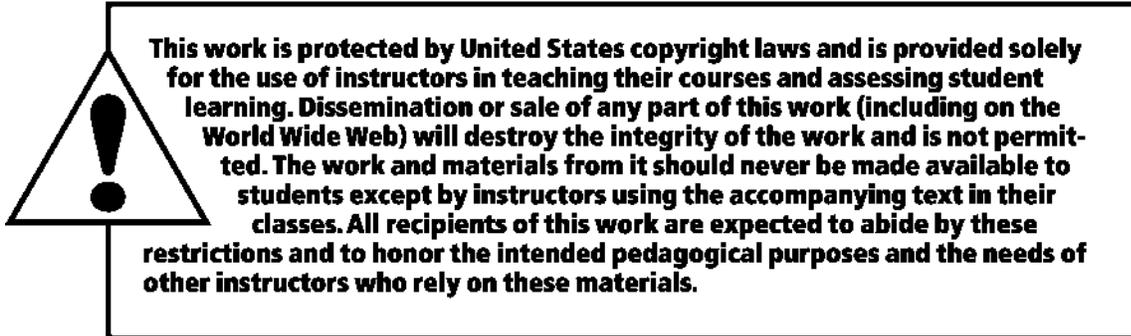


INSTRUCTOR'S RESOURCE  
MANUAL WITH TESTS

MATHEMATICS IN ACTION:  
AN INTRODUCTION TO  
ALGEBRAIC, GRAPHICAL, AND  
NUMERICAL PROBLEM SOLVING  
SIXTH EDITION

*The Consortium for  
Foundation Mathematics*





The author and publisher of this book have used their best efforts in preparing this book. These efforts include the development, research, and testing of the theories and programs to determine their effectiveness. The author and publisher make no warranty of any kind, expressed or implied, with regard to these programs or the documentation contained in this book. The author and publisher shall not be liable in any event for incidental or consequential damages in connection with, or arising out of, the furnishing, performance, or use of these programs.

Copyright © 2020, 2016, 2012, 2008 by Pearson Education, Inc. or its affiliates. All Rights Reserved. Printed in the United States of America. This publication is protected by copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise. For information regarding permissions, request forms and the appropriate contacts within the Pearson Education Global Rights and Permissions Department, please visit [www.pearsoned.com/permissions](http://www.pearsoned.com/permissions).



ISBN-13: 978-0-13-498933-4  
ISBN-10: 0-13-498933-3

# CONTENTS

<b>FOREWORD</b> .....	<b>vi</b>
STUDENT OUTCOMES .....	vii
PERFORMANCE OBJECTIVES .....	vii
GENERAL EDUCATION COMPETENCIES .....	viii
<b>SECTION 1 OVERVIEW</b> .....	<b>1</b>
RESOURCES IN THIS GUIDE .....	1
TEXTBOOK CONTENT AND STRUCTURE .....	1
TEXTBOOK SUPPLEMENTS .....	3
PEDAGOGY .....	5
TECHNOLOGY .....	6
SUGGESTED SYLLABI .....	6
MATHEMATICAL TOPICS COVERED IN THE TEXT .....	6
ANNOTATED LIST OF CORE AND RECOMMENDED SUPPLEMENTAL ACTIVITIES .....	7
SAMPLE COURSE OUTLINES .....	13
ASSESSMENT .....	19
<b>SECTION 2 CHAPTER NOTES</b> .....	<b>21</b>
CHAPTER 1: NUMBER SENSE .....	22
CLUSTER 1 INTRODUCTION TO PROBLEM SOLVING .....	22
CLUSTER 2 PROBLEM SOLVING WITH FRACTIONS & DECIMALS (RATIONAL NUMBERS) .....	23
CLUSTER 3 COMPARISONS AND PROPORTIONAL REASONING .....	24
CLUSTER 4 PROBLEM SOLVING WITH SIGNED NUMBERS .....	25
CHAPTER 2: VARIABLE SENSE .....	26
CLUSTER 1 SYMBOLIC RULES AND EXPRESSIONS .....	26
CLUSTER 2 SOLVING EQUATIONS .....	28
CLUSTER 3 MORE PROBLEM SOLVING USING ALGEBRA .....	29
CHAPTER 3: FUNCTION SENSE AND LINEAR FUNCTIONS .....	30
CLUSTER 1 FUNCTION SENSE .....	30
CLUSTER 2 INTRODUCTION TO LINEAR FUNCTIONS .....	31
CLUSTER 3 LINEAR REGRESSION, SYSTEMS, AND INEQUALITIES .....	32
CHAPTER 4: AN INTRODUCTION TO NONLINEAR PROBLEM SOLVING .....	34
CLUSTER 1 MATHEMATICAL MODELING INVOLVING POLYNOMIALS .....	34
CLUSTER 2 PROBLEM SOLVING WITH QUADRATIC EQUATIONS AND FUNCTIONS .....	34
CLUSTER 3 OTHER NONLINEAR FUNCTIONS .....	35
<b>SECTION 3 LEARNING IN GROUPS</b> .....	<b>37</b>
QUESTIONS AND ANSWERS ABOUT LEARNING IN GROUPS .....	38
What is collaborative learning? .....	38
What skills do students gain through active learning in a collaborative environment? .....	38
What is our role as teachers in a collaborative learning environment? .....	39
What if you have not used collaborative learning strategies before? .....	39
How do we form groups? What size should they be? .....	39
How can we motivate students to learn in a collaborative setting? .....	40
What can we do to ensure every student understands the major concepts? .....	41
A student claims, "This is not how I learned it." How do you respond? .....	41
How can time be used efficiently in a collaborative setting? .....	41
What can be done when a group falls behind or gets ahead? .....	42

