MATH THROUGH CHILDREN'S LITERATURE

Making the NCTM Standards Come Alive

Kathryn L. Braddon, Nancy J. Hall, Dale Taylor

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A Note from the Publisher

As the authors wrote this book they made every attempt to choose children's literature titles which were in print or which were commonly available in a number of libraries they checked. The publishing industry at this time is undergoing great change due mostly to takeovers and mergers. This situation creates havoc in keeping children's literature in print. What is in print today may be out of print tomorrow, and what is out of print today may be back in print tomorrow. We checked the in-print status of the books included in this guide twice within three months and found major differences. Printed here is a list of all of the books mentioned and their in-print status as of June 2, 1998. We feel certain that many of the out-of-print titles listed here will eventually be back in print if you send orders to your favorite distributor and then query the publishers. Many publishers respond by putting the titles back into print. For example, *How Much Is a Million?* and *The Magic School Bus at the Waterworks* are such popular titles that they are due to come back into print at any moment. Have your library media specialist notify publishers of your wants. We are notifying publishers also and will encourage them to keep all the titles from this book in print.

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To my husband, three children, and the students and staff at Manchester-Shortsville Central School.

—Kathryn L. Braddon

To my husband, who is still my best friend, even after all this.

—Nancy J. Hall

To my wife and two sons, Greg and Brent Taylor.

—Dale Taylor

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Preface

Elementary students who love good literature are often the same children who dislike completing worksheets filled with math problems or who struggle with those troublesome word problems. With the whole language philosophy and literature-based language arts becoming more prevalent, it became evident that integrating math and literature would be not only an exciting, but also a logical union.

Math Through Children's Literature was undertaken to recognize and apply the conventional wisdom that children learn by being actively involved in the learning process, rather than by filling out another set of exercises on worksheets. By integrating math and literature, word problems can use familiar stories to allow students to address the mathematical functions rather than struggle needlessly with unfamiliar vocabulary. Mathematical activities that are stimulated by literature inspire students to explore and investigate concepts. And the marriage of math with quality literature fosters the realization that math is all around us.

Math Through Children's Literature utilizes the National Council of Teachers of Mathematics (NCTM) Standards as a base for the math activities and features quality children's literature that is readily available through school or public libraries. Part I gives an overview of mathematics education. Part II provides an overview of math standards 1 through 5. The balance of *Math Through Children's Literature* explores books and related math activities for grades K-3 and 4-6 for standards 6 through 13. Related books and references are suggested for further exploration.

Teachers using this book may want to enhance the math yearbook by integrating a beloved book such as *10 Bears in My Bed.* Others may find that using a book such as *Gator Pie* to introduce fractions helps the students understand textbook material more fully. Some teachers may decide to replace a math textbook unit, such as measurement, with a series of books and activities. No matter how you choose to use *Math Through Children's Literature*, it is hoped that you will investigate further possibilities for exploring math in all aspects of your program, truly making the NCTM Standards come alive!

In *Math Through Children's Literature* every effort has been made to use resource books that are now readily accessible to educators. Most are available through your local bookstore or through public or school libraries. Inquire about titles in print with your local bookstore or book wholesaler. If you have trouble locating a particular title, ask your librarian to assist you with interlibrary loans or advise you regarding similar titles that will also work.

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How to Use This Book

As a teacher, my first reaction to teaching mathematics through literature was dismissive. Mathematics, after all, particularly at the elementary level, should be taught through the use of manipulatives. If math were to be integrated with another subject, it would be science, not language arts. Fortunately, it is sometimes possible to teach an old dog new tricks.

I've learned that teaching mathematics through literature isn't such a crazy idea after all. While mathematics is perhaps the most difficult subject to integrate with reading and language arts, many more literature books lend themselves to this type of integration than I had initially suspected. It's also true that approaching mathematics through literature is often more palatable to many students and teachers who have found earlier experiences with mathematics unpleasant. In addition, stories can show students how math is applied in the "real world" in ways that textbooks rarely do. Finally, the use of literature and the use of manipulatives are not, by any means, mutually exclusive.

This book is organized according to the National Council of Teachers of Mathematics (NCTM) Standards for the elementary level.* These standards reflect the latest in research and successful practices developed by the people who have the greatest expertise in this area. Because the standards advocate an approach to teaching mathematics that may be somewhat different from the way many textbooks are organized, and different from the practices most familiar to teachers, a correlation between the standards and a more conventional scope and sequence is included in the appendix.

