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Math Solving Problems Kids Care About

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Dedication

For my grandchildren—Torin, Shannon, Bjorn and Rhiannon . . .
I hope this book helps you figure things out.

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Introduction

This little book has had much longer legs than I could have possibly anticipated when I finished the manuscript twenty-five years ago in the highlands of Papua New Guinea. When the publisher asked me to update the book, I wanted to do more than give it a fresh look. I felt it important to maintain the integrity of the original approach to teaching problem solving that has been used successfully in so many classrooms over the past two decades. I was grateful for the opportunity to clarify the description of problem-solving strategies and classroom pedagogy and to include some new problems to challenge and, hopefully, amuse. I also gratefully corrected a few errors in the original text pointed out to me over the years by a few persistent students who learned not to believe everything they read in books.

The world has changed considerably since Ronald Reagan was president—the Berlin Wall has come down and the countries to the east have joined with Europe, humanity somehow managed to transition to the twenty-first century without great event (a year early, but that is another story), 911 took on new meaning in the world, and the ubiquitous cell phone has become far more powerful than the computer I used to write the original manuscript for this book. However, a clear-thinking citizenry has never been more important than now as we learn to face the uncertainty of the post-Cold-War era. High-quality mathematics education offers one of the best opportunities for our children to learn problem-solving skills to help them make thoughtful, evidence-based judgments so important to good citizenship, and, just maybe, foster harmony among the peoples of the world.

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Over the past twenty-five years, mathematics textbooks have become increasingly narrow in both content and pedagogy. School leaders have reacted to the poor performance of our children on international tests by significantly increasing the emphasis on routine calculations. Problem solving, when it appears at all, is embedded in lessons largely populated with worked examples and routine exercises. This national trend toward the adoption of curriculum that focuses on the development of algorithms had led to improved test scores on arithmetic and algebraic operations. However, student performance on mathematical applications and problem solving continues to be frustratingly weak among all the socioeconomic levels, but particularly among children from low-income families.

Readers familiar with the original text will find, in this second edition, increased attention to story problems, an expanded description of problem-solving strategies, inclusive strategies for students with special needs, ideas about embedded assessment, and ten new problems. I hope both those of you who are new and those who are returning readers will find these pages a worthy supplement to your mathematics instruction and will help you provide students with engaging practice with problem-solving strategies and improve their mathematical thinking.

This book would not have been possible without drawing upon the respected work of other mathematics teachers, most notably Marilyn Burns, Martin Gardner, Carol Greenes, George Polya, and Dale Seymour. Several people helped with the development of the manuscript for the first edition of this book, including Kiri Mimi, who created the original illustrations at the same time he was working on the first mathematics textbooks published in Papua New Guinea; Gail Anders, Lauyang Posanau, and Priscilla Warbat who prepared the initial manuscript; and Joan Akers and John Wavrik, who generously offered many suggestions to improve the problem descriptions and solutions. I want to thank Andrea Cheng and Sarah Moulton for assisting with the preparation of the manuscript and Bobbie Dempsey for her editorial guidance on the second edition, and especially Stephanie for her curiously improved navigation skills and loving care as we explored South America searching for these pages.

R.J.S.
Buenos Aires
January 2005

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How to Use This Book

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You do not need to be an expert problem solver to teach effective problem-solving skills, but it sure helps! Our primary role as teachers is to establish a nonthreatening environment to encourage efficient problem-solving behaviors among our students. We must also have the courage to learn along with our students, because many of these important problem-solving skills may be as new to us as to our classes. Here are a few hints that you may find helpful:

1. Scan through section I (especially chapter 2) to review strategies and techniques for teaching mathematical problem solving. In particular, look at:
   a. Problems Worth Solving
   b. A Four-step Problem-solving Plan, including the strategies listed in step 2 of the plan.
2. Think about how to organize your classroom to foster effective problem-solving sessions. The following sequence is suggested:
   a. Begin with the whole-class problem-solving warm-up activities to encourage divergent thinking and cooperative problem-solving behavior.
   b. Discuss each particular strategy in a large group (for example, *working backward*). Break up into groups of four and assign everyone the same problem (perhaps "Stack the Deck").
   c. Introduce each strategy in this way, allowing ample time for a whole-class discussion after each session to encourage a sharing of strategies and solutions.
   d. As you and your students become more adept at using various solution strategies, offer a choice of problems. Always allow time for discussion.
3. Other recommendations:
   a. Initial problem-solving sessions should be brief. Extend the duration with experience.
   b. Try to schedule sessions frequently, at least twice a week.
   c. Initially, plan a whole-class discussion after each session. Later, these large-group discussions may be required less frequently.
   d. Every child (group) may be unable to completely solve every problem in the time available. The problems are designed, however, so that everyone is encouraged to make some progress and offer input during the discussions.
   e. The Problem-Starter sheets should be reproduced for each child. The hints provided should help individuals (or groups) formulate a solution strategy.
   f. The problems are sequenced so that they become increasingly complex. With sufficient experience, intermediate and junior-high level students should be successful in solving most of the problems, while the more complex examples may be inappropriate for younger children.
   g. After working through the problems of interest in this book, perhaps you and your class might enjoy enlargeing your collection by reviewing the sources in the bibliography or asking people in your community. Keep in mind the section criteria in chapter 1 when choosing your "problems worth solving."

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Section I

Mathematical Problem Solving

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Chapter 1
What's Worth Knowing

As our world changes before our eyes—our knowledge base becoming obsolete at an alarming rate and value systems seeming to change with or without us—what do we teach our children who must survive and prosper in a changing environment we may scarcely be able to imagine? What is worth teaching today that will be worth knowing in twenty years?

In virtually every field, accepted practices are becoming obsolete as rapidly as new knowledge develops. Teachers find it more and more difficult to remain current in their profession as the years pass. Teachers must search for the essential strands that transcend the blizzard of competing ideologies and techniques in order to function effectively in their classrooms. Specialization, the traditional mechanism designed to contend with information explosion, will continue to play a significant role in our lives. The time is long past when one individual has possessed a thorough understanding of an entire field. (Karl Gauss is purported to be the last individual to understand all contemporary mathematics, and he died more than a hundred years ago. We have developed more mathematics in the past twenty years than in the thousands of years before Gauss!)

Clearly, we must look at learning differently if the children in our schools today are to gain a sense of competence in their lives. Facts and relationships between facts will become less important, learned temporarily and later replaced by a new set of relevant facts and relationships. We are discovering that many of the "facts" associated with everyday life are reflections of our own values and may not be valid in other societies. Ethnocentric thinking, though comfortable, will be less useful in a shrinking, diverse world.

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