What homework should you assign? .....	42
How is homework checked in a collaborative setting?.....	42
What can be done when a group member does not actively participate or contribute?.....	43
What can we do when a student is occasionally late to class?.....	43
What can we do about absenteeism? .....	43
What can be done when two group members have a conflict? .....	44
How do we help students who lack the basic skills that are only reviewed in the course? .....	44
How do we assess learning in groups? .....	44
<b>SECTION 4 TECHNOLOGY .....</b>	<b>45</b>
QUESTIONS AND ANSWERS ABOUT TECHNOLOGY .....	45
How do scientific calculators assist students using this textbook? .....	45
How do graphing calculators assist students using this textbook?.....	46
Which type of calculator should your students use?.....	46
Should students purchase their own calculators?.....	46
Will students be totally dependent on the calculators in using this text? .....	43
How should an instructor proceed when there are many different calculator models in the classroom? .....	47
Are procedures for using the graphing calculator included in this text?.....	47
What computer tutorial programs, graphing/computer algebra systems, or online resources are useful in connection with this textbook? .....	47
How can graphing assignments be assessed?.....	48
SAMPLE ACTIVITIES USING THE GRAPHING CALCULATOR OR COMPUTER PROGRAMS.....	48
<b>SECTION 5 WRITING TO LEARN .....</b>	<b>65</b>
HELPING STUDENTS KEEP A LEARNING LOG .....	65
JOURNAL ASSIGNMENTS .....	66
BRIEF ESSAY ASSIGNMENTS.....	66
ASSESSMENT OF WRITING ASSIGNMENTS.....	66
CRITERIA FOR EVALUATION OF ASSIGNMENTS .....	67
KEEPING A JOURNAL IN MATH .....	68
SAMPLE JOURNAL ASSIGNMENTS .....	72
<b>SECTION 6 BASIC SKILLS PRACTICE .....</b>	<b>89</b>
PRACTICING AND ASSESSING BASIC SKILLS .....	89
Calculator Usage .....	90
Percents, Decimals, and Fractions.....	92
Order of Operations.....	94
Evaluating and Solving Linear Equations .....	96
Solving Literal Equations.....	98
Proportions .....	100
Functional Representations.....	101
Slopes, Intercepts, and Equations of Lines.....	103
Systems of Equations .....	105
Properties of Exponents, Simplifying Algebraic Expressions.....	107
Factoring Algebraic Expressions.....	109
Factoring Trinomials.....	111

<b>SECTION 7 ASSESSMENT .....</b>	<b>113</b>
INDIVIDUAL, GROUP AND TAKE HOME EXAMS BY CHAPTER.....	113
Chapter 1.....	114
Chapter 2.....	136
Chapter 3.....	153
Chapter 4.....	195
INDIVIDUAL AND GROUP FINAL EXAMS.....	213
PORTFOLIOS AS ASSESSMENTS.....	229
<b>SECTION 8 ANSWERS TO BASIC SKILLS PRACTICE WORKSHEETS .....</b>	<b>231</b>
<b>SECTION 9 ANSWERS TO ASSESSMENTS (SECTIONS 4 AND 7).....</b>	<b>235</b>

## FOREWORD

*Mathematics in Action: An Introduction to Algebraic, Graphical, and Numerical Problem Solving*, Sixth Edition, aims to empower underprepared college students by providing them with a true mathematical literacy in the real world, and simultaneously, helping them build a secure foundation for future study in mathematics and other quantitative disciplines. The *Mathematics in Action* series grew out of a National Science Foundation grant (DUE 9455638) that enabled fourteen faculty, primarily from the State University of New York and the City University of New York systems, to work together over a three-year period to design a new curriculum for the traditional elementary, intermediate and college algebra sequence. The rationale for such a project had already been articulated by national organizations and professional societies from the National Research Council's *Everybody Counts* to the NCTM's *Standards* and AMATYC's *Crossroads*. In addition, NSF was funding a massive reform effort on the calculus level that would necessarily affect the courses that feed into calculus and those which follow.

The need for reform was also evident to those of us who teach foundation college mathematics. The diversity of our student body – returning adults, newly-arrived immigrants with English language deficiencies, high-school graduates with a history of poor performance – coupled with the higher level quantitative literacy required of them in the workplace called for an honest and thorough *re-evaluation* of desired student outcomes. The fourteen co-authors agreed to formulate a wish list of topics to be included in building a curriculum from scratch. One basic principle to which we would adhere was that students learn mathematics best by actively *doing* mathematics within a clear and meaningful context.

The original two textbooks in the *Mathematics in Action* series: *An Introduction to Algebraic, Graphical, and Numerical Problem Solving* and *Algebraic, Graphical, and Trigonometric Problem Solving* were the results of a five-year cycle of writing, meeting, piloting, and revising. Because of the success of these textbooks, we have now released fifth editions with updated data and features intended to further help students develop problem-solving skills.

The best one-word description of these texts is *interactive* – short on narrative and templates, and long on structured prompts and thoughtful questions. The authors have carefully attempted to bridge the gap between abstraction and application by encouraging students to construct, apply, and describe their own mathematical models as they solve meaningful problems. Students are challenged to approach the material from multiple perspectives and to share their insights and strategies with one another. The language and varied contexts are geared to adults and build upon their familiarity and sophistication with the world in which we live. You will also discover that the unique “activity” structure of the text is unparalleled in supporting your efforts to foster active learning in a stimulating and cooperative environment.

Activities are presented in “clusters” within each chapter. Each cluster contains a series of learning activities that introduce or reinforce key concepts and skills. Each cluster concludes with two sections: What Have I Learned? and How Can I Practice? The What Have I Learned? exercises are designed to help students synthesize the main ideas of the cluster. The How Can I Practice? exercises are designed to provide additional reinforcement of the numeric and algebraic skills of the cluster. Taken as a whole, these exercises give students the tools they need to bridge the gaps between abstraction, skills, and application. Each chapter also ends with a Gateway review, providing students with an opportunity to check their understanding of the chapter's concepts and skills.

Features that make definitions, procedures and properties more visible to the student include:

- A list of objectives that opens each activity. The objectives also appear in the Table of Contents.
- Activities containing examples that are worked out in great detail.
- Chapter Summaries that list the concepts and skills covered in the chapter with a corresponding description and example. Each concept or skill includes an activity number for reference.
- Activity questions that are numbered for easy reference.
- Definitions, properties, and procedures that are offset and identified.
- Exercise sets at the end of each activity that reinforce topics and provide an appropriate level of difficulty for an elementary or intermediate algebra course.
- Geometry problems that are integrated throughout the text.