The first five elementary mathematical standards can be thought of as components that permeate the entire mathematics curriculum. Problem solving, communication, reasoning, connections, and estimation are the major processes to be woven through the mathematics concepts found in the remaining eight standards. It is sometimes difficult to isolate these processes, and therefore, no books or activities for standards 1 through 5 have been included.

Standards 6 through 13 are considered the content components and the books and activities highlighted in a specific chapter focus primarily on the concepts included in that standard. However, there is a considerable amount of overlap, and standards often build on one another. For example, when adding a deposit to a checking account, you would be dealing with both standard 8—Whole Number Computation and standard 12—Fractions and Decimals. Therefore, you will find cross-referencing among the content standards. Because standards 1 through 5 address processes and permeate so many of the activities, cross-referencing does not include these standards.

The books chosen for each of the content standards can be used to introduce or reinforce the specific mathematical concepts addressed by that particular standard. These books and activities are

*The NCTM Standards are divided into three levels: Kindergarten through fourth grade, fifth grade through eighth grade, and ninth grade through twelfth grade. This division doesn't completely match a book designed to be used by teachers in grades K-6, but we feel we have successfully addressed the concepts important for intermediate grades.

not meant to encompass your entire mathematics curriculum. However, they can generate student interest, illustrate the application of specific concepts, and demonstrate the pervasiveness of mathematics in everyday life.

In addition to being organized according to NCTM Standards, the books have been categorized as either most appropriate for students in grades K-3 or for students in grades 4-6. Within each section is a list of content vocabulary that may be new to the students, and the featured books are presented in order of increasing difficulty. Obviously, student abilities vary a great deal even within a specific grade level. You are the best judge of your students' abilities, and you will need to evaluate which books and activities will be best suited to your students. You can, of course, choose other books from the Related Books and References section listed at the end of each chapter, or adapt activities to the particular needs of your students.

The subtitle to this book is *Making the NCTM Standards Come Alive.* The books highlighted in each chapter were chosen not only for their applicability to the concepts, but also to stimulate student interest. Your enthusiasm to explore the literature and activities with your students is essential and will motivate them even further. Enjoy your adventures!

Part I
THE MATHEMATICS CURRICULUM

1—An Overview of Mathematics Education

HISTORICAL PERSPECTIVE

Mathematics is a process for communicating data and a study of pattern and order. A special role is reserved for mathematics in education because of its universal applicability.

The study of mathematics has existed at least as long as recorded history. Mathematics has changed over the centuries, and its effect on culture has been profound and complex. During the last few centuries mathematics has progressed from its status as a somewhat static field of study to its current dynamic status. In fact, mathematics education as a separate field of scholarly endeavor is essentially a middle-twentieth-century phenomenon.

To understand why mathematics reform today is in debate, we must review our recent history. The present mathematics curriculum was designed to prepare shopkeepers, farmers, and factory workers for the 1940s. Some of those skills are still useful today. However, in the 1990s the requirements of society ask all its citizens, male and female, and all its cultures and backgrounds to be well prepared in the area of mathematics, and this need far exceeds basic computational skills.

The pendulum in educational thought seems to be in constant motion. In mathematics opinions on how and what should be learned shift quite rapidly. A quick review of just the last thirty-five years indicates how ideas in the field of mathematics have developed and changed:

- In the late 1950s, the Sputnik space shot by the Soviets caused the United States to expend a large amount of effort and spend a lot of money on developing mathematics curriculum revisions.

- During the early 1960s, sometimes called the modern math era due to learning-style changes from more traditional approaches, mathematicians developed the assumption that mathematical understanding could best be developed by precision and rigor.

- The late 1960s saw a backlash to these "modern math" textbooks. This period, often called the transition period because of the change from exact, rote learning of math facts and algorithms to a process-driven, hands-on approach, was affected by the writings of such people as Jean Piaget.

- The beginning of the 1970s became known as the laboratory mathematics period because of the extensive use of manipulative teaching materials. With the broadening acceptance of Piaget's ideas, the mathematics curriculum began to include manipulative materials, lab materials, and hands-on activities.

- The end of the 1970s reflected a back to the basics attitude. Unfortunately, no one could agree on what the basics actually were in mathematics. However, two issues did come to the forefront during this time. The first was an understanding that equal access to mathematics education must be available to all people if this country is to remain a world leader or even stay competitive with the rest of the world. The second issue was that technological developments were making many former basic mathematics skills almost obsolete.

