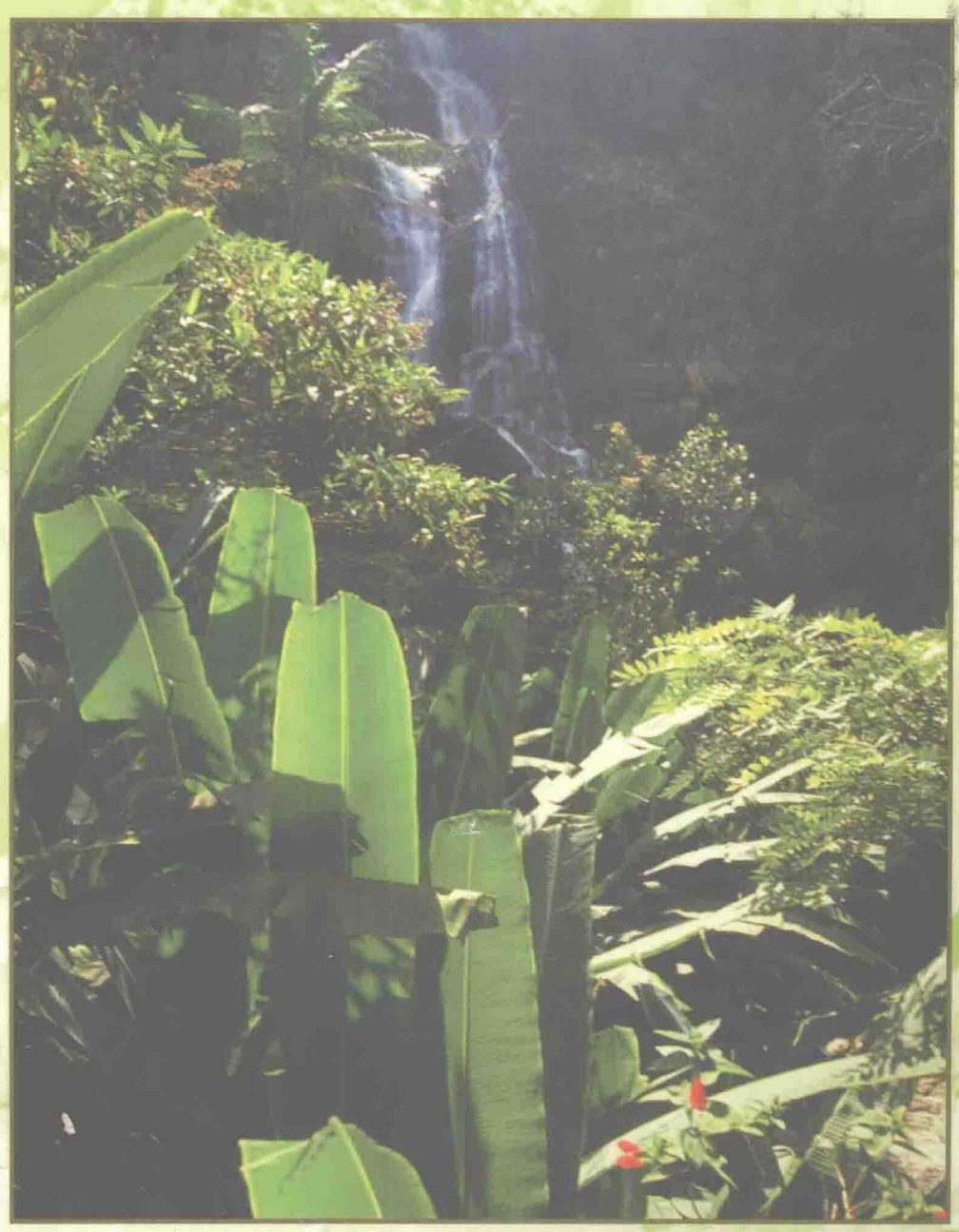
Custom Update • Second Edition

EARTH ALGEBRA

College Algebra with Applications to Environmental Issues



Schaufele • Zumoff • Sims • Sims

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College Algebra with Applications to Environmental Issues

Custom Update • Second Edition

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Preface

Approach

This college algebra text focuses on modeling real data (primarily through curve fitting), concerning environmental issues. Decision making, reading, writing, the use of technology, and oral reporting are stressed. After mathematical concepts and skills are reviewed, much of the work is done in student groups with the instructor serving more as a guide than a lecturer. Students write and present oral reports that summarize the work completed for each application section. These components—group work, student reports, and use of technology—create a course in which students actively participate in their own learning.

The environmental focus provides a mass of quantifiable, accessible data in a context that interests both students and faculty. The mathematics used grows out of the need to answer particular questions, some of which have several possible answers. Students derive models for given data and use them to predict pertinent events. In a final project, students submit proposals to improve environmental conditions. With this approach students actually use mathematics to make decisions about real situations.

