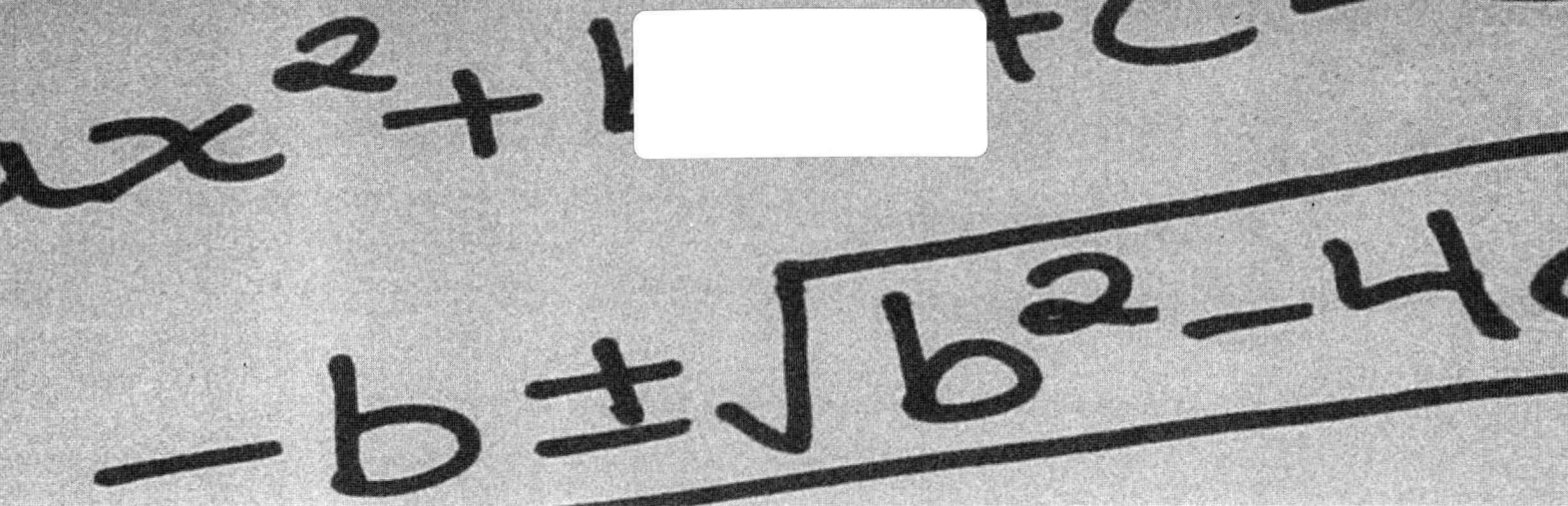


$$ax^2 + bx + c = 0$$
$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

BEGINNING AND
INTERMEDIATE
ALGEBRA

PRELIMINARY EDITION

Sherri Messersmith



BEGINNING AND INTERMEDIATE ALGEBRA

Preliminary Edition

Sherri Messersmith
College of DuPage



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Sherri Messersmith is an Assistant Professor of Mathematics at College of DuPage in Glen Ellyn, Illinois, where she has been teaching developmental math through calculus since 1994. After earning a Bachelor of Science degree in the teaching of mathematics from the University of Illinois at Urbana-Champaign, she taught high school for two years. In 1987, she returned to Urbana as a full-time graduate student. Sherri's teaching experience at UIUC includes two years as a teaching assistant, several summers as an instructor in the University's Bridge Program for at-risk students, and, after having earned a Master of Science in applied mathematics, three years teaching and coordinating large lecture sections of undergraduate math courses. In addition to writing this textbook, she appears in videos accompanying several McGraw-Hill textbooks.

Preface

Why Publish a Preliminary Edition?

During the development of this textbook, reviewer response has been extremely positive. In fact, many reviewers said that they would like to use it to teach their courses as soon as possible! As a result, McGraw-Hill decided to bring my text to the market early in order to give instructors a chance to teach from it and in turn, give me a chance to obtain feedback from those using it in their classrooms for integration into the four-color Second Edition. Early and abundant feedback from faculty and students across the country will allow me to improve upon this Preliminary Edition to make the Second Edition even better for both students and instructors.