### **CHANGES FROM THE FIFTH EDITION**

The Sixth Edition retains all the features of the previous edition, with the following content changes:

- All the data-based activities and exercises have been updated to reflect the most recent information and/or replaced with more relevant topics.
- The introductory scenarios in several activities have been replaced with more robust, up-to-date situations.
- Several new real-world exercises have been added throughout.
- The exposition and treatment of topics has been carefully reviewed and revised/rewritten where necessary to provide students with a more clear and easy to understand presentation.
- New PowerPoint presentations have been developed to support instructors looking to implement the contextual approach to introductory algebra.
- New videos have been developed to support students looking for more assistance on a concept.
- Learning Catalytics questions have been developed for nearly every activity, providing an opportunity for instructors to quickly assess the progress on a given concept and give students an opportunity to use technology as an interactive learning tool.

### **STUDENT OUTCOMES**

In creating a curriculum for an introductory or intermediate algebra course, we found that most of our desired student outcomes fell naturally into five main areas:

- Developing a number sense
- Developing a symbolic sense
- Developing a general function sense
- Developing a thorough linear function sense
- Introducing a sense of nonlinear (especially quadratic) relationships

The word “sense” in each of these areas conveys far more than requisite skills development. It also entails developing mathematical intuition and building techniques of reasoning. Continuously interpreting results demonstrates the relevance of mathematics in everyday life and requires active

participation by every student. Practice with expressing mathematical ideas in words will develop skills that will be very valuable when the student leaves the classroom.

### **PERFORMANCE OBJECTIVES**

At the conclusion of the course and in terms of specific mathematical performance, we expect students will be able to:

- Extract relevant data and solve real-life problems that involve computations with whole numbers, fractions, decimals, and percents.
- Analyze and interpret graphical and tabular data.
- Estimate and determine the magnitude of quantities before formal computation and compare the estimated and computed values for consistency.
- Express numerical quantities, including variables, in meaningful units.
- Evaluate formulas from a variety of disciplines, using calculators when appropriate.
- Interpret an algebraic expression in one variable as an explicit sequence of arithmetic operations to be performed on that variable.
- Recognize and express verbally, numerically, graphically, and symbolically the patterns displayed by linear data.
- Recognize equivalent linear relationships numerically, algebraically, and graphically and translate from one representation to any of the others.
- Solve linear equations and simple systems of linear equations.
- Recognize polynomial functions of degree two or higher, exponential functions, and inverse variation functions as nonlinear.
- Solve quadratic equations by factoring and the quadratic formula.
- Identify and define the basic vocabulary and notation of functions: input, output, domain, range, increasing function, decreasing function, rate of change.

### **GENERAL EDUCATION COMPETENCIES**

*Mathematics in Action* promotes the development of general competencies because it presents mathematics in realistic contextual situations. By the end of the course, we expect that students will be able to:

- Use proportional reasoning appropriately in contextual applications.
- Read technical material with facility to determine information relevant to the solution of a problem.
- Recognize that solution processes are multifaceted, and be able to use the necessary logic and formulas in a path to a solution.
- Communicate solutions to problems verbally and in writing, using logical and clear sequences of thought.
- Express solutions in writing using appropriate vocabulary, sentence structure, and persuasion.
- Demonstrate an improved comfort level when applying critical thinking and problem solving skills.
- Work collaboratively with others to enhance mathematical understanding through problem solving.
- Appreciate the importance of mathematics in everyday life and in the workplace.

## SECTION 1 OVERVIEW

### RESOURCES IN THIS GUIDE

We hope that the content and format of this *Instructor's Resource Manual with Tests* will be of great help to you in teaching with *Mathematics in Action*. This section of the *Manual* is an annotated directory to the resources addressed at length in the other sections. What is available to you in this *Guide* is described under the following headings.

- Textbook Content and Structure
- Supplements available with the textbook
- Pedagogy: Learning in Groups and Writing to Learn
- Technology: Scientific Calculators, Graphing Calculators, and Computer Programs
- Suggestions for Syllabi: Annotated List of the Major Mathematical Topics Covered in the Text
- Sample Course Outlines
- Assessment: Group Oral and Written Tests, Journals, Formal Writing Assignments, Traditional Testing, Basic Skills, Portfolios

*Mathematics in Action* is adaptable to the various needs of courses at the introductory foundation level and we offer you an annotated list of the major mathematical topics covered in the text as the best guide to determining the content of your course. We also offer sample course syllabi, one for an elementary algebra course and one for an intermediate level algebra course. Please note that in planning your course, supplemental teaching and learning aids are available to you and your students. These supplements are listed in this Overview Section for your convenience.

We organized and formatted this *Instructor's Resource Manual with Tests* so, if you choose, you can use the sample graphing calculator experiments, journal assignments, writing assignments, skills worksheets, tests, and exams as presented.

### TEXTBOOK CONTENT AND STRUCTURE

The text is divided into four chapters followed by appendices and a glossary.

- Chapter 1: Number Sense
- Chapter 2: Variable Sense
- Chapter 3: Function Sense and Linear Functions
- Chapter 4: An Introduction to Nonlinear Problem Solving

Each chapter is subdivided into sections we call clusters. Each cluster focuses on a major mathematical topic within the context of a chapter. For example, Chapter 1 Cluster 3 focuses on comparisons and proportional reasoning and Chapter 4 Cluster 2 concentrates on problem solving using quadratic equations and functions.

There are thirteen clusters in all; four in Chapter 1, three in Chapter 2, three in Chapter 3 and three in Chapter 4. The clusters are listed here to give you a convenient overview.

