distinct paths in the history of computers in education. The first is related to the development of teaching machines based on the work of Pressy and Skinner, and the second is from the domain of flight trainers or simulators. Skinner's theory of operant psychology led to the methodology of programmed instruction that was popular between 1955 and 1965 and provided the conceptual basis for early work with computer-assisted instruction (CAI). The two tracks stayed separate until recently, with CAI aimed toward conceptual learning on general purpose computers while simulators taught decision making or hands-on skills on specially designed machines. The emergence of the microcomputer has caused the convergence of the two approaches. The practitioners in the two

domains have been drawn together by a common interest in the psychology of the user interface.

Kearsley and Seidel (1985, 63) note that, to a great extent, the history of CAI has been a series of research projects in education. The evolution of computer technology has always been the driving force in the development of automated instruction. Early CAI systems were developed on time-sharing mainframe computers. Systems such as Control Data's PLATO and Hazeltine's TICCIT added graphics and sophisticated answer analysis capabilities, greatly increasing the kinds of instruction available, but it was the emergence of easily available, low cost microcomputers that really gave CAI a technology push. Kearsley and Seidel (1985, 63) lament that the instructional theory that underlies automated instruction has not kept pace with the development of the hardware. Kearsley and Seidel (1985, 64) see some exceptions (TICCIT and LOGO) and say that CAI is more effective than other media provided that it is well designed and properly implemented, but they look for much greater gains with the development of intelligent computer-assisted instruction (ICAI).

Alessi and Trollip (1985, 47-50) mark the first use of computers in education at the end of the 1950s with the introduction of second generation computers. Large universities were using computers for administrative purposes and some people began to use them for instructional research. From the mid 1960s through the mid 1970s, third generation computers became available in increasing numbers and at lower cost allowing more

school systems and colleges to use them for administrative purposes, but instructional use remained primarily the domain of the universities. Only a few private corporations and the military took any interest in developing instructional uses. PLATO and TICCIT became commercially available during that period and are still being used, in updated forms, today. In the mid 1970s a few small computer companies began experimenting with microcomputers. None were very successful until 1977 when Radio Shack and Commodore introduced the TRS-80 and the PET computers, and Apple Computer introduced its own computer of the same name. With these microcomputers, it became possible for small schools and even individual teachers to buy a computer and start using it for educational purposes. From 1977 to today we have seen phenomenal growth in the educational use of computers.

#### Proliferation of Microcomputers.

Bear (1984, 11) said:

Evidence abounds that microcomputers will play an influential role in education in the 1980's. They have entered classrooms at an amazing rate. The growth has been augmented by the belief among both educators and the general public that microcomputers will improve the instructional effectiveness of schools.

Bear (1984, 11) references a Time Magazine article that reported that 68 percent of registered voters feel that the microcomputer will improve the quality of their children's education. Observing that few educators are trained to use the new technology,

however, and that there has been little research to support its cost-effective use, Bear (1984, 11) concludes that the advocacy of microcomputers in schools has come not from college trainers or from educators in the field, but from the manufactures of microcomputer hardware and software.

Lukesh (1987, 13) says that it is common knowledge that microcomputers are proliferating on college and university campuses around the country, but that our understanding of this proliferation and of the integration of the microcomputers into the curriculum is hazy. From a survey of microcomputer usage in educational institutions who are members of EDUCOM, she found that the average weekly hours of access to institutional microcomputers each student and faculty member had ranged from two hours in public schools and in universities to six hours in four year colleges. While there is a wide range in these values, and some question about whether all available microcomputers were counted, the microcomputer time available appears to be substantial. But, while 74% of the institutions that responded to the survey provided assistance for faculty in using microcomputers for instruction, only 22% had formal projects for integrating microcomputers into the curriculum and only 34% had formal plans to do so.

Levin and Meister (1986, 745) agree that "In the 1980's, computers and education have become inextricably linked in the minds of citizens and on the agendas of school reformers." The price of microcomputers has fallen by 50 percent since 1980.

There has been a tremendous surge in the development of educational software over that same period of time. They (Levin and Meister 1986, 746) make the point, however, that in the rush to join the computer revolution, schools do not always take the time to plan properly and CAI may not be the most cost-effective approach. Levin and Meister (1986, 746) state that almost 90 percent of the cost of CAI is associated with personnel, software, training, and other factors so the reduced cost of the hardware does not necessarily mean that CAI has become cost-effective. In a comparison between CAI and three other methods, they found that peer tutoring was more cost-effective than CAI.

Niemiec, Blackwell and Walberg (1986, 750) dispute Levin and Meister's conclusions because of difficulties with their methodology, and show through their own calculations that CAI is more cost effective than all of the other methods. Kearsley and Seidel (1985, 68), in discussing important issues and problems with CAI, say that one of the most important issues is the significant time and cost associated with the development of computer-based instructional materials.

Diem (1986, 97) in his discussion of a review of case studies to examine the socio-environmental impacts of microcomputers in a variety of classroom environments summarized his findings as follows:

After a quarter century of use, the microcomputer has become an accepted pedagogical tool at all academic levels. Students now come to educational environments with a familiarity of microtechnology unknown 10 or even 5 years ago. Unfortunately, both technological

instructional integration as well as background preparation have, in some cases, not kept pace with student acceptance of the technology.

He goes on to suggest that if we are to capture the instructional power that the technology offers, educators must fully develop their technological skills and be encouraged to use them in the classroom.

### Acceptance of Microcomputers for Education and Training

A number of roles have been put forth for microcomputers in education and training. Scandura (1983, 15) lists three major roles for the computer to play in education: (1) as an object to be understood (learning about the effects of computers); (2) as an object of study in its own right (learning about computers); and (3) as a means of assisting the learning process (using computers to promote school learning). CBT falls in the last category. Maddux and Cummings (1986, 34) classify CBT into two groups. Type I uses include drill and practice, tutorials, educational administrative uses, computer managed instruction, and assessment uses. Type II uses include word processing, programming, simulations, and prosthetic aids for the handicapped. They see Type I uses as those that merely make it easier or more convenient to continue teaching in traditional ways. Type II uses make new and better teaching methods available. They (Maddux and Cummings 1986, 34) believe that continued emphasis on Type I uses will result in a backlash against educational computing that will cause the whole movement to fail.



Bell (1985, 36) describes three characteristics that the current "technology revolution" shares with the early attempts with educational technology. First, it is a reaction to a technological threat from Japan just as early attempts were a reaction to the Soviet Union's Sputnik. Second, the microcomputer is advocated to provide the skills essential to future survival. Lastly, it is a reaction to a flood of instructional software being developed at a great rate and released in an untried and untested form by publishers. The problem with all of this, as Bell (1985, 36) sees it is that "microcomputer courseware has proceeded largely independent of the knowledge base for instructional psychology." She proposes that the skills that each type of software (drill and practice, tutorial, and simulation) can teach be identified, and then select the instructional theory that most specifically addresses the identified skill.

Stallard (1987, 154), concerned that computer education could develop as a fad, fueled by media pressure, rather than as a sound educational undertaking, discusses four common reasons schools pursue the integration of computers into their programs: (1) technological awareness; (2) improved productivity; (3) Cost containment/cost reduction; and (4) improving student achievement. He (Stallard 1987, 156) states that applications should mesh with the instructional needs of the school, but that it is not generally productive to push the technology on

teachers unless it is backed by a thorough plan based on sound premises for using the computer.

Kearsley (1987, v), a long time proponent of CAI, in the prologue to his latest book, notes that over the years he has become increasingly disenchanted with the value of CAI programs. He feels that current attempts to use computers for instruction are too simplistic to have significant effects on learning. He says that we have to be able to incorporate the kind of teaching strategies and subject matter possessed by good teachers into our programs. The challenge is for the intelligent computer-assisted instruction (ICAI) community to learn how to develop such programs starting with the current generation of personal computers.

Why, with all of its promise and grandiose claims, has CAI been so slow to catch on. Zemke (1984, 22-23) quotes Fred O'Neal, Technical Director of Training Systems at WICAT Systems, Inc. who discusses three impediments to the proliferation of CAI. First is the cost of hardware, second the lack of a reliable, easy-to-use technology for instructional design, and finally, symbol manipulation, primarily programming time. Zemke (1984, 24) also quotes the reservations expressed by Dr. David G. Gueulette, an associate professor of education at Northern Illinois University about the wholesale use of computers in training. Gueulette's concerns include: truly effective applications of CAI in public schools have not been particularly extensive; microcomputers are elaborate,

interrelated and dependent systems and are therefore vulnerable to failure; pilot training and driver training simulators lack the ability to teach hands on effectively and few programs are able to convey affective learning objectives or encourage intuitive or serendipitous learning; and as much as one half of the population has a cognitive structure that resists learning from the highly linear and orderly processes of the computer.

Leiblum (1982, 67-68) writes that the slower than expected growth in the use of the computer as an instructional medium is due to disappointment over partially or unfulfilled expectancies about the development of learning theories to support the medium, and the expectation that lower costs would somehow produce an increase in the production of quality CAL programs. The medium has also been misused because certain criteria were overlooked in the selection process and because some factors were underestimated in the planning of CAL applications. Leiblum reviews those factors and provides a checklist for future CAL proposals. Levin and Meister (1986, 746) also cite lack of planning as the reason that microcomputers are underused or unused. Educators think that the purchase price is the principle cost of implementation when it is really only a small portion. Important factors such as trained personnel, good software, maintenance, and secure facilities are ignored.

Schiffman (1986, 7) lists four common explanations for the slow growth in the use of computer software to enhance instruction in the academic curriculum. They are: (1) lack of

quality software; (2) lack of sufficient software and/or hardware; (3) high cost of hardware and software, and (4) lack of teacher training. Shiffman adds "vision" as another factor to explain why some schools that have sufficient hardware and software and teachers who have been trained still report little "software infusion" in the academic disciplines. Teachers must develop a vision of what the computer can do for them as a teaching resource. In the second part of the article Schiffman proposes a program to teach teachers the knowledges and skills necessary to implement "software infusion." Caissy (1987, 7) also sees the teacher as the key to the implementation of microcomputer technology. Caissy (1987, 7) says ". . . until all teachers become familiar with and comfortable with microcomputers, the potential of this marvelous technology for teaching and learning will never be realized."

A study of computer usage in an urban high school (Schofield and Verban 1988) also focused on the teacher in suggesting barriers and incentives to the utilization of microcomputers for instructional purposes. Barriers included teacher's lack of clarity about why and how computers should be used in teaching, lack of familiarity with computers, "overload" of knowledgeable teachers, and the attitude of teachers toward computer use. Incentives to computer use were found to be fewer and weaker. They included teacher's vision of a positive instructional purpose in using computers, enthusiasm for the technology, and a desire to impress the public that modern educational systems are in use. The last two incentives help

get computers into the classroom, but do not lead to their effective use. Schofield and Verban (1988, 36) conclude that more research is needed in why and how computers can be effectively used. Adams (1939, 30), expressing his feeling that computers in schools are worthwhile, lists several common uses for computers and says that students need to see their role models, teachers, using computers as a normal part of work.

Montague and Wulfeck (1984) while forecasting that computer use in the classroom would continue to increase due to availability and declining costs, expressed concern about the hope that their presence would improve the quality of education and training. After noting that CBI systems can be effective and some are, they (Montague and Wulfeck 1984, 4) said:

But, while affordable hardware is a necessary ingredient for widespread effectiveness of CBI, it is not sufficient. Several other ingredients are necessary: good instructional design which uses computer power in appropriate ways, supportable and transportable software, and attention to the ongoing instructional systems into which CBI may be inserted.

They present the thesis that the improvement of instruction through CBI will be a slow, evolutionary process; for several reasons (Montague and Wulfeck 1984, 4):

1. Instructional quality is difficult to achieve regardless of the method of delivery,
2. Computers as instructional tools are in a rudimentary state of development,
3. Improvements in either instructional design or computer-based delivery will depend on fundamental changes in the scientific base, and

4. Systematic planning for acquiring, standardizing and distributing proven instructional programs, and for incorporating them in the schools has not been done.

The Navy's Low Cost Microcomputer Training Systems project (NPRDC 1987) is designed to address the following four problems: (1) development time and costs for Computer-Based Instruction are excessive; (2) CBI requires too much programming expertise; (3) non-standard computers, machine specific programs, non-transportable courseware; and (4) previous NPRDC CBI programs needed standardization on widely available computers. Wetzel, Van Kekerix, and Wulfeck (1987a, 22-25) feel that there is no question about the usefulness of microcomputers for course support, but see some problems with the proliferation of non-standard hardware and software. Regarding instructional delivery, they found through a survey of Navy course managers, that curriculum stability presented a special problem for the computerization of course material. Use of computer aids for instructional management could help in this area by allowing more rapid revisions and aids being developed for Instructional Systems Development (ISD) are aimed at improving quality as well as quantity. It is important to recognize that not all instruction is appropriate for CAI. Like many of the other authors reviewed above, Wetzel, Van Kekerix, and Wulfeck (1987a, 25) say that "the decision to computerize raises questions about what improvements will be achieved over existing methods."

Maloy, Principle Civilian Advisor to the Chief of Naval Education and Training, and Perry, Head of the Training Technology Implementation Office on the staff of the Chief of

Naval Education and Training (1986, 24-25) say that one of the biggest obstacles to the implementation of new technology in education is a lack of communication between the research and instructional communities. Researchers underestimate how difficult it is to put research into practice. Instructors who are concerned with traditional classroom management problems, scarcity of resources, etc. are reluctant to jump up and embrace a new, unproven technology. Instructors do not communicate R&D requirements or areas of greatest need to the researchers. Maloy and Perry (1986, 25) see a role for a third group of people - implementers, " . . . who stand, however shakily, with one foot in the laboratory and the other in the classroom, whose full-time focus is upon the implementation process." The implementers, understanding the difficulty of implementation will coordinate the transition of technology from the lab to the classroom, communicating between the two camps, knowing what is coming out of the labs, providing feedback to the labs, setting up demonstration projects, and addressing fiscal difficulties and social problems.

#### Effectiveness of Computer-Based Instruction

From the beginnings of CBI, those involved in its development and implementation wanted to know if it produced the benefits that were expected. A number of evaluations and studies were undertaken to assess the success of CBI programs. Each of these had varying designs and emphasized different

aspects of the analysis so an overall picture of the effectiveness of CBI could not be gained easily. Kulik, Bangert and Williams (1983, 24) conducted a meta-analysis of 51 independent evaluations of CBT in grades six through twelve. They found that CBT was effective in raising final examination scores approximately .32 standard deviations, from the 50th to the 63rd percentile. Follow-up examination scores also increased, showing positive retention effects, but these were less clear than the immediate effects. Finally, it was shown that the computer substantially reduced the time needed for learning. The results of the meta-analysis were also consistent with a 1981 model developed by Kulik that suggested that CBT would be more effective at the secondary level than at the college level. Interestingly, the meta-analysis also revealed that the computer had an important positive effect on student attitudes.

Bear (1984, 12) questioned whether the results of the meta-analysis reviewed above could be generalized to microcomputers, and cautioned that we should examine whether or not CAI is having any significant impact on student learning. In the meantime, he said, we should apply what we already know about school and teacher effectiveness to the use of microcomputers. Hasselbring (1986) conducted a review of CAI effectiveness studies using box-score and meta-analysis techniques. He admits that the research base on which to evaluate the performance of microcomputers was very limited. He included research on micro-, mini-, and mainframe computers over



the past 2 decades and feels that the conclusions can be applied to today's microcomputers. Hasselbring's (1986, 319) conclusions are as follows:

1. When CBI and traditional instruction are compared, students receiving CBI demonstrate equal or higher achievement.
2. When CBI and traditional instruction are compared, equal or better achievement is obtained in less time.
3. The use of CBI improves student attitudes toward the use of computers in the learning situation.
4. The positive effect on learning achievement occurs regardless of the type of CBI used, the type of the computer system used or the age range of the student.
5. 'Primary CBI,' where no teacher interaction occurs during the learning process, is much less effective than 'adjunct CBI' where teacher interaction is a critical part of the instruction.
6. While advocates of teaching computer programming claim that programming will result in higher-level cognitive skills and capabilities to learn, there is little evidence to support or disprove these claims.
7. Tutorial and drill modes seem to be more effective for low-ability students than for middle or high-ability students.
8. The effect on learning achievement seems to be greatest for learners of pre-college age.

