Contents

Chapter 1: Introduction to Computer-Based Instruction	1
Definitions 1	
Optimizing the Use of CBI 2	
History of CBI 3	
Applications in CBI 6	
Common Basis for All Applications 7	
Tutorials 9	
Reinforced Drill and Practice 10	
Intelligent CBI 12	
Training Simulations 19	
Instructional Games 20	
Training Simulators 21	
Expert Systems 24 Embedded Training 25	
Embedded Training 25 Adaptive CBI Testing 26	
Computer-Managed Instruction 27	
Hardware and Software Considerations in CBI 27	
Study Questions 29	
Chapter 2: Structural and Functional Approaches to CBI Design	31
Introduction 31	
The Structural Perspective 33	
Basic Paradigm 33	
Structure of Human Development 35	
Structural CBI Design 36	

The Functional Perspective

Basic Paradigm 40 Functional View of Human Development 42 Functional CBI Design 43 An Integrated Approach: Structure and Function in CBI Design 47	
Study Questions 48	
Chapter 3: CBI Design, Production, and Evaluation	50
Introduction 50	
Step 1. Conduct Environmental Analysis 51	
Proposed Use of Courseware 52 Available Hardware 53	
Ilser Attitudes 53	
Step 2. Conduct Knowledge Engineering 54	
Understanding Course Content 54	
Conduct Concept (Topic) or Task Analysis 55	
Knowledge Engineering for Intelligent CBI 56	
Step 3. Establish Goals and Instructional Objectives 56	
Stating Goals 56	
Writing Specific Objectives 58 Instructional Objective Taxonomies 59	
Step 4. Sequence Topics and Tasks 62	
Step 5. Write Courseware 62	
Step 6. Design Each Frame 63	
Step 7. Program the Computer 65	
General Programming Languages 66	
Authoring Languages 67	
Frame-Based Authoring Packages 69	
Evaluating Programming Languages, Authoring Languages,	
and Packages 70 Problems with Authoring Systems 72	
The Future of Authoring Languages 73	
Step 8. Produce Accompanying Documents 74	
Step 9. Evaluate and Revise the CBI 78	
Step 10. Implement and Follow-Up 79	
CBI Design-Production as a Collaborative Process 79	
Study Questions 79	
Chapter 4: Design of the Student-Computer Interface	82
Introduction 82	
Special Characteristics of Computer Screens 83	

40

113

Student-Frame Interface 84	
Frame Functional Areas 84	
Single- versus Multiple-Purpose Frames 87	
Displaying Text 88 Displaying Tables and Figures 99	
Student-Computer Dialogue 102	
Dialogue Characteristics 102	
Menus 104	
Natural Language Dialogue 106 Menu Versus Natural Language 107	
Intelligent Interfaces 108	
Student-Performance Record Interface 108	
Performance Record Purpose 108	
Performance Record Design 109	
Study Questions 110	
Chapter 5: Sequencing Topics in CBI Lessons	
Introduction 113	
Procedures for Concept (Topic) and Task Analysis	114
Concept Defined 114	
Concept Analysis 115	
Task Analysis 119	
Sequencing Topics for Concept Lessons Sequencing Topics in Procedural Lessons 120 121	
Whole- and Part-Task Training 122	
Forward Chaining 122	
Backward Chaining 123	
Sequencing Simulation Exercises 124	
Difference Between Simulations and Tutorials	124
Sequencing in Simulations 125 Sequencing in Single-Skill-Level Simulations	125
Sequencing in Multiple-Skill-Level Simulations	126
Learner- versus Program-Controlled Sequences	126
Topic Sequencing 127	
Number of Examples per Rules 127	
Number of Examples per Rules 127 Program Adaptations 129	
Number of Examples per Rules 127 Program Adaptations 129 Self-Pacing 129 Summary of Learner Control of Sequence versus	
Number of Examples per Rules 127 Program Adaptations 129 Self-Pacing 129	

Chapter 6: Writing Introductions, Interactions, Remedial Branches, Reviews, and Tests	132
Introduction 132	
Introduction Frames 132	
Interaction Frames 133	
Learning Principles for Interactions 135	
Shaping with Interactions 141	
Meaningful Responses in Interactions 144 Response Variety in Interactions 144	
Response Variety in Interactions 144 Determining the Number of Interactions Needed 147	
Remedial Frames 148	
Remedial Frames for Single Errors 148	
Remedial Frames for Error Patterns 151	
Review Frames 151	
CBI Tests 152	
Purpose 152	
Relîability 155	
Validity 157	
Study Questions 159	
Chapter 7: Tailoring CBI Interactions for Specific Performance Levels	160
Introduction 160	
CBI Techniques for Acquisition 161	
Design of Acquisition Level Sequences 161	
Introducing Examples and Nonexamples 164	
Techniques for Building Fluency 165	
Techniques for Generalization 171	
Generalization Based on Physical Similarity 172	
Generalization Based on Rule Learning 172	
Generalization Based on Analogy 173	
Generalization Drills, Games, and Simulations 175	
Techniques for Proficiency Maintenance 179	
Study Questions 180	
Chapter 8: Evaluating and Revising CBI	182
Introduction 182	
Structural Evaluation Using Checklists 183	
Structural Evaluation Procedures 184 Cotagories of Structural Evaluation Items 185	
Categories of Structural Evaluation Items 185	