## 2 OVERVIEW

### Chapter 1 Number Sense

- Cluster 1 Introduction to Problem Solving
- Cluster 2 Problem Solving with Fractions and Decimals (Rational Numbers)
- Cluster 3 Comparisons and Proportional Reasoning
- Cluster 4 Problem Solving with Signed Numbers

### Chapter 2 Variable Sense

- Cluster 1 Symbolic Rules and Expressions
- Cluster 2 Solving Equations
- Cluster 3 More Problem Solving using Algebra

### Chapter 3 Function Sense and Linear Functions

- Cluster 1 Function Sense
- Cluster 2 Introduction to Linear Functions
- Cluster 3 Linear Regression, Systems, and Inequalities

### Chapter 4 An Introduction to Nonlinear Problem Solving

- Cluster 1 Mathematical Modeling Involving Polynomials
- Cluster 2 Problem Solving with Quadratic Equations and Functions
- Cluster 3 Other Nonlinear Functions

Each cluster is further divided into sections named

- *Activities* (with Exercises)
- *What Have I Learned?*
- *How Can I Practice?*

*Activities* are the essence of *Mathematics in Action*. They are where mathematical concepts and skills are introduced and developed in meaningful contextual problems and situations. We expect that students will see for themselves the need to master arithmetic and algebra skills, and be able to answer their own frequently asked questions, “Why do I need to learn this?” and “When will I ever use this outside this class?”

In *Activities*, students respond to a series of structured prompts and questions that direct them to recall and apply mathematical knowledge they already have, and that lead them to acquire the other concepts and skills they must have to be successful problem solvers. Basic arithmetic and algebra skills are presented as they are needed in the contextual problems. *Activities* also include exercises that may be assigned as additional practice in class or for homework.

A set of *Activities* in a cluster is followed by a section entitled *What Have I Learned?* As the name implies, students stop here to think about what they have learned before continuing to the next cluster. They have the opportunity to analyze and synthesize the ideas they studied in the cluster, and to test their knowledge by applying what they have learned to solve similar problems. You may want to use these sections to assess your students’ progress. Journal and writing assignments are good assessment tools for the questions in *What Have I Learned?* In addition, you will find suggestions for assessment in Sections

4, 5 and 7 of this guide. Students can also be encouraged to make these assignments part of their portfolios where they will have easy access to what they have learned when they are preparing for exams.

*How Can I Practice?* sections follow *What Have I Learned?* sections to provide further opportunities for practice.

Our textbook also addresses the need for plentiful skills practice and preparation for gateway exams that may be required in various programs. Appendix C includes two *Skills Check* sections specifically aimed to reinforce arithmetic skills.

Each chapter concludes with

- *Chapter Summary*
- *Gateway Review*

The *Chapter Summary* lists important concepts and skills from the chapter, together with a brief description and example of the concept or skill. The *Chapter Summary* provides reinforcement of what has been learned in the chapter and is helpful to students studying for exams.

Following each *Chapter Summary* are *Gateway Reviews*, composed of exercises that test the fundamental concepts and skills in their respective chapters. Please note that some additional skills worksheets are provided in Section 6 of this *Guide*. You will also find several appendices in *Mathematics in Action* that provide just-in-time instruction on basic arithmetic and algebraic skills and the use of a graphing calculator.

- Appendix A: Fractions
- Appendix B: Decimals
- Appendix C: Skills Checks
- Appendix D: Algebraic Extensions
- Appendix E: Getting Started with the TI-84 Plus Family of Graphing Calculators

The textbook also contains the following:

- Answers to selected problems and gateway questions (the Instructor's Edition contains answers to every problem within the text itself)
- Glossary
- Index

## TEXTBOOK SUPPLEMENTS

A number of supplemental instructional and learning aids are available for users of *Mathematics in Action* and they are described here.

### Instructor Supplements

#### **Annotated Instructor's Edition**

**ISBN 10 – 0-13-498931-7**

**ISBN 13 – 978-0-13-498931-0**

Contains all the content found in the student edition, plus answers to all exercises directly beneath each problem and Learning Catalytics instructor annotations.

## 4 OVERVIEW

### **Instructor’s Resource Manual with Tests**

**ISBN 10 – 0-13-498933-3**

**ISBN 13 – 978--0-13-498933-4**

This valuable teaching resource includes the following materials:

- Sample syllabi suggesting ways to structure the course around core and supplemental activities.
- Sample course outlines containing timelines for covering topics.
- Teaching notes for each chapter—ideal for using the text for the first time.
- Extra skills practice worksheets for difficult topics.
- Sample chapter tests and final exams.
- Information about incorporating technology in the classroom, such as graphing calculators.

### **TestGen®**

**ISBN 10 – 0-13-516330-7**

**ISBN 13 – 978-0-13-516330-6**

TestGen® enables instructors to build, edit, print and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions.

### **Instructor’s Training Videos**

From author Ernie Danforth, the videos provide instructors with advice ranging from the Consortium teaching philosophy to tips for implementing group-work.

### **New! PowerPoint Lectures**

These slides present key concepts and definitions from the text. These have been created to support instructors looking to implement this contextual approach in the classroom, and can also be used as a student study aid.

### **Student Supplements**

#### **Worksheets for Classroom or Lab Practice**

**ISBN 10 – 0-13-516714-0**

**ISBN 13 – 978-0-13-516714-4**

- Provide extra practice to ensure that students have many opportunities to work problems related to the concepts learned in every activity.
- Concept Connections, a feature unique to these worksheets, offer students an opportunity to show in words that they understand the mathematical concepts they have just practiced.

### **Supplements for Instructors and Students**

#### **MyLab Math® Online Course (access code required)**

MyLab Math from Pearson is the world’s leading online resource in mathematics, integrating interactive homework, assessment, and media in a flexible, easy to use format. It provides engaging experiences that

personalize, stimulate, and measure learning for each student. Moreover, it comes from an experienced partner with educational expertise and an eye on the future.

MyLab Math is a complete online course that provides interactive, multimedia instruction correlated to this textbook content. A MyLab course provides the full eText with a multimedia library to provide additional support for students when they need it. For this revision, a new video series and PowerPoint series are available, in addition to MyLab's exercises with learning aids and feedback, a personalized study plan, and more.