Beginning and Intermediate Algebra has evolved from the notes, worksheets, and teaching techniques I have been using for over twenty years. I have learned a great deal from attending national conferences and faculty forums that has also helped me shape this textbook. Although it is a Preliminary Edition, it is not untested: for a full year before going to print, other instructors and I have taught our beginning and intermediate algebra courses from this book, and it has been carefully checked for accuracy both inside and outside the classroom. A student who had used an earlier draft of my manuscript wrote to me during her next semester to say, “Thank you for giving me a copy of your book. It was a lifesaver. It really made things clear. I miss your book this semester. The regular textbook doesn’t have enough problems...to practice with. Keep up the good work!! I’ve never thought I was good at math, ‘til now. Thanks.”

How Is This Textbook Different From Others?

Writing Style

Many students in beginning and intermediate algebra courses do not read at the college level and may, in fact, be in a developmental reading course. Without sacrificing mathematical rigor, I have written this book using language that is mathematically sound yet easy enough for students to understand. While class-testing the book, many students told us that when they were absent from class, they could read the book and understand the material they had missed. Reviewers liked the book’s readability and student-friendly tone as well. One reviewer, Corinna Goehring at Jackson State Community College, wrote, “[The] plain language is great! The author has succeeded in taking the intimidation out of a math text! It is rigorous enough to prepare anyone for the next level and yet not intimidating.”

Breakdown of Topics

My book breaks down topics into simpler, more easily learned component parts. Two topics of note are among some of the most difficult for students: Exponents (Chapter 2) and Radicals (Chapter 10).

In Chapter 2, Sections 2.2 and 2.3 are each divided into two sections. In 2.2a, where the Product Rule and Power Rules are introduced, students will *only* practice these skills individually. Once they are comfortable with each of these rules, Section 2.2b explains how to combine the rules to simplify expressions, and it is here that the students practice putting these rules together. Then, in Section 2.3a, negative exponents are introduced. In this section, however, I only present real number bases so that, again, students gain practice working with the most basic of rules. In Section 2.3b, I introduce variables as bases and the expressions to be simplified become more complex. This approach has proven to be very effective, I believe, because students are introduced to and get to practice the rules at the most basic level before moving on to more difficult problems.

My approach in Chapter 10, Radicals, is similar. Section 10.1 covers, *only*, simplifying radicals such as $\sqrt{25}$, $\sqrt[3]{-64}$, and $\sqrt[4]{\frac{16}{81}}$. Section 10.2 presents rational exponents, comparing them to previous work with integer exponents. Most textbooks present the simplifying of radicals such as $\sqrt{18}$, $\sqrt[3]{40}$, $\sqrt{20x^8y^{11}}$, and $\sqrt[4]{48a^9b^{20}}$ in the same section. My book does not. In Section 10.3, I introduce simplifying radical expressions containing only *square* roots. Students are more comfortable working with square roots than they are working with higher roots. Once they understand and practice the concepts involved in simplifying expressions containing *square* roots, it is easier for them to extend these ideas to expressions containing higher roots. This is the reason higher roots are in a separate section. After students practice simplifying expressions containing square roots in Section 10.3, they move on to doing the same with higher roots in Section 10.4. This is something reviewers liked as well. Reviewer Carolyn Rieffel of Louisiana Technical College said, “The organization and presentation of the material was excellent. I really liked separating the topics into so many sections. This makes it much easier for students to absorb the material. They only have to master one technique at a time. The thorough treatment of simplifying square roots before simplifying higher roots is very good.”

