Features of the Seventh Edition

NEW TO THE SEVENTH EDITION

Mathematics for Elementary Teachers: A Conceptual Approach has always contained features that effectively decrease future teachers' math anxiety and help them to see connections between their college mathematics courses and the mathematics they envision teaching to elementary-school students. Some new features to further these goals have also been added for the seventh edition.

- **New color photos** highlight key information and pedagogy and provide an appealing learning experience.

From ancient times tessellations have been used as patterns for rugs, fabrics, pottery, and architecture. The Moors, who settled in Spain in the eighth century, were masters of tessellating walls and floors with colored geometric tiles. Some of their work is shown in Figure 9.35, a photograph of a room and bath in the Alhambra, a fortress palace built in the middle of the fourteenth century for Moorish kings.

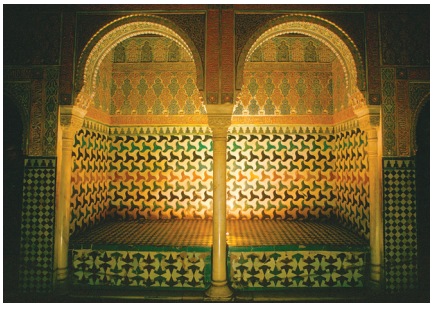
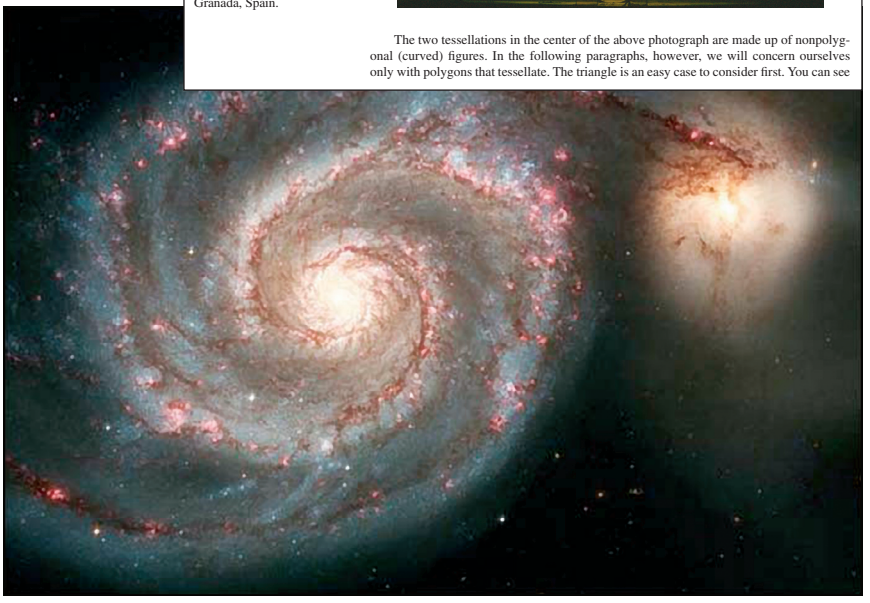


Figure 9.35
The Sala de las Camas (Room of the Beds), a beautifully tiled room in the Alhambra, the palace of fourteenth-century Moorish kings, in Granada, Spain.

The two tessellations in the center of the above photograph are made up of nonpolygonal (curved) figures. In the following paragraphs, however, we will concern ourselves only with polygons that tessellate. The triangle is an easy case to consider first. You can see

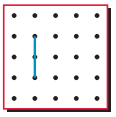


The graceful winding arms of the spiral galaxy M51 was captured.

- **Writing and Discussion exercises** help develop students' critical-thinking, communication, and reasoning skills. Many of these problems encourage future teachers to consider and resolve questions from the elementary-school classroom.

Writing and Discussion

1. A class of middle school students was forming line segments and slopes on geoboards. The slope was intuitively explained by the teacher by referring to the slope of a roof or the slope of a road. One student asked if the line segment on this geoboard had the greatest possible slope. Explain how you would answer this question.



2. Suppose that you have discussed slopes with your class. Then, after graphing temperatures of cooling water (Example H in this section), a student asks: "Does the temperature graph have a slope"? Research this question and form a response you could give to your student.
3. The Standards quote on page 87 discusses the need for students to learn the relationship of slopes of lines to rates of change. Write an example that would make sense to a middle school student to explain what is meant by *rate of change* and why the slope of a line is a constant rate of change.
4. The Standards quote on page 83 notes that from preschool on, students should encounter functions. If you were introducing this topic by playing "What's My Rule" (see page 78) with your students, how would you use this game to explain to them the idea of a function?