### **Instructor's Training Video available in MyLab Math® (access code required)**

The Instructor's Training Video discusses effective ways to implement the teaching pedagogy of the *Mathematics in Action* series, focusing on how to make collaborative learning, discovery learning, and alternative means of assessment work in the classroom. (Available in the Instructor Resources tab in MyLab Math®)

PowerPoint Lectures are available in MyLab Math. These slides present key concepts and definitions from the text. These have been created to support instructors looking to implement this contextual approach in the classroom, and can also be used as a student study aid.

To learn more about how MyLab Math combines proven learning applications with powerful assessment, visit [www.MyLabMath.com](http://www.MyLabMath.com) or contact your Pearson representative.

## **PEDAGOGY**

The pedagogical theme of *Mathematics in Action* is active learning, facilitated by emphasis on:

- Writing to Learn Mathematics
- Strategies for Problem Solving
- Collaborative Learning in Groups
- Whole-Class Interactive Discussions
- Use of Technology

Writing-to-learn strategies are built into the structure of the textbook, so students are consistently helped to think by writing, a time-honored way to learn mathematics. Section 5 of this *Guide* presents additional writing-to-learn techniques to share with your students.

Students need to recognize and assimilate thinking strategies for problem solving. In Section 2, we describe our insights on the purposes and goals of individual activities, problems, and exercise sets, and the problem-solving strategies they elicit.

In the classroom, we found, as many have, that the most active learning takes place in group settings where the teacher is a guide who helps students find their own correct understanding of concepts. Small groups promote attention to individual needs in learning, increase peer support for puzzling out solutions, and provide experience in teamwork. Whole-class interactive discussions allow an instructor to efficiently explain key concepts and clear up common misunderstandings, give students the opportunity to develop self-reliance in learning quantitative and algebraic skills for problem solving, and encourage the sharing and discussing of ideas in a large group setting. In Section 3, we share our experiences and offer

## 6 OVERVIEW

suggestions for using collaborative learning and interactive discussion with the *Activities* and other components in the textbook.

### TECHNOLOGY

Calculators and graphing programs are not only tools for doing mathematics and solving problems; they have fundamentally changed the way we teach and learn mathematics. We developed our textbook recognizing this modern pedagogical truth and you will find suggestions and ideas for using technology with the textbook in Section 4 of this *Guide*.

Technology is an integral part of the textbook and a number of technical tools are compatible with the activities in the course.

- Scientific Calculators
- Graphing Calculators
- Graphing Software
- Tutorial Software for Skills Practice

Scientific calculators are required and sufficient for the course, although graphing calculators are useful and are occasionally referenced for visual representation of functions in Chapters 3 and 4. Tutorial software can serve as an adjunct for practicing basic skills. You will find further discussion, suggestions, and examples regarding these tools in Section 4.

### SUGGESTIONS FOR SYLLABI

*Mathematics in Action: An Introduction to Algebraic, Graphical, and Numerical Problem Solving* can be used as the text in a variety of foundation level courses. Among the authors, we have adopted all or part of the book for courses in arithmetic, elementary algebra, intermediate algebra, and introduction to functions. The number of contact hours for each of these courses varies considerably from three to six hours, with the latter often including a computer laboratory component.

We compiled the following annotated list of the major mathematical topics covered in the textbook to serve as an effective guide for you to construct a syllabus that best suits your course. We have attempted to identify those activities that provide the essence of each major topic. In addition to these core activities, we have suggested other highly recommended activities that expand or reinforce the mathematical theme. We encourage you to use the many remaining activities for further exploration and practice.

### MATHEMATICAL TOPICS COVERED IN THE TEXTBOOK

Below is a list of the major topics covered in *Mathematics in Action*. We then present an annotated list that indicates both the core activities and recommended supplemental activities that explore each of these topics.

- Arithmetic Operations using Whole Numbers, Fractions (Rational Numbers) and Decimals
- Numerical Literacy through Proportional Reasoning
- Arithmetic Operations using Signed Numbers

- Introduction to Variable Quantities; Numerical, Symbolic and Graphical Representations of Relationships Between Input and Output Variables
- Symbolic Representation of Variable Quantities
- Constructing, Evaluating, and Solving Single-Operation Algebraic Models
- Constructing, Evaluating, and Solving Two-Operation Algebraic (Linear) Models
- Equivalent Algebraic Expressions: Numerically, Graphically, and Algebraically
- Solving More Complex (Linear) Equations
- Function Definition and Notation
- Rates of Change
- Linear Functions: Numerical, Graphical, and Algebraic Features
- Scatterplots and Linear Regression Equations
- Problem Solving with Linear Functions
- Systems of Linear Equations
- Linear Inequalities
- Polynomials and Properties of Exponents
- Problem Solving with Quadratic Equations and Functions
- A Brief Glimpse at Other Function Families

## **ANNOTATED LIST OF CORE AND RECOMMENDED SUPPLEMENTAL ACTIVITIES**

### **Arithmetic Operations using Whole Numbers, Fractions and Decimals (Rational Numbers)**

Recommended: Activity 1.1     The Bookstore  
Steps in Problem Solving

Develop communication skills and problem-solving skills; organize information.

Recommended: Activity 1.2     The Classroom  
Problem-Solving Strategies

Develop communication skills and problem-solving skills; organize information.

**Core:** Activity 1.3     Properties of Arithmetic  
Properties and Vocabulary for Arithmetic Calculations

Use the order of operations convention to evaluate arithmetic expressions containing positive integers; use the Distributive and Commutative Properties; exponential notation; use Scientific Notation for large numbers.

Recommended: Appendix A     Fractions  
Templates and skill practice.

Recommended: Appendix B     Decimals  
Templates and skill practice.

## 8 OVERVIEW

**Core:** Activity 1.4 Top Chef  
Operations with Fractions and Mixed Numbers  
Add and subtract fractions; multiply and divide fractions.

**Core:** Project 1.5 Course Grades and Your GPA  
Problem Solving Using Fractions and Decimals  
Solve problems with fractions and decimals.