Concentrating on the effectiveness of microcomputers in helping students attain mastery, Mich and Nardine (1986) studied the results of a microcomputer-based drill and practice program for attaining multiplication skills by third graders. They found that the performance of those who had used the program was significantly greater than those who had not, and that the performance gains were maintained over time. Their results

suggested that the practice in math skills given by the program, rather than the computer-assisted activity, itself, accounted for the performance improvement.

Brown (1986) conducted a broader-based study of CBI effectiveness, in which he compared pretest and posttest scores for students who had completed about five hours of CBI in Computer Literacy, Social Studies and Language Arts. Significant gains were made in each area. Brown (1986, 29) concluded that CBI seems to improve the learning process when the rules of effective instruction are followed.

A study of courses in the military that could be presented both by conventional and computer-based instruction found that student achievement was about the same with either (Orlansky and String 1981). Although computer assisted instruction was rated as superior to conventional in 15 of 40 cases and inferior in only one, the differences were not considered to have had practical significance. Time saved using computer-assisted instruction rather than conventional was significant, however, with a median of about 30 percent. While they recognized a need for more controlled studies, Orlansky and String concluded that the evidence verified the value and suitability of computer-based training in the military.

#### Viability of Drill and Practice as a Form of CBI

The current literature is full of criticism of the use of computers for drill and practice because it does not fully use

the power of the computer or because it does not increase the cognitive abilities of students. Maddux and Cummings (1986, 34) go so far as to say that if uses such as drill and practice, and tutorials " . . . continue to predominate, there will be a backlash against educational computing and the entire movement will fail." Streibel (1986, 138-139), in examining the assumptions and contexts of use of the various approaches to CAI, noted that drill and practice is a behavioral form of learning technology which may not be the best way to supplement instruction. He grants that the development of factual knowledge and skills is important, but says that it must always be in a subordinate role to personal and communal growth and development. The discussions that follow reflect his bias against behavioral approaches to learning and the mastery paradigm and his preference for programs that lead to "critical thinking or personal empowerment."

Bear (1984), in an article that expressed a great deal of caution regarding jumping on the microcomputer bandwagon before considering whether such a decision will improve the overall effectiveness of schools, recognized a role for drill and practice. Bear (1984, 13) said:

Since microcomputers, with quality software, can provide the reinforcement, monitoring, branching, feedback, and remedial instructions characteristic of effective teaching, it is likely that schools employing them primarily for drill-and-practice of basic skills will be more successful in improving overall school effectiveness, as commonly measured in the literature by standardized achievement tests.

He makes the point that CAI will probably be most effective if it uses techniques that good teachers use in the classroom. Unlike some others, he feels that drill and practice does that. Scandura (1983, 16) also feels that today's low cost microcomputers provide a highly cost effective means for developing and delivering drill and practice CBI. He says that drill and practice is best where students need a high level of skill in a well defined area.

The criticism of drill and practice, then, is largely unjustified (Alessi and Trollip 1985, 134). Although drill and practice may not capitalize on the full power of the computer, it can produce drills that are more effective than other media. The criticism that drills do not teach, but just practice what the student already learned is true, but they are not intended to teach. The drill must be preceded with the presentation of information by a textbook, a classroom lesson, or a group discussion. Goldman and Pellegrino (1986, 134) agree, stating that drill and practice is appropriate only after a student has grasped the concept. It is not designed to teach new material. "[It] tirelessly presents examples of the concept for the child to work, thereby reinforcing the material that has been taught previously." They say that drill and practice software is suited to anything that corresponds to basic skills.

Alessi and Trollip (1985, 135) also make the point that drill and practice is useful for more than just arithmetic and

spelling, as many believe. It may be applied to simple paired associate learning, verbal information, and to simple or complex problem solving. Dalgish (1987, 85), in discussing English as a second language software, says that drill and practice can no longer be reflexively dismissed. It is the form of the drill and practice that comes under fire, not the concept itself. Mathison and Brown (1986, 38) present a flowchart with a process for integrating CAI into the classroom. It includes the need for practice or remediation opportunities as reasons to consider CAI.

Wetzel, Van Kekerix, and Wulfeck (1987b, 17), in discussing appropriate CBI applications for different types of learning objectives, say that "Facts and Categories can be repetitively presented for learning and testing according to a number of CBI drill and practice schemes." They recommend the Language Skills Computer-Assisted Instruction (LSCAI) program that is part of the Computer-Based Educational Support System developed by the Navy Research and Development Center for learning technical vocabulary and facts that are usually required in entry level courses. LSCAI contains common drill and practice exercises such as true-false, multiple choice and matching as well as some game-like exercises.

#### Selective Application of CBI for Specific Learning Objectives

Experience to date with educational technology and research on teaching and learning are helping us to see more clearly what

is needed in the way of software that can facilitate learning (Eisele 1986, 25). On top of the list is clearly defined performance objectives, followed by clearly identified prerequisites for mastery, powerful attention getting displays, response producing stimuli, and effective feedback. Shiffman (1986, no.1: 7) in describing the attributes of successful Software Infusion stated that the primary characteristic is that the software used by the teacher was directly related to a stated objective of the curriculum. Learning has a different form depending on what is being learned (Gagne, Wager, and Rojas 1981, 17-19). They describe the identification of learning outcomes according to Gagne's previous works and then the events of instruction that are needed to effectively meet those learning outcomes. The various types of CAI are then discussed in light of the events of instruction that they support. Drill and practice, for example, contains two events of instruction. It elicits response from the learner and it provides feedback. Merrill, et al. (1986, 11-12) also propose the use of learning outcomes to select CAI applications. Pollock (1985) uses Gagne, Wager, and Rojas' guidelines to benchmark programs for authoring software. Weller (1988) says that instructional software should be designed with specific learning outcomes in mind.

Researchers at the Navy Personnel Research and Development Center found that most Navy courses have many types of objectives, some of which are better adapted to CBI than others.

Wetzel, Van Kekerix, and Wulfeck (1987b, 20) recommend, therefore, that:

Instead of computerizing all types of curricula, CBI should be integrated with conventional classroom and laboratory instruction in selected applications that offer some form of improvement for specific training objectives or course components.

The Navy's Instructional Systems Development program (DoD 1985) is based on a behavioral approach to training and clearly defines course objectives. Wetzel, Van Kekerix and Wulfeck (1987b) use a classification scheme based on the Instructional Quality Inventory (IQI) (Ellis and Wulfeck 1982, 8) to analyze course objectives and then relate the objective content to the various CBI applications. Wetzel, Van Kekerix, and Wulfeck (1987b, 20) say, ". . . the Navy should not talk about computerizing entire schools or courses but rather particular task/content topics or objectives."

#### CBI as an Adjunct to Traditional Instruction

The idea of using CBI along with or as an adjunct to already existing kinds of instruction is supported by several researchers. Schiffman (1986, no.2: 7), in describing "software infusion" says that the term should not be applied to situations where the computer is used as a primary delivery system. Selected software should be incorporated in an ". . . overall teacher designed and implemented lesson plan in the same way other instructional resources might be." Stallard (1987, 155) talks about combining traditional lectures with individualized instruction on computers. The instructor provides the benefits

of human contact, while the computer does most of the management and delivery of instruction. Caissy (1987, 21-22) discusses various ways of integrating computers into classroom activities. They include; reinforcement using drill and practice and tutorials to reinforce skills taught in the classroom; remediation to provide review and practice for students having difficulty, and enrichment to provide additional challenge for those who complete assignments ahead of others. Hasselbring (1986, 322) notes that none of the potential gains from CBI are inherent. "On the contrary, the greatest gains from the medium seem to occur when it is integrated into the ongoing curriculum and not used as a replacement for existing courses."

#### Navy Policies and Current CAI Initiatives

##### Naval Education and Training Command Policies.

The Chief of Naval Education and Training (CNET) policy is to use interactive courseware (ICW) whenever an analysis indicates that ICW will be the most effective means of supporting instructors and enhancing the instructional process (CNET, 1988b). Interactive Courseware is defined as computer-based instruction, with or without the use of videodisk, that supports the learning process. Responsibilities are assigned to various Navy commands to ensure that prudent professional and management techniques are used to maximize the return on investment. CNET (1988a) has also directed that education and training Research, Development, Test, and



Engineering (RDT&E) requirements be identified and RDT&E resources be used for the purposes of:

- (1) Increasing effectiveness of education and training without significant increases in costs,
- (2) Introducing improved methods for development of instructional programs and instructional delivery systems, and
- (3) Improving technology transfer of R&D products into the training environment.

CNET must review and approve all studies and analyses conducted in the Navy training Command that use substantial resources (greater than \$25,000), have command-wide policy implications, or require the use of external organizations. The Navy Personnel Research and Development Center has agreed to work jointly with CNET and the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) (OP-01) in the planning and conduct of a comprehensive research and development program to aid CNET in accomplishing his mission.

#### Current Navy CAI Initiatives.

The Low Cost Microcomputer Training Systems project, sponsored by OP-01 and the CNET Training Technology Implementation Office, and conducted by the Navy Personnel Research and Development Center (1987) is an example of the cooperation between these activities to support the Navy's training mission. Intended to address the following problems,

1. Development time and costs for Computer-Based Instruction (CBI) are excessive,
2. CBI requires too much programming expertise,

3. Non-standard computers, machine specific programs, non-transportable courseware, and
4. Previous NPRDC CBI programs needed standardization on widely available computers.

the project was designed to assess Navy requirements for CBI, develop CBI software for wide Navy application, and develop demonstration test-beds for authoring and delivery software. Two technical reports on Navy CBI requirements have been issued (Wetzel, Van Kekerix, and Wulfeck 1987a; 1987b) and the Computer-Based Educational Software System (CBESS), developed by the University of Utah and the Navy Personnel Research and Development Center, fulfilled the requirement to develop CBI software. The Navy Personnel Research and Development Center is currently enhancing features of the CBESS programs and developing CBESS test-beds.

CBESS is a set of programs developed at the University of Utah in conjunction with the Navy Personnel Research and Development Center, San Diego, CA (Brandt 1987a; 1987b; 1987c; Brandt, Othmer & Halff, 1987). The CBESS programs address four parts of the learning process.

Primary Instruction. The TRY program can be used for a variety of purposes from the delivery of quizzes to interactive instruction designed to replace traditional classroom instruction.

Memorization. The Computer-Based Memorization System (CBMS) uses games to help students memorize facts.

CBMS games are not intended for primary instruction, but are to provide the repeated exposure to facts needed for memorization.

Vocabulary Instruction. The Language Skill (LSCAI) program helps students learn vocabulary by completing exercises of from four to nine words each. Material is presented in context to introduce the words. Then the knowledge is tested and reinforced by up to eight activities such as true-false, multiple choice, matching, labeling and fill-in the blanks.

Problem Solving. The Equipment Problem Solving Trainer (EPST) allows students to practice problem solving techniques on simulated equipment into which faults are inserted. Students can change switch positions, read equipment displays, take test point readings, and replace parts of the equipment.

The development of CBESS programs is different from that of most CBI in that the author does not plan and implement interactive lessons. Rather, he enters subject matter into databases which are accessed by the instructional delivery programs. This not only saves the development time normally needed to write interactive lessons; it allows subject matter experts, not necessarily familiar with theories of learning, to develop CBT programs. Each of the CBESS programs uses similar procedures for identifying databases and database components and all use the same user interface. Because this project demonstrates the LSCAI system, only it will be described in detail.

LSCAI, like most of the CBESS programs is data-based. The author enters and edits the subject matter that is used by the delivery system to present activities to the student. The author can concentrate on the words, their definitions, and context material, instead of worrying about how to present them. LSCAI activities are divided into three groups:

1. Introduction to Exercise Words. Material is presented in context. The context sequence can include graphics and video as well as short paragraphs.
2. Individual Word Activities. For each word in an exercise, students may; (1) build its definition from phrases listed in a menu, (2) select the definition from a visible or hidden multiple choice menu, (3) mark synonyms, antonyms, or related words, or (4) spell the word.
3. Collective Word Activities. For all of the words in an exercise, students may; (1) match the words to their definitions, (2) match the words with graphics (label), or (3) Enter the words in a "cloze" paragraph (fill in the blanks).

The author may designate which activities are done for each particular exercise, or the student may be given some control over which activities he wants to do. Words may actually

consist of more than one word. "Steam System" could be entered as a word, for instance, to drill the student on what the steam system is, or does, in a particular application.

The Chief of Naval Education and Training has initiated a new program to apply the best techniques and instructional technologies available at a selected "model school." The goals of the "Model School Program" are to: identify and implement good practices in such areas as facilities planning and care, equipment acquisition, management techniques, and instructional technologies; capitalize on the untapped "brainpower" that exists throughout the Navy; create a ripple effect across the training establishment by learning from each other's initiatives to upgrade our schoolhouses; and provide a basis on which can be built a "proficiency maintenance system" that assesses proficiency and provides retraining and requalification opportunities. An overall goal is ". . . to provide, through the orderly application of what works, a more proficient sailor for the fleet" (NETPMSA 1988, 1). A number of annual reviews will be conducted in such areas as curriculum, equipment/devices and facilities, management practices, instructional delivery, and instructional technology courseware applications. The instructional technology courseware applications area is to include evaluation of both current applications and new additions. New R&D based applications, specific curriculum-based applications, and remedial applications are to be assessed. Following the assessment, implementation processes will be formalized including the identification of

responsibilities and resource requirements. In support of the Model School Project, Perry (1988) described intervention points for remediation along a continuum of Navy training. Intervention points are; before instruction if entry skills are not sufficient to complete the course, during instruction for students who have the minimum skills to enter the course, but still have difficulty mastering some of the instruction, and after instruction if there has been some time that has elapsed between completion of the training and use of that training on the job. Intervention during instruction should be weighed against other alternatives if a large percentage of students are being setback at some particular point in the instruction. If a small but consistent number of students are having difficulty the problem should be identified and compensating instruction provided. Most significant to this dissertation, Perry says that we should allow for the fact that some students take longer to learn than others and we should simply assign more drill and practice.

#### Evaluation of Instructional Software.

Evaluation occurs during all stages of instructional development. Kearsley (1983, 144-162) describes two major types of evaluation, formative and summative. Formative evaluations are conducted while the system is in prototype form to identify ways to improve its efficiency or effectiveness. Summative evaluations are conducted after a system is operational to

assess the system in terms of alternate approaches (comparative), effects on job performance (validation), or cost/benefit. There are three stages of formulative evaluation; prototyping the system or lessons, pilot testing, and field testing. Prototyping involves the development of some small portion or curriculum, usually selected as representative of the full-scale effort. Mock-ups or sample display screens may be used in place of the more expensive versions that would be used with a final system. Pilot testing involves trying out the prototype with a small group of simulated students. The purpose is to detect any major problems in the hardware, software, and courseware. Field testing is carried out in the actual training setting, after all of the problems identified in pilot testing have been corrected. Final revisions are made based on the results of field testing before the system becomes fully operational.

In describing an eight-step instructional development model, Alessi and Trollip (1985, 277) list the last step as evaluating how well the lesson looks and how well it works. This involves both pilot testing, and validation. Alessi and Trollip (1985, 375-393) start the evaluation with a "Quality Review Phase" which tests the lessons against various standards to ensure that it works properly. Alessi and Trollip's pilot testing, which follows the Quality Review Phase, uses real students, rather than simulated students to evaluate the system. They refer to evaluation in the real instructional setting as validation rather than field testing, but the purpose is the same.