Making Connections

1. In the **PreK–2 Standards—Number and Operations** (see inside front cover) under *Understand Numbers . . .*, read the expectation that involves the use of multiple models. Name three models from Section 3.1 and explain how they satisfy this expectation.
2. Compare the **Standards** quote on page 131 with the **Research** statement on page 135. What conclusions can you draw from these two statements? Explain why you think that more than half the fifth and sixth grade students have this deficiency.
3. The **Standards** quote on page 133 notes that "concrete materials can help students learn to group and ungroup by tens." Use one of the models from this section to illustrate and explain how this can be done.
4. The one-page **Math Activity** at the beginning of this section introduces base-five pieces. Explain some of the advantages of using base five to help understand our base-ten numeration system.
5. The **Historical Highlight** on page 126 gives examples of number bases from different cultures. Check the Internet for at least two other examples of ancient numeration systems, other than those in this section, that ossible, offer a guess t have been selected.

- **Making Connections exercises** require students to relate or connect the section concepts to the NCTM Standards and Expectations and to special features such as the Historical Highlights, Research Quotes, Problem Openers, and sample Elementary-School text pages.

Technology Connection

Palindromic Sums

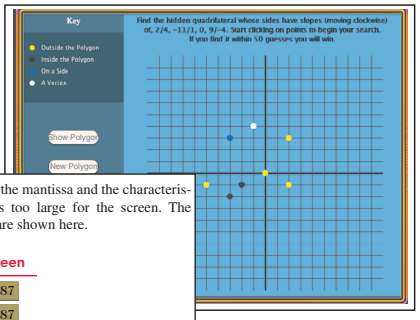
Notice that 48 + 84 = 132 and 132 + 231 = 363, and 363 is a palindromic number. Will all two-digit numbers eventually go to palindromic numbers using this process of reversing digits and adding? The online 1.3 Mathematics Investigation will help you explore this and similar questions.

Mathematics Investigation
Chapter 1, Section 3
www.mhhe.com/bennett-nelson

- **Technology Connections** offer explorations utilizing calculators or computers and can be extended into broader problem-solving investigations to give students a deeper understanding of a topic. Some of the Connections involve resources available on the companion website, including the Interactive Applets, the Mathematics Investigations, and the Virtual Manipulatives.

Technology Connection

Try to find a hidden polygon on a coordinate system. Given the number of sides and the slopes of the sides, you will be told if the points you select are inside (black), outside (yellow), on the boundary (blue), or at a vertex of the polygon (white). Where would you select your next point or points for the information shown here?