### Numerical Literacy through Proportional Reasoning

**Core:** Activity 1.6 Everything is Relative  
Ratios as Fractions, Decimals, and Percents  
Relative versus actual measures; express ratios as fractions, percents, and decimals; ratios as comparison.

**Core:** Activity 1.7 The Opioid Epidemic  
Proportional Reasoning  
Proportional reasoning using ratios.

**Core:** Activity 1.8 Who Really Did Better?  
Actual and Relative Change, Percent Increase and Decrease  
Investigate relative (percent) versus actual change – percent increase or percent decrease.

**Core:** Activity 1.9 Going Shopping?  
Growth and Decay Factors  
Define and explore growth and decay factors.

**Core:** Activity 1.10 Take an Additional 20% Off  
Consecutive Growth and Decay Factors  
Apply growth or decay factors consecutively.

**Core:** Activity 1.11 Fuel Economy  
Rates and Unit Analysis  
Solve problems involving unit-of-measure conversions by Unit (Dimensional) Analysis.

### Arithmetic Operations using Signed Numbers

Recommended: Activity 1.12 Celsius Thermometers  
Addition and Subtraction of Integers  
Add, subtract, and compare signed numbers; compute absolute values.

Recommended: Activity 1.13 Shedding the Extra Pounds  
Multiplication and Division of Integers  
Multiply and divide signed numbers.

**Core:** Activity 1.14 Order of Operations Revisited  
Negative Exponents and Scientific Notation  
Evaluate arithmetic expressions containing positive and negative numbers using the order of operations convention; evaluate expressions with negative exponents; Scientific Notation for very small numbers.

### Introduction to Variable Quantities; Numerical, Graphical and Symbolic Representations of Relationships Between Input and Output Variables

**Core:** Activity 2.1 Symbolizing Arithmetic Formulas and Algebraic Expressions  
Generalize from an arithmetic calculation to a symbolic representation by utilizing variables.

**Core:** Activity 2.2 Blood Alcohol Levels  
Represent a Two-Variable Relationship Algebraically, Numerically, and Graphically  
Identify input and output in situations involving two variables; interpret relationships numerically and graphically.

**Recommended:** Activity 2.3 College Expenses  
Symbolic Rules  
Identify input and output variables from a graph; write verbal rules and translate into symbolic rules.

### Symbolic Representation of Variable Quantities

**Core:** Activity 2.4 Are they the Same?  
Equivalent Expressions and Grouping Symbols  
Identify equivalent algebraic expressions by examining their outputs and comparing the graphs.

### Constructing, Evaluating and Solving Single-Operation Algebraic Models

**Core:** Activity 2.5 Let's Go Shopping  
Solve an Equation Containing One Operation  
Construct, evaluate and solve equations of the form  $ax = b$  and  $x + a = b$ .

### Constructing, Evaluating, and Solving Two-Operation (Linear) Algebraic Models

**Core:** Activity 2.6 Leasing a Copier  
Solve an Equation Containing Two or More Operations  
Construct, evaluate and solve equations of the form  $ax + b = c$ ,  $a \neq 0$ .

**Core:** Activity 2.7 The Algebra of Weather  
Solve a Formula for a Specified Variable  
Solve a formula (literal equation) for a specified variable.

**Core:** Activity 2.8 Four Out of Five Dentists Prefer Crest  
Proportions  
Construct and solve proportion equations using equivalent fractions and cross multiplication.

### Equivalent Algebraic Expressions: Numerically, Graphically and Algebraically

**Core:** Activity 2.9 Do It Two Ways  
Distributive Property, Greatest Common Factor, and Combining Like Terms  
Use the distributive property to transform one algebraic expression into an equivalent one. Expand and factor expressions; combine like terms.

## 10 OVERVIEW

Recommended: Activity 2.10    Decoding  
   Simplifying Algebraic Expressions  
Recognize an algebraic expression as a code of instruction; simplify algebraic expressions.

### Solving More Complex (Linear) Equations

**Core:** Activity 2.11    Comparing Energy Costs  
   Mathematical Models, General Strategy for Solving Linear Equations  
Model and solve equations of the form  $ax + b = cx + d$ .

Recommended: Project Activity 2.12    Summer Job Opportunities  
   Problem Solving Using Linear Equations  
Use critical thinking skills to make decisions based on solutions of systems of two linear equations.

### Function Definition and Notation

**Core:** Activity 3.1    Summer Olympics  
   Functions, Numerical and Graphical Representation of Functions  
Introduction to functions; function notation; graphical and numerical representations; expansion of rectangular coordinate system to include all 4 quadrants in the plane

**Core:** Project 3.3    Comparing Symbolically Defined Functions and their Graphs  
Define functions by symbolic rules.

**Core:** Activity 3.4    Course Grade  
   Representing Functions Symbolically  
Determine symbolic rule that defines a function as well as practical domain and range of a function.

### Rates of Change

**Core:** Activity 3.2    How Fast Did You Lose?  
   Average Rate of Change  
Average rate of change—definition, contextual interpretations

### Linear Functions: Numerical, Graphical, and Algebraic Features

**Core:** Activity 3.5    The Snowy Tree Cricket  
   Slope and Intercepts of a Line  
Define linear functions by their constant rate of change and graph consisting of a single line; identify slope as the constant rate of change.

**Core:** Activity 3.6    Software Sales  
   Slope-Intercept Equation of a Line  
Write equation of line in slope intercept form; graph linear function using y-intercept and slope; use intercepts to graph linear equation.

Recommended: Activity 3.7    Predicting Population  
   Problem Solving Using Slope-Intercept Equation of a Line  
The slope-intercept form of a linear function; relative error in measurement using a linear model

**Core:** Activity 3.8 College Tuition  
Point-Slope Equation of a Line

Determine equation for linear function when given two points. Identify lines having negative, zero or undefined slopes; equations of horizontal and vertical lines.

