Making Math Connections
Using Real-World Applications with Middle School Students
Second Edition

Contents

Preface

Mathematical things—numbers, statistics, fractals, cyberspace, dimensions, polyhedra, tessellations—have a pervasive way of creeping into our everyday experiences until the objects seem to become household terms. How does this happen? Through comments made by newscasters, statespeople, artists, writers, philosophers, scientists, musicians, architects, people in all areas of life. Why? Because mathematical things help to measure, describe, predict, and quantify so many facets of our lives. Be it things that deal with our bodily functions, our economics, our environment, politics—almost anything you can name will some way have mathematics connected to it. Name ten things you use or do in a day and see how many of these have something mathematical linked to them.

—Theoni Pappas, *The Music of Reason*

The investigations in *Making Math Connections, Second Edition,* have been designed to introduce students in Grades 5 through 8 to the *usefulness* and importance of mathematics in their real lives and how they use math every day. This revised edition is divided into six chapters where connections are made between mathematics and science, social studies, literature, and art. These chapters are: "Our Earth: Natural Disasters," "Physics, Formulas, and Math," "Our Body Systems, Forensics, and Math," "Quilts, Tessellations, and Three-Dimensional Geometry," "The Stock Market Project," and "Math and Literature." The chapters are not organized by mathematics scope and sequence but rather by topics, and are designed to teach important middle school math skills and concepts through real-world applications—showing students that school math and real math are not mutually exclusive. Why is this approach so important?

I once asked a group of seventh-grade students, "Do you think that your answer makes sense?" Without blinking an eye, one of the students answered, "Math hasn't made sense since fifth grade! We just memorize how to get the answers and you know, the way to get the right answer doesn't *always* make sense!" How could *my* students believe that "math made no sense"? And, more important, how could I make mathematics a sense-making experience for them?

Research shows that children do not enter school believing mathematics to be irrelevant to their everyday lives. The National Research Council (2001) states that children actually begin learning mathematics well before they enter

school. Many of their experiences require them to use mathematics in a "real-world" setting. They share equally, count their toys, judge who has the most or the least, and "calculate" how many more marbles they need to get to a particular number. These children do not perceive mathematics as an isolated subject with rules and procedures, but as a useful and efficient way to quantify and understand their world.

However, when students enter a classroom where the primary focus is the memorization of arithmetic facts, where there is a preoccupation with learning rote and low-level computational skills, children may lose their belief that mathematics "makes sense." They become passive recipients of isolated rules rather than active participants in connected learning. Mathematics is no longer a tool to help them problem-solve. "School math" and "real math" become disconnected; students' curiosity and interest decline. How can we maintain the students' belief that mathematics is important—a vital and meaningful tool that we use to help us interpret and quantify our modern world? They need to see the relationship between what they are learning and their lives outside of the mathematics classroom.

One current theory of mathematics education, Realistic Mathematics Education (RME), maintains that mathematics is a *human activity* and must be connected to reality (Freudenthal, 1991). This teaching and learning theory of mathematics education, introduced in the Netherlands at the Freudenthal Institute (Zulkardi & Nieveen, 2001), has five components: (1) using a real-world context as a starting point for learning, (2) using visual models to bridge the gap between abstract and applied mathematics, (3) having students develop their own problem-solving strategies for "doing" mathematics, (4) making mathematical communication an integral part of the lesson, and (5) connecting mathematics to other disciplines and to meaningful real-world problems. *School mathematics* becomes connected to *real mathematics* when students understand how it opens doors to future careers. When teachers emphasize mathematical connections, they help students see mathematics as an integrated whole rather than as a set of isolated and disconnected skills and procedures that are to be learned by rote memorization. It is through mathematical applications that students perceive the *usefulness* of mathematics and appreciate the need to study and understand mathematical skills and concepts.