Alessi and Trollip (1985, 375-386) provide a Quality Review Checklist to ensure that the most important aspects of the program are considered during the Quality Review Phase:

- Language and grammar
- Surface features of the displays
- Questions and Menus
- Invisible functions of the lesson
- The subject matter
- Off-line materials

Discussion of each of these areas is provided to facilitate an effective evaluation so that revisions can be made prior to pilot testing.

A six-step process is proposed for pilot testing (Alessi and Trollip 1985, 386-389). The steps are:

- Select the helpers.
- Explain the procedure to them.
- Find out how much of the subject matter they know already.
- Observe them go through the lesson.
- Interview them afterwards.
- Revise the lesson.

Pilot testing is crucial for quality lessons. The decision to be made is how much pilot testing to do, not whether or not it should be done. The cost-effectiveness of additional testing should be considered. The product has to accomplish its purpose, but it does not necessarily have to be perfect.

A number of guides have been proposed for the evaluation of microcomputer-based instructional software. Caffarella (1987) proposed a guideline for the use of teachers, media specialists and computer coordinators. The Northwest Regional Educational Laboratory (1982) developed an Evaluator's Guide for



Microcomputer-based Instructional Packages as part of the MicroSIFT project of their Computer Technology Program. The thoroughly tested guide is intended to provide teachers and other educators with background information and forms to help them evaluate educational software and courseware. MicroSIFT is a clearinghouse for microcomputer-based educational software and courseware. A network of schools forms the basis of the MicroSIFT evaluation process and the Evaluator's Guide for Microcomputer-based Instructional Packages was originally developed for their use. It has been found to be useful for individual teachers and others who wish to evaluate courseware, as well.

Callison and Haycock (1988), noted reference in the literature to the importance of learner review, but could find no model available for student evaluation. They designed a form to collect data that would reflect both student attitude and student perceived educational value of instructional programs. Signer (1983) developed evaluation instruments for both students and teachers. She (Signer 1983, 35) found differences in the perceptions of students and teachers, with the students being more critical. Teachers, as expected, were more concerned with the specific content of the program and the varying pedagogical complexities of the different topics. Students evaluated programs on the basis of interest, clarity, and their level of participation. Evaluations from both perspectives are valuable.

## Chapter 3

### DESIGN PROCEDURES AND METHODOLOGY

#### Overview

An extension of the Navy's Low Cost Microcomputer Systems Project (DCNO(MPT) 1986, 62; NPRDC 1987), this dissertation builds on research and development conducted at the Navy Personnel Research and Development Center (NPRDC), San Diego, CA. It demonstrates of the use of the Language Skills CAI (LSCAI) program to develop and deliver review, structured self-study, and remediation for students undergoing Navy technical skill training. LSCAI is part of the Computer-based Educational Software System (CBESS) developed by the University of Utah and NPRDC.

In the first part of this project, a unit of instruction to use for the project was identified. Courses at NATTC, Lakehurst were considered on the basis of course stability, student throughput, attrition and setback rates, and level of instruction to determine which might benefit the most from CBI. An analysis of learning objectives was then conducted to find out which of those courses that could benefit from CBI would be most adaptable to a drill and practice application to be used for review, structured self-study and remediation. In the second part of the project, information is provided for others who may

contemplate using the LSCAI authoring system. Two of the goals of the CBESS program are to reduce CBI development time and costs and to reduce the programming expertise needed to produce CBI. Information was gathered while authoring the prototype program about how much time it takes to develop courseware, what problems are encountered, and what level of expertise is needed to effectively use the system. A summary of the capabilities and limitations of the authoring system were also provided by completing the Authoring Tool Evaluation Form developed by Gillingham et al. (1986). The third portion of this project was a pilot test of the prototype to see how the instructional software might be improved and to make an assessment about whether it will be useful for review, structured self-study, and remediation. Finally, a preliminary cost-effectiveness analysis was completed to determine whether further development of a system such as that proposed for this project should be pursued, and to demonstrate how a framework for implementers to use for conducting a cost-effectiveness analysis.

A Plan of Action and Milestones (POA&M) for the completion of this project is shown in Table 1. A detailed discussion of the project development steps is presented later. It should be noted that the data needed to choose a course of instruction for the project was collected prior to approval of the proposal. Because a purpose of the project is to demonstrate the use of the LSCAI system for review and self-study, it was necessary to find out if the courses at Lakehurst had sufficient need to make such a project worth-while. The data in Table 2 was readily

available from reports generated by the Navy Integrated Training Resources and Administration System (NITRAS). Data concerning learning objectives were gathered to see if the types of learning objectives in the courses taught at Lakehurst are consistent with those in similar courses taught at other training sites, as reported by Wetzell, Van Kekerix and Wulfeck (1987b). This determination was important because the viability of the LSCAI system depends on the amount of emphasis on objectives that require the remembering of facts. A review of course outlines revealed that a large number of learning objectives were of that type so the concept of the project could be supported using one of the Lakehurst courses of instruction.

Because this dissertation is an extension of a research and development project being conducted by the Navy the concurrence of the Navy Personnel Research and Development Center and the Chief of Naval Education and Training's Office of Training Technology Implementation had to be obtained. To remain on schedule while the concept was being reviewed, work on the project was continued and the data were analyzed to determine which NATTC course could most benefit from a microcomputer-based review and self-study program. When that determination was made, work began on the exercises for the CAI program.

The prototype program was not completed until after a draft of the dissertation proposal was submitted. Initial feedback indicated some problems with the proposal submission, but general approval of the concept. Although approval of the proposal had not yet been received, pilot testing was begun with the instruc-

tor evaluations, and student volunteers tested the program and completed evaluation forms.

Because the jury of instructors that evaluated the prototype program included all of the instructors and instructional development personnel concerned with the selected course, the data are considered to meet the necessary criteria for content validity. The student evaluation data may have been biased, however, because only volunteers were used and they may not have been

Table 1

PLAN OF ACTION AND MILESTONES (POA&M)  
FOR THE DEVELOPMENT OF A MICROCOMPUTER-BASED  
REVIEW, STRUCTURED SELF-STUDY, AND REMEDIATION PROGRAM

Activity	Contact Person	Milestone Date
-----		
- Identify Course of Instruction		
-- Obtain list of courses at NATTC Lakehurst and their attrition/ setback rates, annual throughput, and level of training.	NATTC Student Control Office	15 SEP 88
-- Obtain information on any major changes being contemplated.	School Dir's & Course Mgr's	20 SEP 88
-- Analyze course data and nominate courses for further consideration.	None	25 SEP 88
-- Obtain curriculum outlines for nominated courses.	Curriculum Standards Off.	29 SEP 88
-- Complete IQI Analysis.	None	16 OCT 88
-- Choose course for CBI.	None	16 OCT 88
-- Pick course module for prototype program.	School Supervisor	21 OCT 88
-----		

Table 1 continued on next page

Table 1 (Continued)

PLAN OF ACTION AND MILESTONES (POA&M)  
 FOR THE DEVELOPMENT OF A MICROCOMPUTER-BASED  
 REVIEW, STRUCTURED SELF-STUDY, AND REMEDIATION PROGRAM

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- Development of Prototype Program		
-- Discuss project idea with researchers at NPRDC	NPRDC	1 SEP 88
-- Obtain CBESS Software and Documentation	NPRDC (DR. Wetzel)	30 SEP 88
-- Review CBESS Documentation and load in local PC	None	15 OCT 88
-- Commence authoring exercises using LSCAI Authoring System.	None (Coord. w/ Dr. Wetzel and NATTC Instr.)	1 DEC 88
-- Complete prototype CBI program	None	15 JAN 89
- Pilot Test Prototype CBI Program		
-- Choose staff and student evaluation instruments	None	3 DEC 88
-- Identify staff evaluators desired	None	15 DEC 88
-- Ask staff evaluators to volunteer	Staff Volunteers	3 JAN 89
-- Complete Staff Evaluations	Staff Volunteers	18-23 JAN 89
-- Commence Student Evaluations	Student Volunteers	25 FEB 89
-- Analyze Evaluation Comments	None	1 MAR 89
-- Complete Final Project Report	None	19 MAR 89

---

representative of the overall student population. A new student evaluation that used the methodology described later in this section was used.

### Selection of a Course unit

Because this project is being conducted at the Naval Air Technical Training Center (NATTC) at Lakehurst, NJ, only the courses of instruction taught at that center are considered for CBI in this project. NATTC, Lakehurst is the home of the Navy Security Guard School, Aviation Boatswain Mate Schools, Aircrew

Table 2

#### NATTC, LAKEHURST COURSE INFORMATION

COURSE SHORT TITLE	LEVEL (1)	PERIODS THEORY/LAB	FY 88 THROUGHPUT	PERCENT ACADEMIC ATTRITE/SETBACK
Security Guard	C	98/105	1733	1/3
EAF	A	104/114	110	0/0
PR Basic	A	138/270	524	1/5
PR Advanced	C	165/287	86	0/0
ABH A-1	A	91/142	354	0/0
ABH C-1 Sea Track	A	113/79	100	0/0
ABF A-1	A	194/101	230	1/2
Av Fuels C-1	C	153/47	120	0/0
ABE A-1 ComCore	A	115/38	467	0/0
ABE A-1 C13 Track	A	107/37	280	1/1
ABE A-1 C7/11 Track	A	108/36	186	0/0
AvFuels System	O	64/0	20 (Officers)	0/0
ALRE C13	C	224/88	70	3/0
ALRE C13 Mod 1	C	255/45	80	0/0
ALRE C7/11	C	221/91	36	2/0
Optical Land Sys	C	155/157	28	0/0
Catapult Elec	C	87/69	20	0/0
ALRE O C7/11	O	77/22	40 (Officers)	0/0
ALREM	O	170/150	5 (Officers)	0/0

(1) Levels of instruction: A - Basic Skill Training  
 C - Advanced Skill Training  
 O - Officer Courses

Survival Equipmentman Schools, and the Marine Corps Expeditionary Airfield School. Table 2 contains relevant data for each of the courses taught at NATTC, Lakehurst.

Wetzel, Van Kekerix, and Wulfeck (1987a, 14) identified curriculum stability as a special problem when considering courses for CBI. The first criteria for course unit selection, therefore, was the stability of the available courses. Course managers and School Directors were asked if any major changes were being considered for any of the courses at NATTC, Lakehurst. If there were changes being contemplated, the course was removed from consideration.

The data in Table 2 were then reviewed to determine which of the remaining courses might most benefit from computerized review, structured self-study and remediation. The following criteria were used in that review:

1. Level of training to be provided. Researchers (Scandura 1983, 16; Bear 1984, 13) have found that drill and practice is more effective for basic skills and where students need a high level of skill in a well defined area. "A" School courses teach basic, entry level, skills. "C" Schools are taught at the advanced or journeyman level. Officer Courses generally teach management of technical areas, but present only a familiarity with the technical skills, per se.
2. The annual throughput of the course. Greater benefits will accrue if there are a large number of students that may use the system than if the numbers are relatively small.



3. Attrition and set-back rates. High attrition and set-back rates indicate that students are having difficulty in mastering the material required. According to the literature (Bear 1984, 13; Alessi and Trollip 1985, 134; Brown 1986, 38; Goldman and Pellegrino 1986, 134) drill and practice CBI can be effective in reinforcing material already learned so that it can be mastered.
4. Nature of the learning objectives. The literature is clear that not all objectives are adapted to CBI, and that some are better than others (Merrill, et al. 1986, 11-12; Shiffman 1986, no.1;7; Wetzel, et al. 1987b, 20). The LSCAI program is designed to present drill and practice for the learning of technical vocabulary.

A non-weighted, multi-attribute analysis was used to nominate two or three courses using the first three criteria, above. Each of the courses being considered was rated on a scale from one to five for each of the criteria. No weights were assigned to the criteria because they are considered equal in

Table 3

BENEFIT OF CBI FOR NATTC, LAKEHURST COURSES  
 BASED ON TRAINING LEVEL, THROUGHPUT  
 AND ATTRITION/SETBACK RATES

COURSE	LEVEL	THROUGH- PUT	ATTRITION/ SETBACK	TOTALS
Course #1				
Course #2				
Course #3				
etc.				

importance. A summary table such as that shown in Table 3 was used to present the results of the analysis.

Learning objectives for nominated courses were then evaluated using the Instructional Quality Inventory (Wulfeck, et al. 1978; Ellis, Wulfeck and Fredericks 1979; Ellis and Wulfeck 1982). This is a scheme for classifying objectives and test items according to:

1. What the student must do; that is, the task to be performed.

2. The instructional content; that is; the type of information the student must learn.

In the TASK dimension, the student can either REMEMBER information, or USE the information to do something. This distinction corresponds to the difference between knowledge and application, and between declarative and procedural knowledge. Use is further broken down into AIDED, where information is provided, and UNAIDED, where the student must use recalled information. REMEMBER is also broken down into RECOGNIZE, where the student must identify information that is provided or choose among alternatives and RECALL, where the student provides information from memory.

There are five types of content:

Facts are simple associations between names, objects, symbols, locations, etc. Facts can only be remembered, while the other content types can be remembered or used.

Categories are classifications defined by certain specified characteristics.

Procedures consist of ordered sequences of steps or operations performed in a single or a specific situation.

Rules also consist of ordered sequences of operations, but they can be performed on a variety of objects or in a variety of situations.

Principles involve explanations, predictions, or diagnoses based on theoretical or cause-effect relationships.

A matrix was used by Wetzel, Van Kekerix and Wulfeck (1987b, 4) to present their analysis of course objectives for microcomputer-based training systems. A similar matrix, shown in Table 4, is used for the analysis presented here.

Table 4  
IQI TASK/CONTENT MATRIX

Task	Content				
	Fact	Category	Procedure	Rule	Principle
Remember-recall					
Remember-recognize					
Use-aided					
Use-unaided					

The IQI analysis determined which NATTC, Lakehurst course

would be most amenable to a drill and practice CBI application for review, self-study, and remediation. The discussion of CBI applications presented by Wetzel, Van Kekerix and Wulfeck (1987b, 16-19) provides the basis for these determinations. They (Wetzel, et. al. 1987, 17-19) say that facts and categories are amenable to drill and practice schemes, procedures and rules usually involve some type of simulation, and principles can be demonstrated with dynamic graphic representations and tested with programs that generate problems from large data bases to instantiate the principles.

#### Authoring of CBT Courseware

The product of this dissertation is a prototype of a CBI module to be used for review, structured self-study and remediation by students undergoing Navy technical skill training. The material presented in the CBI module had to conform to the approved course of instruction as it is taught in the classroom. To the extent possible, lesson material was extracted directly from existing Lesson Topic Guides (instructor guides) to ensure a continuity between that taught in the classroom and the review. This also ensured that the CBI does not diverge from the learning strategy that underlies the instructional systems design. All of the material taught in the classroom is not covered in the CBI module; just that which supports learning objectives that are applicable to drill and practice programs (Facts and Categories), particularly those that are applicable to presentation by the LSCAI program (those involving the knowledge or definition of technical terms).

CBESS contains authoring as well as delivery systems for each of its applications. The development of the CBI program for the selected course unit uses the LSCAI authoring system, LSAUT. The author has received no formal training in the use of the LSCAI authoring system, but does have access to manuals and sample programs provided by the Navy Personnel Research and Development Center (NPRDC). Researchers at NPRDC were available by telephone to answer questions or to provide other assistance. Authoring activities were logged to document the time it took to develop instructional software and to document any problems that were encountered. An Authoring Tool Evaluation Form developed by Gillingham, et al. (1986, 15-17), is completed to further document the capabilities and limitations of the LSCAI authoring system. The Authoring Tool Evaluation Form is at Appendix A.

