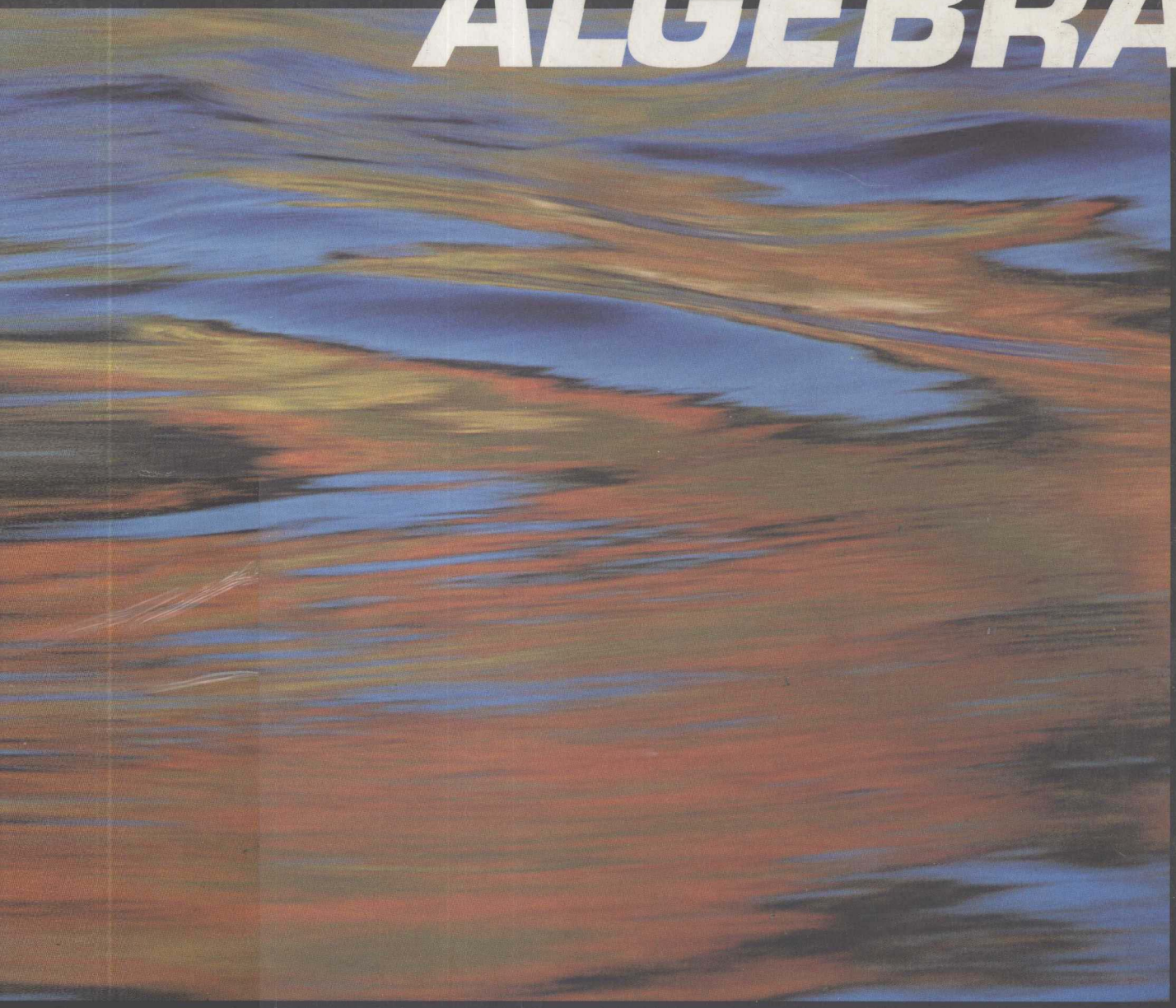
ELEMENTARY ALGEBRA



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ELEMENTARY ALGEBRA

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ABOUT THE AUTHORS

DONALD HUTCHISON is active in several professional organizations. He is a member of the ACM committee that has undertaken the writing of computer curriculum for the two-year college. Since 1990 he has chaired the Technology in Mathematics Education committee for AMATYC.

