6e

Mathematics in Action

An Introduction to Algebraic, Graphical, and Numerical Problem Solving

THE CONSORTIUM FOR FOUNDATION MATHEMATICS

This page intentionally left blank

Mathematics in Action

An Introduction to Algebraic, Graphical, and Numerical Problem Solving

Sixth Edition

The Consortium for Foundation Mathematics

Ralph Bertelle	*Columbia-Greene Community College*
Judith Bloch	*University of Rochester*
Roy Cameron	*SUNY Cobleskill*
Carolyn Curley	*Erie Community College—South Campus*
Ernie Danforth	*Corning Community College*
Brian Gray	*Howard Community College*
Arlene Kleinstein	*SUNY Farmingdale*
Kathleen Milligan	*Monroe Community College*
Patricia Pacitti	*SUNY Oswego*
Renan Sezer	*Ankara University, Turkey*
Patricia Shuart	*Polk State College—Winter Haven, Florida*
Sylvia Svitak	*Queensborough Community College*

Pearson

VP, Portfolio Management: Chris Hoag
Director, Portfolio Management: Michael Hirsch
Courseware Portfolio Manager: Matt Summers and Karen Montgomery
Courseware Portfolio Management Assistant: Kayla Shearns
Content Producer: Kathleen A. Manley
Managing Producer: Karen Wernholm
Producer: Marielle Guiney
TestGen Content Manager: Rajinder Singh
Manager, Content Development: Eric Gregg
Senior Product Marketing Manager: Alicia Frankel
Marketing Assistant: Brooke Imbornone
Senior Author Support/Technology Specialist: Joe Vetere
Composition: Pearson CSC
Cover and Interior Design: Pearson CSC
Cover Image: Darryl Leniuk/DigitalVision/Getty Images

Cataloging-in-Publication Data on file with the Library of Congress

1 19

Pearson

ISBN 13: 978-0-13-511562-6
ISBN 10: 0-13-511562-0

In Memoriam

In the spring of 2018, two of our fellow authors, Brian Gray and Carolyn Curley lost long battles with cancer. They have been an integral part of the team from the beginning of this project, which began as a National Science Foundation project in the 1990's.

Brian was a steadying influence on the team. His enthusiasm never got too high and never too low. Brian was always able to focus on what needed to be done and accomplish it with quality in a timely fashion. Brian was knowledgeable in many fields. This gave him a broad perspective on life and the lives of our students as well.

Carolyn was our "Joy Girl"! Carolyn loved life, and she loved to have fun. Her motto seemed to be, "If it is not fun, why are we doing it." She always encouraged and inspired the team and was incredibly insightful and creative. She was totally dedicated to the book and to our team. Even during her final months, she was constantly asking, "what can I do?" Carolyn had a great feel for the needs of the students as well as the instructor. She was instrumental in creating our Instructor Resource Manuals.

To paraphrase from a Broadway musical, Brian and Carolyn, because we knew you we have been changed. We have been changed for good! May you both rest in peace.

CONTENTS

APPENDICES

PREFACE

Our Vision

Mathematics in Action: An Introduction to Algebraic, Graphical, and Numerical Problem Solving, Sixth Edition, is intended to help college mathematics students gain mathematical literacy in the real world and simultaneously help them build a solid foundation for future study in mathematics and other disciplines.

Our team of twelve faculty, primarily from the State University of New York and the City University of New York systems, used the AMATYC *Crossroads* Standards to develop this *Mathematics in Action* series to serve a very large population of college students who, for whatever reason, have not yet succeeded in learning mathematics. It became apparent to us that teaching the same content in the same way to students who have not previously comprehended it is not effective, and this realization motivated us to develop a new approach.