Geometry Review

In Chapter 1, you will find a review of basic concepts from geometry. Throughout beginning and intermediate algebra courses, students need to know, among many other things, that the sum of the angles of a triangle is 180° , the perimeter of a rectangle is $2(\text{length}) + 2(\text{width})$, and that the area of a triangle is $\frac{1}{2}(\text{base})(\text{height})$. The reality is, however, that many do not. Faculty across the country have said they wished textbooks would include a section containing a review of geometry. I have incorporated such a review here, and Section 1.3 provides the material necessary for faculty to teach and students to practice those geometry concepts they will need later in a beginning or intermediate algebra course.

Exercise Sets

Throughout the sections, the examples are presented from the most basic to the more rigorous so that students may see the how the concepts work at the simplest level before progressing to more

difficult problems. The exercise sets are constructed the same way. The problems in the exercise sets begin with very simple, often one-step problems so that students can practice the skills at their most basic level and so that students can gain confidence in their abilities to “do” mathematics. After practicing these “simple” problems, the exercises become more complex.

Summary Exercises

Many students can understand concepts and perform operations within the context of one section, yet when it comes time to put several ideas together, students struggle. This is why most chapters contain one or two *Summary Exercises* sections – so that students have the opportunity to practice together those skills previously learned in isolation. Within the text of these sections, I try to teach students strategies to use to put all of the ideas together. After having presented all of the techniques for factoring in Chapter 7, for example, the text in the *Summary Exercises* section walks students through the thought processes involved in trying to decide which factoring technique to use to factor a particular polynomial. I do this through the use of questions that the students are encouraged to ask themselves. “*Can I factor out a GCF?*”, for example, is one question I tell students to ask themselves as the first step in factoring any polynomial. The exercise sets in the *Summary Exercises* sections reflect this philosophy of pulling together many different concepts. In the exercise set for factoring, for example, the polynomials the students are asked to factor are given in no particular order so that the first thing a student must do is decide which factoring technique to use.

Worksheets

My book is accompanied by ready-made worksheets for instructors to use as they see fit. They are available online via MathZone (www.mathzone.com – see below for more information). Some worksheets are geared toward helping students brush up on basic skills. For example, in order to successfully learn how to simplify exponential expressions such as $(2a^4b^7)^5$ and radical expressions like $\sqrt[3]{125t^6}$, students must first know that $2^5 = 32$ and that $\sqrt[3]{125} = 5$ since $5^3 = 125$. So, I have several worksheets instructors can give to their students so that they can learn how to quickly recall facts such as $3^4 = 81$ and $(-8)^2 = 64$ to prepare them to learn how to simplify exponential and radical expressions.

The purpose of some worksheets, however, is to help instructors teach new content in the classroom. These worksheets can be found for topics throughout the book, and one such place is in chapter 3 where applications of linear equations are presented. When teaching students how to solve application problems, I begin by explaining one or two problems on the board. Then, I break up the students into groups, and they solve the problems on the worksheets. This allows them to discuss the problems together, and it allows me to walk around the room to answer questions. The worksheets can be a basis for active-learning activities within the classroom and have proven very effective over the years. Reviewers loved the worksheets and even thought of different ways to use them. Some reviewers said that they would give them to students as take-home quizzes.

Other Key Features of This Book


You Try Problems

After almost every example, there is a “*You Try*” problem that mirrors that example. This provides students with the opportunity to practice a problem similar to what the instructor has presented before moving on to the next concept. The answers to the “*You Try*” problems appear at the end of the section immediately before the exercise set.

Be Careful!

There are some mistakes that are very common for students to make. The “Be Careful!” boxes make students aware of these common errors so that, hopefully, they will not make these mistakes themselves.

Writing Problems

To reinforce students’ understanding of concepts, most exercise sets include writing problems – exercises that require students to explain an idea or answer a question in their own words. These exercises are denoted with a  icon.

Interesting Applications

Applications are a very important part of an algebra course. I have incorporated real-world, up-to-date, relevant information that will appeal to students of all backgrounds. While teaching from an earlier version of this book, our students told us that some of the problems were interesting and fun – something they have not seen in other math books.