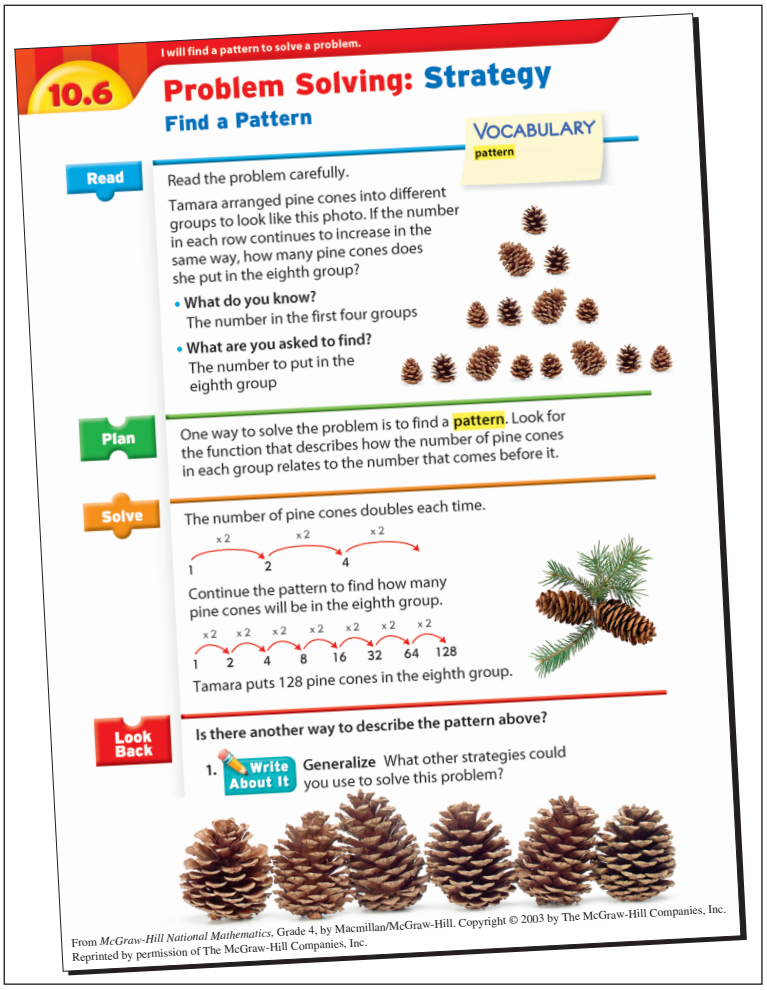


Technology Connection

Calculators that operate with scientific notation will print the mantissa and the characteristic whenever a computation produces a number that is too large for the screen. The keystrokes for entering 4.87×10^{17} and the view screen are shown here.

Keystrokes	View Screen
4.87	4.87
×	4.87
10 ∧ 17	1. 17
=	4.87 17

- **Updated full-color Elementary School Text Pages** taken from current grade-school textbooks show future teachers how key concepts from the section are presented to K–6 students.



I will find a pattern to solve a problem.

10.6 **Problem Solving: Strategy**

Find a Pattern

VOCABULARY
pattern

Read

Read the problem carefully.

Tamara arranged pine cones into different groups to look like this photo. If the number in each row continues to increase in the same way, how many pine cones does she put in the eighth group?

- **What do you know?**
  The number in the first four groups
- **What are you asked to find?**
  The number to put in the eighth group

Plan

One way to solve the problem is to find a **pattern**. Look for the function that describes how the number of pine cones in each group relates to the number that comes before it.

Solve

The number of pine cones doubles each time.

×2 ×2 ×2
1 2 4

Continue the pattern to find how many pine cones will be in the eighth group.

×2 ×2 ×2 ×2 ×2 ×2 ×2
1 2 4 8 16 32 64 128

Tamara puts 128 pine cones in the eighth group.

Look Back

Is there another way to describe the pattern above?

1. **Write About It** **Generalize** What other strategies could you use to solve this problem?

- **Statistical data, graphs, and references** have been revised and updated where appropriate.
- **NCTM's** Content Standards and Process Standards for PreK–2, Grades 3–5, and Grades 6–8 are printed inside the front and back covers for quick reference and integrated via the new Making Connection exercises.

HALLMARK FEATURES

Chapter Level

- A **Spotlight on Teaching** opens each chapter with a selection from the NCTM Standards that relates to the chapter content.

- **Chapter Reviews** and **Chapter Tests** at the end of each chapter help students practice and reinforce their knowledge.

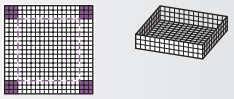
Spotlight on Teaching

Excerpts from NCTM's Standards 2 and 3 for Teaching Mathematics in Grades 5–8*

Reasoning is fundamental to the knowing and doing of mathematics. . . . To give more students access to mathematics as a powerful way of making sense of the world, it is essential that an emphasis on reasoning pervade all mathematical activity. Students need a great deal of time and many experiences to develop their ability to construct valid arguments in problem settings and evaluate the arguments of others.

. . . As students' mathematical language develops, so does their ability to reason about and solve problems. Moreover, problem-solving situations provide a setting for the development and extension of communication skills and reasoning ability. The following problem illustrates how students might share their approaches in solving problems:

The class is divided into small groups. Each group is given square pieces of grid paper and asked to make boxes by cutting out pieces from the corners. Each group is given a 20 × 20 sheet of grid paper. See figure [below]. Students cut and fold the paper to make boxes sized 18 × 18 × 1, 16 × 16 × 2, . . . , 2 × 2 × 9. They are challenged to find a box that holds the maximum volume and to convince someone else that they have found the maximum. . . .



Building a grid-paper box.

