

Learning Through Problem Solving

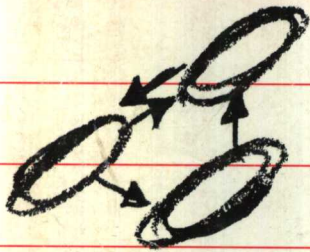
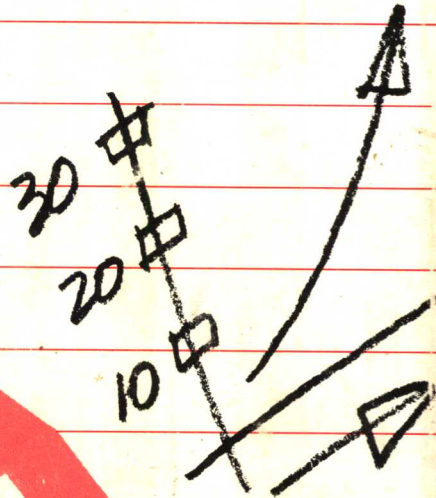


Figure it out!



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LEARNING
through
PROBLEM
SOLVING

Contributing Editors

**Daniel K. Apple
Steven W. Beyerlein
Mark A. Schlesinger**

Concept List

Chapter 1 - Learning to Learn

Learning	Learning Skills	Life Long Learning
Concept	Model	Learning Process
Critical Thinking	Self Assessment	Discovery
Teamwork	Cooperative Learning	The Good Learner
Learning Curve	Reflections	

Chapter 2 - Computer as Learning Tool

File	Directory	Computer Program
Data File	Keyboard	Table of Contents
Indexing	Accessing Information	Variables
Calculations	Statements	Functions
Graphs	Sensitivity Analysis	DOS Commands
Workspace	Help System	

Chapter 3 - Journal Writing

Exploring Who You Are	Learning Through Journal Writing	Majors
Writing for Yourself	Word Processing	Faculty
Writing for Others	College Activities	Recording
General Education	Financing a College Education	
College Community	Student Services	

Chapter 4 - Problem Solving

What is a problem?	Problem Solving Skills	Objectives
College Degree	Problem Solving Methodology	Goals
Educational Goals		

Chapter 5 - Making a Presentation

Project Team	Group Problem Solving	Value System
Presentations	Evaluation	Project Team
Quality		

Chapter 6 - Tables

Labels and Formats	Extracting Data from a Table	Tables
Equating Tables	Creating and Editing Tables	Matrices
Searching	Tables as Named Variables	Subscripts
Sorting	Appending	Removing

Chapter 7 - Graphical Analysis

Graphing Tables	Labeling	Graph Size
Legends	Multiple Graphs	Scatter Plot
Line Graphs	Graphing Manipulated Tables	Pie Graphs

	Chapter 8 - Data Management	
Query Language	Validating Data	Extracting Data
Combining Data	Rearranging Data	Recoding Data
Exporting Data	Importing Data	Merging Tables
	Chapter 9 - Data Analysis	
Sampling	Frequency Distribution	Histograms
Central Tendency	Variability	Grouping Data
Correlation	Regression	
	Chapter 10 - Graphs of Functions	
Set	Comparative Modeling	Domain
Function	Plotting Ordered Pairs	Ordered Pairs
Finite Sequence	Graphing a Function	Graph Options
Intervals	Changing the Graph's Range	Scaling Graphs
	Chapter 11 - Writing a Report	
Report	Structure of a Report	Audience
Visual Aids	Transferring Text and Data	Readability
Printing	Transferring Graphs	Abstract
Methods	Conclusions	References
Appendices	Recommendations	Introduction
	Chapter 12 - Models	
Models	Deterministic Models	Input/Output
Variables	Testing and Validation	Assumptions
Validation	Independent Variable	Input Data
Dependent Variable		
	Chapter 13 - Modeling Concepts	
Concept	Concept Learning	Questioning
Skill	Concept Model	Assessment
Tool	Why, What, How, What If	
	Chapter 14 - Finance	
Investment	Principal	Interest
Future Value	Simple Interest	Present Value
Compound Interest	Net Present Value	Amortize
Cash Flow	Time Value of Money	
	Chapter 15 - Data Manipulation	
Data	Data Transformation	Patterns
Recoding Data	Rearranging Data	Combining Data
Subsets	Repeating Patterns	

