Fall 2007

The Integration of Children's Literature Into Mathematics

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Regis University
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Final Project/Thesis

Disclaimer

THE INTEGRATION OF CHILDREN'S LITERATURE INTO MATHEMATICS

by

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A Research Project Presented in Partial Fulfillment
of the Requirements for the degree
Master of Education

REGIS UNIVERSITY

November, 2007

ABSTRACT

The Integration of Children's Literature into Mathematics

By using children's literature in mathematics, teachers can help students see that life is full of problem solving opportunities. In this applied project, the author developed a handbook for upper elementary teachers to integrate literature into the mathematics curriculum while maintaining a commitment to a standards-based curriculum.

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

Teachers around the world have criticized the use of traditional, drill and skill, methods of teaching mathematics (Hong, 1996; O'Brien & Moss, 2004). New teaching methods integrating literature and mathematics however can be used to develop a more positive classroom environment and improve student attitudes toward mathematics (Mink & Fraser, 2002). In traditional mathematics instruction, separation is maintained between mathematics and other content areas. However, by integrating literature into mathematics, teachers can: (a) create relevance, (b) increase motivation, (c) promote critical thinking and (d) improve problem solving skills through the use of storybook examples (Haury, 2001; Mink & Fraser).

Statement of the Problem

Mathematics instruction should involve student participation and problem solving to encourage higher level thinking; it should not be based solely on the computation of algorithms and repetitive worksheets (Burns, 1999). One way to increase student participation is by integrating children's literature into mathematics instruction. Stories can provide relevance for students, because the use of literature provides a setting for problem solving and the storybook characters can model the process of finding a solution. Students can take the mathematical skills they have learned through the literature examples and apply the steps when solving math problems in real life.

Purpose of the Project

The purpose of this project was to develop a handbook that teachers can use to help integrate children's literature into upper elementary mathematics lessons. The author of this project intended to provide best practices to effectively integrate literature into mathematics and include appropriate literature recommendations aligned with Colorado Mathematics Content Standards for the upper elementary grades.

Chapter Summary

In summary, mathematics instruction should not be based solely on repetition, computation, and mathematical processes (NCTM, 1989). Integrating children's literature in mathematics is one way to provide relevance and demonstrate problem solving strategies. In Chapter 2, Review of Literature, current literature is presented to support the view that children's literature should be integrated into the mathematics curriculum. In Chapter 3, Method, the procedures for the development of this project are detailed. In Chapter 4, Results, the teacher handbook is included. Finally, in Chapter 5, Discussion, contributions, limitations, suggestions, and further research are reviewed.

Chapter 2

REVIEW OF LITERATURE

The purpose of this project was to develop a handbook that could be used to help teachers integrate children's literature in upper elementary mathematics lessons. In traditional mathematics instruction, there is a heavy reliance on repetitive computation, known as drill and skill instruction. The over reliance or overuse of drill and skill instruction and repetitive calculations prevents students from being able to connect mathematics to their life; as a result students fail to fully develop the necessary problem solving skills they need for the real world. However, the integration of literature into mathematics instruction, as this literature review will show, can address this problem. The use of children's literature in mathematics can: (a) create relevance for students, (b) provide a setting for problem solving, and (c) demonstrate the process to find a solution.

Traditional Mathematics Instruction

Historically, mathematics instruction has been based on curricula designed to promote the recall of: (a) basic skills, (b) mathematical processes, and (c) vocabulary (Campbell, 1996). Students can spend years learning to compute, but may never apply the mathematics they have learned (Hopkins & Dorsey, 1992). Additionally, the use of memorization in mathematics places the importance on finding an answer rather than understanding the mathematical problem presented (Campbell).

History of Mathematics

It is speculated that mathematics has been utilized by humans since before recorded history (Braddon, Hall, & Taylor, 1993). Although mathematics has been present in all cultures, it is not a static field, but rather, a complex and ever changing field. Prior to the 1940s, U.S. mathematics instruction was designed to prepare students for careers as: (a) shopkeepers, (b) farmers, or (c) factory workers. These careers required repetitive calculations with precise answers, so an appropriate early mathematics curriculum focused on computation and number facts.

A drastic change in mathematics education occurred in the late 1950s when the policymakers in the U.S. responded to the Soviet Union's launch of Sputnik with an increase in funding for mathematics education (Tate, 1996). In addition to the monetary increase, substantial revisions were made in mathematics curriculum. The post-Sputnik mathematics curriculum focused on technical problem solving skills combined with science education to create competitive students who could send U.S. astronauts into space. Unfortunately, even after *Brown v. Board of Education* and other promises for educational equality, the new curriculum was not implemented in poor and urban areas; students of poverty were not afforded the same problem solving education as their wealthier peers (Tate).

The changing technologies and innovative space program in the post-Sputnik era demanded a problem solving society, while the drastic inequalities in education called for major mathematics reform in the United States. Significant changes in education were about to take place in the late 1960s.