#### Evaluation of Instructional Software.

The prototype CBI module developed for this project was pilot tested using both actual students and staff personnel. Students were selected randomly from a class undergoing training in the material presented in the prototype program. All staff members involved with developing or instructing ABF A-1 classes were asked to participate in the pilot test evaluation. Students were asked to complete the Student Evaluation Form developed and tested by Callison and Haycock (1988, 27-28). It is shown in Appendix B. Callison and Haycock (1988, 28-31) provide background on development of the form, describe its use and encourage others to duplicate and use it. The staff

evaluators were asked to complete an evaluation using the Evaluator's Guide for Microcomputer-Based Instructional Packages developed by MicroSIFT, a project of the Computer Technology Program of the Northwest Regional Educational Laboratory (1982). The evaluation form is shown in Appendix C. Extensive pilot and field testing of both the evaluation instrument and guide are described in the beginning of the Evaluator's Guide (Northwest Regional Educational Laboratory 1982, acknowledgements). A list of participants is provided if additional validation data is required.

Staff evaluators included:

- The Curriculum and Instructional Standards Officer (CISO); an officer responsible for the instructional quality of all courses at the training center
- The course Subject Matter Expert; a Navy Chief Petty Officer with extensive background in the course material and experience as an instructor
- The Education Specialist assigned to the selected course; a civilian with an educational background and curriculum development expertise
- The School Officer; A Senior Chief Petty Officer responsible for all of the courses in a given subject area. A qualified instructor and subject matter expert
- Three instructors who are qualified to teach the course selected for the project

The participants listed above comprise nearly all of the people

on the staff who have something to do with the selected course. Participation was voluntary, but all who were asked to take part in the evaluation consented to do so. Representativeness of the sample is not considered to have been jeopardized by the need to use volunteer participants.

Because only two microcomputers at NATTC Lakehurst are currently configured to run the LSCAI system the number of students involved in the student evaluation was limited. Half of an 18 student class was randomly selected for participation. Every other name from an alphabetic class roster starting with the first or second entry depending on an odd or even number on a single dice roll was used. Those selected were asked to use the prototype program at a specified time in the evening when they would normally be expected to be studying by conventional means the material that they learned in class that day. No compensation or special favors were offered to either staff or student personnel for their participation.

The methodology described above assumed that the class from which the sample of students was taken was representative of all classes that go through the school. In reality, each class is somewhat different, but the randomness of student assignment is assumed for the purposes of this study. Class grade averages over the past year ranged from 92.80 to 88.00 percent, with a mean of 90.24 and a standard deviation of 1.66 percent. The class used for the pilot test had an average of 90.80 percent.

All evaluators were asked to review the Language Skills CAI Student Manual prior to beginning an evaluation session. An

opportunity to ask questions before starting was provided. Help was provided, as requested, as evaluators completed the CBI exercises. Difficulties encountered by evaluators are noted.

### Cost-Effectiveness Analysis

One of the reasons given for the failure of microcomputer-based CAI is a lack of planning. Levin and Meister (1986, 740) said that many schools consider the cost of hardware to be the major expense, when in reality, the costs associated with train-personnel, good software, maintenance and secure facilities are much more significant. Maloy and Perry (1986, 25) said that it is up to the new category of people that they called implementers to get a better grasp of such matters of implementation as cost-benefit analysis, life cycle costing, and policy implications. Because one of the purposes of this project is to provide information to those who may be considering a system such as that developed for this paper, some thoughts concerning cost-benefit analysis are given.

Orlansky and String (1979, 11a) note that all known evaluations of the benefits of computer-based instruction for military training have compared different methods of instruction by comparing the costs associated with them. Effectiveness of the instruction is considered to be constant. Because a given level of mastery is the measure of successful completion of the course used for this project, effectiveness of the instruction must be constant. Any differences in methods can be expressed in terms of the costs related to reduced training time or a reduction in



the number of students that must enter training. If we can project a reduced setback rate, student training time is decreased, and if we can project a reduced attrition rate, fewer trainees are needed to get a specific number of graduates. If new methods replace class time with off-duty study, training time is decreased and instructor requirements are reduced. Orlansky and String (1979, 12b) agree that student time savings and attrition should not be treated as measures of effectiveness, but are measures of cost. Effectiveness, then, is considered constant for this analysis. The anticipated costs associated with implementing a system based on the prototype as opposed to staying with the conventional classroom review methods that are used today are presented. Continuing (annual) costs and cost savings are also presented.

Costs that were considered include:

Cost of hardware

Cost of software

Cost of secure facility (Computer Lab)

Cost of personnel to staff computer lab (If needed)

Cost of software application development

Cost savings due to expected reduction in attrition

Cost savings due to expected reduction in setbacks

Cost savings due to less review time needed in class

Cost savings from reduced need for instructor reviews  
in the evening.

The cost analysis presented is necessarily preliminary in nature. Much of it can be refined after field testing of

the system makes more clear such things as number of computers that may be required, and the real effect on setback and attrition rates. The analysis presented should give some idea, however, about the kinds of things that should be considered and an initial indication about whether a microcomputer-based review, structured self-study and remediation system should be developed. One time and annual costs and cost savings for each of the areas listed above were calculated based on information concerning the course used for the prototype and projected benefits to be gained from implementation of such a system. The one time cost to implement the entire system and the annual savings expected from it compared to the present system were then calculated so that some cost-benefit conclusions could be drawn.

### Summary

The methodology described above is summarized in the following outline:

#### Part I. Selection of a unit of instruction

1. Course stability
2. CBI benefit analysis
  - a. Level of training
  - b. Student throughput
  - c. Attrition and Setback rates
3. Analysis of learning Objectives

#### Part II. Authoring of prototype program

1. Time to develop courseware
2. Problems encountered

3. Level of expertise needed

4. Authoring system evaluation

Part III. Evaluation of instructional software

1. Student evaluation

2. Staff evaluation

Part IV. Preliminary cost-effectiveness analysis

## Chapter 4

### RESULTS

#### Selection of a Course Unit

##### Course Stability

Discussion with Course managers and School Directors revealed that major changes are being made in several of the courses at NATTC Lakehurst in the next year. The Navy Security Guard School will be disestablished by July 1, 1989. The training will subsequently be provided along with similar U.S. Air Force training at Lackland Air Force Base, Texas. All of the Aviation Boatswain Mate (Equipment) (ABE) courses are in the process of being rewritten to comply with a new operation and maintenance training philosophy for catapult and arresting gear systems. The following courses are affected:

Security Guard	ABE A-1 ComCore
ABE A-1 C13 Track	ABE A-1 C7/11 Track
ALRE C13	ALRE C13 Mod 1
ALRE O C7/11	ALREM

##### Level of Training

Training is delivered to three levels of students at NATTC, Lakehurst: Initial Skill Training ("A" Schools); Advanced Skill Training ("C" Schools); and officer courses. Table 2, in Chapter 3, shows the level at which each of the courses of instruction at NATTC, Lakehurst is presented. Table 5, below,

summarizes training level information for those courses considered for CBI.

Table 5

LEVEL OF TRAINING OF COURSES PRESENTED  
AT NATTC, LAKEHURST

INITIAL SKILL TRAINING	ADVANCED SKILL TRAINING	OFFICER COURSES
EAF	PR Advanced	AvFuels System
PR Basic	ABH C-1 Sea Track	
ABH A-1	AV Fuels C-1	
ABF A-1	Optical Landing System	
	Catapult Elec	

Annual Throughput

Table 2 in Chapter 3 also lists the annual planned throughput of each of the courses at NATTC, Lakehurst. Table 6 contains a list of the NATTC, Lakehurst courses considered for CBI, rank ordered by annual throughput.

Table 6

NATTC, LAKEHURST COURSES RANK ORDERED  
BY ANNUAL PLANNED THROUGHPUT

COURSE	THROUGHPUT
PR Basic	524
ABH A-1	354
ABF A-1	230
Av Fuels C-1	120
EAF	110
ABH C-1 Sea Track	100
PR Advanced	86
Optical Land Sys	28
Catapult Elec	20
AvFuels System	20

## Attrition and Setback Rates.

Courses considered for CBI that have attrition and/or setback rates greater than zero are listed in Table 7 along with their percentages. They are rank ordered according to the combined attrition and setback rates.

Table 7

### NATTC, LAKEHURST COURSES WITH ATTRITION OR SETBACK RATES GREATER THAN ZERO

COURSE	ATTRITION RATE (%)	SETBACK RATE (%)	TOTAL
PR Basic	1	5	6
ABF A-1	2	2	4

## CBI Benefit Analysis

Table 8 contains a multi-attribute analysis matrix in which each of the courses being considered for CBI as part of this project are rated from one to five in each of the three criteria presented above. A rating of one indicates little or no benefit would be gained; five indicates a great deal of benefit. The ratings are totaled and the courses are rank ordered in the table by total benefit rating.

## Nature of Learning Objectives.

Based on the factors summarized above, the PR Basic, ABH A-1 and ABF A-1 Courses were selected for further consideration for CBI program development. Selection of one of these courses was based on the nature of their learning objectives using the

Table 8

BENEFIT OF CBI FOR NATTC, LAKEHURST COURSES  
 BASED ON TRAINING LEVEL, THROUGHPUT  
 AND ATTRITION/SETBACK RATES

COURSE	LEVEL	THROUGH- PUT	ATTRITION/ SETBACK	TOTALS
PR Basic	5	5	5	15
ABF A-1	5	3	3	11
ABH A-1	5	4	1	10
EAF	5	2	1	8
Av Fuels C-1	3	2	1	6
ABH C-1 Sea Track	3	2	1	6
PR Advanced	3	2	1	6
Optical Land Sys	3	1	1	5
Catapult Elec	3	1	1	5
AvFuels System	1	1	1	3

Instructional Quality Index (IQI). The number of enabling objectives by classification category for each of the courses is shown in Tables 9, 10, and 11.

Table 9

NUMBER AND PERCENTAGE OF PR BASIC COURSE LEARNING  
 OBJECTIVES IN EACH IQI TASK/CONTENT CATEGORY

Task	Content				
	Fact	Category	Procedure	Rule	Principle
Remember- recall	0	0	0	0	0
Remember- recognize	48 (42%)	30 (27%)	10 (9%)	0	0
Use- aided	N/A	0	25 (22%)	0	0
Use- unaided	N/A	0	0	0	0

Table 10

NUMBER AND PERCENTAGE OF ABH A-1 COURSE LEARNING  
OBJECTIVES IN EACH IQI TASK/CONTENT CATEGORY

Task	Content				
	Fact	Category	Procedure	Rule	Principle
Remember- recall	0	0	0	0	0
Remember- recognize	107 (37%)	4 (1%)	74 (26%)	13 (4%)	2 (1%)
Use- aided	N/A	1 (1%)	88 (30%)	0	0
Use- unaided	N/A	0	0	0	0

Table 11

NUMBER AND PERCENTAGE OF ABF A-1 COURSE LEARNING  
OBJECTIVES IN EACH IQI TASK/CONTENT CATEGORY

Task	Content				
	Fact	Category	Procedure	Rule	Principle
Remember- recall	0	0	0	0	0
Remember- recognize	105 (50%)	5 (2%)	56 (27%)	3 (1%)	13 (6%)
Use- aided	N/A	0	25 (12%)	1 (1%)	0
Use- unaided	N/A	0	0	0	0

Percentages do not add to 100 due to rounding.



# Authoring Instructional Software

## Authoring System

The LSCAI authoring system, LSAUT, was used to author the prototype program for this dissertation. The background and experience of the program author is discussed in the next chapter. Authoring activities were logged as the program was developed. Table 12 summarizes courseware development times. Few

Table 12

### COURSEWARE DEVELOPMENT TIME

Hours of Classroom Instruction Covered	5.0
Total Courseware Development Time	52.2
Time Required to Develop Graphics	12.3
Development Time Per Hour of Instruction	10.4

problems were noted in using the authoring system. The following difficulties were noted, however:

1. The documentation said 512K memory is required for LSSTU operation. In reality, 640K is needed.
2. LSSTU terminates without warning when memory is exceeded (Occurred only when attempting to use a 512K system. Memory was never exceeded when 640K expansion was installed).
3. The mouse device would not function when the mouse driver delivered with the mouse system was installed. The mouse driver that is built-in to LSSTU interferes with the mouse system driver. Removal of the mouse system driver solved the problem.
4. When editing text in a window, complicated changes involving underlining and line deletes sometimes caused the text to garble. The text had to be deleted and the window edited anew to correct the problem.

Authoring system capabilities and limitations were documented using the Authoring Tool Evaluation Form developed by Gillingham, et al. (1986). The completed form is shown in Appendix A.

## Prototype CBI Program

A prototype of a microcomputer-based review, structured self study, and remediation program was developed for this project. It consists of several exercises on material presented in a portion of the ABF A-1 Course. The individual exercises, developed using the LSCAI authoring system, LSAUT, are delivered by the LSCAI delivery system, LSSTU.

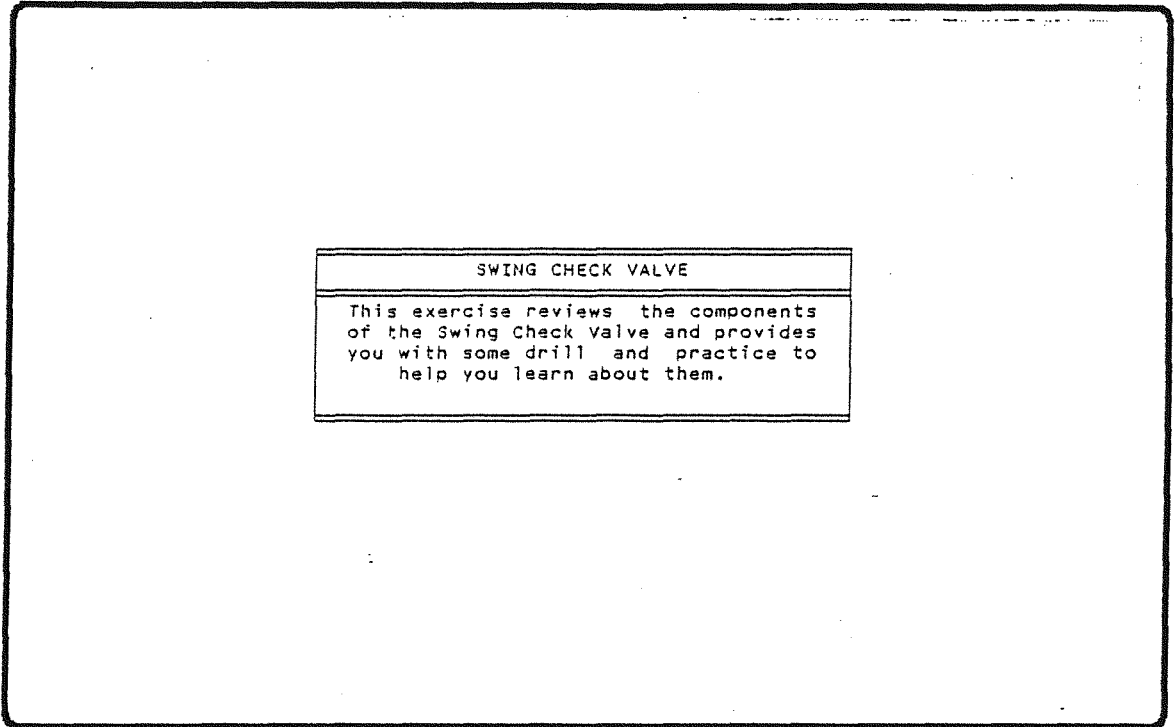
Students are presented with a menu from which they can choose the course material that they want to review. Figure 1 shows the main menu screen. After pressing a letter corresponding to a specific exercise and then <ENTER> a lesson introduction screen (Figure 2) is presented that tells the student what the exercise is about. The appropriate LSSTU exercise is then loaded and executed.

Figure 1

AVIATION BOATSWAIN MATE (FUELS) (ABF) "A" SCHOOL - UNIT 2 REVIEW AND PRACTICE	
BEFORE ATTEMPTING ANY OF THE FOLLOWING EXERCISES, YOU SHOULD REVIEW THE APPLICABLE PARTS OF THE LANGUAGE SKILLS CAI STUDENT MANUAL WHICH CAN BE PROVIDED TO YOU BY YOUR INSTRUCTOR.	
A INTRODUCTION TO GAGES B GAGE COMPONENT REVIEW C INTRODUCTION TO VALVES D GATE VALVE REVIEW E GATE VALVE DRILL #1	F GATE VALVE DRILL #2 G GLOBE VALVE REVIEW H BUTTERFLY VALVE REVIEW I SWING CHECK VALVE J EDUCTOR REVIEW
PRESS THE LETTER CORRESPONDING TO THE EXERCISE THAT YOU WANT THEN PRESS <ENTER>.	