Chapter 16 - User-Defined Functions

Functions	Creating Procedures	Global Variables
Documentation	Argument Testing	Local Variables
Defining Your Own Functions		

Chapter 17 - Applications

Variables	String Manipulation	Menus
Entering Scalars	Entering Vectors and Matrices	Looping
Jump/Name	Controlling User Environment	Error Trapping
Execute Statement	Functions and Procedures	Conditional If

Chapter 18 - Libraries

Creating Libraries	SOLVE Libraries	Documentation
Catalog System	Instructional Media	Libraries
	Modifying Libraries	

Chapter 19 - Math Tools

Sequences	Differential Equations	Matrix Algebra
Series	Root Solving	Curve Fitting
Calculus	Differentiation	Integration
Inner Products	Matrix Multiplication	Matrix Inverse
Linear Regression	Systems of Equations	Trig Curve Fitting
Polynomial Curve Fitting		

Chapter 20 - Graphing Tools

Graphics Screen	Real World Coordinates	Graphics Object
Drawing an Object	Homogeneous Coordinates	Scale a Graph
Overlaying Graphs	Windowing Graphs	Shear a Graph
Translate a Graph	Composite Matrix	Rotate a Graph
Graph a Reflection		

Chapter 21 - Simulation

Randomness	Empirical Distributions	Sampling
State Variables	Continuous Distributions	Simulations
Random Variables	Discrete Distributions	
	Cooperative Research	

Preface

What's the Problem?

Business, government, and education require employees who excel as:

1. Quick Learners
2. Critical Thinkers
3. Problem Solvers
4. Communicators
5. Professionals Knowledgeable in their Field
6. Team Players
7. Self Starters
8. Creative Thinkers

It has been argued that society in general requires excellence in these areas. This is especially true when people are responsible for choosing their leaders and influencing them.

Higher Education's Role

The above attributes have become important goals of higher education. Unfortunately, it cannot be assumed that students possess these attributes when they enter college. In fact, critics of higher education contend that many college *graduates* have only minimal development of their abilities in these areas. Skills should be introduced early to teach students how to learn, but curricula for this purpose have not been abundant in higher education. This course meets the challenge of introducing problem solving and critical thinking through a series of learning exercises based on our learning process model, discussed in Chapter 1. The course also provides a foundation for implementing problem solving in all areas of the curriculum. Faculty have found this curriculum creates excitement about learning because the students explore how to solve real problems.

Premise

前提
Our premise is that learning is most effective when students can confront a problem that needs to be solved. A related premise is that to be a good problem solver, one must learn new concepts-hence, the title of this book, *Learning through Problem Solving*.

Overview of This Book

This book consists of 21 chapters. Each chapter is designed to be a self-contained learning and problem solving activity lasting one to three hours. The course is best implemented in a problem solving lab with 10 computers. However, courses based on material in this book have also proven effective in a variety of settings, from large lecture halls to individual self-study. Each chapter takes student teams through a discovery process. The process, based on our learning process model, applies learning exercises to over 150 concepts. Students read about concepts, ask and respond to critical thinking questions, and perform exercises requiring them to transfer concepts to new situations. At the completion of our learning cycle, students can tackle one or more problem solving projects in or out of the classroom. Students are expected to present verbal and/or written accounts of their solutions.

Outcomes of Using This Book

結果

This book is a resource to help students:

1. Learn faster and better by understanding and modeling the learning process, strengthening learning skills, building self confidence, practicing self-assessment, and mastering a set of core concepts.
2. Improve critical thinking and creativity by discovering and modeling concepts, asking questions, and clarifying understanding.
3. Develop a problem solving methodology by identifying, defining, and understanding problems and then modeling, validating, and documenting their solution.
4. Improve communication skills by working together (using "cooperative" or "collaborative" learning), giving presentations, maintaining a journal, and writing reports.
5. Examine personal values and leadership qualities as they relate to group problem solving, citizenship in college, and preparation for life beyond college.

Who Can Benefit?