Problem-Solving and Critical-Thinking Skills

Throughout the narrative and examples, students are led through the problem – solving process. One technique I use is to encourage the student, “*Ask yourself.*” In Chapter 11, for example, when students are learning how to solve a quadratic equation like $m^2 - 8m + 13 = 0$, I tell the student to ask him/herself, “*Can I factor $m^2 - 8m + 13$?*” to help that student to decide what method to use to solve the equation. This technique of getting students to ask themselves questions appears throughout the book. I try to encourage students to ask questions of *themselves* to improve their critical-thinking skills and to help them become better problem solvers.

End-of-Chapter Material

At the end of each chapter you will find a comprehensive Chapter Summary, a Chapter Review with many exercises, and a Chapter Test. A Cumulative Review appears at the end of every chapter after the first.

Supplements

The following supplements are available to accompany the Preliminary Edition of *Beginning and Intermediate Algebra*.

Instructor's Testing and Resource CD-ROM (ISBN-13: 9780073047782, ISBN-10: 0073047783)

Brownstone Diploma® testing software, available on CD-ROM, offers instructors a quick and easy way to create customized exams and view student results. Instructors may use the software to sort questions by section, difficulty level, and type; add questions and edit existing questions; create multiple versions of questions using algorithmically-randomized variables; prepare multiple-choice quizzes; and construct a grade book.

MathZone www.mathzone.com

McGraw-Hill's MathZone is a cutting-edge, customizable web-based system that offers a complete solution to instructors' online homework, quizzing and testing needs. MathZone guides students through step-by-step solutions to practice problems and facilitates student assessment through the use of algorithmically-generated test questions. Student activity within the MathZone site is automatically graded and accessible to instructors in an integrated, exportable grade book. The MathZone site also contains the worksheets (*see description above*) in a downloadable format for instructors' convenience.

Feedback Appreciated!

One of the reasons for bringing out the book in a Preliminary Edition is to get feedback from faculty and students across the country so that I can make the Second Edition of this book the best that it can be. If you have *any* comments, questions, or suggestions, I would love to hear from you! You can email me at messersm@cod.edu.

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Sherri Messersmith
College of DuPage

Contents

Chapter 1 The Real Number System and Geometry

Section 1.1	Review of Fractions	1
Section 1.2	Exponents and Order of Operations	22
Section 1.3	Geometry Review	28
Section 1.4	Sets of Numbers and Absolute Value	46
Section 1.5	Addition and Subtraction of Real Numbers	56
Section 1.6	Multiplication and Division of Real Numbers	66
Section 1.7	Algebraic Expressions and Properties of Real Numbers	77
Chapter Summary		89
Chapter 1 Review		96
Chapter 1 Test		100

Chapter 2 Variables and Exponents

Section 2.1	Simplifying Expressions	103
Section 2.2a	The Product Rule and Power Rules for Exponents	109
Section 2.2b	Combining the Rules	120
Section 2.3a	Integer Exponents with Real-Number Bases	124
Section 2.3b	Integer Exponents With Variable Bases	129
Section 2.4	The Quotient Rule	134
Summary Exercises: Putting All the Rules Together		139
Section 2.5	Scientific Notation	146
Chapter Summary		155
Chapter 2 Review		159
Chapter 2 Test		163
Cumulative Review for Chapters 1–2		164

Chapter 3 Linear Equations and Inequalities

Section 3.1	Solving Linear Equations Part I	167
Section 3.2	Solving Linear Equations Part II	179
Summary Exercises		190
Section 3.3	Applications of Linear Equations to General Problems, Consecutive Integers, and Fixed and Variable Cost	195
Section 3.4	Applications of Linear Equations to Percent Increase/Decrease and Investment Problems	207
Section 3.5	Geometry Applications and Solving Formulas for a Specific Variable	218
Section 3.6	Applications of Linear Equations to Proportions, $d = rt$, and Mixture Problems	233
Section 3.7	Solving Linear Inequalities in One Variable	251
Section 3.8	Solving Compound Inequalities	264
Chapter Summary		272
Chapter 3 Review		281