### Scatterplots and Regression Lines

Recommended: Activity 3.9 Education Pays  
Line of Best Fit and Regression Equations

Construct scatterplots from sets of data; use a scatterplot to estimate a line of best fit; generate linear regression models using technology.

Recommended: Lab Activity 3.10 Body Parts  
Problem Solving Using Regression Equations

Collect sets of data by measurement; use a scatterplot to estimate a line of best fit; generate linear regression models using technology.

### Systems of Linear Equations

**Core:** Activity 3.11 Smartphone Plan Options  
Systems of Linear Equations in Two Variables

Solve a system of two linear equations numerically, graphically and symbolically by the substitution method; interpret the solution.

**Recommended:** *Appendix D Addition Method for Solving a System of Two Linear Equations*

**Core:** Activity 3.12 Healthy Lifestyle  
Solving a System of Linear Equations in Two Variables Using the  
Addition Method

Solve a system of two linear equations algebraically by the substitution method and by the addition method.

Recommended: Project Activity 3.13 Modeling a Business  
Problem Solving Using Systems of Linear Equations in  
Two Variables

Solve a system of two linear equations by any method; determine and interpret the break-even point; interpret break-even points in contextual situations.

### Linear Inequalities

Recommended: Activity 3.14 How Long Can You Live?  
Linear Inequalities

Solve linear inequalities in one variable algebraically and graphically.

### Polynomials and Properties of Exponents

**Core:** Activity 4.1 Fatal Crashes  
Polynomials

Identify, classify and simplify polynomials; add and subtract polynomials; evaluate and interpret polynomial models.

**Core:** Activity 4.2 Volume of a Storage Box  
Properties of Exponents

Properties of exponents; identify greatest common factor in an algebraic expression; factor an algebraic expression completely; use the distributive property to expand an algebraic expression in factored form.

**Core:** Activity 4.3 Room for Work  
Operations with Polynomials  
Products of polynomials including difference of squares and perfect-square trinomials

### Problem Solving with Quadratic Equations and Functions

**Core:** Activity 4.4 The Amazing Property of Gravity  
Solving Quadratic Equations  
Evaluate, graph and interpret functions of the form  $y = ax^2$ ; solve equations of the form  $ax^2 = c$  algebraically by taking square roots and graphically; solve an equation of the form  $(x \pm a)^2 = c$  algebraically by taking square roots.

**Core:** Activity 4.5 What Goes Up, Comes Down  
Quadratic Functions and Their Graphs  
Evaluate and graph quadratic functions of the form  $y = ax^2 + bx$ ; identify and interpret the  $x$ -intercepts; factor a binomial to solve an equation of the form  $ax^2 + bx = 0$  using the zero-product property.

**Core:** Activity 4.6 How High Did It Go?  
Solving Quadratic Equations by Factoring  
Recognize and write a quadratic equation in standard form  $ax^2 + bx + c = 0$ ; solve a factorable quadratic equation of form  $x^2 + bx + c = 0$  using the zero-product property; identify a quadratic function from its algebraic form.

**Core:** Activity 4.7 More Ups and Downs  
Solving Quadratic Equations Using the Quadratic Formula  
Solve quadratic equations using the quadratic formula; identify the solutions of a quadratic equation with points on the corresponding graph.

**Recommended:** *Appendix D Factoring Trinomials with Leading Coefficient  $a \neq 1$*   
*Solve quadratic equations of the form  $ax^2 + bx + c = 0$  by factoring.*

### A Brief Glimpse at Other Function Families

**Core:** Activity 4.8 Inflation  
Exponential Functions  
Recognize an exponential function as a rule for repeatedly applying the same growth or decay factor; graph exponential functions from numerical data and symbolic rules; recognize and graph exponential functions from symbolic rules.

**Core:** Activity 4.9 A Thunderstorm  
Direct Variation  
Explore direct variation functions  $y = k \cdot x$  and  $y = k \cdot x^n$ , for  $n$  a positive integer.

**Core:** Activity 4.10 Diving Under Pressure, or Don't Hold Your Breath  
Inverse Variation

Explore inverse variation functions of the form  $y = \frac{k}{x}$ .

**Core:** Activity 4.11 Hang Time  
Square Root Functions

Explore the square root function  $y = a\sqrt{x}$ .

## SAMPLE COURSE OUTLINES

The course outlines contained in this section represent several syllabi for which the textbook is appropriate. In all cases, the outlines should be viewed as suggestions and should be used in conjunction with individual activity notes found in Section 2 of this manual. We encourage you to adapt them as best suits your curriculum and students. The **core activities** in each Cluster appear in bold font.

### COURSE OUTLINE FOR ELEMENTARY ALGEBRA CLASS: CHAPTERS 1, 2, 3 (MEETING 4 HOURS PER WEEK FOR 15 WEEKS)

#### Chapter 1 Number Sense

Cluster 1 Introduction to Problem Solving (4 hours)

Activity 1.1 The Bookstore  
Steps in Problem Solving

Activity 1.2 The Classroom  
Problem-Solving Strategies

Activity 1.3 Properties of Arithmetic  
Properties and Vocabulary for Arithmetic Calculations

What Have I Learned?

How Can I Practice?

Cluster 2 Problem Solving with Fractions and Decimals (Rational Numbers) (2 hours)

Activity 1.4 Top Chef  
Operations with Fractions and Mixed Numbers

Project 1.5 Course Grades and Your GPA  
Problem Solving Using Fractions and Decimals

What Have I Learned?

How Can I Practice?

Cluster 3 Comparisons and Proportional Reasoning (7 hours)

Activity 1.6 Everything is Relative  
Ratios as Fractions, Decimals, and Percents

Activity 1.7 The Opioid Epidemic  
Proportional Reasoning

Activity 1.8 Who Really Did Better?  
Actual and Relative Change, Percent Increase and Decrease

## 14 OVERVIEW

- Activity 1.9 Going Shopping?  
Growth and Decay Factors
- Activity 1.10 Take an Additional 20% Off  
Consecutive Growth and Decay Factors
- Activity 1.11 Fuel Economy  
Rates and Unit Analysis

What Have I Learned?