Mathematics in Action is based on the principle that students learn mathematics best by doing mathematics within a meaningful context. In keeping with this premise, students solve problems in a series of realistic situations from which the crucial need for mathematics arises. *Mathematics in Action* guides students toward developing a sense of independence and taking responsibility for their own learning. Students are encouraged to construct, reflect on, apply, and describe their own mathematical models, which they use to solve meaningful problems. We see this as the key to bridging the gap between abstraction and application and as the basis for transfer learning. Appropriate technology is integrated throughout the books, allowing students to interpret real-life data verbally, numerically, symbolically, and graphically.

We expect that by using the *Mathematics in Action* series, all students will be able to achieve the following goals:

- Develop mathematical intuition and a relevant base of mathematical knowledge.
- Gain experiences that connect classroom learning with real-world applications.
- Prepare effectively for further college work in mathematics and related disciplines.
- Learn to work in groups as well as independently.
- Increase knowledge of mathematics through explorations with appropriate technology.
- Develop a positive attitude about learning and using mathematics.
- Build techniques of reasoning for effective problem solving.
- Learn to apply and display knowledge through alternative means of assessment, such as mathematical portfolios and journal writing.

Our vision for you is to join the growing number of students using our approaches who discover that mathematics is an essential and learnable survival skill for the 21st century.

Pedagogical Features

The pedagogical core of *Mathematics in Action* is a series of guided-discovery activities in which students work in groups to discover mathematical principles embedded in realistic situations. The key principles of each activity are highlighted and summarized at the activity's conclusion. Each activity is followed by exercises that reinforce the concepts and skills revealed in the activity.

The activities are clustered within each chapter. Each cluster contains regular activities along with project and lab activities that relate to particular topics. The lab activities require more than just paper, pencil, and calculator; they also require measurements and data collection and are ideal for in-class group work. The project activities are designed to allow students to explore specific topics in greater depth, either individually or in groups. These activities are usually self-contained and have no accompanying exercises. For specific suggestions on how to use the three types of activities, we strongly encourage instructors to refer to the *Instructor's Resource Manual with Tests* that accompanies this text. New PowerPoints have been created to support instructors looking to implement this contextual approach to algebra.

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 pull together the key concepts of the cluster. The "How Can I Practice?" exercises are designed primarily to provide additional work with the numeric, algebraic, and graphing 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 ends with a Summary containing a brief description of the concepts and skills discussed in the chapter, plus examples illustrating these concepts and skills. The concepts and skills are also referenced to the activity in which they appear, making the format easier to follow for those students who are unfamiliar with our approach. Each chapter also ends with a Gateway Review, providing students with an opportunity to check their understanding of the chapter's concepts and skills.

What's New in the Sixth 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.

MyLab Math Changes in the Sixth Edition

- Exercise coverage has been enhanced to ensure better conceptual flow, encourage conceptual thinking about math topics, and balance out the coverage of skills related questions.
- A new video program built around the Consortium approach will provide additional multimedia support.
- Learning Catalytics questions are now premade to complement teaching with Mathematics in Action. Learning Catalytics allows students to use their own mobile devices in the classroom for real-time engagement.
- Skill Builder assignments provide just-in-time adaptive practice at the exercise level, delivering questions personalized to each student with the goal of enabling them to better complete their homework assignment.

Acknowledgments

The Consortium would like to acknowledge and thank the following people for their invaluable assistance in reviewing and testing material for this text in the past and current editions:

Mark Alexander, *Kapi'olani Community College*

Kathleen Bavelas, *Manchester Community College*

Shirley J. Beil, *Normandale Community College*

Carol Bellisio, *Monmouth University*

Ann Boehmer, *East Central College*

Barbara Burke, *Hawai'i Pacific University*

San Dong Chung, *Kapi'olani Community College*

Marjorie Deutsch, *Queensboro Community College*

Jennifer Dollar, *Grand Rapids Community College*

Irene Duranczyk, *University of Minnesota*

Kristy Eisenhart, *Western Michigan University*

Mary Esteban, *Kapiolani Community College*

Brian J. Garant, *Morton College*

Thomas Grogan, *Cincinnati State Technical and Community College*

Maryann Justinger, *Erie Community College—South Campus*

Brian Karasek, *South Mountain Community College*

Jim Larson, *Lake Michigan College*

Miriam Long, *Madonna University*

Ellen Musen, *Brookdale Community College*

Roberta Pardo, *Chandler-Gilbert Community College*

Kathy Potter, *St. Ambrose University*

Cindy Pulley, *Heartland Community College*

Robbie Ray, *Sul Ross State University*

Janice Roy, *Montcalm Community College*

Andrew S. Russell, *Queensborough Community Collge*

Amy C. Salvati, *Adirondack Community College*

Philomena Sawyer, *Manchester Community College*

Brenda Shepard, *Lake Michigan College*

Karen Smith, *US Blue Ash*

Kurt Verderber, *SUNY Cobleskill*

Our sincere thanks goes to these dedicated individuals at Pearson who worked to make this revision a success: Michael Hirsch, Matt Summers, Karen Montgomery, Alicia Frankel, Kathy Manley, Marielle Guiney, Eric Gregg, Kayla Shearns and the entire salesforce.

We would also like to thank our accuracy checkers, Rick Ponticelli and Lauri Semarne.

Finally, a special thank you to our families for their unwavering support and sacrifice, which enabled us to make this text a reality.

The Consortium for Foundation Mathematics

Resources for Success

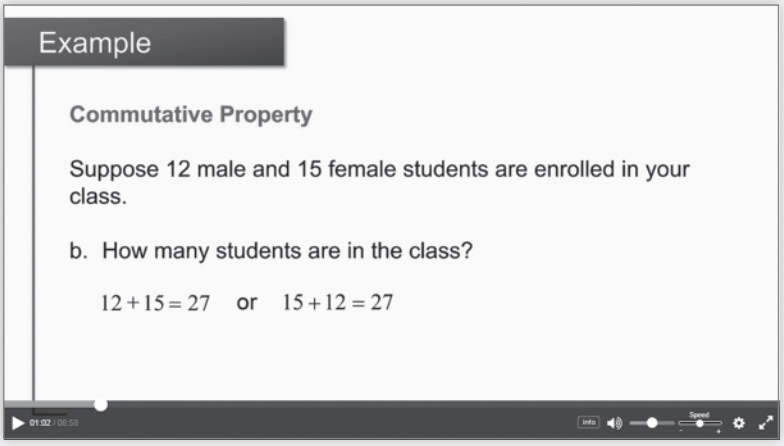
Pearson MyLab

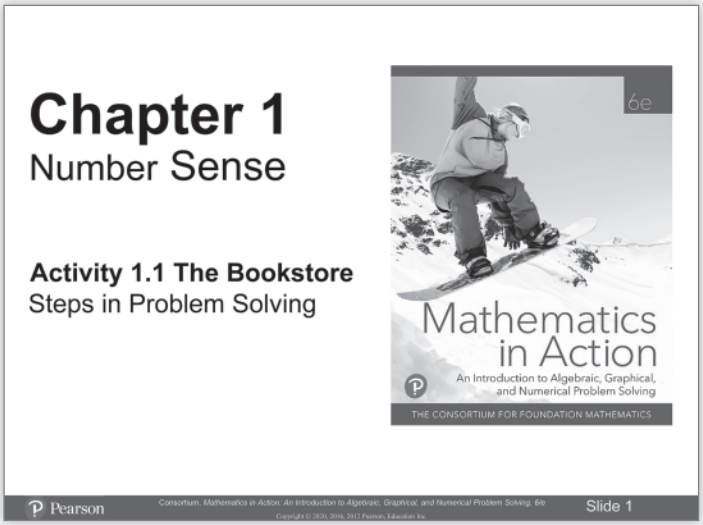
Get the Most Out of MyLab Math for *Mathematics in Action: An Introduction to Algebraic, Graphical, and Numerical Problem Solving*, Sixth Edition by the Consortium for Foundation Mathematics

The active learning at the heart of the Mathematics in Action series is complemented by a full suite of resources in the MyLab course created specifically for the unique Consortium approach. Brand new and expanded MyLab resources ensure more than ever that students have a consistent experience from the text to MyLab. The integration of Consortium's activity-based learning with the #1 choice in digital learning for developmental math ensures that students build a solid conceptual understanding of topics.