This book was designed for seven different settings:

1. Freshman Seminar
2. Introduction to Business
3. Introduction to Engineering
4. Introduction to Computer Science (Computer Literacy)

5. Introduction Computer Information Systems
6. Freshman Science Lab Courses (e.g., Chemistry and Physics)
7. Mathematics (Basic Math through Calculus)

In addition, many colleges and high schools have courses whose principle focus is the enhancement of problem solving skills. In several respects this book grew out of such courses, and it remains connected to its roots. This in no way defines the limits of what is possible in using this book. While the problems posed in this course are by necessity specific, and tend to relate to the subject areas listed above, the problem solving approach presented here can be applied to situations and concepts limited only by your imagination. In sum, *we intend this book to benefit teachers and students who have a stake in extending problem solving across the curriculum.*

= do. We look forward to hearing about the experiences of teachers and students who use this book. You can write to us at:

Pacific Crest Software
875 NW Grant Avenue
Corvallis, Oregon 97330

About the Authors

In Chapter Order

Daniel K. Apple is President of Pacific Crest Software. Dr. Apple specializes in helping college faculty teach problem solving and critical thinking more effectively across the curriculum. He also conducts summer teaching institutes across the country.

Steven W. Beyerlein is Assistant Professor of Mechanical Engineering, University of Idaho. Dr. Beyerlein is interested in the development of pre-engineering problem solving skills through the use of computer technology.

Mark A. Schlesinger is Assistant Chancellor of the University of Massachusetts/Boston and an Associate Professor in the College of Management. Dr. Schlesinger developed a required problem solving and critical thinking course for management students and has taught that course for 15 years. He also teaches management communication and information systems, and writes and consults on problem solving and critical thinking.

Paul Kramer is Professor of Physics, State University of New York College of Technology, Farmingdale, New York. Dr. Kramer has incorporated the use of journal writing in his physics courses for the last six years. In addition, he uses cooperative learning in all his lab and lecture courses.

Larry Freeman is Associate Vice President for Academic Affairs at Governors State University. Dr. Freeman teaches English courses where he uses problem solving techniques and is currently working on the development on a course focused on problem solving. He is also responsible for helping to incorporate problem solving in various curricula around the university.

Linda Hobart is Associate Professor at Finger Lakes Community College, Canandaigua, NY. Ms. Hobart is active in developing opportunities for more students to gain access to science and technology programs through innovative first year courses. She is also active during summers consulting and delivering teacher workshops for elementary through high school science teachers to help them incorporate more thinking, problem solving, and computer skills into their curricula.

Robert R. Johnson is Professor of Mathematics at Monroe Community College NY. Professor Johnson teaches a wide range of math courses, and has a special interest in statistics. He is the author of "Elementary Statistics" Edition 6. He has been involved in a campus-wide "writing across the curriculum" program.

Michael H. Tindall is Professor and Chairman of Computer Science at Seattle Pacific University. Dr. Tindall teaches operating systems and computer design in addition to computer based problem solving and programming.

George D. Brower is Associate Professor of Economics and Business at Moravian College in Bethlehem, PA. Dr. Brower teaches economics and business statistics, operations management, and econometrics. He emphasizes practical applications and experiments in cooperative learning and criterion grading to improve students' problem solving and communication skills.

Kenneth C. Wolff is Chairperson of the Department of Mathematics and Computer Science at Montclair State College, NJ. Dr. Wolff teaches linear algebra and calculus in new and innovative ways, incorporating cooperative learning, technology, discovery learning, and a modified spiral approach.

Marie Baehr is Assistant Professor of Physics at Elmhurst College, IL. Dr. Baehr's major interest is in physics education. She is active in incorporating the use of computers in introductory physics labs.

Gordon L. Godshalk is Associate Professor and Director of the Environmental Studies Program at Alfred University, NY. Dr. Godshalk teaches ecology and environmental studies emphasizing hands-on experience and problem solving skills.

David R. Burgess is Associate Professor at Rivier College. He teaches chemistry and physics courses. Dr. Burgess has a special interest in strengthening the science literacy and basic reasoning skills of Rivier's students. He has developed an introductory physical science course that combines technology with student centered learning to improve critical thinking, learning, and problem solving skills.