The chart on page xiv illustrates how each activity can be aligned with the mathematics curriculum. The National Council of Teachers of Mathematics' *Principles and Standards of School Mathematics* (NCTM, 2000) has divided 10 standards into two groups: the Content Standards and the Process Standards. The five Content Standards—Number and Operation, Algebra, Geometry, Measurement, and Data Analysis and Probability—clearly describe the content that students should learn. The five Process Standards—Problem Solving, Reasoning and Proof, Communication, Connections, and Representation—illustrate what students should be doing to acquire and use the content knowledge. "This set of ten Standards does not neatly separate the school mathematics curriculum into nonintersecting subsets. . . . Process can be learned within the Content Standards and content can be learned within the Process Standards. Rich connections and intersections abound" (NCTM, 2000, pp. 30–31).

The activities and projects in *Making Math Connections* concentrate on mathematical applications and making mathematical connections. The "Connection" Standard, one of the Process Standards, states that

> Instructional programs . . . should enable students to—
>
> - recognize and use connections among mathematical ideas;
> - understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
> - recognize and apply mathematics in contexts outside of mathematics.
>
> —NCTM, 2000 (p. 64)

HOW IS THE BOOK ORGANIZED?

The activities in *Making Math Connections* were designed for use in mathematics class, Grades 5 through 8. Each of the chapters is organized in the following manner:

I. The Venn Diagram visually describes the interrelationship between curricular areas. These diagrams are included to help middle school instructional teams work together to plan integrated units and to help mathematics teachers relate the activities to real-world applications. Following the Venn diagrams is a brief introduction of the chapter with descriptions of each of the activities.

II. Teacher's Planning Information: There are several pages of planning information for each activity. These pages contain the following:

1. *Mathematical Connections:* Principal mathematical skills and concepts are listed. These mathematically rich problems make connections to a variety of Content and Process Standards and therefore correlate to more than one math skill.
2. *Other Curricular Connections:* A brief description of the curricular interrelationships of the lesson.
3. *Concepts:* The mathematical concepts are delineated in terms of student outcomes. A careful analysis of these concepts will help define the assessment components to develop teacher-designed rubrics.
4. *Materials Needed:* Before beginning the investigation, carefully check out the list of required materials.
5. *Background Information and Procedures:* This area has been expanded in this second edition. Since the activities relate to subject areas other than mathematics, background information has been supplied to the mathematics teacher to help explain how the activity connects to other disciplines. For example, what criteria do scientists use to compare the intensity or magnitude of natural disasters? The Teacher's Planning Information for "Our Earth: Natural Disasters" contains historical

information and tables that describe the scales used to measure earthquakes, volcanoes, hurricanes, and tornadoes. Procedures include a brief outline of the activity—not a detailed, step-by-step analysis of the lesson. This section contains suggestions for introducing the lesson through the use of questioning and student discussion. It is important for students to "buy into" the lesson and be curious about the final results.

6. *Assessment:*
   (a) Most of the activities have student worksheets that require calculations and problem solving. These can be used as part of the assessment process.
   (b) Each activity includes at least one journal question that gives students the opportunity to communicate mathematically by either describing the activity in their own words or applying what they learned to a new problem. Answers have been included for those journal questions that require computation.
   (c) Teacher-designed rubrics can also be used to assess other aspects of the activity.

7. *Selected Answers:* When a lesson has a unique answer, it will be found at the end of the Teacher's Planning Information for that lesson rather than at the back of the book (as in the first edition).

III. The Math Investigation: Following the teacher's planning pages are ready-to-use activities. Fourteen of these investigations are new to the second edition. These include activities related to poetry and other literature, forensic science, and symmetry. In addition, data for all of the activities has been updated to make them more current. While the investigations are very different, their purpose is to encourage students to participate in mathematical applications and they encourage active student involvement. Many times students work collaboratively to problem-solve solutions.

IV. Additional Readings and Internet Web Sites: At the end of each chapter there are suggestions of books that relate to the activities in the entire chapter. These are books that students might enjoy or the teacher can use to obtain ideas for additional activities. A brief description of each book is included. If there are related Web sites, they are included in this section as well. These provide additional resources and data for both teacher and student use.

In addition, the Resources section at the back of the book includes material to help teachers plan their middle school mathematics lessons:

Resource A: "Alternatives to Traditional Assessment" is a discussion of alternatives to traditional assessment strategies. Not all activities can be graded as "right" or "wrong"—a more multifaceted assessment is required.

Resource B: "Design Your Own Lessons" contains suggestions to help with planning and blank forms to organize your ideas.