CHAPTER REVIEW

1. Decimals
- **a.** The word *decimal* comes from the Latin *decem,* meaning 10.
- **b.** The number of digits to the right of the decimal point is called the **number of decimal places.**
- **c.** The **place values** to the right of the decimal point are decreasing powers of 10.
- **d. Decimal Squares** and **number lines** are visual models for decimals.
- **e.** An **inequality** for decimals less than 1 can be determined by comparing their tenths digits. If these are equal, compare their hundredths digits, etc.

2. Rational numbers
- **a.** Any number that can be written in the form a/b, where $b \neq 0$ and a and b are integers, is called a **rational number.**
- **b.** Every rational number can be represented as either a **terminating** or a **repeating decimal.**
- **c.** Every terminating or repeating decimal can be written as a rational number in the form a/b.

5. Estimation
- **a. Compatible numbers** is the technique of computing estimations by replacing one or more numbers with approximate compatible numbers.
- **b. Rounding** is the technique of replacing one or both numbers in a computation with approximate numbers.
- **c. Front-end estimation** is the technique of using the leading nonzero digit to obtain a rough estimation.
- **b. Compatible numbers** is the technique of using pairs of numbers that are especially convenient for mental calculation. In computing with decimals it is sometimes convenient to use equivalent fractions in place of the decimals.
- **c. Substitution** is the technique of replacing a decimal or a percent by a sum or difference of two decimals or percents.
- **d. Add-up** is the technique of obtaining the difference of two decimals by adding up from the smaller to the larger decimal.

CHAPTER TEST

1. Describe Decimal Squares to explain each of the following:
a. $.4 > .27$ **b.** $.7 = .70$
c. $.225 < .35$ **d.** $.09 < .1$

2. Write each fraction as a decimal.
a. $\frac{3}{4}$ **b.** $\frac{7}{100}$ **c.** $\frac{2}{3}$ **d.** $\frac{7}{8}$ **e.** $\frac{4}{9}$ **f.** $\frac{6}{25}$

3. Write each decimal as a fraction.
a. .278 **b.** $.\overline{35}$ **c.** .03 **d.** $.7\overline{326}$

4. Round each decimal to the given place value.
a. .878 (hundredths) **b.** .449 (tenths)
c. .5096 (thousandths) **d.** $.\overline{6}$ (ten thousandths)

5. Perform each operation and describe Decimal Squares to illustrate each answer.
a. $.7 + .6 =$ **b.** $3 \times .4 =$
c. $.62 - .48 =$ **d.** $.80 \div .05 =$

6. Perform the following operations.
a. $.006 + .38 - .2$ **b.** $.62 \times .08$
c. $.14763 \div .21$ **d.** $47 + .8 \times 340$

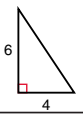
11. Classify each number as rational or irrational.
a. $2\sqrt{60}$ **b.** $2\sqrt[3]{27}$ **c.** $62\sqrt{8}$
d. $2\sqrt{10} + 5$ **e.** $3\sqrt{\frac{1}{4}}$ **f.** $2\sqrt[3]{60}$

12. Approximate each number below to one decimal place.
a. $2\sqrt{34}$ **b.** $2\sqrt[3]{18}$

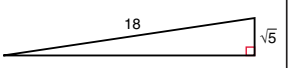
13. Determine whether each set is closed or not closed with respect to the given operation, and give a reason or show a counterexample.
a. The set of rational numbers under addition
b. The set of irrational numbers under multiplication
c. The set of irrational numbers under addition

14. Simplify each square root.
a. $2\sqrt{405}$ **b.** $2\sqrt{24}$

15. Find the missing length for each triangle.
a.

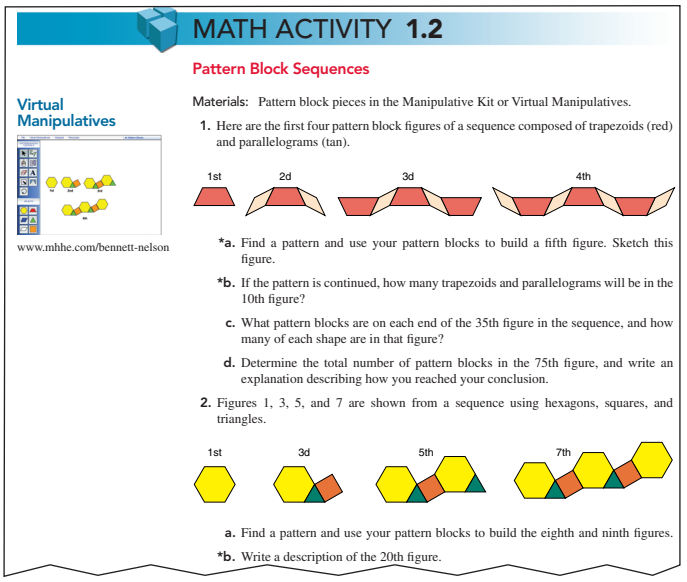


b.