A new video program for support where and when students need it

A completely new video series offers students support in and out of the classroom. Videos are available as short, objective-level videos or longer section lecture videos. This program is created specifically for the Consortium series and its unique approach—so students can be assured that terminology and problem solving techniques in the videos are completely consistent with what they experience in the classroom.





A new PowerPoint program

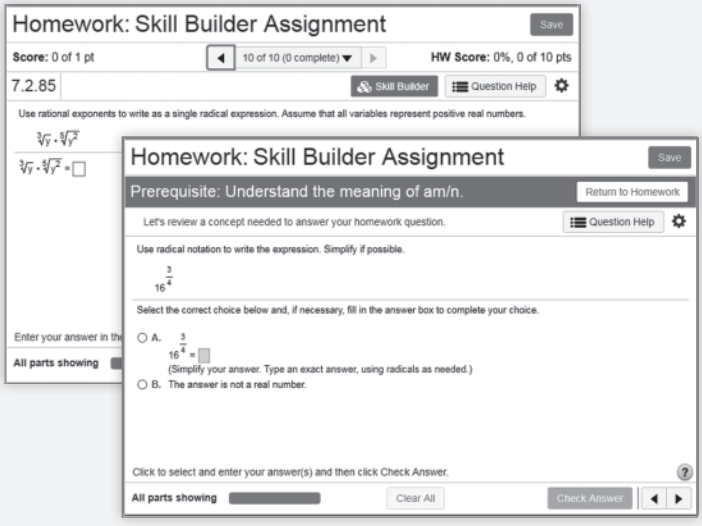
PowerPoints are available for the first time with this title! Presenting an overview of key concepts from each activity, these can be used by students as study or review aids, and can also be used by instructors to help structure class-time. Accessible, screen-reader friendly versions of the PowerPoints are available in the MyLab course.

pearson.com/mylab/math

Pearson MyLab

Support College Success

A new **Mindset module** is available in the course, with mindset-focused videos and exercises that encourage students to maintain a positive attitude about learning, value their own ability to grow, and view mistakes as a learning opportunity.

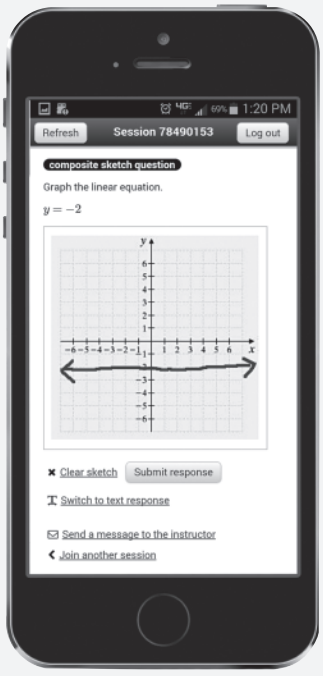


Personalize Learning

New! Skill Builder exercises offer just-in-time additional adaptive practice. The adaptive engine tracks student performance and delivers questions to each individual that adapt to his or her level of understanding. This new feature allows instructors to assign fewer questions for homework, allowing students to complete as many or as few questions as they need.