214

220

Functional Evaluation of CBI Using Stude Performance Data 193	nt
Functional Evaluation Procedures 19	4
Four Functional Evaluation Plans 19	7
Measures of Student Performance 19	3
Using Data from an Entire Class 200)
Using Individual Students 201	
User Opinion 203	
Evaluating Cost-Effectiveness 204	
Step 1: Determining Costs of CBI 204	ļ.
Step 2: Determining Cost-Effectiveness	207
Making an Overall Decision 209	
Revising CBI 209	
Making Structural Changes 210	
Revising to Improve Function 210	
Revising to Improve Opinions 211	
Improving Cost-Effectiveness 212	
Study Questions 212	

References

Index

List of Figures

1.1	Steps in instruction.	8
1.2	Reinforced drill and practice format.	11
1.3	Flexible student-computer dialogue in an ICBI module.	16
1.4	ICBI structural components.	18
1.5	Instructional game format.	22
1.6	High-, medium-, and low-physical-fidelity simulators used in Allen, Hays, and Buffardi (1986).	23
1.7	Main menu and embedded training menu.	26
2.1	Model of human information processing.	34
2.2	Increase attention by explaining benefit.	37
2.3	Stimulate curiosity with prequestioning.	37
2.4	Link content together with chronological narrative.	38
2.5	Keep information flow high to prevent boredom. This frame contains only a little information.	e 38
2.6	This frame contains more information and is less boring than the frame in Figure 2.5.	39
2.7	The use of mnemonics is an aid to memory.	39
2.8	Emphasis on components is important.	40
2.9	Basic learning paradigm.	41
2.10	Instructional events in CBI.	44
2.11	CBI provides frequent opportunities for students to respond.	44

2.12	Progression from beginner- to generalization-level	
	responses.	45
2.13	Contrived and natural positive reinforcers.	46
2.14	Harsh error messages can be devastating, not at all funny.	47
3.1	Schematic for a lesson, topic, and subtopic.	64
3.2	Sample storyboard for simple branching CBI lesson.	66
3.3	Designer's screen from "Instructional Design Environment."	75
3.4	Page from student handbook accompanying CBI lesson "Know Your Man-Made Fibers."	77
4.1	Sample layout of functional areas within a single frame.	85
4.2	Sample screen with important screen elements.	86
4.3	Screen format used in a lesson teaching word processing.	86
4.4	Interaction contained on a single frame.	88
4.5A	Functional areas should remain consistent from frame to frame.	89
4.5B	This frame's functional areas are consistent with Figure 4.5A.	90
4.5C	This frame's functional areas are not consistent with the two preceding frames.	90
4.6	High-resolution graphics in CBI lesson on how to use LOTUS 1-2-3.	92
4.7	A cluttered-looking frame.	93
4.8	Frame in Figure 4.7 redesigned.	94
4.9	Windows used to accomplish complex dialogue.	95
4.10	Pull-down window can be used to request a summary student status report.	96
4.11	Illustration of a highlighting technique called "blocking."	97
4.12	Example of repeated figure in a frame sequence.	101
4.13	Frame sequence illustrating display of text, tables, and dialogue.	103
4.14	Menu format showing student instructions and list of options.	106
4.15	Sample student progress record displayed during CBI lesson, at instructor workstation.	110
4.16	Sample student performance record for one session.	111
5.1	Key terms that become interaction topics.	116

XVI LIST OF FIGURES

5.2	Prerequisite concepts for lesson on communication in gulls.	117
5. 3	Critical and variable attributes of a concept.	118
5.4	Task analysis for connecting battery to volt-ohmmeter (VTM) and turning on VTM power.	119
6.1	Introduction frames for a lesson.	134
6.2	Interaction frame, text present, multiple choices given, to shape a copy skill.	142
6.3	Interaction frame, text present, no answer choices given, to shape a copy skill.	142
6.4	Interaction frame, text absent, answer choices given, to shape a difficult copy skill.	143
6.5	Interaction frame, text absent, no answer choices given, to shape a difficult copy skill.	143
6.6A	A copy or "overcued" frame.	145
6.6B	Query that gets the student to apply the new definition.	145
6.6 C	Query that gets the student to apply the new definition.	146
6.7	Review sequence before a lesson test.	152
6.8	Quiz problem from CBI to teach LOTUS 1-2-3.	154
6.9	Paper test incorporated into CBI lesson to teach word processing.	156
7.1	Performance quality increases with time and practice.	161
7.2	Antecedent events and queries in acquisition sequences.	162
7.3	Acquisition-level sequence in concept teaching.	165
7.4	Drill game format for fluency building.	169
7.5	Exercise to foster primary stimulus generalization.	173
7.6	Exercise to foster recombinative generalization.	174
7.7	Exercise to foster generalization by stimulus equivalence or analogy.	174
7.8	Simulation activity for generalization practice of material already learned.	176
7.9	New event introduced into a static simulation used for generalization practice.	180
8.1	Decision diagram for evaluating the relative effectiveness and cost of two instructional methods.	210