Section Level

- A one-page **Math Activity** precedes every section in the text and provides opportunities for hands-on problem solving and group discussions. Most of the Math Activities involve students in the use of either the physical or Virtual Manipulatives.



MATH ACTIVITY 1.2

Pattern Block Sequences

Virtual Manipulatives

www.mhhe.com/bennett-nelson

Materials: Pattern block pieces in the Manipulative Kit or Virtual Manipulatives.

1. Here are the first four pattern block figures of a sequence composed of trapezoids (red) and parallelograms (tan).

1st 2d 3d 4th

*a. Find a pattern and use your pattern blocks to build a fifth figure. Sketch this figure.

*b. If the pattern is continued, how many trapezoids and parallelograms will be in the 10th figure?

c. What pattern blocks are on each end of the 35th figure in the sequence, and how many of each shape are in that figure?

d. Determine the total number of pattern blocks in the 75th figure, and write an explanation describing how you reached your conclusion.

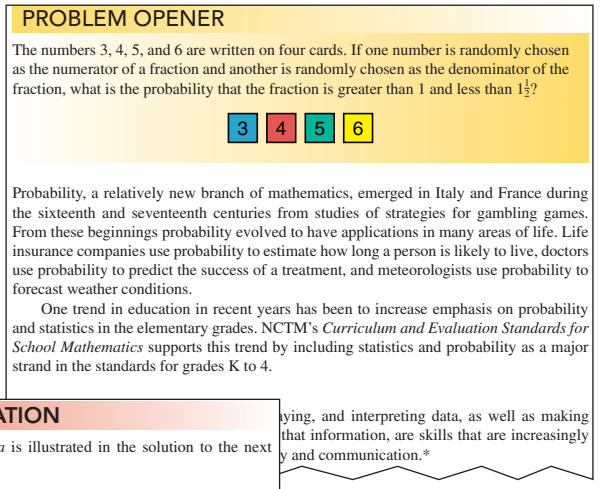
2. Figures 1, 3, 5, and 7 are shown from a sequence using hexagons, squares, and triangles.

1st 3d 5th 7th

a. Find a pattern and use your pattern blocks to build the eighth and ninth figures.

*b. Write a description of the 20th figure.

- **Problem Solving** is strongly and consistently emphasized throughout the text. Each section begins with a *Problem Opener* that poses an interesting problem to be solved and extended. *Problem-Solving Applications* in the sections utilize Polya's four-step approach and one or more problem-solving strategies to analyze a problem related to the concepts of the section. *Reasoning and Problem-Solving exercises* provide further opportunities to practice problem solving.



PROBLEM OPENER

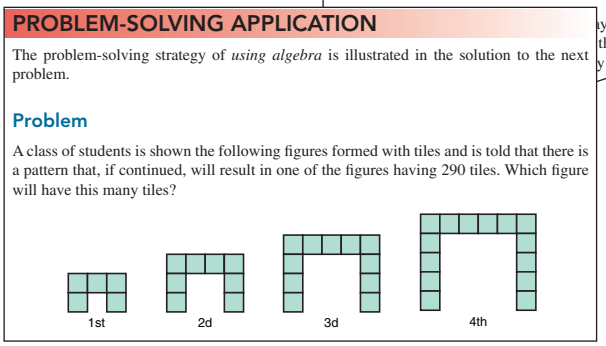
The numbers 3, 4, 5, and 6 are written on four cards. If one number is randomly chosen as the numerator of a fraction and another is randomly chosen as the denominator of the fraction, what is the probability that the fraction is greater than 1 and less than $1\frac{1}{2}$?

3 4 5 6

Probability, a relatively new branch of mathematics, emerged in Italy and France during the sixteenth and seventeenth centuries from studies of strategies for gambling games. From these beginnings probability evolved to have applications in many areas of life. Life insurance companies use probability to estimate how long a person is likely to live, doctors use probability to predict the success of a treatment, and meteorologists use probability to forecast weather conditions.