Get Students Engaged

New! Learning Catalytics questions specific to Consortium's content are pre-built and available through MyLab Math. Learning Catalytics is an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking. Consortium-specific questions have been pre-made, and are noted in the Annotated Instructor's Edition at point-of-use when relevant for a particular section's objective. Search for MathInActionINTRO#, where # is the chapter number, in Learning Catalytics to begin using the Consortium questions with your students!



pearson.com/mylab/math

Pearson MyLab

Resources for Success

Whether you are using Mathematics in Action for the first time or the tenth time, we know that having a full suite of resources to support teaching and learning is essential to implementing this unique approach. All resources are built specifically for each Consortium title, giving students and instructors resources that match and complement the main text and MyLab.

Instructor Resources

Annotated Instructor's Edition

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

The following instructor resources are available to download through Pearson's Instructor Resource Center, or from MyLab Math.

Instructor's Resource Manual with Tests

This resource includes:

- Sample syllabi suggesting ways to structure the course around core and supplemental activities.
- Sample course outlines with 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®

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 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 Lecture Slides

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 Resources

Worksheets for Classroom or Lab Practice

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.

TO THE STUDENT

The book in your hands is most likely very different from any mathematics textbook you have seen before. In this book, you will take an active role in developing the important ideas of arithmetic and beginning algebra. You will be expected to add your own words to the text. This will be part of your daily work, both in and out of class. It is the belief of the authors that students learn mathematics best when they are actively involved in solving problems that are meaningful to them.

The text is primarily a collection of situations drawn from real life. Each situation leads to one or more problems. By answering a series of questions and solving each part of the problem, you will be led to use one or more ideas of introductory college mathematics. Sometimes, these will be basic skills that build on your knowledge of arithmetic. Other times, they will be new concepts that are more general and far reaching. The important point is that you won't be asked to master a skill until you see a real need for that skill as part of solving a realistic application.

Another important aspect of this text and the course you are taking is the benefit gained by collaborating with your classmates. Much of your work in class will result from being a member of a team. Working in small groups, you will help each other work through a problem situation. While you may feel uncomfortable working this way at first, there are several reasons we believe it is appropriate in this course. First, it is part of the learning-by-doing philosophy. You will be talking about mathematics, needing to express your thoughts in words. This is a key to learning. Secondly, you will be developing skills that will be very valuable when you leave the classroom. Currently, many jobs and careers require the ability to collaborate within a team environment. Your instructor will provide you with more specific information about this collaboration.

One more fundamental part of this course is that you will have access to appropriate technology at all times. You will have access to calculators and some form of graphics tool—either a calculator or computer. Technology is a part of our modern world, and learning to use technology goes hand in hand with learning mathematics. Your work in this course will help prepare you for whatever you pursue in your working life.

This course will help you develop both the mathematical and general skills necessary in today's workplace, such as organization, problem solving, communication, and collaborative skills. By keeping up with your work and following the suggested organization of the text, you will gain a valuable resource that will serve you well in the future. With hard work and dedication you will be ready for the next step.

The Consortium for Foundation Mathematics

CHAPTER 1

Number Sense

Your goal in this chapter is to use the numerical mathematical skills you already have—and those you will learn or relearn—to solve problems. Chapter activities are based on practical, real-world situations that you may encounter in your daily life and work. Before you begin the activities in Chapter 1, think about your previous encounters with mathematics and choose one word to describe those experiences.

CLUSTER 1 Introduction to Problem Solving

ACTIVITY 1.1

The Bookstore

Steps in Problem Solving

OBJECTIVES

1. Develop problem-solving skills.
2. Organize information.
3. Practice communication skills.
4. Write a solution in sentences.

By 11 A.M., a line has formed outside the crowded college bookstore. You ask the guard at the gate how long you can expect to wait. She provides you with the following information: She is permitted to let 6 people into the bookstore only after 6 people have left; students are leaving at the rate of 2 students per minute; and she has just let 6 new students in. Also, each student spends an average of 15 minutes gathering books and supplies and 10 minutes waiting in line to check out.