Don spent his first 10 years of teaching working with disadvantaged students. He taught in an intercity elementary school and an intercity high school. He also worked for two years at Wassaic State School in New York and two years at the Portland Habilitation Center. He worked with both physically and mentally disadvantaged students in these two settings.

In 1982 he was hired by Jim Streeter to teach at Clackamas Community College. It was here that he discovered the two things that, along with his family, serve as a focus for his life. Jim introduced him to the joy of writing (with the first edition of *Beginning Algebra*) and Jack Scrivener converted him to a born-again environmentalist. In 1989 Don became Chair of the Mathematics department at Clackamas Community College.

LOUIS HOELZLE has been teaching at Bucks County Community College for 23 years. He has taught the entire range of courses from Arithmetic to Calculus. This gives him the perspective of the current and future needs of developmental students.

Over the past 30 years Lou has also taught Physics courses at four year colleges. This gives him the perspective of the practical applications of mathematics. In addition, Lou has done extensive reviewing of manuscripts and writing of several solutions manuals for major texts. In these he has focused on writing for the student.

Lou is also active in professional organizations and has served on the Placement and Assessment Committee for AMATYC since 1989. In 1989, Lou became Chair of the Mathematics Department at Bucks County Community College.

While a graduate student at the University of Washington, JAMES STREETER paid for his education as a math tutor. In 1968 he moved on to Clackamas Community College to become their first mathematics chair. Jim recognized that he faced a very different population than the one for whom he had tutored at UW. It was here that he began to formulate the ideas that would eventually become the basis for this series.

PREFACE

Elementary Algebra is designed for a one-term course. The focus of the text is to make students better problem-solvers. Our emphasis as writers is to communicate this to our readers. By directing our attention to readability, we encourage the participation of students in the learning process. Each topic is presented in a straightforward fashion with numerous examples to clarify the concept being developed. All the features are designed to encourage, facilitate, and motivate problem solving among the students.

Technology Many problems are included that require the use of a scientific calculator or graphing tool  . In addition, there are examples that indicate how technology can enhance the study of mathematics through **exploration, visualization,** and **geometric interpretation.**

These examples usually appear as the final example in a related section. They allow the student to make a connection between the algebra and the more intuitive graphic representation while maintaining the integrity of the algebra.

Applications The problem sets in an algebra text should relate enough to student experience to stimulate interest in the topic. One of our goals has been to create a set of applications that will be relevant to the students' lives. As a consequence, students will be more ready to expend the time and effort involved in learning techniques needed to solve the problems.

Each chapter opens with an **environmental essay** that connects mathematics to the real world. The essays can be used to encourage class discussions and collaborative learning. In addition there are exercises in each chapter that specifically relate to the environmental essay for that chapter. These are easily identified by a tree logo  that appears next to the exercise number. Our goal has been to produce a set of noncontrived applied problems that students can solve with the skills that they have just learned.

Exercises In response to the NCTM standards and AMATYC and MAA guidelines, several types of exercises involving **writing, discussion, critical thinking, exploration,** and **technology** appear in the book.

- **Check Yourself exercises,** which follow each example, are designed to actively involve the student in the learning process. Answers are provided at the end of each section for immediate feedback.

- **Build Your Skills exercises** allow the student to practice and master the basic skills of each section.
- **Transcribe Your Skills exercises** require written or verbal answers that aid in interpretation, conceptualization, and comprehension. They also provide opportunities for individual students to have varying (but correct) answers to the same question. This can lead to important class and small-group discussions.
- **Think about These exercises** require the student to extend or generalize from the concept just learned. These exercises promote and utilize students' critical skills.
- **Skillscan exercises** draw problems from previous sections of the text. They are designed to aid the student in the process of reviewing concepts that will be applied in the next section.
- **Scientific and Graphing calculator exercises** give students the opportunity to use a tool to help them visualize the solution to a problem that cannot be easily solved algebraically.