Figure 2

EXERCISE INTRODUCTION SCREEN



The LSSTU program then delivers the exercise that the student selected. The exercise activities and their sequence are determined by the author of the program. Exercise activities available in the LSCAI system include the following:

Introduction to Exercise Words -Context Material

Individual Word Activities

- \* Definition Building

  - Hidden Multiple Choice

  - Visible Multiple Choice

- \* Antonyms, Synonyms, and Related Words

- \* Spelling

## Collective Word Activities

Matching

Graphics Labeling

Cloze Paragraph (Fill in the Blanks)

Activities marked with an asterisk (\*) are available in LSCAI but are not used in the prototype program. The reasons for the use of particular types of exercise and not others is discussed in Chapter 5. The following paragraphs describe the screens that are presented to the student and how the student interacts with the system during each of the exercise activities used in the prototype program. Representative screens from the prototype program are shown to illustrate its use.

### Introduction of Exercise Words - Context Material

Exercises normally begin with a review of the material presented in class. The review is presented as a sequence of screens that may contain text, graphics or a combination of the two. Figure 3 is an example of a screen that contains only textual material. Figure 4 shows a screen that contains both text and graphics. Portions of the graphic may be highlighted to correspond to the textual material covered in that frame. Text presented in the windows can be changed without changing the graphic. The context sequence is specified by the program author. The student is prompted to press <enter> when ready to continue to the next screen. On the final context screen, the student chooses either to see the material again or go on to the exercise activities.

Figure 3

REVIEW SCREEN CONTAINING TEXTUAL MATERIAL

SAFETY AND CARE OF GAGES

1. Follow standard safety precautions.
2. Apply pressure slowly.
3. Avoid over-pressure.
4. Protect from vibration, temperature, and corrosion.

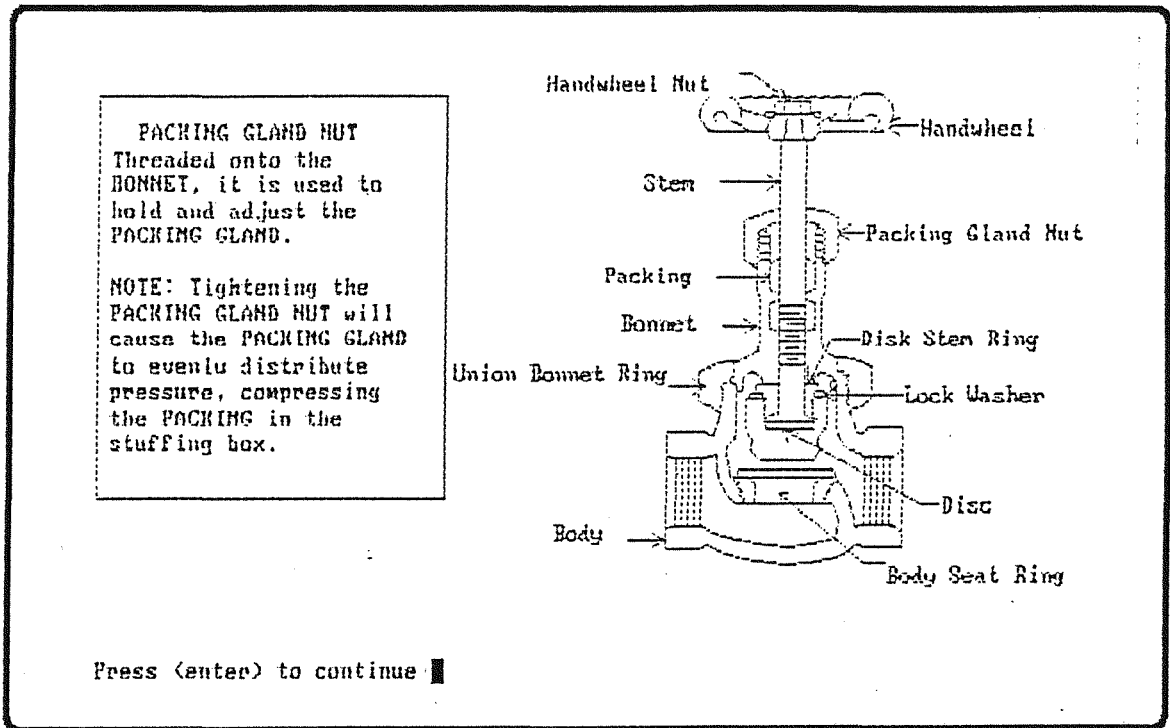
Do you want to see the material again: Yes  No

Hidden Multiple Choice.

In the Hidden Multiple Choice Activity the student is presented with the full definition for a word in the exercise and asked if it is the correct one for the word shown. This activity is similar to a traditional true-false exercise. If NO is selected when the correct definition is displayed a message is shown stating that the answer was wrong and the correct definition is displayed. If YES is selected when the incorrect definition is shown the student is told that the answer was incorrect and the exercise continues with new definitions until the correct one is displayed. The system asks a student after an incorrect response if additional information about that word is desired. If YES is selected, a Related Context Sequence is

Figure 4

REVIEW SCREEN CONTAINING BOTH TEXT AND GRAPHICS



displayed. The Related Context Sequence, if supplied by the author, contains text and/or graphical information to help the students understand the definition that they just missed. Figure 5 contains an example of a Hidden Multiple Choice frame.

### Visible Multiple Choice

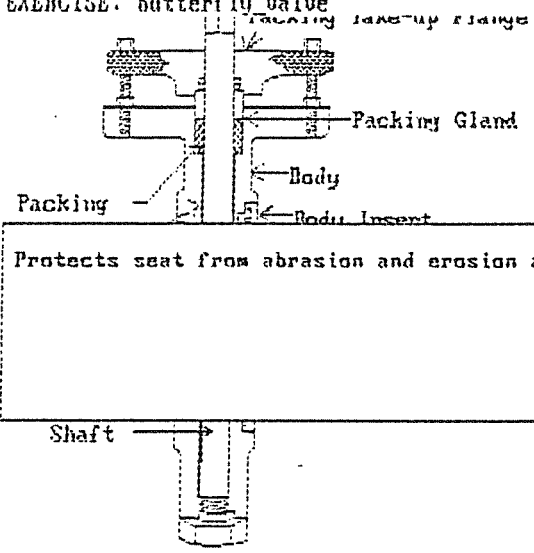
In the Visible Multiple Choice activity students are shown a list of definitions for the words in the exercise and are asked to select the correct one for the word shown. If the student responds correctly the system presents the next word or, if all of the words have been tested, it goes on to the next activity. If the student responds incorrectly, the correct answer is highlighted and the student is allowed to either view

Figure 5

HIDDEN MULTIPLE CHOICE SCREEN

LSCAI:  
EXERCISE: butterfly valve

RECEIVED 8  
POSSIBLE 6



SHAFT BEARING

Supports shaft in the body.  
Self-lubricated.

Protects seat from abrasion and erosion and positions lip seal in body.

Shaft

Is this the definition for 'Disc'? Yes

Related Context Information or go on with the exercise. If the student confuses two words that are often confused, the system will present a sentence to help the student differentiate between them in the future. Figure 6 shows a Visible Multiple Choice screen before the student has responded. Figure 7 contains an example of a screen that displays information on two often confused words.

Matching

Figure 8 shows a Matching exercise. The student matches words in the left menu to paraphrased definitions in the right window. Highlighted definitions are associated with highlighted words by selecting the command "Match." The student can move

Figure 6

VISIBLE MULTIPLE CHOICE SCREEN

LSCAI:	RECEIVED	8
EXERCISE: gage_intro	POSSIBLE	8

Definitions

1. Measures two pressures above atmospheric and indicates the difference between the two. Example: Filter inlet-outlet gage.
2. Measures a single pressure above atmospheric. Example: Pump discharge.
3. Measures pressure above and below atmospheric. Example: Pump suction gage.
4. Measures pressure below atmospheric. Example: Pump suction.

Select definition of 'VACUUM type gage'.  
Select

Figure 7

VISIBLE MULTIPLE CHOICE SCREEN WITH A  
SENTENCE DIFFERENTIATING BETWEEN  
OFTEN CONFUSED DEFINITIONS

LSCAI:	RECEIVED	8
EXERCISE: gage_intro	POSSIBLE	6

Definitions  
-- 3 more above --

4. Measures pressure below atmospheric. Example: Pump suction.

To, you have confused the word 'SIMPLEX type gage' with 'VACUUM type gage'. Here is a sentence to help in distinguishing them.  
VACUUM gages measure pressure below atmospheric, while SIMPLEX gages measure a pressure above atmospheric.

To exit window type ^O (Ctrl O)

Select definition of 'VACUUM type gage'.  
Select



from window to window and select words and definitions using the "Switch\_Menu" command and the up and down arrow keys or a mouse. When the student is satisfied with the responses the command "Evaluate" is selected. The system shows the student which matches are incorrect and allows one more try. After the second try, the correct matches are displayed and the system goes on to the next activity.

Figure 8

MATCHING SCREEN

LSCAI:		RECEIVED	8
EXERCISE: gate_drill1		POSSIBLE	8
Words		Definitions	
<ul style="list-style-type: none"> <li>1 Stem</li> <li>2 Yoke Sleeve Nut</li> <li>Body</li> <li>Bonnet</li> <li>3 Handwheel</li> </ul>		<ul style="list-style-type: none"> <li>1. Raises or lowers the gate to open and close the valve.</li> <li>2. Fastens the HANDWHEEL to the YONE SLEEVE.</li> <li>3. Provides leverage to open or close the valve.</li> <li>4. Supports the valve bonnet assembly, provides a passage for fluid flow, and contains the seats.</li> <li>5. Bolted to the valve body. Used to support stuffing box and stem.</li> </ul>	
<p>Match joins the highlighted word with the highlighted definition.          Unmatch separates the highlighted word from any definition.</p>			
<p>Match Unmatch Switch_menu Evaluate</p>			

Graphics Labeling

A label Screen is shown in Figure 9. A screen containing text and graphics, or graphics alone is presented to the student in much the same way that the context material was presented.

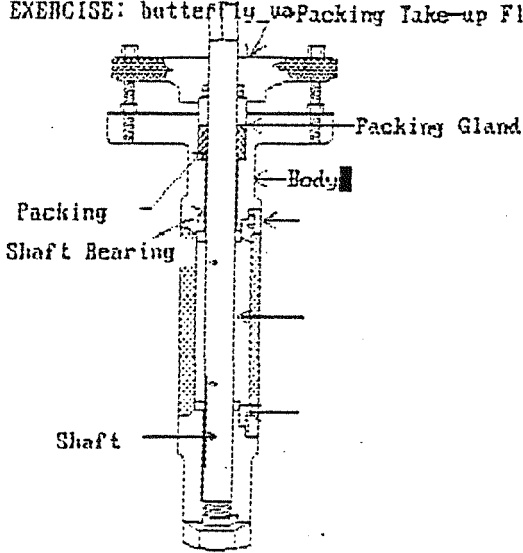
In this case, however, the student must label components of the piece of equipment represented in the graphic by entering text at locations shown by the cursor on the screen. When the student has entered the labels the "Evaluate" command is selected. The system then tells the student that the labels are right or it erases those that were entered incorrectly and gives the student one more try. After the second try, the correct labels are shown and the student can go on to the next activity. Figure 10 shows a screen after the student has completed one try in which four components were incorrectly labeled. The incorrect responses were erased and the student is prompted to press <enter> to try again.

Figure 9

GRAPHICS LABELING SCREEN

LSCAI:  
EXERCISE: butterfly\_valve Packing Take-up Flange

RECEIVED 18  
POSSIBLE 38



Packing Gland

Body

Packing

Shaft Bearing

Shaft

BUTTERFLY VALVE  
COMPONENTS

- Body
- Body Insert
- Disc
- Flexible Lip Seal
- Packing
- Packing Gland
- Packing Take-up Flange
- Shaft
- Shaft Bearing

<TAB> moves cursor among positions. Press <ENTER> to get back to menu.

LABEL OBJECTS: Label\_objects Evaluate

Figure 10

GRAPHICS LABELING SCREEN THAT PROMPTS  
STUDENT FOR A SECOND TRY

LSCAI:  
EXERCISE: globex

RECEIVED 24  
POSSIBLE 30

GLOBE VALVE COMPONENTS

- Body
- Body Seat Ring
- Bonnet
- Disc
- Disc Stem Ring
- Stem
- Handwheel
- Handwheel Nut
- Lock Washer
- Packing
- Packing Gland Nut
- Union Bonnet Ring

Handwheel Nut

Handwheel

Packing

Bonnet

Disc Stem Ring

Lock Washer

Body

Body Seat Ring

<TAB> moves cursor among positions. Press <ENTER> to get back to menu.  
The filled in labels are correct. Try again. Press <enter> to continue █  
LABEL OBJECTS: Label\_objects Evaluate

Cloze Paragraph (Fill in the Blanks)

A screen containing textual material is presented to the student. Blanks that must be filled in by the student are indicated with underlines. The student moves from one answer space to the next with the <TAB> key and enters the appropriate words. When complete, the command "Evaluate" is selected. The system erases incorrect responses and prompts the student to try again. After the second try, answers that are still incorrect are replaced on the screen by the correct answers shown between greater-than and less-than symbols (<>). Figure 11 shows a cloze paragraph screen before the student has entered any answers. Figure 12 contains the same activity after one try where the student had one of the answers wrong. Figure 13 shows that

Figure 11

CLOZE PARAGRAPH SCREEN  
BEFORE FILLING IN THE BLANKS

LSCAI: EXERCISE: gatex	RECEIVED 8 POSSIBLE 8
<p>GATE VALUE REVIEW</p> <p>This is a very short review of some of the information just covered. For a more complete review to help you learn the GATE VALUE components, you should complete GATE VALUE DRILLS 1 and 2.</p> <p>GATE VALUES are used to <input type="text"/> flow and to <input type="text"/> flow.</p> <p>They are operated in the fully <input type="text"/> or fully <input type="text"/> position.</p> <p>Turning the handwheel clockwise <input type="text"/> the valve.</p> <p>Turning the handle counter-clockwise <input type="text"/> the valve.</p> <p style="text-align: center;">To exit window type ^O (Ctrl O)</p> <p>Fill in underlined spaces. &lt;TAB&gt; moves cursor among positions.</p>	

Figure 12

CLOZE PARAGRAPH SCREEN  
WITH AN ERROR AFTER THE FIRST TRY

LSCAI: EXERCISE: gatex	RECEIVED 8 POSSIBLE 8
<p>GATE VALUE REVIEW</p> <p>This is a very short review of some of the information just covered. For a more complete review to help you learn the GATE VALUE components, you should complete GATE VALUE DRILLS 1 and 2.</p> <p>GATE VALUES are used to <u>start</u> flow and to <u>stop</u> flow.</p> <p>They are operated in the fully <u>open</u> or fully <u>closed</u> position.</p> <p>Turning the handwheel clockwise <input type="text"/> the valve.</p> <p>Turning the handle counter-clockwise <u>opens</u> the valve.</p> <p>The filled in entries are correct. Try again. Press &lt;enter&gt; to continue <input type="text"/></p>	

activity after the student has had two tries and has still failed to enter one of the answers correctly.

Figure 13

CLOZE PARAGRAPH SCREEN  
WITH AN ERROR AFTER THE SECOND TRY

LSCAI:	RECEIVED	18
EXERCISE: gatex	POSSIBLE	12

GATE VALUE REVIEW

This is a very short review of some of the information just covered. For a more complete review to help you learn the GATE VALUE components, you should complete GATE VALUE DRILLS 1 and 2.