How Can I Practice?

Skills Check 1 Appendix C

Cluster 4 Problem Solving With Signed Numbers (3 hours)

- Activity 1.12 Celsius Thermometers  
Addition and Subtraction of Integers
- Activity 1.13 Shedding the Extra Pounds  
Multiplication and Division of Integers
- Activity 1.14 Order of Operations Revisited  
Negative Exponents and Scientific Notation

What Have I Learned?

How Can I Practice?

Skills Check 2 Appendix C

Chapter 1 Summary

Chapter 1 Gateway Review (1 hour)

## Chapter 2 Variable Sense

Cluster 1: Symbolic Rules and Expressions (6 hours)

- Activity 2.1 Symbolizing Arithmetic  
Formulas and Algebraic Expressions
- Activity 2.2 Blood Alcohol Levels  
Represent a Two-Variable Relationship Algebraically, Numerically, and Graphically
- Activity 2.3 College Expenses  
Symbolic Rules
- Activity 2.4 Are They the Same?  
Equivalent Expressions and Grouping Symbols

What Have I Learned?

How Can I Practice?

Cluster 2: Solving Equations (6 hours)

- Activity 2.5 Let's Go Shopping  
Solve an Equation Containing One Operation

Activity 2.6 Leasing a Copier  
Solve an Equation Containing Two or More Operations

Activity 2.7 Algebra of Weather  
Solve a Formula for a Specified Variable

Activity 2.8 Four Out of Five Dentists Prefer Crest  
Proportions

What Have I Learned?

How Can I Practice?

Cluster 3: More Problem Solving Using Algebra (5 hours)

Activity 2.9 Do It Two Ways  
Distributive Property, Greatest Common Factor, and Combining Like Terms

Activity 2.10 Decoding  
Simplifying Algebraic Expressions

Activity 2.11 Comparing Energy Costs  
Mathematical Models, General Strategy for Solving Linear Equations

Project 2.12 Summer Job Opportunities  
Problem Solving Using Linear Equations

What Have I Learned?

How Can I Practice?

Chapter 2 Summary

Chapter 2 Gateway Review (1 hour)

### Chapter 3 Function Sense and Linear Functions

Cluster 1 Function Sense (4 hours)

Activity 3.1 Summer Olympics  
Functions, Numerical and Graphical Representation of Functions

Activity 3.2 How Fast Did You Lose?  
Average Rate of Change

Project 3.3 Symbolically Defined Functions and their Graphs

Activity 3.4 Course Grade  
Representing Functions Symbolically

What Have I Learned?

How Can I Practice?

Cluster 2 Introduction to Linear Functions (7 hours)

Activity 3.5 The Snowy Tree Cricket  
Slope and Intercepts of a Line

Activity 3.6 Software Sales  
Slope-Intercept Equation of a Line

## 16 OVERVIEW

Activity 3.7 Predicting Populations  
Problem Solving Using Slope-Intercept Equation of a Line

Activity 3.8 College Tuition  
Point-Slope Equation of a Line

What Have I Learned?

How Can I Practice?

Cluster 3 Linear Regression, Systems and Inequalities (2 hours)

Activity 3.9 Education Pays  
Line of Best Fit and Regression Equations

Lab 3.10 Body Parts  
Problem Solving Using Regression Equations

What Have I Learned?

How Can I Practice?

**Four Hourly Exams (4 hours)**

**Weekly Quizzes (4 hours)**

**Worksheets/Review (4 hours)**

**Total Course Hours 60 hours**

### **COURSE OUTLINE FOR IMMEDIATE ALGEBRA CLASS: CHAPTERS 2, 3, 4 (MEETING 4 HOURS PER WEEK FOR 15 WEEKS)**

#### **Chapter 2 Variable Sense**

Cluster 1: Symbolic Rules and Expressions (4 hours)

Activity 2.1 Symbolizing Arithmetic  
Formulas and Algebraic Expressions

Activity 2.2 Blood Alcohol Levels  
Represent a Two-Variable Relationship Algebraically, Numerically, and Graphically

Activity 2.3 College Expenses  
Symbolic Rules

Activity 2.4 Are They the Same?  
Equivalent Expressions and Grouping Symbols

What Have I Learned?

How Can I Practice?

Cluster 2: Solving Equations (5 hours)

Activity 2.5 Let's Go Shopping  
Solve an Equation Containing One Operation

Activity 2.6 Leasing a Copier  
Solve an Equation Containing Two or More Operations

Activity 2.7 Algebra of Weather  
Solve a Formula for a Specified Variable

Activity 2.8 Four Out of Five Dentists Prefer Crest  
Proportions

What Have I Learned?

How Can I Practice?

Cluster 3: More Problem Solving Using Algebra (4 hours)

Activity 2.9 Do It Two Ways  
Distributive Property, Greatest Common Factor, and Combining Like Terms

Activity 2.10 Decoding  
Simplifying Algebraic Expressions

Activity 2.11 Comparing Energy Costs  
Mathematical Models, General Strategy for Solving Linear Equations

Project 2.12 Summer Job Opportunities  
Problem Solving Using Linear Equations

What Have I Learned?

How Can I Practice?

Chapter 2 Summary

Chapter 2 Gateway Review (1 hour)

### Chapter 3 Function Sense and Linear Functions

Cluster 1 Function Sense (4 hours)

Activity 3.1 Summer Olympics  
Functions, Numerical and Graphical Representation of Functions

Activity 3.2 How Fast Did You Lose?  
Average Rate of Change

Project 3.3 Symbolically Defined Functions and their Graphs

Activity 3.4 Course Grade  
Representing Functions Symbolically

What Have I Learned?

How Can I Practice?

Cluster 2 Introduction to Linear Functions (5 hours)

Activity 3.5 The Snowy Tree Cricket  
Slope and Intercepts of a Line

Activity 3.6 Software Sales  
Slope-Intercept Equation of a Line

Activity 3.7 Predicting Populations  
Problem Solving Using Slope-Intercept Equation of a Line