  These exercises are also designed to teach students how to use the calculator effectively as a tool for approximating solutions that can be found easily only by algebraic methods.
- **Chapter Summaries and Summary Exercises** give the student an opportunity to practice and review at the end of each chapter.
- **Self-Tests** at the end of each chapter give students guidance in preparing for in-class tests.
- **Cumulative Review Exercises** are designed to give the student further opportunity for building skills and gaining confidence.

Pedagogy Each concept is illustrated with an example that is introduced by a transitional sentence or paragraph. The transitional material allows the student to see the need for a new example. This prepares the student to focus on the key element of each example.

Every example in the text is followed immediately by a parallel problem **(Check Yourself).** Answers to these problems are provided at the end of the section for immediate feedback. This procedure keeps the student continually involved in the learning process. Examples frequently contain *annotations* within the solution that help the students understand the more complicated algebraic steps.

Screens are used in examples in which the student is asked to simplify an expression. By the use of such screening, what the student is expected to simplify is made immediately clear.

Margin notes serve several purposes. They give related historical information, they explain word origins, they remind students of related material, and they caution students against making common mistakes.

Student Supplements

- A **Student's Solutions Manual** is available through the college bookstore. It contains worked-out solutions and answers to the odd-numbered end-of-section exercises.

- **Student Activities Manual** contains individual and group activities that help illustrate and reinforce algebraic topics.
- **Mathworks** is a self-paced interactive tutorial specifically linked to the text. The Mathworks logo  appears next to each text section for which the tutorial can be used. It reinforces selected topics and provides unlimited opportunities for the student to review concepts and to practice problem solving. It requires virtually *no* computer training and is available for IBM, IBM compatible, and Macintosh computers.
- Course **Videotapes** are available for use from instructors. The videotape logo  appears next to each section for which they can be used.
- A **Graphing Calculator Enhancement Manual** presents an integrated approach that utilizes calculator-based graphing to enhance understanding and development. It includes calculator exercises and examples as well as appendixes on how to use the most popular brands of calculators.

Instructor's Supplements

- A **Teacher's Annotated Answer Manual** contains all the exercises in the text along with answers.
- An **Instructor's Solutions Manual** contains an answer section as well as detailed solutions to all exercises and Cumulative Review Exercises found in the text.
- An **Instructor's Resource Manual** contains multiple-choice placement tests for two levels, three forms of multiple-choice and open-ended chapter tests, two forms of multiple-choice and open-ended cumulative tests, two forms of multiple-choice and open-ended final tests, and an answer section. It also includes tips and suggestions for incorporating the *Student Activities Manual* in the classroom.
- The **Professor's Assistant** is a unique computerized test generator available to instructors. It is a system that allows the instructor to create tests using algorithmically generated test questions and those from a standard testbank. This testing system enables the instructor to choose questions either manually or randomly by section, question type, difficulty level, and other criteria. It is available for IBM, IBM compatible, and Macintosh computers.
- A **Printed and Bound Testbank** is also available. It is a hard-copy listing of the questions found in the standard testbank.

For further information about these supplements, please contact the local college division sales representative.

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Donald Hutchison
Louis Hoelzle

TO THE STUDENT

You are about to begin a course in algebra. We have made every attempt to provide a textbook that will help you understand what algebra is about and how to effectively use it. We have made no assumptions about your previous experience with algebra. Your rate of progress through the course will depend both upon the amount of time and effort that you give to the course and to your previous background in mathematics. There are some specific features in this textbook that will aid you in your studies. Here are some suggestions about how to use those features.