GATE VALUES are used to start flow and to stop flow.

They are operated in the fully open or fully closed position.

Turning the handwheel clockwise closes the valve.

Turning the handle counter-clockwise opens the valve.

Wrong! Answers you missed are shown in (\_\_\_\_). Press <enter> to continue █

### Exercise Scoring

The LSCAI delivery system, LSSTU, scores each of the exercise activities and displays the results in the upper right hand corner of the screen. For this application the score is for the benefit of the student only, and is not used as an indication of mastery or entered into the student's record. Each of the activities is scored somewhat differently. In Hidden and Visible Multiple Choice each correct answer adds six to the possible and received scores, while an incorrect answer adds six only to the possible score. In the Matching activity, six is

added to the received score for each correct answer on the first try and three is added for correct answers on the second try. Six is added to the possible score for each word in the exercise. The Labeling exercise also gives six for correct answers on the first try and three for the second. In the Cloze Paragraph activity, two is added for each correctly filled in blank on the first try and one is added for a correct answer on the second try. The possible total is incremented by two for each blank. After an exercise has been completed, a summary of scores in each activity is displayed for the student's information. Figure 14 shows such a screen. The student is then returned to the main menu from which another exercise can be selected, or the previous exercise can be repeated.

Figure 14

SCORE SUMMARY SCREEN

Definition building:	8 out of 8
Hidden multiple choice:	8 out of 8
Visible multiple choice:	8 out of 8
Associated words:	8 out of 8
Spelling:	8 out of 8
Matching:	24 out of 38
Labeling:	39 out of 48
Cloze Paragraph:	18 out of 12
Total:	73 out of 98

Press <enter> to continue █

# Evaluation of Instructional Software

## Student Evaluation

The CBI program developed for this project was evaluated by a sample of eight students. After reviewing the program, they completed the Student Evaluation Form developed by Callison and Haycock (1988, 27-28). The form is shown in Appendix B. In response to the first question, none of the eight students checked that they stopped working with the program before the minimum evaluation time of 30 minutes because it was too difficult or because they got bored. All eight completed the evaluation. Students used the program from 30 to 48 minutes, with a mean of 41.6 minutes (Std.Dev. = 5.8). Table 13 shows the

Table 13

### STUDENT EVALUATION STATEMENTS AND NUMBER OF EVALUATORS WHO AGREED WITH EACH OF THEM

Number of Eval- uators Who Agree	Student Evaluation Statements
7	I'd like to do this program again.
7	The graphics were helpful.
1	I got lost in the program and didn't know what to do.
4	I really had to think in order to get the right answer.
6	This program helped me when I made a mistake.
0	I got all of the answers right on the first try.
8	Compared to the other times I studied this subject, this program was fantastic.
6	I would rather do this program with a classmate than by myself.
2	I would like to be graded by my instructor on the work I did with this program.
6	If I could, I would take this program home to use it.
0	This program was a waste of my time.
0	This program lasts too long.
7	I think my friends would enjoy this program.
1	I could not do this program without help from an instructor.
0	This program was too easy for me.

number of students who checked that they agreed with each of the 15 statements listed on the Student Evaluation Form. Student evaluators were asked to rate the microcomputer program on a scale from "0" (lowest) to "100" (highest). Ratings ranged from 90 to 100, with a mean of 97.8 and standard deviation of 3.7.

Student evaluators were asked to use a statement, drawing, or any other written means of expression, to present an idea or fact that they remembered from the program. Responses (unedited) were as follows:

The graphic drawing of gages and matching

The labeling of the gages was some help

It was really quite a learning experience. I usually have trouble comprehending the material, but with the material right out in front of me, help me a lot

It had good graphics that gave me a better understanding of the topic (lesson).

It had great details and features.

To the question, "What did you LIKE most about the program?", the following responses were received:

The challenge that it gave me on the match part.

I liked about: how it was so exciting to set there and think on a game like program that helped me

Help focussing more on the detail

The graphics were helpfull.

The graficks

How it correct you error. It help when your studying.

It gave me questions that made me think. The instructions manual does not -(too easy). Fill-ins are helpful.



What I like most about this program is that the computer drills the questions you dont know in your head

Student evaluators were asked to name any similar computer programs, books or other materials with which they had worked and that they thought were NOT AS GOOD as this program. Only two of the eight evaluators responded to this question. They said:

I worked with the Apple Computer on circuit boards and it was too difficult for me to understand the keys. This program works with a few keys.

The ABF Instructions Manual is not as good.

To the question, "What did you DISLIKE most about the program?", the following responses were given:

The way the program really makes you think and think hard

I like everything about it

I didn't, I like the program. It was very useful.

Nothing

Nothing. It has no faults

I wanted more time

None of the student evaluators responded to the question that asked to them to name any other similar computer programs, books, or other materials that they thought were better than this program.

#### Staff Evaluation

Seven members of the Naval Air Technical Training Center, Lakehurst staff (instructors and instructional development

personnel) evaluated the program using the MicroSIFT Evaluator's Guide For Microcomputer-based Instructional Packages (Northwest Regional Educational Laboratory 1982). An evaluation form with the number of evaluators that selected each of the ratings for each statement, is in Appendix C.

### Cost-Effectiveness Analysis

The benefit to be gained through the implementation of a microcomputer-based review, structured self-study, and remediation program was considered by using a cost-effectiveness analysis. Effectiveness was considered to be constant, and costs and cost savings compared to current review and self-study methods were calculated. Table 14 presents the results of the analysis.

Table 14

#### COSTS AND COST SAVINGS RESULTING FROM IMPLEMENTATION OF A MICROCOMPUTER-BASED REVIEW SYSTEM

Factor	One-Time Cost (Cost Saving) \$	Annual Cost (Cost Saving) \$
Cost of Hardware	9,900	-0-
Microcomputer Maintenance	-0-	375
Software	-0-	-0-
Computer Laboratory	3,950	-0-
Laboratory Staff	-0-	-0-
Application Development	24,278	-0-
Reduced Attrition Rate	-0-	(2914)
Reduced Set-Back Rate	-0-	(5652)
Reduced Review Time in Class	-0-	(35,068)
Reduced Review Time in Evening	-0-	-0-
<b>TOTALS</b>	<b>38,128</b>	<b>(43,259)</b>

## Chapter 5

### DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

#### Selection of a Course Unit

There is general agreement in the literature that computer-based instruction (CBI) should not be implemented just to take advantage of new technology or with the hope that it will automatically lead to an improvement in instructional quality. CBI should be considered for use only in those areas judged to benefit from its implementation. A need for improvement that can be provided better by CBI than through traditional instructional means should be identified, and then the type of CBI that is applied should be based on the instructional content of the material to be presented.

U.S. Navy policy is to use interactive courseware whenever an analysis shows that it will be the most effective means of supporting instructors and enhancing the instructional process (CNET 1988b, 1). Researchers at the Navy Personnel Research and Development Center (Wetzel, Van Kekerix and Wulfeck 1987b, 21) recommended that CBI be used for specific situations including presentation of introductory or familiarization materials and tasks requiring high levels of practice. They also felt that the Navy's high emphasis on training objectives for remembering

facts and using procedural steps should be supported with CBI involving drill and practice and simulation.

While the normal chain of events in the consideration of CBI should be, first, to identify a training need and then see if there is a CBI application that would best serve that need, the purpose of this dissertation caused the process to be reversed. The CBI application was already known, so the first step in this project was to identify a course unit that would benefit from computerized review, structured self-study and remediation delivered by the Language Skills Computer-Assisted Instruction (LSCAI) system.

Factors considered in selection of a course unit were course stability, level of training, annual throughput, and attrition and setback rates. Course stability was considered first because a lack of stability would eliminate a course from further consideration. The last three criteria were considered using a multi-attribute analysis in which each course was assigned a value from one to five indicating its benefit for computerization in regard to each criterion (See Table 8). No weights were assigned to the three criteria because they are all considered equal in importance.

The courses selected for further study using the multi-attribute analysis were PR Basic, ABF A-1, and ABH A-1. The ABF A-1 course was finally selected from these based on the results of an analysis of the instructional content of the three courses using the Instructional Quality Inventory (IQI).

Discussion of the analyses are presented in the following paragraphs.

### Course Stability

Wetzel, Van Kekerix and Wulfeck (1987b, 14) found that course stability is a special problem in considering courses for CBI. It would not be cost-effective to develop courseware for a course in which major changes were expected to occur. Course Managers and School directors at NATTC, Lakehurst were asked to identify any major changes that were being planned for courses under their purview. Two such changes, effecting eight courses, were identified. Effected courses are listed on page 65 in Chapter 4 of this report. The eight courses were removed from further consideration for CBI development.

### Level of Training

Training is delivered to three levels of students at NATTC, Lakehurst: Initial Skill Training ("A" Schools); Advanced Skill Training ("C" Schools); and officer courses. The literature reveals that drill and practice can be effective when used in the training of basic skills (Bear 1984; Goldman and Pellegrino 1986). Some research suggests that CBI is more effective in the lower grade levels where basics are taught than in higher grades where higher order thinking skills are emphasized (Kulik, Bangert and Williams 1983). Wetzel, Van Kekerix and Wulfeck (1987b, 8) noted that a somewhat lower percentage of "A" School students reached criterion on first attempts at module

tests than students in higher level courses. Initial Skills training ("A" schools) were judged, therefore, to have the greatest potential to benefit from CBI of the type delivered by the LSCAI system. They were given the highest benefit rating of five. Advanced courses were assigned a three, and the one officer course was given a one.

### Throughput

The costs associated with the purchase of hardware and the development or purchase of software for CBI have to be amortized across the students who benefit from the resulting instruction. The greater the number of students who use the system, the greater the total benefit that can be derived from it. The annual throughput of each of the NATTC, Lakehurst courses considered for CBI in this project was reviewed (see Table 6) and a benefit rating was assigned (see table 8). The PR Basic course had the highest throughput of the courses considered and was awarded a benefit rating of five. Ratings then ranged down to one based on the decreasing magnitude of the throughput.

### Attrition/Setback Rates

Attrition and setback rates indicate a failure to attain mastery of the material presented. The literature is clear that drill and practice CBI is most effective in reinforcing material that has already been taught in the classroom so that students can attain mastery. The highly structured, behavioral approach to learning used by the Navy requires that students master the

skills presented. Learning objectives relate directly to job tasks that the students must know to do their job effectively in a ship or aviation squadron.

Attrition and setback rates greater than zero for those NATTC, Lakehurst courses considered for CBI are shown in Table 7. Only the PR Basic and ABF A-1 Courses had any attrition or setbacks because of academics. Attritions or setbacks due to medical, legal or other problems were not considered in this dissertation. Although the rates for the PR Basic and ABF A-1 courses are low, they are meaningful because they indicate difficulty in attaining mastery even after considerable review and remediation. PR Basic, having the highest rate was awarded a benefit rating of five. ABF A-1 was given a three, and the other courses the lowest rating, one.

#### Analysis of learning Objectives

Based on the results of the multi-attribute analysis described above, the PR Basic, ABH A-1, and ABF A-1 courses could benefit from the use of CBI systems that provide review, structured self-study and remediation. The learning objectives for these courses were analyzed using the Instructional Quality Inventory (IQI), as previously described, to determine which would be most amenable to the type of instruction provided by the Language Skills Computer-Assisted Instruction (LSCAI) program. The results of the IQI analysis are shown in Tables 9, 10, and 11.

Learning objectives that require the remembering of facts are particularly suited to drill and practice type CBI. Fifty percent of the learning objectives in the ABF A-1 course are in that category, while the PR Basic and ABH A-1 courses have 42 and 37 percent, respectively. The ABF A-1 course, therefore, has a greater proportion of its objectives that could be supported with LSCAI than the others. The ABH A-1 course is heavily oriented toward the learning of procedures, with 56 percent of its objectives in those categories. Thirty-nine percent of the ABF A-1 and 31 percent of the PR Basic objectives concern the learning of procedures. The PR Basic and ABH A-1 courses have greater proportions of their objectives in the USE categories which may be amenable to simulation type CBI, but are not well suited to drill and practice. The ABF A-1 course has only 13 percent of its objectives in USE categories. Because of the high proportion of objectives requiring the remembering of facts, and the low proportion of objectives in the USE categories, the ABF A-1 course was selected as the one that would be best suited to CBI of the type delivered by the LSCAI program.

#### Authoring of CBI Courseware

A major purpose of this dissertation is to provide others who may be considering the use of CBI with information that they can use for cost-benefit analysis and implementation planning. Many articles point to a lack of planning as the main reason for



the lack of success of many CBI programs (Leiblum 1982; Diem 1986; Levin and Meister 1986; Lukesh 1987; Stallard 1987). The Training Technology Implementation Office under the Chief of Naval Education and Training was set up to ensure a focus on planning in the implementation process. The cost of courseware acquisition and development is an important factor in such planning. Costs include both the dollars spent for software and the time that consultants or in-house personnel spend in making a system usable.

Because the development of the Computer-Based Educational Software System (CBESS) was funded by the Navy, the products of it, including LSCAI, will be made available at no cost to Navy training commands. Development of specific applications, however, will have a cost that must be considered. Those costs will depend on whether consultants must be contracted or if development can be done by in-house personnel. The following questions must be answered:

- What qualifications are required for personnel to be able to develop courseware using LSCAI?
- How long will courseware development take?
- What problems may be encountered?
- What capabilities does the authoring system have?

This dissertation provides a demonstration of the use of the LSCAI authoring system and answers the above questions as they apply to this particular application. Detailed logs were maintained during program development, documenting the time required for each step and what problems were encountered.

Development of the instruction was straight-forward because the prototype program merely reviews the material already developed into traditional classroom lecture presentations. Material was extracted from instructor guides almost word for word to ensure continuity between the classroom presentations and the review. This also ensured that the instructional theory underlying the course development was not changed. The instructor guides are stored on Apple microcomputer diskettes so the material could be transferred electronically to a Zenith 248, edited as necessary, and then imported directly into the program by the authoring system. The types of LSCAI drill and practice exercise activities used in the prototype were determined by the learning objectives. Spelling of component names is not an objective of the ABF A-1 course, so that activity is not included in any of the exercises. The definition building activity helps a student learn word definitions. Because ABF A-1 students have to recognize functional definitions, rather than memorize them, that activity was not used. Multiple Choice, matching, and fill-in the blanks activities were used. The labeling activity is used extensively. Students must type in the names of the components in the labeling activity. Because the objectives do not require that students memorize the component names, or know how to spell them, a list of components is displayed along with the graphic to be labeled.

## Qualifications of Courseware Developer

The courseware for this project was developed on a part time basis by one person, working alone. Ready access was available to all curriculum materials such as Curriculum Outlines and Lesson Topic Guides (lesson plans). The developer had previous Navy instructor training and extensive experience as a classroom and flight instructor. His educational background includes a Masters degree in Systems Management and completion of coursework for a Doctor of Science in Training and Learning Technology. He also has a strong knowledge of microcomputer systems, including the MS-DOS operating system and numerous applications packages and utilities.

The developer did not have a knowledge of the technical material presented by the CBI program. He had never used the LSCAI authoring system before beginning this project, and he received no training in it. The software provided by NPRDC had some sample programs included with it and the documentation provided was extensive. The developer's experience and background in both training and microcomputers aided him in using this material to learn the authoring system quickly and without difficulty. With a small amount of training and some additional assistance, it is felt that any curriculum developer or instructor with a basic knowledge of microcomputers could learn to develop software using the LSCAI authoring system. No knowledge of programming is needed. The developer enters course information through the menu-driven authoring system, and the

delivery system then does the work of presenting the instruction.

#### Courseware Development Time

The courseware developed for this project provides review and practice for the material presented in five hours of classroom instruction. Total development time was 52 hours and 14 minutes. This equates to 10 hours and 24 minutes of development time for each hour of primary instruction. Compared to a rule of thumb that 100 to 200 hours of total development time are required for each student-hour of CAI developed (Kearsley 1983, 95), the value of the LSCAI authoring system is obvious. It must be noted, however, that the LSCAI system presents only certain types of instruction, and while it does it in an interesting and effective way, its capabilities are limited compared to some other kinds of systems.