One trend in education in recent years has been to increase emphasis on probability and statistics in the elementary grades. NCTM's *Curriculum and Evaluation Standards for School Mathematics* supports this trend by including statistics and probability as a major strand in the standards for grades K to 4.

...ying, and interpreting data, as well as making ...that information, are skills that are increasingly ...y and communication.*



PROBLEM-SOLVING APPLICATION

The problem-solving strategy of *using algebra* is illustrated in the solution to the next problem.

Problem

A class of students is shown the following figures formed with tiles and is told that there is a pattern that, if continued, will result in one of the figures having 290 tiles. Which figure will have this many tiles?

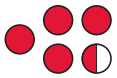
1st 2d 3d 4th

- **Real-world applications** are used extensively to illustrate the connections between mathematical concepts and many different aspects of the physical and natural world. These applications help engage students' interest by highlighting some fascinating examples of how studying mathematics enables us to better understand the world around us.
- **Worked-out examples** appear throughout each section to explain solution steps.

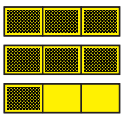
EXAMPLE O

Write a mixed number and an improper fraction to express the shaded amount of each figure. In part 1, each disk represents 1, and in part 2, each bar represents 1.

1.



2.



Solution **1.** $4\frac{1}{2}$ or $\frac{9}{2}$ (Since each whole disk has 2 halves, a total of 9 halves are shaded.)

$$4\frac{1}{2} = 4 + \frac{1}{2} = \frac{8}{2} + \frac{1}{2} = \frac{9}{2}$$

2. $2\frac{1}{3}$ or $\frac{7}{3}$ (Since each whole bar has 3 thirds, a total of 7 thirds are shaded.)

$$2\frac{1}{3} = 2 + \frac{1}{3} = \frac{6}{3} + \frac{1}{3} = \frac{7}{3}$$

Electronic timers for athletic competition measure time to hundredths and thousandths of a second. This photo shows the finish of a 100-meter final in dispute as both the United States' Gail Devers and Jamaica's Merlene Ottey (in lanes 3 and 4, respectively) had times of 10.94 seconds at the 1996 Summer Olympics in Atlanta. Officials determined that Devers won the race by .005 second over Ottey. (Notice the right foot of Devers has crossed the finish line.)

The two oblique hexagonal prisms in Figure 9.52 are crystals that grew with these flat, smooth faces and straight edges. Their lateral faces are parallelograms.

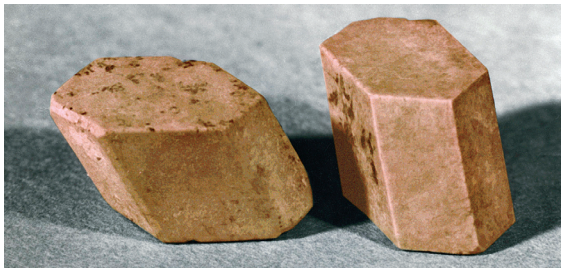


Figure 9.52
Prisms of the crystal orthoclase feldspar

- **Quotes from NCTM Standards** appear frequently in the text and margins to link the content and pedagogy to offer recommendations for teaching.

NCTM Standards

Two concepts underlie every branch of mathematics: One is the *set,* and the other, which will be defined in this section, is the *function. The Curriculum and Evaluation Standards for School Mathematics* comments on the importance of functions:

> One of the central themes of mathematics is the study of patterns and functions. This study requires students to recognize, describe, and generalize patterns and build mathematical models to predict the behavior of real-world phenomena that exhibit the observed pattern. The widespread occurrence of regular and chaotic pattern behavior makes the study of patterns and functions important.*

**Curriculum and Evaluation Standards for School Mathematics* (Reston, VA: National Council of Teachers of Mathematics, 1989), p. 98.

- **Research Statements** can be found in the margins and relate the topic being discussed to the performance of school students.

Research Statement

Students' difficulties in constructing equations stem in part from their inability to grasp the notion of the equivalence between the two expressions in the left and right sides of the equation.

MacGregor 1998

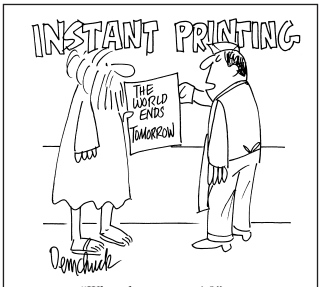
- **Historical Highlights** familiarize students with the origins and evolution of key mathematical ideas and provide background on some of history's outstanding mathematicians.