The Back to Basics Movement

The Back to Basics mathematical movement occurred in the late 1960s and early 1970s in an attempt to establish educational equality (Tate, 1996). The movement recommended a core curriculum for mathematics instruction that focused on: (a) computation, (b) facts, and (c) mathematical procedures. In this core curriculum, problem solving and more advanced concepts were excluded in favor of equal education across socioeconomic class. The Back to Basics movement did show an increase of standardized assessment scores for low socioeconomic students (Secada, 1992, as cited in Tate, 1996). However, Tate states that the mathematical demands of the 1970s society required more than basic math skills, and the Back to Basics curriculum did not adequately prepare students for the challenges of college preparatory mathematics (Tate).

The lack of problem solving skills and over emphasis on computation during the Back to Basics Movement called for another mathematics reform. Previous mathematics curricula, according to the members of the National Council of Teachers of Mathematics (NCTM, 1989), failed to:

> foster (a) mathematical insight, (b) reasoning, and (c) problem solving; and emphasizes rote activities. Even more significant is that children begin to lose their belief that learning mathematics is a sense-making experience. They become passive receivers of rules and procedures rather that active participants in creating knowledge. (p. 15)

As a result, current mathematics teachers and state policy makers in the U.S. turned to a standards based curriculum to maintain consistency across the nation and to promote a balance between teaching computation and problem solving skills to students in the mathematics classroom.

Current Mathematics Reform

It is the responsibility of mathematics teachers to prepare students to be capable problem solvers. Current societal challenges (e.g., the use of science and technology) require citizens to have the ability to reason logically and be able to solve problems (Campbell, 1996). Students need to understand mathematical concepts, rather than simply perform lengthy algorithms (O'Brien & Moss, 2004). Today's students will often have access to calculators, computers, and other technologies to achieve mathematical solutions, but students will still need to know how to apply the computations they have learned to determine if their answer is a reasonable estimate, rather than calculate an exact computation (NCTM, 1989). According to Burns (1999), students today are able to perform these complex algorithms but they need more practice in higher level thinking and problem solving. Instead of having students practice complex calculations in algorithm form, teachers can and should use more story problem examples in the classroom to model higher level thinking.

National Council of Teachers of Mathematics Standards

The National Council of Teachers of Mathematics (NCTM) is a mathematical education organization (NCTM, 1989); its members have developed standards to determine what mathematical curriculum should include. Educational policymakers in individual states use the NCTM standards as models to design state curriculum standards. In the NCTM Standards, five goals are specified in order for all students to accomplish mathematical literacy. A mathematical literate student is defined as one who has:

1. Learned to value mathematics
2. Become confident in their ability to do mathematics
3. Become a mathematical problem solver

4. Learned to communicate mathematically
5. Learned to reason mathematically (p. 5)

A mathematically literate student can be a successful problem solver in a technological society. Today's employers search for mathematically literate employees because it is necessary for workers to communicate mathematically / quantitatively and express their findings to management. The five goals for mathematical literacy are also important for today's students because these skills allow a citizen to be a productive member of society who has the ability to (a) "explore, (b) to conjecture, and (c) to reason logically, (d) as well as to use a variety of mathematical methods effectively to solve problems" (p.6).

Therefore, when the goals presented in the NCTM Standards are achieved, students will develop an appreciation for computation and learn multiple, effective computation problem solving strategies, such as: (a) estimation, (b) mental mathematics, (c) pencil and paper, (d) calculator, and (e) computer (Hopkins & Dorsey, 1992). Through the use of multiple computation methods, students will be able to apply the appropriate strategy while problem solving.

Goals of Mathematics Teachers

Mathematics education should not be based on a basic skills curriculum; instead, it should include problem solving and student participation (Campbell, 1996). The overall goal of mathematics education is for the student to understand the problem, and feel that it makes sense (Campbell; O'Brien & Moss, 2004). Teachers can help students make sense of problems through discussions and participation in mathematics. By giving students the opportunity to participate in classroom discussions, students can see how different mathematical concepts are connected to each other and are relevant to society

(Hopkins & Dorsey, 1992). Polya (1945, as cited in O'Brien & Moss) reported that the goal of mathematics teachers is to bring out independent thinking when he said:

> A teacher of mathematics has a great opportunity if he fills his allotted time with drilling his students in routine operations; he kills their interest, hampers their intellectual development, and misuses his opportunity. But if he challenges the curiosity of his students by setting them problems proportionate to their knowledge and helps them to solve their problems with stimulating questions, he may give them a taste for, and some independent means of, independent thinking. (p. 296)

Teachers of mathematics need to remember to maintain relevance of math lessons and help students connect lessons to the real world, continuing their curiosity after they leave the classroom. This curiosity will continue independent thinking and promote a life of mathematics learning.

Current Trends in Mathematics Instruction

Curriculum in schools is shifting to a field in which "reading, writing, and mathematics are viewed as tools for learning and not as ends in themselves" (Whitin, Mills, & O'Keefe, 1994, p. 171). The use of an integrated curriculum results in an approach to instruction in which students see life as a series of interrelated problems vs. segmented subject areas. This cross-curricular view helps students use their multiple problem solving skills when facing challenges in their daily life.