Chapter 3 Test	284
Cumulative Review for Chapters 1–3	285
Chapter 4 Linear Equations in Two Variables	
Section 4.1 Introduction to Linear Equations in Two Variables	296
Section 4.2 Graphing by Plotting Points and Finding Intercepts	316
Section 4.3 The Slope of a Line	336
Section 4.4 The Slope-Intercept Form of a Line	358
Section 4.5 Writing an Equation of a Line	370
Section 4.6 Parallel and Perpendicular Lines	386
Chapter Summary	395
Chapter 4 Review	404
Chapter 4 Test	413
Cumulative Review Chapters 1–4	414
Chapter 5 Solving Systems of Linear Equations	
Section 5.1 Solving Systems by Graphing	382
Section 5.2 Solving Systems by Substitution	393
Section 5.3 Solving Systems by the Addition Method	404
Summary Exercises	414
Section 5.4 Applications of Systems of Two Equations	419
Chapter Summary	432
Chapter 5 Review	438
Chapter 5 Test	440
Cumulative Review for Chapters 1–5	440
Chapter 6 Polynomials	
Section 6.1 Review of Rules of Exponents	443
Section 6.2 Addition and Subtraction of Polynomials	448
Section 6.3 Multiplication of Polynomials	458
Summary Exercises	473
Section 6.4 Division of Polynomials	478
Chapter Summary	494
Chapter 6 Review	499
Chapter 6 Test	503
Cumulative Review Chapters 1–6	504
Chapter 7 Factoring Polynomials	
Section 7.1 The Greatest Common Factor and Factoring by Grouping	506

Section 7.2	Factoring Trinomials of the Form $x^2 + bx + c$	519
Section 7.3	Factoring Polynomials of the Form $ax^2 + bx + c$ ($x \neq 1$)	528
Section 7.4	Factoring Binomials and Perfect Square Trinomials	540
Summary Exercises		556
Section 7.5	Solving Quadratic Equations by Factoring	562
Section 7.6	Applications of Quadratic Equations	570
Chapter Summary		583
Chapter 7 Review		590
Chapter 7 Test		593
Cumulative Review Chapters 1–7		594

Chapter 8 Rational Expressions

Section 8.1	Simplifying Rational Expressions	596
Section 8.2	Multiplying and Dividing Rational Expressions	609
Section 8.3	Finding the Least Common Denominator	618
Section 8.4	Adding and Subtracting Rational Expressions	631
Summary Exercises		643
Section 8.5	Simplifying Complex Fractions	647
Section 8.6	Solving Equations Containing Rational Expressions	659
Section 8.7	Applications	674
Chapter Summary		684
Chapter 8 Review		694
Chapter 8 Test		699
Cumulative Review Chapters 1–8		700

Chapter 9 Absolute Value Equations and Inequalities and More on Solving Systems

Section 9.1	Solving Absolute Value Equations	702
Section 9.2	Solving Absolute Value Inequalities	708
Section 9.3	Linear Inequalities in Two Variables	717
Section 9.4	Systems of Linear Equations in Three Variables	733
Section 9.5	Solving Systems Using Gaussian Reduction	748
Chapter Summary		765
Chapter 9 Review		775
Chapter 9 Test		779
Cumulative Review Chapters 1–9		780