Keep in mind that a review of *all* of the chapter material will further enhance your ability to grasp later topics and to move more effectively through the following chapters.

1. If you are in a lecture class, make sure that you take the time to read the appropriate section of the text *before* your instructor's lecture on the subject. Then take careful notes on the examples that your instructor presents during class.

2. After class, work through similar examples in the text, making sure that you understand each of the steps shown. Examples are followed by *Check Yourself* exercises. Algebra is best learned by being involved in the process and that is the purpose of these exercises. Always have a pencil and paper at hand and work out the problems that are presented and check your results immediately. If you have difficulty, go back and carefully review the previous examples. Make sure that you understand what you are doing and why. The best test of whether you do understand a concept lies in your ability to explain that concept to one of your fellow students. Try working together.

3. At the end of each chapter section you will find a set of exercises. Work these carefully in order to check your progress on the section you have just finished. You will find the solutions for the odd-numbered exercises in the back of the book. If you have had difficulties with any of the exercises, review the appropriate parts of the chapter section. If your questions are not completely cleared up, by all means do not become discouraged. Ask your instructor or an available tutor for further assistance. A word of caution: Work the exercises on a regular (preferably daily) basis. Again, learning algebra requires becoming involved. As is the case with learning any skill, the main ingredient is practice.

4. When you have completed a chapter, review by using the *Chapter Summary.* You will find all the important terms and definitions in this section, along with examples illustrating all the techniques that have been developed in the chapter. Following the summary are *Summary Exercises* for further practice. The exercises are keyed to chapter sections, so you will know where to turn if you are still having problems.

5. When done with the *Summary Exercises,* try the *Self-Test* that appears at the end of each chapter. This will give you an actual practice test to work as you review for in-class testing. Again, answers with section references are provided.

6. Finally, an important element of success in studying algebra is the process of regular review. We have provided a series of *Cumulative Review Exercises* throughout the textbook. These will help you review not only the concepts of the chapter that you have just completed, but those of previous chapters. Use these in preparation for any midterm or final examinations. If it appears that you have forgotten some concepts that are being tested, don't worry. Go back and review the sections where the idea was initially explained, or the appropriate chapter summary. That is the purpose of these cumulative tests.

We hope that you will find our suggestions helpful as you work through this material, and we wish you the best of luck in the course.