- Early in the 1980s came the publication *An Agenda for Action*, published by the National Council of Teachers of Mathematics.[1] Its primary focus suggested that problem solving be given a greater effort in the 1980s. However, problem solving was found to be more difficult and complicated to teach than anyone had imagined.

- The second half of the 1980s was called the era of realization because of the need for reforms in mathematics education due to the large amount of research supporting this view. Writings such as *Everybody Counts, Curriculum and Evaluation Standards for School Mathematics*, and *Reshaping School Mathematics* set the direction for mathematics in the 1990s.[2] These writings designated criteria for the K-12 mathematics curriculum as well as a focus on how students come to understand mathematics.

THE ESSENTIALS OF EDUCATION

The public has a valid concern about the basic skills and knowledge of our students, and it should reject simplistic solutions to these problems. The three *R*s we have traditionally spoken about are limited in scope when one views the complex, highly technological society we live in. Also, expecting the historic testing methods and evaluation systems teachers used in the past to measure what is now considered essential is not possible given the large limitations on these instruments and today's expanded needs.

The primary goal of education at this time is to develop informed, thinking individuals able to participate in today's complex society. Skills and abilities do not grow in isolation from other content areas; rather, all subjects using language and symbol systems, the development of reason, and the experiences that lead to emotional and social maturity must grow in concert.

Preparing students to meet the needs of the twenty-first century requires all disciplines to join together and acknowledge their interdependence. Also, all segments of society—legislators, parents, educators, and the business community—must work together to identify what is truly essential for students to know.

THE ROLE OF READING

Reading is a process in which the reader's knowledge and textual information act together to produce meaning. Good readers skillfully integrate information in the text with what they already know. Skilled readers are flexible. How they read depends upon the complexity of the text, their familiarity with the topic, and their purpose for reading.

As proficiency develops reading should be thought of not so much as a separate subject in school, but as integral to learning mathematics, literature, social studies, and science. When connections among these subject areas develop, students are better able to understand motive and action, form and function, or cause and effect. The idea that reading instruction and subject-matter instruction should be integrated is an old one in education, but there is little indication that such integration often occurs in practice.

One primary characteristic that distinguishes an effective classroom from an ineffective one is the teacher's commitment to the belief that all children can learn to read and be successful students.

Becoming a Nation of Readers: The Report of the Commission on Reading[3] emphasizes why it is important to integrate the school's subject areas. Mathematics is a communication tool that works directly with the skill of reading and allows the student to use and understand data found in all school subjects and to interpret the logic and patterns found in those subjects. Reading and mathematics skills must go hand in hand for the student to become a successful learner.

CHANGE

Much has been and will be written about the adjustments necessary in mathematics education. The primary reason to write this book is to demonstrate how teachers and parents can begin effecting this change for students.

HOW DO THE NCTM CURRICULUM AND EVALUATION STANDARDS DIFFER FROM WHAT IS BEING DONE TODAY?

The standards emphasize

- applying mathematics over mathematics computation;
- spending less time on rote drill and more time on problem solving;
- using computers and calculators as "fast pencils" during the course of problem solving;
- seeing mathematics as an integrated whole rather than as a series of isolated topics;
- learning the *meaning* of operations such as addition and multiplication, as well as simply learning the operations.

The greatest difference for today's elementary-age students can be achieved by changing two attitudes. First, rote learning of basic mathematics facts (adding, subtracting, multiplying, and dividing skills) is still of vital importance. However, rote learning of basic facts is better taught after the student has acquired purpose for these facts, not before students are allowed to do mathematics, which is traditionally what has happened in the United States. Second, the breadth of mathematics should be taught as soon as students have usefulness for this information in relating to their world.

ROTE LEARNING OF MATHEMATICS BASIC FACTS

In the United States a tradition was begun that is quite different from most other parts of the world. Parents and teachers believe that once a child begins school the memorization of the basic math facts must be accomplished prior to the student doing mathematics. In fact, teachers and parents have been so successful at presenting this idea that many people believe that the computational skill is mathematics rather than a vehicle to do mathematics.

Certainly rote learning of math facts and processes is of value to today's students. These skills help students understand much about our number system. Rote learning of math facts and processes also provides students a necessary and efficient method to perform computational functions.