Emile de Breteuil, 1706–1749

HISTORICAL HIGHLIGHT

France, during the post-Renaissance period, offered little opportunity for the education of women. Emile de Breteuil's precocity showed itself in many ways, but her true love was mathematics. One of her first scientific works was an investigation regarding the nature of fire, which was submitted to the French Academy of Sciences in 1738. It anticipated the results of subsequent research by arguing that both light and heat have the same cause or are both modes of motion. She also discovered that different-color rays do not give out an equal degree of heat. Her book *Institutions de physique* was originally intended as an essay on physics for her son. She produced instead a comprehensive textbook, not unlike a modern text, which traced the growth of physics, summarizing the thinking of the philosopher-scientists of her century. The work established Breteuil's competence among her contemporaries in mathematics and science.*

- **Cartoons** teach or emphasize mathematical concepts in a humorous and fun way.



"When do you want it?"

- **Boxed Features** highlight key definitions, rules, properties and theorems.

Rules of Signs for Division Let a and b be positive integers:

1. Positive divided by negative equals negative.
$$a \div {}^{-}b = {}^{-}(a \div b)$$
$$24 \div {}^{-}6 = {}^{-}(24 \div 6) = {}^{-}4$$
2. Negative divided by positive equals negative.
$${}^{-}a \div b = {}^{-}(a \div b)$$
$${}^{-}14 \div 2 = {}^{-}(14 \div 2) = {}^{-}7$$
3. Negative divided by negative equals positive.
$${}^{-}a \div {}^{-}b = a \div b$$
$${}^{-}30 \div {}^{-}6 = 30 \div 6 = 5$$

Exercise Sets

- **Skill and concept exercises** appear in each section, with answers to odd-numbered problems provided in the back of the text.

Exercises and Problems 9.1

This 1909 Picasso painting, *Brick Factory in Tortosa*, has many examples of geometric figures and angles. Find at least one example of each of the following.

1. **a.** Acute angle
   b. Trapezoid
   c. Obtuse angle
   d. Convex pentagon
2. This photo of a growth structure in sapphire shows angles that each have the same number of degrees.
   a. Are these angles acute or obtuse?

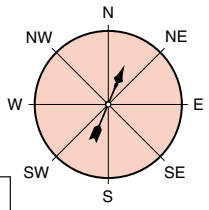
- **Special exercise types,** in addition to those previously described, include calculator exercises (marked); exercises that require the use of mental calculating and estimating techniques (marked); and "Reasoning and Problem Solving" exercises that reinforce Polya's four-step problem-solving approach (marked PS).

In exercises 30 and 31, enter the number in the top view screen into your calculator. What numbers and operations can be entered to change the screen to the one under it without changing the digits that are the same in both screens?

30. a. 1034692.
1834692.

b. 938647.

36. Sharon and Justin belong to an outdoor orienteering club. Sharon uses her compass to walk over the trail given by the following directions from her orienteering assignment sheet: Start at the Wilderness Club House; go north 1 mile; go east 2 miles; go southeast 1 mile; go south 1 mile; go northeast 1.5 miles; and go southwest 2 miles. If Justin's route is symmetric to Sharon's route about the east-west line through the clubhouse, will Justin's route end north or south of the clubhouse?



Estimate each computation in exercises 33 and 34, using *compatible numbers*. Show your compatible-number replacement.

33. a. $\frac{6}{7} \times 34$ **b.** $9\frac{4}{5} + 5\frac{1}{6}$

34. a. $8 \times 4\frac{1}{7}$ **b.** $\frac{3}{4} \times 81$

FEATURES OF THE ONLINE LEARNING CENTER

www.mhhe.com/bennett-nelson
The Online Learning Center for the seventh edition of *Mathematics for Elementary Teachers: A Conceptual Approach* features improved and updated resources in an easy-to-access Flash-based interface. There are three major headings: Information Center, Instructor Center, and Student Center. Instructors can obtain a password from their local McGraw-Hill representative; the Student Center is accessible without a password.

NEW—Flash-based Virtual Manipulatives, interactive versions of the cardstock Manipulative Kit pieces, are available for carrying out the one-page Math Activities in the text. Each manipulative piece has a toolbar, a work area, a note pad, and a menu for easy access to the corresponding activities.