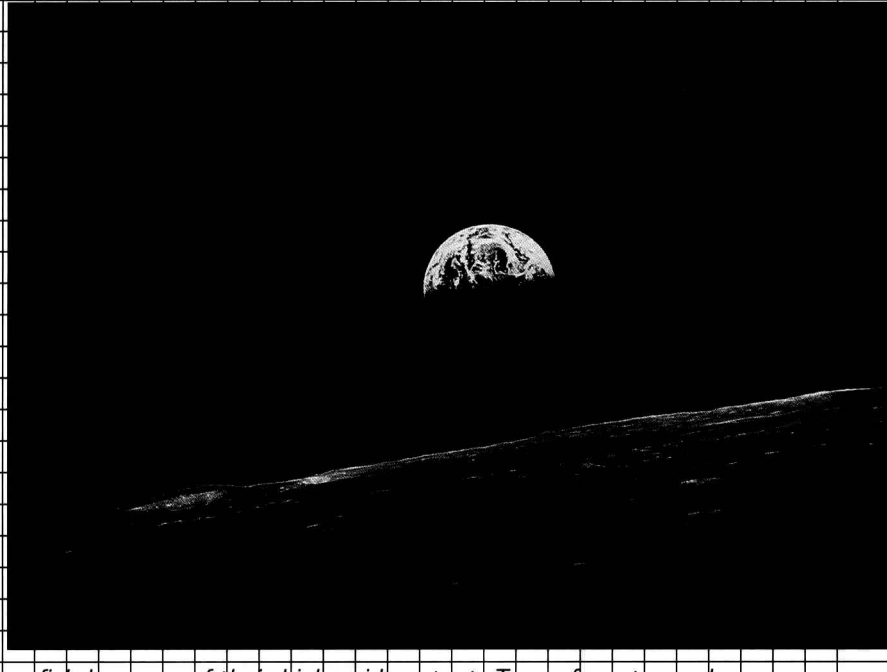
Donald Hutchison
Louis Hoelzle

CONTENTS

THE LANGUAGE OF ALGEBRA

CHAPTER ONE

INTRODUCTION TO ENVIRONMENTAL PROBLEMS



The environment is no longer the concern of only a few scientists and environmental activists. Environmental pollution and disruption have become front-page news for the citizens of the planet.

The earth's population has more than doubled in the last 40 years. It is highly likely that it will double again in the next 40 years. Almost 61,000 square kilometers (abbreviated km^2) (1 km^2 = 0.3861 mi^2) of desert is formed each year. We are destroying 202,000 km^2 of tropical forest every year. One-third of the world's cropland is losing soil faster than it is being formed. Thousands of lakes in the northern hemisphere contain no fish because of their high acid content. Tons of waste wash up onto the world's beaches daily. Understanding how we are affected by these problems is important to our individual lives. Knowing how individual people cause environmental problems helps us make decisions about our personal actions and lifestyles.

Each chapter of this text will begin with an environmental essay. These essays will show how people are causing rapid changes on this planet. The essays will also discuss how these changes are affecting the people of the planet. The essays will show a connection between the actions of individuals and the problems that affect us all.

Exercises within the problem sets will relate to the theme of that chapter. These exercises will provide practice with the mathematics necessary to grasp the importance of the ideas discussed in each essay. While the algebra has occasionally been simplified, these are real problems facing all of us.

Environmental problems are not confined to one part of the globe or to one aspect of the environment. The air, water, land, plants, animals, and humans have all been affected by these problems. Problems such as acid rain, ozone depletion, and overpopulation make the news regularly. We also hear about world hunger, extinction of plants and animals, and global warming. These are not local problems. They affect the entire planet. The essays will show that individual action can both help avoid creating future problems and help cure some of those that already exist. The exercises will show that basic algebra can help us analyze and solve these problems. ■

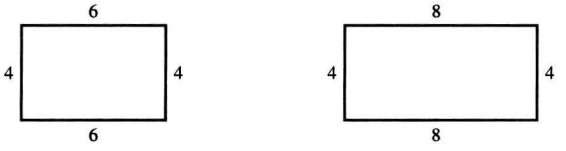
1.1 From Arithmetic to Algebra

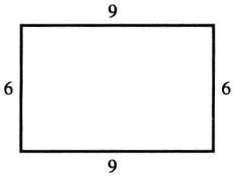
OBJECTIVES: 1. To represent the operations of addition, subtraction, multiplication, and division by using the notation of algebra
2. To identify algebraic expressions

In arithmetic you learned how to do calculations with numbers by using the basic operations of addition, subtraction, multiplication, and division.

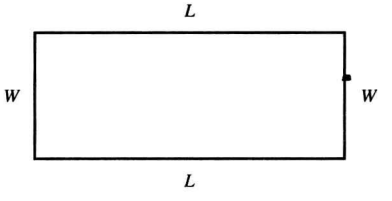
In algebra you will still be using numbers and the same four operations. However, you will also be using letters to represent numbers. Letters such as x, y, L, or W are called *variables* when they represent numerical values.

Here we see three rectangles whose lengths and widths are labeled with numbers.





If we need to represent the length and width of *any* rectangle, we can use the variables L and W.



In arithmetic: + denotes addition, − denotes subtraction, × denotes multiplication, ÷ denotes division.

You are familiar with the symbols used to indicate the four fundamental operations of arithmetic.

Let's look at how these operations are indicated in algebra.

ADDITION

$x + y$ means the *sum* of x and y or x *plus* y.