Karl E. Krumsieg is University Consultant for Pacific Crest Software, Corvallis, OR. Mr. Krumsieg spends a majority of his time teaching faculty members how to deliver courses which emphasize critical thinking, problem solving, and the development of learning skills.

Donald Bishko is Director of the School of Engineering and Business Administration, SUNY College at New Paltz. He has taught Computer Programming, later to be named "Problem Solving," for the past 23 years in a large lecture format. Dr. Bishko's interests are in the applications of computer science in business administration and operations research.

Vincent Calluzzo is Associate Professor of Management Science and Systems in the Hagan School of Business at Iona College in New Rochelle, NY. Dr. Calluzzo teaches courses in business applications development and end user computing, and is a consultant developing computer applications for small business.

David L. Housman is Assistant Professor of Mathematics and Computer Science at Drew University in NJ. Dr. Housman's recent interests include undergraduate research experiences in cooperative game theory and the use of computers in undergraduate statistics and calculus courses to heighten conceptual understanding.

Ned W. Schillow Professor of Mathematics at Lehigh County Community College, PA. Professor Schillow has incorporated critical thinking and computer technology into his teaching and has coauthored a critical thinking workbook for calculus. He has participated in four Eisenhower grants helping K-12 teachers to incorporate technology and problem solving into their curricula.

David Bozak is Chair of Computer Science at SUNY College at Oswego. Dr. Bozak, a psychologist by training, concentrates on using computers as learning tools across several disciplines. He is a leader in innovative approaches to the teaching of graphics, statistics, and computer fundamentals.

David W. Craig is Professor of Chemistry at Hobart and William Smith Colleges, Geneva, NY. Dr. Craig's work in chemistry education has focused on the use and design of mathematical models to enrich both introductory and advanced courses in chemistry and biochemistry. He has also contributed to the design and implementation of a campus-wide network that integrates mini-computer and micro computer capabilities for writing, computation, and bibliographic searching on a single desktop workstation.

Dana Yarak is a writer, consultant, and designer who resides in Chicago. Mr. Yarak's upcoming book explores the educational system and will map out priorities for the future expenditure of our educational dollars.

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TABLE OF CONTENTS

Concept List	iv
Preface	vii
About the Authors	x
Acknowledgements	xiii
Chapter 1 - LEARNING TO LEARN	1
Chapter 2 - THE COMPUTER AS LEARNING TOOL	14
Chapter 3 - JOURNAL WRITING	32
Chapter 4 - PROBLEM SOLVING	48
Chapter 5 - MAKING A PRESENTATION	65
Chapter 6 - TABLES	79
Chapter 7 - GRAPHICAL ANALYSIS	95
Chapter 8 - DATA MANAGEMENT	109
Chapter 9 - DATA ANALYSIS	125
Chapter 10 - GRAPHS OF FUNCTIONS	145
Chapter 11 - WRITING A REPORT	158
Chapter 12 - MODELS	180
Chapter 13 - MODELING CONCEPTS	192
Chapter 14 - FINANCE	207
Chapter 15 - DATA MANIPULATION	219
Chapter 16 - USER-DEFINED FUNCTIONS	234
Chapter 17 - APPLICATIONS	247
Chapter 18 - LIBRARIES	275
Chapter 19 - MATH TOOLS	287
Chapter 20 - GRAPHING TOOLS	318
Chapter 21 - SIMULATION	333
APPENDICES	354

LEARNING TO LEARN

Daniel K. Apple

Steven W. Beyerlein

Mark A. Schlesinger

Solving Problems: From Mystery to Mastery

Chapter One familiarizes you with the concepts and learning processes central to this book. We first identify and discuss the concepts that we will explore. Next, we offer models and exercises to help you learn these concepts. Finally, we encourage you to develop skill with these new tools through problem solving projects. The authors of subsequent chapters also adopt this format.

系列格式, 構成

CONCEPTS

Learning. We define learning as the application of concepts, information, and skills to new situations to form new concepts. 適用, 応用

Learning Skills. Learning skills are things you must do well to learn more effectively. This book will help you acquire and gain confidence in using many learning skills.

Life Long Learning. We learn throughout our lives, not just when we are young or in school. It is up to us to choose when and how to apply our learning skills to new situations.