Currently, 38 people are ahead of you in line. You know that it is a 10-minute walk to your noon class. Can you buy your books and still expect to make it to your noon class on time? Use the following questions to guide you in solving this problem.

1. What was your initial reaction after reading the problem?

2. Have you ever worked a problem such as this before?

3. Organizing the information will help you solve the problem.

a. How many students must leave the bookstore before the guard allows more to enter?

b. How many students per minute leave the bookstore?

c. How many minutes are there between groups of students entering the bookstore?

d. How long will you stand in line outside the bookstore?

e. Now finish solving the problem and answer the question: How early or late for class will you be?

4. In complete sentences, write what you did to solve this problem. Then explain your solution to a classmate.

SUMMARY Activity 1.1

Steps in Problem Solving

1. Sort out the relevant information and organize it.

2. Discuss the problem with others to increase your understanding of the problem.

3. Write your solution in complete sentences to review your steps, and check your answer.

EXERCISES Activity 1.1

1. Think about the various approaches you and your classmates used to solve Activity 1.1, The Bookstore. Choose the approach that is best for you, and describe it in complete sentences.

2. What mathematical operations and skills did you use?

ACTIVITY
1.2

The Classroom

Problem-Solving Strategies

OBJECTIVES

1. Develop problem-solving strategies.
   - Organize information.
   - Draw a picture.
   - Recognize a pattern.
   - Do a simpler problem.
2. Communicate problem-solving ideas.

The Handshake

This algebra course involves working with other students in the class, so form a group of 3, 4, or 5 students. Introduce yourself to every other student in your group with a firm handshake. Share some information about yourself with the other members of your group.

1. How many people are in your group?

2. How many handshakes in all were there in your group?

3. Discuss how your group determined the number of handshakes. Be sure everyone understands and agrees with the method and the answer. Write the explanation of the method here.

4. Share your findings with the other groups, and fill in the table.

NUMBER OF STUDENTS IN GROUP	NUMBER OF HANDSHAKES
2	
3	
4	
5	
6	
7	

5. a. Describe a rule for determining the number of handshakes in a group of 7 students.

b. Describe a rule for determining the number of handshakes in a class of n students.

6. If each student shakes hands with each other student, how many handshakes will be needed in your algebra class?

7. Is shaking hands during class time a practical way for students to introduce themselves? Explain.

George Polya's book *How to Solve It* outlines a four-step process for solving problems.

i. Understand the problem (determine what is involved).

ii. Devise a plan (look for connections to obtain the idea of a solution).

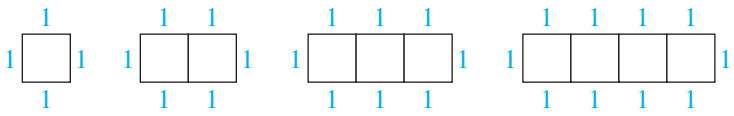
iii. Carry out the plan.

iv. Look back at the completed solution (review and discuss it).

8. Describe how your experiences with the handshake problem correspond to Polya's suggestions.

The Classroom

Suppose the tables in your classroom have square tops. Four students can comfortably sit at each table with ample working space. Putting tables together in clusters as shown will allow students to work in larger groups.



9. Construct a table of values for the number of tables and the corresponding total number of students.

NUMBER OF SQUARE TABLES IN EACH CLUSTER	TOTAL NUMBER OF STUDENTS
1	4
2	6

10. How many students can sit around a cluster of 7 square tables?

11. Describe the pattern that connects the number of square tables in a cluster and the total number of students that can be seated. Write a rule (as a complete sentence) that will determine the total number of students who can sit in a cluster of a given number of square tables.

12. There are 24 students in a math course at your college.

a. How many tables must be placed together to seat a group of 6 students?

b. How many clusters of tables are needed to seat the whole class?