NEW—Daily Planning Guides offer tips on how to divide the content of each section in the text across two lecture periods and provide suggestions for additional projects and assignments for each class.

Interactive Mathematics Applets demonstrate key mathematical concepts in engaging context. The applets include Solving Tower Puzzles, Hunting for Hidden Polygons, Deciphering Ancient Numeration Systems, Analyzing Star Polygons, Taking a Chance, Competing at Place Value, Building Bell-Shaped Distributions, Opening Game-Show Doors, Predicting Cross Sections, Filling 3-D Figures, and Creating Escher-Type Tessellations.

Math Investigations are offered for each section to promote a deeper understanding of topics from the text through the use of computers, calculators, and laboratory activities. Data for fourteen of the investigations can be generated using the *Mathematics Investigator* software available on the site.

Editable Chapter Tests are available for instructors to download for help with student assessment.

Color Transparency Masters for the Manipulative Kit items can be downloaded for producing transparencies in-class use.

Grids and Dot Paper are available in a variety of formats, along with black-and-white masters for geoboards, regular polygons, Decimal Squares, base-10 grids, the coordinate system, and the random-number chart.

Bibliographies and Internet links for further reading are provided for each section of the text.

Logo Instruction on the site includes special commands, worked examples, and exercises. Answers for the odd-numbered Logo exercises are included on the Online Learning Center and answers for the even-numbered exercises are included in the *Instructor's Manual*.

Network Graphs Instruction on the site includes worked examples and exercises. Answers for the odd-numbered Network exercises are included on the Online Learning Center and answers for the even-numbered exercises are in the Instructor's Manual.

ADDITIONAL SUPPLEMENTS FOR INSTRUCTORS

Instructor's Resource Manual *ISBN–13: 978–0–07–321330–9 (ISBN–10: 0–07–321330–6)*

The *Instructor's Resource Manual* contains extensions for all of the Problem Openers in the text, answers for the Problem Openers and extensions, answers for one-page Math Activities, solutions for the even-numbered exercises, and answers for the Math Investigations on the Online Learning Center. There are also two chapter tests on the content of each chapter and answers for each test.

Instructor's Testing and Resource CD-ROM *ISBN–13: 978–0–07–328956–4 (ISBN–10: 0–07–328956–6)*

This cross-platform CD-ROM utilizing Brownstone Diploma© testing software enables instructors to quickly and easily create customized exams. Instructors can search for questions by topic, edit existing questions or add new ones, and scramble questions and answer keys for multiple versions of a single test.

ADDITIONAL SUPPLEMENTS FOR STUDENTS

Mathematics for Elementary Teachers: An Activity Approach, Seventh Edition *ISBN–13: 978–0–07–305370–7 (ISBN–10: 0–07–305370–8)*

The *Activity Approach* contains Activity Sets that correspond to each section of the text and augment the ideas presented in the sections. Each Activity Set consists of a sequence of inductive activities and experiments that enable the student to build an understanding of mathematical ideas through the use of models and the discovery of patterns. In addition to the Manipulative Kit of color cardstock materials. (See description below), over thirty Material Cards are included that complement the color cardstock materials in the Manipulative Kit. A section on *Ideas for the Elementary Classroom* at the end of each chapter includes a suggested Elementary-School activity that has been adapted from one of the chapter's Activity Sets. *Mathematics for Elementary Teachers: A Conceptual Approach* is available packaged with the *Activity Approach* and the Manipulative Kit ISBN–13: 978–0–07–345334–7 (ISBN–10: 0–07–345334–X).

Manipulative Kit *ISBN–13: 978–0–07–321328–6 (ISBN–10: 0–07–321328–4)*

The kit, consisting of common manipulative pieces on colored cardstock, helps students carry out the one-page Math Activities in the text. It is available with the *Activity Approach* at no extra cost *ISBN*–13: 978–0–07–329856–6 (0–07–329856–5).

Student's Solution Manual *ISBN–13: 978–0–07–321329–3 (ISBN–10: 0–07–321329–2)*

The *Student's Solutions Manual* contains detailed solutions to the odd-numbered exercises and Chapter Tests. The introduction offers suggestions for solving problems and for answering the new Writing and Discussion and Making Connections questions in the text. Additional questions and comments have been included at the ends of some of the solutions to give students opportunities to extend their learning.

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