Concept. A concept is an idea that represents a set of relationships. It can be modeled, explored, and used as a building block for future learning and problem solving.

Model. A model is a representation of something. Models can help us to understand and use that something. 表現

Learning Process. Learning is a process. This book gives you a model of the learning process that should help you learn more effectively.

Critical Thinking. When we think critically, we explore ideas by identifying important issues. This book and your instructor will help you to ask the questions that can help you think more critically.

Self Assessment. Self assessment occurs when we think critically about our own learning process.

Discovery. Discovery (or inquiry) is a very effective means of learning. Most people discover more when they ask their own questions and seek their own answers. A partner or your instructor can help in this process.

Teamwork. A team is a group of people actively cooperating in an organized way to achieve a goal. You can use teamwork to help you learn faster and to make learning more fun.

CONVERSATION WITH DAN, STEVE, AND MARK

Learning. We defined learning as "the application of concepts, information, and skills to new situations to form new concepts." The crux of this definition is that learning involves *change*. Some changes are easy; other changes are very difficult; and so it is with learning. Here is an example of learning that illustrates this kind of change.

Three-year-old Jeffrey knew the concept of truck: a large vehicle that traveled on roads. He also knew the concept of plane: a vehicle that flew in the air. One day, Jeffrey and his parents were meeting relatives at the airport. As he watched a 747 taxi down the runway he exclaimed, "Truck!" and pointed joyfully. In a matter of moments Jeffrey's "truck" lifted into the air. Eyes wide, Jeffrey yelled, "Plane! Plane!" and smiled at the discovery of a new concept. (Our thanks to George Spiro for this story.)

Jeffrey started with two incomplete concepts. First he *observed*, and linked what he saw to his concept of truck. Then he observed a new situation and arrived at a new concept of plane. In addition to observation skills, he used several others we shall discuss below. Jeffrey's experience is a good model of what learning is all about.

Learning Skills. Figure 1-1 presents a list of skills and tools which you can use to become a better learner. These are broken down into eight categories. This isn't a psychologist's taxonomic breakdown, but it is a reasonable list of "skills for life" you will need to use in college and later in life.

Life Long Learning. What once was a nice-sounding phrase in adult education catalogs is now an essential demand made on everyone by a constantly changing society. The fact is, a small percentage of what you will learn in your lifetime takes place in college. What's more, much of what you will need to know ten years from now cannot be predicted. New technology continues to generate new challenges as well as new concepts to be understood.

The aim of this book is to give you an opportunity to improve the way you learn, think, and solve problems. This will involve acquiring and practicing new skills. Consider your effort as an investment that will multiply itself many times over as you use these tools to increase your capacity to learn and to solve problems for the rest of your life. Sure, it takes some work, but it can also be quite enjoyable! And something that you're going to be doing the rest of your life should be enjoyable, don't you agree?

Concept. We said earlier that a concept is "an idea that represents a set of relationships." We learn concepts from birth, and without them everything we perceive would be unassociated "data." Little Jeffrey at the airport already knew that something with certain attributes was a truck. In this sense, a concept is a kind of shorthand. The concept of "truck" substitutes for having to say "a large vehicle that travels on the ground." Note that concepts don't simply come to you. As a learner, you create new concepts. If you don't do this, you won't learn.

Model. We describe a model as a representation of something. In Figure 1-1, we have presented a model of learning skills and tools in eight categories. The Gross National Product (GNP) is a model of our national economic productivity. Grades are one way to represent or model your performance in a class. (Whether these examples accurately reflect the qualities they are supposed to represent is another story, worthy of some critical thinking!)

OBTAINING AND ORGANIZING INFORMATION

Listening
Reading
Observing
Feeling
Categorizing

CONCEPTUAL LEARNING SKILLS

Modeling concepts
Articulating concepts
Visualizing concepts
Thinking systemically
Generalizing

LEARNING TOOLS

Math tools
Prediction
Estimation
Vocabulary
Computer tools

THINKING

Thinking critically (asking key questions)
Thinking quickly
Analyzing (breaking things into components)
Synthesizing (putting concepts together)
Modeling
Remembering

Figure 1-1 Learning Skills and Tools