Chapter 10 Radicals and Rational Exponents

Section 10.1	Finding Roots	781
--------------	---------------	-----

Section 10.2	Rational Exponents	789
Section 10.3	Simplifying Expressions Containing Square Roots	823
Section 10.4	Simplifying Expressions Containing Higher Roots	823
Section 10.5	Adding and Subtracting Radicals	836
Section 10.6	Combining Multiplication, Addition, and Subtraction of Radicals	844
Section 10.7	Dividing Radicals	853
Section 10.8	Solving Radical Equations	874
Chapter Summary		888
Chapter 10 Review		899
Chapter 10 Test		904
Cumulative Review for Chapters 1–10		905
Chapter 11 Quadratic Equations		
Section 11.1	Review of Solving Equations by Factoring	907
Section 11.2	Solving Quadratic Equations Using the Square Root Property	913
Section 11.3	Complex Numbers	923
Section 11.4	Solving Quadratic Equations by Completing the Square	935
Section 11.5	Solving Quadratic Equations Using the Quadratic Formula	947
Summary Exercises		963
Section 11.6	Equations in Quadratic Form	968
Section 11.7	Formulas and Applications	978
Chapter Summary		988
Chapter 11 Review		997
Chapter 11 Test		1001
Cumulative Review for Chapters 1–11		1002
Chapter 12 Functions and their Graphs		
Section 12.1	Relations and Functions	1005
Section 12.2	Function Notation and Linear Functions	1017
Section 12.3	Graphs of Other Functions	1033
Section 12.4	Transformations of Graphs	1052
Section 12.5	Quadratic Functions and their Graphs	1061
Section 12.6	Applications of Quadratic Functions and Graphing Other Parabolas	1075
Summary Exercises		1089
Section 12.7	The Algebra of Functions	1096
Section 12.8	Variation	1107
Chapter Summary		1119
Chapter 12 Review		1127

Chapter 12 Test	1132
Cumulative Review for Chapters 1–12	1133
Chapter 13 Inverse, Exponential, and Logarithmic Functions	
Section 13.1 Inverse Functions	1136
Section 13.2 Exponential Functions	1148
Section 13.3 Logarithmic Functions	1163
Summary Exercises	1181
Section 13.4 Properties of Logarithms	1188
Section 13.5 Common and Natural Logarithms and Change of Base	1203
Section 13.6 Solving Exponential and Logarithmic Equations	1216
Chapter Summary	1231
Chapter 13 Review	1242
Chapter 13 Test	1247
Cumulative Review for Chapters 1–13	1248
Chapter 14 Conic Sections, Nonlinear Inequalities, and Nonlinear Systems	
Section 14.1 Review of Parabolas	1250
Section 14.2 The Circle	1256
Section 14.3 The Ellipse and the Hyperbola	
Summary Exercises	1274
Section 14.4 Nonlinear Systems of Equations	1278
Section 14.5 Quadratic and Rational Inequalities	1289
Section 14.6 Second-Degree Inequalities and Systems of Inequalities	1304
Chapter Summary	1312
Chapter 14 Review	1321
Chapter 14 Test	1324
Cumulative Review for Chapters 1–14	1325
Chapter 15 Sequences and Series	
Section 15.1 Sequences and Series	1327
Section 15.2 Arithmetic Sequences and Series	1341
Section 15.3 Geometric Sequences and Series	1356
Section 15.4 The Binomial Theorem	1372
Chapter Summary	1383
Chapter 15 Review	1389
Chapter 15 Test	1394
Cumulative Review for Chapters 1–15	1396

Chapter 1

The Real Number System and Geometry

1.1 Review of Fractions

Why review fractions and arithmetic skills? Because the manipulations done in arithmetic and with fractions are precisely the same skills needed to learn algebra.

Let's begin by defining some numbers used in arithmetic:

Natural numbers: 1, 2, 3, 4, 5, ...

Whole numbers: 0, 1, 2, 3, 4, 5, ...

Natural numbers are often thought of as the counting numbers. **Whole numbers** consist of the natural numbers and zero.

Natural and whole numbers are used to represent complete quantities. To represent a part of a quantity we can use a fraction.

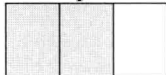
What is a fraction?

Definition: A **fraction** is a number in the form $\frac{a}{b}$ where $b \neq 0$. a is called the **numerator**, and b is the **denominator**.

Note: 1) A fraction describes a part of a whole quantity.

2) $\frac{a}{b}$ means $a \div b$.

Example 1: What part of the figure is shaded?



SOLUTION

The whole figure is divided into 3 equal parts. Two of the parts are shaded.

Therefore, the part of the figure that is shaded is $\frac{2}{3}$.

$\frac{2}{3} \rightarrow$ number of shaded parts

$\frac{2}{3} \rightarrow$ total number of equal parts in the figure. ■