Distinguishing Features of the Text

Earth Algebra incorporates the NCTM *Standards for School Mathematics* and the *AMATYC Standards for Introductory College Mathematics before Calculus.* The following unique features are incorporated into the text:

- traditional topics motivated through the modeling of environmental data;
- modeling of polynomial, rational, exponential and logarithmic functions;
- a series of studies focused on a single issue;
- group work integrated throughout the text;
- use of technology, in the form of graphing calculators or computer software;
- oral and written reports and additional assignments; and
- emphasis on decision making and critical thinking.

The use of mathematics to study real-world problems, in particular global warming and the greenhouse effect, makes mathematics a hands-on subject.

Organization of the Text

The text is organized into five parts. Each part opens with an overview of the environmental issues to be examined and the mathematical concepts to be used. Concepts traditionally studied in college algebra are used to create models. Students make predictions, decisions, and recommendations about environmental issues based on these models.

Each modeling chapter, in which environmental issues are presented, is preceded by concept chapters in which the mathematical ideas necessary to complete the study are presented. The concept chapters, which now include more drill exercises than in the previous editions, allow students to practice the mathematical skills before applying them to the environmental applications. Each mathematical topic presented is used in an application. There are no extraneous topics, but the text is flexible enough that instructors can choose which parts are to be covered. The Instructor's Guide contains more information about the connections between chapters in *Earth Algebra.*

To complete the environmental applications, the class is divided into groups. Exercises for the groups are indicated in the text by the Group Work icon, and many include open-ended questions. The students write or present oral reports that summarize the work done for each section of the application.

Part I of *Earth Algebra* discusses the issue of global warming and how it is affected by carbon dioxide buildup. Students are introduced to the ideas of curve fitting and mathematical models. Part II examines three influences on carbon dioxide levels: automobile emissions in the United States, U.S. energy consumption, and the destruction of tropical rainforests around the world. For

each of these influences, three factors are analyzed and then combined to produce functions describing total carbon emissions from each source. In Part III geometric series are discussed and then used to determine total atmospheric accumulation from each source. Part IV shows how two variables—people and money—affect sources of CO_2 emissions. In Part V alternative energy sources are analyzed through linear programming, then student groups devise plans for decreasing future CO_2 emissions. Each group presents its plan to the class.

The Developmental Story of the Text

We wrote the preliminary version of *Earth Algebra* in response to our departmental concern over problems encountered in the traditional college algebra course. We pondered the question of what makes college algebra boring to so many students. One of our colleagues suggested, "If you want to make a course interesting, then you should study something of interest." To do this we chose to couch most of the standard topics of college algebra in the vitally important issues of the environment. The course has been part of the Kennesaw State University curriculum since Fall 1991, and student reaction has been quite favorable. Revisions were made for the first edition, published in 1995, which incorporated suggestions from users of the preliminary edition.

Changes in the Second Edition

In the development of this edition we have incorporated suggestions from users of the first edition and the participants of the many workshops and presentations that we have made over the past five years. The introductory chapter on functions has been revised extensively. It now includes a review of sets, and discussion of five methods of describing a function (as a set of ordered pairs, a graph, a table, an equation, and an arrow diagram). The chapters on linear and quadratic functions have been expanded to include a discussion of different forms for these functions. Additional practice exercises have been added to all of the concept chapters. The modeling chapters have been revised to include the use of technology to generate the regression equations for a given set of data. All data have been updated, additional modeling exercises have been included, and new exercises have been added that reflect current debates on global warming. Changes for the second edition include:

- use of TI 82 and 83 graphing calculator technology;
- use of regression to generate equations to fit data;
- exercises that reflect current events in global warming issues;
- additional modeling and drill exercises;
- updated environmental data; and
- extensive revision of the introductory "concept" chapters.

Marlene Sims and Stanley Sims, both of Kennesaw State University, have been added as co-authors. Both have had extensive experience in teaching Earth Algebra from its earliest form to the present, and have led numerous Earth Algebra workshops for students, part-time college faculty, and high school teachers.