There are real difficulties, however, with teaching rote learning of mathematics facts prior to developing a need for these skills. People do not remember unrelated facts very well. Many who teach memorization skills recognize this problem and have become successful helping people memorize facts by teaching them to tie known facts to new information. Teachers know the many hours they spend almost entirely on math facts and basic computational procedures in grades kindergarten through sixth and how little long-term retention of these skills their students have had.

Teachers can improve the rote learning of math facts by delaying this instruction until students understand the number system and have need for this skill. An example of this is when a kindergarten teacher begins the school year by having play money—pennies, nickels, dimes, and quarters—available to students. Whenever students need a pencil, paper, crayon, or work sheet, they must buy it with play money. Initially the teacher must help a few sellers make the correct change. After several days enough students have learned the procedure so that peer help is all that is needed. Shortly after the first month of school nearly all students in the room are able to make the correct change up to twenty-five cents. At this time the teacher may begin teaching adding and subtracting facts through 25. Kindergartners, with very few exceptions, are able to quickly rote learn their adding and subtracting math facts through 25. Note that the teaching of the math facts was not greatly delayed. In fact, these kindergarten students will learn their math facts much quicker than is the norm in this country. Even if this activity is delayed until first grade, the students are still far ahead of what is considered normal.

The withholding of mathematics power is the other major loss students have suffered because of the traditional expectations required in rote learning. Students who solve problems that are real and valuable to them want to do it again and again. Teachers and parents should therefore have as a goal an environment that is rich in real-life problem-solving situations for children, and they should provide the efficient tools that the children can effectively use to help them solve these problems. This means students should have access to calculators, computers, paper and pencil, and memorization abilities necessary to solve their problems as soon as they need and can be taught to use each of these skills.

THE BREADTH OF MATHEMATICS

Parents and teachers have observed children doing mathematics prior to their school years.

Young children work with number sense and numeration when they begin counting and grouping objects.

Preschoolers work with whole number operations when they count how old they are and show the results on their fingers. Children at this age can also quickly tell who received more or less candy, Christmas gifts, and so on.

Before students start to school they often use whole-number computation. They not only can say who received more candy, Christmas presents, or pennies, but they can say how many more.

Often overlooked is the geometry and spatial sense preschoolers have developed. Remember how they draw shapes, play with fitting shapes into balls and puzzles, and how these skills help them to better understand their own world.

Certainly measurement plays a big part in very young children's learning to relate to their world. Remember how they always want to compare their physical size with that of other children and adults.

Collecting and analyzing data is a big part of a preschooler's life. Statistics and probability are regularly used by children to determine whether they have their fair share.

Certainly before the age of five, children enjoy and want to use fractions and decimals. Remember how they always want the bigger half.

Preschoolers spend a great deal of time discovering patterns and relationships. Consider how many times a young child looks at things to discover how they go together or how they are alike or different.

WHY STUDY MATHEMATICS? – INTEGRATION

The integration of mathematics into language arts and science through useful and creative problem-solving activities almost always raises the level of learning. Help in understanding the integration process may be found in the rather broad definitions of these three major areas of learning. Language arts may be considered as the curriculum area devoted to the study of the communication skills of speech, writing, hearing, reading, and sometimes touch. Science may be considered the curriculum area for the study and understanding of any and all fact and the development of a variety of learning processes. Mathematics may be considered the curriculum area devoted to the study of the communication skills of gathering and comparing data as well as to the study of patterns and order. The communication skills necessary for language arts and math allow us to both receive and share information. Consider the difference that occurs when we attempt to develop our communication skills in math and language arts in isolation, versus when those skills are practiced performing activities we see as important to our lives.

Integration is a buzzword in education today, but too often the meaning seems to suggest that if the teacher throws any two subject areas together, something better will happen. With a little more purposeful thought, teachers can easily raise the interest, complexity, and success of some of their favorite activities.

Some of the learning taxonomies one finds today suggest there are different levels of learning and that teachers and parents should strive to help students achieve more complex learning skills. It has been suggested that learning complexity follows the pattern outlined below.

- restatement of fact
- restatement of facts in child's own words
- showing or doing, using information
- breaking a whole into parts
- building a new whole from parts
- making judgments from the facts

By considering how teachers have traditionally taught each subject area in isolation, one can understand how activities with students have stayed largely at the lower levels of these taxonomies. In fact, many believe that at least 90 to 95 percent of classroom instruction time has traditionally been spent in the first two steps. However, when a teacher attempts to teach language-arts and mathematics skills for the purpose of understanding science, most activities involved in this integration are seen to cause the students to work at least at the fourth level or higher.