13. Discuss the best way to arrange the square tables into clusters given the number of students in your class.

SUMMARY Activity 1.2

1. Problem-solving strategies include:

- discussing the problem
- organizing information
- drawing a picture
- recognizing patterns
- doing a simpler problem

2. George Polya's book *How to Solve It* outlines **a four-step process for solving problems**.

i. Understand the problem (determine what is involved).

ii. Devise a plan (look for connections to obtain the idea of a solution).

iii. Carry out the plan.

iv. Look back at the completed solution (review and discuss it).

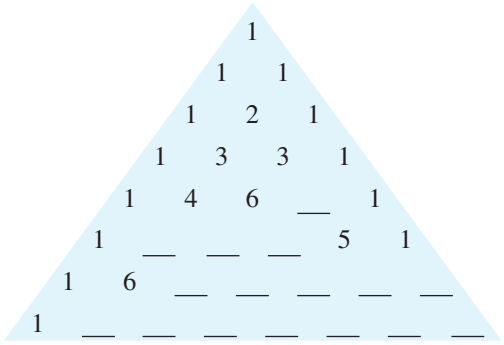
EXERCISES Activity 1.2

1. At the opening session of the U.S. Supreme Court, each justice shakes hands with all the others.

a. How many justices are there?

b. How many handshakes occur?

2. Identify how the numbers are generated in this triangular arrangement, known as Pascal's triangle. Fill in the missing numbers. This triangular table first appeared in 1653 in the "Treatise on the Arithmetical Triangle," written by Blaise Pascal, a French mathematician and physicist. The two major areas in which Pascal's triangle is used today are algebra and probability.



3. An **arithmetic sequence** is a list of numbers in which consecutive numbers share a common difference. Each number after the first is calculated by adding the common difference to the preceding number. For example, the arithmetic sequence 1, 4, 7, 10, . . . has 3 as its common difference. Identify the common difference in each arithmetic sequence that follows.

a. 2, 4, 6, 8, 10, . . .

b. 1, 3, 5, 7, 9, 11, . . .

c. 26, 31, 36, 41, 46, . . .

4. A **geometric sequence** is a list of numbers in which consecutive numbers share a common ratio. Each number after the first is calculated by multiplying the preceding number by the common ratio. For example, 1, 3, 9, 27, . . . has 3 as its common ratio. Identify the common ratio in each geometric sequence that follows.

a. 2, 4, 8, 16, 32, . . .

b. 1, 5, 25, 125, 625, . . .

5. The operations needed to get from one number to the next in a sequence can be more complex. Describe a relationship shared by consecutive numbers in the following sequences.

a. 2, 4, 16, 256, . . .

b. 2, 5, 11, 23, 47, . . .

c. 1, 2, 5, 14, 41, 122, . . .

6. In biology lab, you conduct the following experiment. You put two baby rabbits in a large caged area. In the first month, the pair produces no offspring (rabbits need a month to reach adulthood). At the end of the second month the pair produces exactly

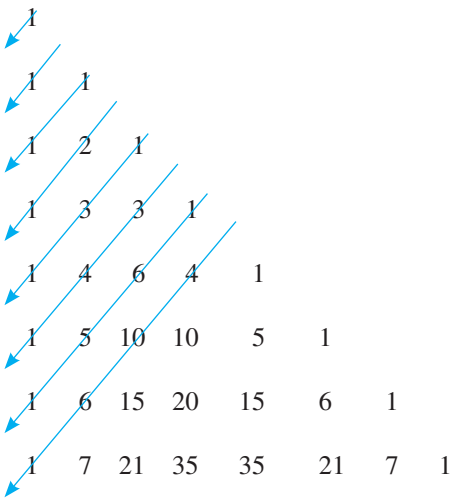
one new pair of rabbits (one male and one female). The result makes you wonder how many male/female pairs you might have if you continue the experiment and each existing pair of rabbits produces a new pair each month, starting after their first month. The numbers for the first 4 months are calculated and recorded for you in the following table. The arrows in the table illustrate that the number of pairs produced in a given month equals the number of pairs that existed at the beginning of the preceding month. Continue the pattern, and fill in the rest of the table.