A strong feature of LSCAI is its graphics capability. As expected, the authoring of graphics frames took a significant portion of the development time. Of the total 52.2 hours of development time, 12.3 (24 percent) were dedicated to producing graphics. Some of this time could have been saved by "scanning in" graphics material. LSCAI has the ability to operate with a scanner, but none were available at Lakehurst when this project was completed.

The developer felt that the authoring progressed more rapidly as he became more familiar with the LSCAI authoring

system. The documentation can neither support or refute that because the amount and sophistication of material in the exercises had a greater effect on development time than did the author's expertise.

### Problems in Authoring Courseware

Few problems were encountered in developing the courseware using the LSCAI authoring system. The system is fully menu driven and, although it has many options and capabilities, it is easy to use. Only one serious problem was identified. The documentation says that a minimum of 512K RAM memory is required to run the LSCAI delivery and authoring programs. Although one of the Principal Investigators at NPRDC told the developer that 640K was needed to use the program, development was begun on a 512K Zenith 248 while awaiting delivery of a memory expansion. None of the exercises could be completed in just 512K. The most serious aspect of this problem, however, is that the sequence editor and the authoring program terminate when you exceed the available memory, and all work completed up to that point, but not yet saved, is lost! A total of 4 hours and 15 minutes of effort were lost in three such incidents. After the memory was expanded to 640K, no further difficulties were experienced. A recommendation will be made to NPRDC, that a feature be added to the program that warns when memory is being exceeded so that the author can get out of the system gracefully without losing data that has been entered.

Another problem that was bothersome for some time was the inability to get the mouse to work with the system. That was a particular problem when developing graphics. The problem was resolved when a small note was seen in the Installation and Operation Overview portion of the documentation that said that the LSCAI system had its own mouse driver built in so that an additional driver was not needed. When the driver delivered with the mouse system was uninstalled, the mouse worked as advertised.

### Authoring System Capabilities

The capabilities of the LSCAI authoring system, LSAUT, are documented in Appendix A. The form used was developed by Gillingham et al. (1986) to determine the extent to which authoring tools allow non-programmer, education professionals to create lessons within a reasonable time frame. It was also intended as a tool for potential users to evaluate new authoring systems. It is provided here so that potential users of LSAUT will have information on which to base a decision regarding its use for some specific application.

### Pilot Test of Courseware

The courseware developed for this project was designed to provide review, structured self-study and remediation to students undergoing initial skills training in the Navy Aviation Boatswain Mate (Fuels) "A" School course (ABF A-1). The LSCAI

system presents introductory information, and then a series of up to eight activities that use common drill and practice exercises such as true-false, multiple choice, matching, labeling, and fill in the blanks. Material already presented in a traditional classroom setting is reviewed by viewing the introductory information. Practice is then provided by the drill and practice exercises. The program will be made available to students for self-study outside of normal school hours. If students do poorly on examinations in class or otherwise show that they are having difficulty mastering the material, instructors may direct that they spend some time using the system.

The prototype program that resulted from this project is described in Chapter 4. It was pilot tested using a sampling of students and a jury of staff personnel. The students completed the Student Evaluation Form developed by Callison and Haycock (1988) specifically for student evaluation of microcomputer software (Appendix B). The staff personnel (see page 59 in Chapter 3) completed the questionnaire included with the Northwest Regional Educational Library's (1982) Evaluators Guide for Microcomputer-Based Instructional Packages (Appendix C).

#### Student Evaluation

A random sample of eight students was taken from an ABF A-1 class of 17. The students were asked to evaluate the prototype program which covered the material that had been presented in

class that day. They used the CBI program in the evening when they would normally have been expected to be studying the same material by traditional means using notes taken in class, and a student workbook. A summary of their evaluations is on pages 84 through 86 of Chapter 4.

Reaction of student evaluators to the exercises presented by the LSCAI system was very positive. None of the students stopped using the program because it was either too difficult or too boring. None agreed with the statements that could be considered negative. Most agreed with the statements that reflected approval of the program and a desire to use it again. When asked to rate the program on a scale of "0" (lowest) to "100" (highest), the mean rating was 97.8. The consistency of the high ratings, with all responses falling between 90 and 100 and a standard distribution of just 3.7, affirms the student evaluators' satisfaction with the program.

When student evaluators were asked to express something that they remembered from the program, none mentioned something from the exercise content. All of those who commented referred to something about the quality of the program. This is probably because the students were more oriented toward evaluating the program, than they were to the review of the day's material while they were filling out the evaluation form. Their positive impression of the delivery system also may have diverted their thoughts from its content to its function. In any case, the comments were very favorable, with the use of graphics being the most popular feature.



In response to questions about what the students particularly liked about the program, they said they liked the way it reviewed the classroom material in a game-like way and they particularly liked the graphics. They noted that the exercises presented a challenge and helped them to focus on detail.

Only two students responded to the questions that asked them to compare the program with other computer programs, books or other materials that they had used. One said it was better than a CBI program that he had previously used because there were fewer key combinations to use in operating the program. The other said that the program was better than the study guide because the study guide is too easy and doesn't make the student think. Lack of more response to these questions is because students had no prior experience with anything that they felt that they could compare with the program they evaluated here.

#### Staff Evaluation

Seven instructors and curriculum development specialists evaluated the program using the Northwest Regional Laboratory (1982) Evaluator's Guide for Microcomputer-Based Instructional Packages. The MicroSIFT project, for which this evaluator's guide was developed, provides evaluations of microcomputer-based instructional packages, many of which are available through the National Institute of Education's Educational Resources

Information Center (ERIC). Anyone contemplating the use of CBI of the type presented by LSCAI should review this evaluation, and compare it with other available courseware. The use of this particular evaluator's guide should facilitate comparison with other programs that have been evaluated under the MicroSIFT program.

Appendix C, an Instructor Software Evaluation, is a summary of the seven staff evaluations. All seven of the evaluators recommend use of the package with little or no change. All of the criteria were rated either as Strongly Agree or Agree by all evaluators except for one. One evaluator disagreed with the statement: "The purpose of the package is well-defined." While he agreed that the purpose was explained to him, he noted in follow-on discussion that the program itself did not present a statement to the user that defined its purpose. Such a statement should be added to an introduction in future versions of the program.

#### Cost-Effectiveness Analysis

The cost-effectiveness analysis presented here must be considered preliminary in nature because it is based only on the pilot test of a prototype program. It does suggest, however, the factors that should be considered when the use of CBI is being planned. The benefits of CBI can be compared to other methods of instruction by comparing either the costs or the effectiveness of the competing methods with the other held constant. All known evaluations of military training have

compared costs with effectiveness held constant (Orlansky and String 1979, 11a). Because Navy technical skills training is competence-based and a given level of mastery is required for course completion, variations in the effectiveness of the instructional methods would result only in differences in the time that it takes to complete the course. The time differences can be expressed in terms of personnel (both student and instructor) costs. For the purposes of this analysis, then, effectiveness will be considered to be constant, and costs of implementing a CBI system such as that presented in this dissertation will be compared with traditional review, self-study, and remediation methods.

Results of the cost-effectiveness analysis are summarized in Table 14 in Chapter 4. The one time cost to implement a microcomputer-based review, structured self-study, and remediation system is \$38,128. An additional annual cost of \$375 is anticipated for microcomputer maintenance. Annual savings that result from the implementation of such a system are \$43,634. The system would pay for itself within the first year of its use and then would continue to provide savings of \$43,259 annually thereafter. The preliminary nature of the analysis increases the uncertainty of the results, but the very short payback time and magnitude of savings provides the basis for further consideration of the LSCAI system for this type of application. A more detailed discussion of the factors considered in the cost benefit analysis is presented in the following paragraphs.

## Cost of Hardware

Microcomputer systems capable of running the LSCAI system would have to be available to students in the evening when they normally review the material covered in class that day or prepare for a test scheduled in the future. Choices for placement of computers are: (1) distribute the computers in the classrooms in the schoolhouse, (2) assign them to individual students, or (3) place them together in one or more computer laboratories. For the type of application presented here, the computer laboratory option seems to be the most practical. The normal class size for the ABF A-1 Course is 15. It is estimated that students may use the computers for one to two hours at a time and that there are three hours per evening available for study. It is expected that they will use the system individually or with one other person. Five microcomputer systems should be enough to support this level of activity.

The prototype program requires an IBM AT class microcomputer with at least 640 kilobytes of memory and a color graphics monitor with an extended graphics adapter. A hard disc drive and a mouse are not required, but are desirable. The cost for a Zenith 248 workstation with the capabilities described above, based on the prices available in the Air Force-Navy contract with Zenith is \$1980. Five workstations would cost a total of \$9900. This is a one time cost.

## Microcomputer Maintenance

Maintenance on the Zenith 248 microcomputers at NATTC, Lakehurst is conducted by a contractor who maintains all Zenith equipment at the Naval Air Engineering Center. NATTC reimburses the Naval Air Engineering Center an hourly service charge plus parts as billed by the contractor. Based on historical data, the contractor estimates an annual maintenance cost of \$75 per microcomputer. The annual cost of maintaining the five microcomputers in the computer center would be \$375.

## Cost of Software

The CBESS software, which includes the LSCAI authoring system, LSAUT, and the LSCAI delivery system, LSSTU, was developed by the Navy Personnel Research and Development Center in conjunction with the University of Utah. It is available free of charge to Navy training activities.

## Cost of a Secure Facility (Computer Laboratory)

The cost of a secure space to place microcomputers so that they are convenient to users, but still protected from theft, mistreatment, or vandalism is often forgotten in implementation planning (Levin and Meister 1986, 746). At NATTC, Lakehurst, a space is available in the administration building near the duty office. Duty personnel are available 24 hours a day to supervise activity in the room and to give general assistance to users. The personnel on duty may or may not be familiar with the material presented in the exercises but will be available to

ensure the security of the equipment and can be trained to help with the basics of microcomputer and LSCAI system use. One time costs to make the space suitable for use as a computer laboratory include:

Electrical wiring upgrade	\$2500
5 Workstation tables	1000
Additional Tables and Chairs	450
TOTAL	\$3950

No recurring costs are incurred as a result of the use of the room for this purpose. The space is already assigned to the Naval Air Technical Training Center and the cost of utilities, janitorial, and other services dedicated to it are negligible.

#### Cost of Personnel to Staff Computer Laboratory

Personnel currently assigned to the duty office could be responsible for supervising the computer laboratory. A benefit of a CBI system of the type proposed here is that it contains the knowledge that the student is to learn. Personnel available to assist people using the system do not have to be knowledgeable in the subject matter. They need only be trained in microcomputer basics and how to operate the CBESS programs. No cost is associated with this factor.

#### Cost of Courseware Development

Although there is no cost for the CBESS system software, the costs associated with the development of specific applications must be considered. The time and expertise needed to develop a program such as the prototype developed for this dissertation are significant. As discussed earlier in this

chapter, the typical Navy instructor who has a basic knowledge of microcomputers could learn to use the LSCAI authoring system, LSAUT, in a short period of time. In developing the application for this project, it took an average of 10 hours and 24 minutes to develop each hour of instruction. The ABF A-1 course has a total of 139 hours of primary classroom instruction. Assuming that all of this instruction is amenable to the type of CBI that can be presented using the LSCAI system, it would take about 36 man-weeks of development time to develop exercises to cover the entire course. The cost of a Navy First Class Petty Officer is \$674.40 per week (NAVCOMPT 1988, Encl.1, 1). The cost to develop a review, structured self-study and remediation program for the entire ABF A-1 course would be \$24,278.

#### Cost Savings Due to Reduced Attrition

A two percent attrition rate from the ABF A-1 course was experienced in fiscal year 1988. The five students were dropped after 11 to 24 days of instruction, with an mean of 21. The training and the time that the attrited sailor was in training was wasted. While the real cost to the Navy was that fewer trained Aviation Boatswain Mates were sent to the fleet, the value of wasted training time plus the cost to transfer a sailor to Lakehurst can be used as a measure of attrition cost. An Airman Recruit (the level of the typical ABF student) costs \$62.80 per day (NAVCOMPT 1988, Encl.1,1). The transportation cost from recruit training to Lakehurst is \$138 (Average of airline fares from the recruit training sites to Philadelphia,

PA.). The average attrite, then, cost the Navy \$1456.80. If a review, structured self-study and remediation program such as the prototype could prevent just two of five attritions annually, an savings of \$2914 would be realized.

#### Cost Savings Due to Reduced Setbacks

A two percent set-back rate was also experienced in fiscal year 1988. Two of the five set-backs eventually became attrites and were considered in the analysis above. The other three were set back after 6 to 16 days of training with a mean of 13. After waiting a mean time of 17 days they recommenced training with the next class. The cost of the setbacks can be calculated by multiplying the daily cost of a typical student times the number of days in training before being set back and while waiting for the next class to begin, a mean time of 30 days. If all three of the setbacks could have been prevented by a program such as the prototype presented here, a savings of \$5652 would have resulted.

#### Cost Savings Due to Less Review Time Needed in Class

Review time is scheduled at the end of each classroom session and a total of forty hours is held at the end of instructional units. It may be possible to delete the review time scheduled at the end of each unit if the students have available a microcomputer-based review system such as the prototype. Instructor requirements are based on contact periods of instruction (CNET 1989, 1). An Instructor Staffing Model



(CNET 1989, Encl.1, App.A) is used to calculate the number of instructors needed for each course. The deletion of the forty hours of review time in the ABF A-1 course results in a reduction of one instructor. The annual pay and allowances of one Navy First Class Petty Officer (typical instructor) is \$35,068 (NAVCOMPT 1988, Encl.1, 1). An annual savings of this amount, then, could be realized by implementing a micro-computer-based review, structured self-study and remediation program.

#### Cost Savings From Reduced Need for Evening Review Periods

Instructors often set up review sessions in the evening when students are experiencing difficulty with the material presented in the classroom. While it is expected that a microcomputer-based review program could reduce the need for this, no monetary savings are obtained because instructors are not compensated for this time, and the calculation of instructor requirements does not include it as a factor.

#### Conclusions and Recommendations

1. The pilot test and preliminary cost-effectiveness analysis of the prototype program developed for this dissertation showed that benefits could be gained from such a system. Full development and implementation of the system is recommended.
2. Microcomputer-based CBI using the Language Skills Computer Aided Instruction (LSCAI) system is effective for the delivery of review, structured self-study, and remediation.

LSCAI should be considered for this kind of application wherever learning objectives require the remembering of facts, especially the learning of technical vocabulary such as the functional definitions of system components.

3. Microcomputer-based review, structured self-study, and remediation can reduce the number of experienced personnel needed as instructors in Navy schools. Implementation should be considered across the Navy training establishment where learning objectives, student throughput, attrition and setback rates, and level of instruction indicate that benefits from such programs could be gained.
4. Implementation of CBI for review, self-study and remediation using low-cost microcomputers and CBESS software can be cost effective. The cost of implementing CBI is much greater than just the purchase of the hardware. Complete implementation planning and cost analysis must take place to ensure that all factors are considered. The low cost of hardware and the availability of effective authoring and delivery software at no cost to Navy training activities may make some applications of CBI cost-effective now where they were not in the past.
5. Demonstration projects, such as this, show the benefits and cost-effectiveness of selected applications of CBI. They should continue to be encouraged and funded by the Chief of Naval Education and Training's Office of Training Technology Implementation to facilitate the movement of technology from the laboratory to the classroom.

6. Drill and Practice type CBI that uses the capabilities of modern microcomputers to generate graphics and dynamic exercises can provide instruction that is challenging, interesting, and enjoyable. The Navy Personnel Research and Development Center should be funded to continue the research and development that resulted in the CBESS system to refine those programs already developed and to ensure that new microcomputer capabilities are exploited.
7. While the program developed for this project was designed for review, structured self-study, and remediation for the ABF A-1 course at NATTC, Lakehurst, NJ, it may be useful for augmenting on-the-job training for sailors on board ships. More than half of the personnel assigned to duty as ABF's in the Navy do not attend the school at Lakehurst; but are trained, on the job, after they get to their ship. A microcomputer-based system that reviews the basics of system and component nomenclature could be helpful. It is recommended that after the program presented in this dissertation is fully developed it be tested on board selected Navy aircraft carriers for that purpose.