ACKNOWLEDGMENTS

Key to the development of this edition were the users who took the time and effort to give us suggestions and comments. We especially thank the following reviewers for taking on the effort of reviewing our book: Tom Adamson, *Phoenix College;* Richard B. Basich, *Lakeland Community College;* Lea Campbell, *Lamar University—Port Arthur;* Shay Cardell, *Central Arizona College;* Laura Corrigan, *Central Florida Community College;* Iris B. Fetta, *Clemson University;* Luke Foster, *Owensboro Community College;* Jay Graening, *University of Arkansas;* Charles Hadlock, *Bentley College;* Julia Hassett, *DeVry Institute of Technology;* Richard Hickman, *Modesto Junior College;* Linda Horner, *Broward Community College;* Annita W. Hunt, *Clayton State College;* Charles Jones, *Ball State University;* Judith M. Jones, *Valencia Community College, East Campus;* Bill Keigher, *Rutgers University;* Donna LaLonde, *Washburn University;* Martha Ann Larkin, *Southern Utah University;* Frances Leach, *Delaware Technical and Community College;* David M. Mathews, *Longwood College;* Marveen McCready, *Chemeketa Community College;* Iris McMurtry, *Motlow State Community College;* Hector Mendez-Berrueta, *University of Georgia;* Steve Prehoda, *Frederick Community College;* Don Shriner, *Frostburg State University;* Arthur Sparks, *Georgia Southern University;* J. Phillip Taylor, *Thomas College;* Sandy Wagner, *University of North Carolina at Wilmington;* Charles Wall, *Trident Technical College;* Mary Jane Wolfe, *University of Rio Grande;* Ed Zeidman, *Essex Community College.*

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Finally, a special thanks to Pauline, to Lanier, and to Nancy Leigh for their understanding, tolerance, and encouragement.

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Stanley Sims

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To The Student

"If you want to make a course interesting, then you should study something of interest."

M. Sims, March 1990

These simple but deceptively wise words were delivered at the first meeting of an ad hoc committee at Kennesaw State. The charge to this committee was the following: "Do something about college algebra." Although our Department Chair claims that we volunteered, we, in actuality, were appointed co-chairs of this committee. This appointment was an immediate and direct response to this public statement: "We are wasting our time and the students' time teaching our existing college algebra course."

The opening profundity of Ms. Sims could very well have been the impetus for this book. What, indeed, could be done to make college algebra interesting? And, what makes college algebra boring to practically every student on this planet? The answers to the latter question were easily determined by a review of questions perennially posed by its students. Here are a few familiar ones:

1. "What's this stuff good for?" (in response to most anything);
2. "Who cares?" (in response to thought provoking word problems, such as "Train A leaves New York . . . ," or "Sally is twice as old as John . . .");
3. "When will I ever have to do this again in my life?" (in response to simplification of a complex fraction that only Rube Goldberg could have designed); and lastly, our favorite:
4. "Is x always equal to 2?" (in response to having solved a hideous equation involving roots of rational expressions).

There are answers, of course, to all these. In reverse order:

4. "Yes."

3. "I'm not sure."

2. "*You* should, if you want to pass this course."

1. "Designing electrical circuits," "constructing bridges," "putting a woman on the moon," etc., etc., etc.

The first question probably encompasses all the others (except possibly number 4), so we briefly observe that all the answers provided to this query are true but rather inadequate in yielding a meaningful link between factoring and space walking to any student at the beginning college level.

One of our principal goals, perhaps we should say dreams, is to forever lay question 1 to rest, at least among students of Earth Algebra. In an attempt to provide the interest, we have couched college algebra in the vitally important issues of the environment. Neither train A, nor Sally's age, will be of concern herein. Real data about real things are provided in this text, and models are derived to fit. Models use relatively simple algebraic equations, such as linear, quadratic, and rational; also exponential and logarithmic functions are summoned when appropriate. We define a "best" model for a given set of data, and after its derivation, students use it to predict relevant events, then to propose reasonable societal restrictions for improvement of future environmental conditions. The equations are actually used to make decisions about real-world situations. After completion of the first pilot segment of this course, both of us commented that we have been teaching freshman mathematics courses entitled "Decision Math" for some fifteen years now, and this was the first time our students had ever used mathematics to make a decision.

It is our intention that the majority of the material in this text be studied in small groups, ranging from three or four students each. We have found that this stimulates responsibility and confidence. Students' written reports and oral presentations incorporated into the studies place real meaning to "$x = 2$." Two what? Two decades? Two tons of carbon dioxide? And whatever "two" is, how is it relevant?

The text is designed for study with the aid of graphing calculators or computer software. These mercifully remove the deep, dark tedium and drudgery involved in manipulation of demonic algebraic expressions.

Earth Algebra is intended for study in a beginning level college algebra course. Most of the standard topics usually covered in a traditional college al-

gebra course are included, although most manipulation of algebraic expressions and graphing of more sophisticated equations are handled with the calculator. However, with the aid of the graphing calculator, we are able to include other topics that may not normally have been covered in the traditional course.

Overall, it is our sincere wish that both the student and the instructor find the reading of this book enjoyable and educational. And to the student: may you learn a little mathematics—and what it's good for—along the way.

Finally, this project is supported by generous grants from the National Science Foundation and the U.S. Department of Education: Fund for the Improvement of Post Secondary Education. For this support, the authors are proud and grateful.

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