MONTH	NUMBER OF PAIRS AT THE BEGINNING OF THE MONTH	NUMBER OF NEW PAIRS PRODUCED	TOTAL NUMBER OF PAIRS AT THE END OF THE MONTH
1	1	0	1
2	1	1	2
3	2	1	3
4	3	2	5
5			
6			
7			
8			

The list of numbers in the second column is called the **Fibonacci sequence**. This problem on the reproduction of rabbits first appeared in 1202 in the mathematics text *Liber Abaci*, written by Leonardo of Pisa (known as Fibonacci, or "son of Bonacci"). Use the first two numbers, 1 and 1, to describe how the next number is generated. Your rule should generate the rest of the numbers shown in the sequence in column 2.

7. If you shift all the numbers in Pascal's triangle so that all the 1s are in the same column, you get the following triangle.

a. Add the numbers crossed by each arrow. Put the sums at the tip of each arrow.



b. What is the name of the sequence formed by these sums?

8. There are some interesting patterns within the Fibonacci sequence itself. Take any number in the sequence, and multiply it by itself; then subtract the product of the number immediately before it and the number immediately after it. What is the result? Pick another number, and follow the same procedure. What result do you obtain? Try two more numbers in the sequence.

For example, choose 5.

$5 \cdot 5 = 25$

$3 \cdot 8 = 24$

$25 - 24 = 1$

For example, choose 3.

$3 \cdot 3 = 9$

$2 \cdot 5 = 10$

$9 - 10 = -1$

Internet Exploration

9. a. Explore the Internet and obtain data and information regarding the role of team work in the workplace. What are the characteristics of an effective work team?

b. Do you believe that your instructor's use of group work will help prepare you for working in groups in a workplace? Explain.

c. What issues might you experience in class group work that could also possibly arise in the workplace? How can these issues be resolved?

ACTIVITY
1.3

Properties of Arithmetic

Properties and Vocabulary for Arithmetic Calculations

OBJECTIVES

1. Identify and use the commutative property in calculations.
2. Use the associative property to evaluate arithmetic expressions.
3. Use the order of operations convention to evaluate arithmetic expressions.
4. Identify and use the properties of exponents in calculations.
5. Convert numbers to and from scientific notation.

Counting, addition, and then subtraction are the first tools you learned to describe quantitative situations—from childhood games to tomorrow's weather forecast. By including multiplication and division as well, a person possesses the basic quantitative skills so fundamental to everyday life. In this activity, you will review the properties and vocabulary for arithmetic calculations and discover a compact way of writing very large numbers.

Terminology

The four operations of arithmetic—addition, subtraction, multiplication, and division—are called **binary** operations because they are all ways for combining two numbers at a time.

- When two numbers are *added*, the numbers are called **terms** and the result is called the **sum**.
- When two numbers are *subtracted*, the numbers are also called **terms** and the result is called the **difference**.
- When two numbers are *multiplied*, the numbers are called **factors** and the result is called the **product**.
- When two numbers are *divided*, the number being divided is called the **dividend**, the number it is divided by is called the **divisor**, and the result is called the **quotient**.

Commutative Property

1. Suppose 12 male and 15 female students are enrolled in your class.

   a. What arithmetic operation must you use to determine the total number of students in the class?

   b. How many students are in the class?

   c. Does it matter in which order you perform this operation?

The fact that the sum of 12 and 15 is the same regardless of the order in which they are added illustrates the commutative property of addition.

When the order in which two numbers are added is reversed, the sum remains the same. This property is called the **commutative property of addition** and can be written symbolically as

$$a + b = b + a.$$

2. Is the commutative property true for the operation of subtraction? Multiplication? Division? Explain by giving examples for each operation.

SUBTRACTION	MULTIPLICATION	DIVISION