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Authoring Tool Evaluation Form - Continued

- Y N  
 - X 10. Does the tool have a variety of program utilities?  
 If Yes, check the following:  
 - - a. Test for readability  
 - - b. Test for grade level  
 - - c. Other: \_\_\_\_\_
11. Does the tool have the following capabilities for text displays:  
 X a. Editing  
 - X b. Variety of fonts. If yes, how many? \_\_\_\_\_  
 - X c. Variety of character sets. If yes, how many? \_\_\_\_\_
- X - 12. Does the tool have a graphics editor or similar capabilities?  
 If yes, can the tool provide:  
 X a. Character sets. If yes, how many? \_\_\_\_\_  
 X b. Color. If yes, how many? 16  
 X c. Animation  
 X d. Change of color  
 X e. Change of characters (Size, color, font)  
 X f. High resolution (53200 pixels)  
 X g. Low resolution (1600 pixels)  
 X h. Pixel addressable positions  
 X i. Create basic shapes in memory  
 X j. Drawing figures  
 X k. Drawing graphs  
 X l. Sprites  
 X m. Rotation of three dimensional objects  
 X n. Other: Scanner Input Available
- X - 13. Does the tool include a lesson editor or similar capabilities? If yes, can the tool provide:  
 X a. Immediate execution mode  
 X b. Cursor moving commands  
 X c. Text changing commands  
 X (1) inserting files  
 - X (2) search and replace  
 - X (3) copy  
 X (4) replace  
 X d. Special display positioning features  
 X e. Other: Sequence Editor, Windowing
- X 14. Does the tool have a sound editor or similar capabilities? If yes can the tool provide:  
 - a. Graphic notation  
 - b. Special Effects  
 - c. Other: \_\_\_\_\_

Authoring Tool Evaluation Form - Continued

- Y N  
X - 15. Does the tool have a test editor or similar capabilities? If yes, can the tool provide:
- a. Formulation of the following types of questions and responses
    - X - (1) multiple choice
    - X - (2) fill in the blank
    - X - (3) dichotomous
    - X - (4) listing
    - X - (5) labeling
    - X - (6) identifying
    - X - (7) matching
    - X (8) short answer
  - b. Numbering questions automatically
  - X - c. Randomization of question selection
  - X d. Ability to develop a question pool
  - X e. Weighing questions for scoring purposes
  - X - f. Other: Dynamically produces drill and practice exercises rather than tests, per se.
- X - 16. Does the tool have computer-managed instruction capabilities? If yes, can the tool provide:
- a. Student data
    - X (1) T scores
    - X (2) Z scores
    - X (3) rank ordering of students
    - X - (4) pass/fail for objective
    - X - (5) number of errors
    - X - (6) number of correct
    - X - (7) % correct
    - X - (8) number of tries per item
    - X - (9) other: Displays score summary for each exercise
  - b. Management tools for data collection
  - X - c. Response latency measures
  - X - d. Monitor student progress on-line
  - X - e. Other: Can require mastery before going to next Exercise.
- X 17. Does the tool have the necessary command structures to handle student responses? If yes, can the tool provide:
- X - a. Corrections for errors in spelling
  - X - b. Acknowledgement of inappropriate space
  - X - c. Changes in upper and lower case letters
  - X d. Matching synonyms
  - X e. Provisions for alternate answers

Authoring Tool Evaluation Form - Continued

- Y N  
X - 18. Has the tool branching capabilities? If yes, can the tool provide:  
X - a. Linear (Note 1)  
X - b. Direct (Note 1)  
- - c. Dynamic  
- - d. Looping
19. Does the documentation provide:  
X - a. Understandable directions  
X - b. The purpose of the software  
X - c. A table of contents  
X - d. Execution of the software
- X - 20. Does the documentation's index have accurate pagination?
- X - 21. Is the documentation index easy to use? If yes:  
X - a. Does the documentation facilitate rapid use of the tool?  
X - b. Is there a cross reference?

-----  
LESSON CREATION

- Y N 1. Is the format/strategy of the tool:  
- X a. Non-procedural  
X - b. Procedural  
If yes, answer the following:  
X - (1) Drill and practice  
X - (2) Tutorial  
- X (3) Demonstration  
- X (4) Simulation  
- X (5) Instructional Games  
- X (6) Inquiry  
- X (7) Other:

Authoring Tool Evaluation Form - Continued

2. Indicate the ease of use for the following:

Ease of use:

- 1. Very easy
- 2. Easy

- 3. Difficult
- 4. Very difficult
- N/A. Not applicable

		Ease			
1	X	3	4	N/A	a. Special key functions
					b. TEXT DISPLAY
1	2	3	X	N/A	(1) Erasing portions of the screen
1	X	3	4	N/A	(2) Display text and graphics on the same screen
X	2	3	4	N/A	(3) Display text and numbers on the same screen
X	2	3	4	N/A	(4) Moving text on the screen
1	2	3	4	X	(5) Changing fonts
1	2	3	4	X	(6) Changing character sets
X	2	3	4	N/A	(7) Underlining (HIGHLIGHTING)
1	2	X	4	N/A	(8) Designing symbols
X	2	3	4	N/A	(9) Changing colors
					c. GRAPHICS
1	2	3	4	X	(1) Designing 3 dimensional figures
1	2	3	4	X	(2) Rotation of 3 dimensional figures
X	2	3	4	N/A	(3) Multiple colors
1	2	3	X	N/A	(4) Animation with simple coding
1	2	3	4	X	(5) Designing character sets
X	2	3	4	N/A	(6) Changing color
1	2	3	4	X	(7) Changing character
X	2	3	4	N/A	(8) Designing high resolution graphics
X	2	3	4	N/A	(9) Designing low resolution graphics
1	X	3	4	N/A	(10) Drawing figures
1	2	3	4	X	(11) Drawing graphs
1	2	X	4	N/A	(12) Sprites
X	2	3	4	N/A	(13) Pixel addressable positions
X	2	3	4	N/A	(14) Setting graphic files

Authoring Tool Evaluation Form - Continued

d. LESSON EDITOR

X	2	3	4	N/A	(1) Rapid test-revise-test cycle
1	2	X	4	N/A	(2) Manipulate text
X	2	3	4	N/A	(3) Change text
1	2	X	4	N/A	(4) Manipulate graphics
1	X	3	4	N/A	(5) Change graphics
X	2	3	4	N/A	(6) Insert files
1	2	3	4	X	(7) Search and replace
1	X	3	4	N/A	(8) Copy
1	2	3	4	X	(9) Replace text
X	2	3	4	N/A	(10) Duplication of lesson from another screen

e. SOUND EDITOR

1	2	3	4	X	(1) Graphics notation
1	2	3	4	X	(2) Special effects

f. TEST EDITOR (Note 2)

X	2	3	4	N/A	(1) Multiple choice questions
X	2	3	4	N/A	(2) Fill in
1	2	3	4	X	(3) Dichotomous
1	2	3	4	X	(4) Listing
X	2	3	4	N/A	(5) Labeling
1	2	3	4	X	(6) Identifying
X	2	3	4	N/A	(7) Matching
1	2	3	4	X	(8) Short Answer
X	2	3	4	N/A	(9) Randomizing question selection
1	2	3	4	X	(10) Developing question pool
X	2	3	4	N/A	(11) Scoring question

g. BRANCHING

1	2	3	4	X	(1) Looping
1	2	3	4	X	(2) Linear
1	2	3	4	X	(3) Direct
X	2	3	4	N/A	(4) Dynamic

Authoring Tool Evaluation Form - Continued

3. Rate the flexibility of the tool in the following areas:

Flexibility:

- |                  |                      |                     |
|------------------|----------------------|---------------------|
| 1. Very flexible | 3. Not very flexible | N/A. Not applicable |
| 2. Flexible      | 4. Inflexible        |                     |

	Flexibility				
X	2	3	4	N/A	a. Text display
X	2	3	4	N/A	b. Graphics
1	2	3	4	X	c. Sound
X	2	3	4	N/A	d. Lesson creation
1	2	3	4	X	e. Branching

OUTCOME OF THE LESSON

Rate the quality of the following:

Quality:

- |              |         |                     |
|--------------|---------|---------------------|
| 1. Excellent | 3. Fair | N/A. Not applicable |
| 2. Good      | 4. Poor |                     |

	Quality				
1	2	3	4	X	a. HELP system
X	2	3	4	N/A	b. Text display
1	X	3	4	N/A	c. Low resolution graphics
X	2	3	4	N/A	d. High resolution graphics
X	2	3	4	N/A	e. The tool in general

Rate the time required to do the following:

Time:

- |               |                 |                     |
|---------------|-----------------|---------------------|
| 1. Just right | 3. Okay         | N/A. Not applicable |
| 2. Reasonable | 4. Unreasonable |                     |

	Time				
X	2	3	4	N/A	a. Learn the system
X	2	3	4	N/A	b. Do the lesson
X	2	3	4	N/A	c. Do text displays
1	X	3	4	N/A	d. Do graphics
1	2	3	4	X	e. Make sound
X	2	3	4	N/A	f. Enter test questions (Note 2)

Note 1: Multiple choice supports simple feedback for errors.

Note 2: The LSCAI system dynamically generates drill and practice exercises rather than tests, per se.

Appendix B

Student Evaluation Form

=====  
Name: \_\_\_\_\_ Class #: \_\_\_\_\_

Date: \_\_\_\_\_ Exercise Name \_\_\_\_\_

How many exercises have you completed prior to this one \_\_\_\_\_  
-----

Before starting to work with the microcomputer program that you will evaluate, take some time to review the student guide that explains how to use it. It is requested that you evaluate at least two of the program exercises, and fill out a form for each one that you evaluate.

After you have spent at least 30 minutes working with the program given to you to evaluate, you may stop and read through the questions given below. If you feel that you have completed the program, you may respond to the questions. You may, however, take more time to examine the program if you desire. If you have to leave the program before spending at least 30 minutes with it, do not complete the form. Wait until you can spend more time with the program.

Read statements a, b, and c before you begin your evaluation. CHECK one of the following statements which is true for this evaluation:

- \_\_\_ a. I stopped working with this program before the minimum 30 minutes because it is too difficult. (If you checked this statement do not complete the rest of the form.)
- \_\_\_ b. I stopped working with this program before the minimum 30 minutes because I got bored. (If you checked this statement, do not complete the rest of the form.)
- \_\_\_ c. I have examined the program for at least 30 minutes; or if more than 30, how long? \_\_\_\_\_ (If you checked this statement and you feel ready to complete the form, proceed.)



I. CHECK each of the following statements with which you AGREE:

1. \_\_\_ I'd like to do this program again.
2. \_\_\_ The graphics were helpful.
3. \_\_\_ I got lost in the program and didn't know what to do.
4. \_\_\_ I really had to think in order to get the right answer.
5. \_\_\_ This program helped me when I made a mistake.
6. \_\_\_ I got all of the answers right on the first try.
7. \_\_\_ Compared to the other times I studied this subject, this program was fantastic.
8. \_\_\_ I would rather do this program with a classmate than by myself.
9. \_\_\_ I would like to be graded by my instructor on the work I did with this program.
10. \_\_\_ If I could, I would take this program home to use it.
11. \_\_\_ This program was a waste of my time.
12. \_\_\_ This program lasts too long.
13. \_\_\_ I think my friends would enjoy this program.
14. \_\_\_ I could not do this program without help from an instructor.
15. \_\_\_ This program was too easy for me.

II. On a scale of "0" (lowest) to "100" (highest), I rate this microcomputer program as: \_\_\_\_\_:

III. Using a statement, drawing, or any other written means of expression, give in the space below an idea or fact you remember from the program.

IV. a. What did you LIKE most about the program?

b. Name any other similar computer programs, books, or other materials with which you have worked and you think are NOT AS GOOD as this program.

V. a. What did you DISLIKE most about the program?

b. Name any other similar computer programs, books, or other materials with which you have worked and you think are BETTER than this program.

=====  
From Callison and Haycock. A Methodology for Student  
Evaluation of Educational Microcomputer Software.  
EDUCATIONAL TECHNOLOGY 28 no.1: 25-32. 1988.

## Appendix C

### Northwest Regional Educational Laboratory Evaluator's Guide for Microcomputer-Based Instructional Packages With Number Responses by Staff Evaluators

=====

#### Ratings

SA = Strongly Agree      A = Agree      D = Disagree  
SD = Strongly Disagree      NA = Not Applicable

#### Importance

H = Higher

L = Lower

-----

Rating					Importance		
SA	A	D	SD	NA	H	L	
<b>CONTENT</b>							
5	2	0	0	0	5	0	1. The content is accurate.
6	2	0	0	0	5	0	2. The content has educational value.
7	0	0	0	0	4	1	3. The content is free of race, ethnic, sex, and other stereotypes.

#### INSTRUCTIONAL QUALITY

5	1	1	0	0	5	0	4. The purpose of the package is well-defined.
6	1	0	0	0	5	0	5. The package achieves its defined purpose.
6	1	0	0	0	5	0	6. Presentation of content is clear and logical.
4	3	0	0	0	5	0	7. The level of difficulty is appropriate for the target audience.
4	3	0	0	0	5	0	8. Graphics/color/sound are used for appropriate instructional reasons.
6	1	0	0	0	5	0	9. Use of the package is motivational.
5	2	0	0	0	5	1	10. The package effectively stimulates student creativity.

Northwest Regional Educational Laboratory Evaluator's Guide  
for Microcomputer-Based Instructional Packages  
With Number Responses by Staff Evaluators  
(continued)

SA	A	D	SD	NA	H	L	
6	1	0	0	0	5	0	11. Feedback on student responses is effectively employed.
6	1	0	0	0	6	0	12. The learner controls the rate and sequence of presentation and review
6	1	0	0	0	5	0	13. Instruction is integrated with previous student experience.
6	1	0	0	0	4	0	14. Learning is generalizable to an appropriate range of situations.

TECHNICAL QUALITY

4	2	0	0	1	4	0	15. The user support materials are comprehensive.
4	2	0	0	1	4	0	16. The user support materials are effective.
5	2	0	0	0	5	0	17. Information displays are effective.
6	1	0	0	0	6	0	18. Intended users can easily and independently operate the program.
6	1	0	0	0	5	0	19. Teachers can easily employ the package.
5	1	0	0	1	1	0	20. The program appropriately uses relevant computer capabilities.
4	2	0	0	1	4	0	21. The program is reliable in normal use.

Check Only One:

- 7   I would use or recommend use of this package with little or no change.
- 0   I would use or recommend use of this package only if certain changes were made.
- 0   I would not use or recommend this package.

From Northwest Regional Laboratory. EVALUATOR'S GUIDE FOR MICROCOMPUTER-BASED INSTRUCTIONAL PACKAGES. Portland, OR: Northwest Regional Educational Laboratory, 1982.

## BIOGRAPHICAL SKETCH

John Kaiser is the Commanding Officer of the Naval Air Technical Training Center in Lakehurst, New Jersey. He is currently pursuing an Sc.D. in Training and Learning Technology from Nova University in Fort Lauderdale, Florida. He received an M.S. in Systems Management from the University of Southern California in 1974 and a B.S. from Rutgers University in 1963. A career Navy officer with the rank of Captain and 26 years of service, he specializes in the management of manpower, personnel and training.

Captain Kaiser has extensive training experience both in the classroom and as a flight instructor. He has served as a key advisor on the staffs of the Assistant Secretary of the Navy (Manpower and Reserve Affairs) and the Deputy Chief of Naval Personnel. In his current position he is responsible for the development and delivery of technical skills training to 6500 students annually through 19 courses of instruction.