Standards Based Curriculum

All students deserve a high quality public education (Thompson, 2001). Standards based reform was created to develop an equivalent education for the 50 million school children in this country. According to Thompson, the purpose of the standards based reform movement was to decrease teacher isolation and increase collaboration around a common set of standards so that: (a) students, (b) teachers, (c) parents, and (d)

administrators hold a shared understanding of educational goals. Additionally, the use of a standards based education allows for public accountability and includes the teacher's responsibility to meet annual goals and objectives.

Standards based education defines what all students should learn at each grade level (Thompson, 2001). This consistency helps to provide an equal education for all U.S. students. Additionally, standards based education maintains numerous assessment opportunities to evaluate whether content is aligned to the standards. Students who are not proficient can be identified through the numerous assessments and may be eligible for additional support.

The Effect of Assessment on Mathematics Instruction

The overemphasis on assessment has affected both students and teachers. O'Brien and Moss (2004) predicted that the extreme use of standardized tests will produce another generation of students who hate mathematics and will become mathaphobes. Additionally, Wise (1996, as cited in Robinson, 1996), President of the National Council for the Accreditation of Teacher Education, declared, "Test-driven mandates say to teachers - Don't teach everything, just the basics; don't teach children to write, just teach them to fill in the blanks; don't teach them to think, just teach them to give the right answers" (p. 390). Unfortunately, there is a fundamental mismatch between the core curriculum that the members of the NCTM recommended and the basic skills that are measured in most standardized assessments. For instance, most standardized mathematical achievement tests assess basic computational skills and facts rather than the higher order thinking skills promoted by the members of NCTM (Robinson). Therefore,

teachers need to implement teaching and assessment practices that promote both fundamental and higher order thinking skills concurrently.

Learning Difficulties in Mathematics

Students and adults of all ages have difficulties with mathematics. While many students in the U.S. suffer from mathematical learning difficulties (Smith, 1997), others suffer daily from anxiety related to mathematics. Kinesthetic approaches to instruction can assist students to overcome their difficulties in mathematics.

Mathematics Anxiety

Many U.S. adults and children suffer from a psychological disorder called "mathematics anxiety" (Smith, 1997). Mathematics anxiety can be described as: (a) an uneasiness when asked to perform mathematically; (b) avoidance of mathematics classes until the last possible moment; (c) feelings of physical illness, faintness, dread, or panic; (d) inability to perform on a test; and (e) participation in tutoring sessions which result in very little success (Smith). This disorder has become a problem in the U.S. because many people cannot perform simple problem solving activities in order to function in social, educational, or occupational settings.

Cruikshank and Sheffield (1992), report that mathematics anxiety is the result of incompetent teachers. Cruikshank and Sheffield believe that teachers, who fail to implement the following seven measures, instill mathematics anxious behaviors in their students:

1. Show they like mathematics
2. Make mathematics enjoyable
3. Show the use of mathematics in careers and everyday life
4. Adapt instruction to student interest
5. Establish short-term, attainable goals

6. Provide successful activities
7. Use meaningful methods of teaching so that math makes sense (p. 24)

Effective teachers who implement the seven successful traits mentioned above create a positive learning environment for their students. A positive classroom environment reduces anxiety and increases successful mathematical learning.

The use of effective mathematics instruction has been shown to ameliorate mathematics anxiety (Vinson, Haynes, Jonita, & Gresham, 1997). Vinson et al. found that when students were involved in hands on instruction through the use of manipulatives, constructivism, literature, and other problem solving activities, the effective instruction helped make mathematics meaningful. Similarly, Smith (1997) reported that mathematics anxiety, a learned behavior, can be unlearned through the use of positive self talk. As a learned behavior, Smith explained that students can talk their way through their mathematics anxiety and boost their self confidence through positive self-talk.

Integration of Literature and Mathematics

Teachers can successfully integrate literature into the mathematics curriculum. Whitin (1992) wrote, "There is no more powerful vehicle for meeting new goals in mathematics than the use of children's literature in the classroom" (p. 24). Integrating literature into mathematics can help teachers use a constructivist approach to: (a) provide relevance, (b) increase motivation, (c) promote critical thinking and (d) improve problem solving skills through storybook examples (Haury, 2001; Mink & Fraser, 2002).

Mathematics should not be taught solely through children's literature, but rather integrating literature into mathematics should be used as one piece of a well designed

mathematics curriculum (Hurst, 1996). According to Hurst, the goal of a successfully integrated curriculum is to blur the distinction between mathematics and literature to let children explore mathematics concepts without destroying the work of literature. Although some books are mathematical stories, other books introduce mathematics in more subtle ways (Welchman-Tischler, 1992). There are many uses for children's literature in mathematics; Welchman-Tischler identified seven ways to use stories in mathematics.

1. To provide a context or model for an activity with mathematical content,
2. To introduce manipulatives that will be used in varied ways (not necessarily as in the story),
3. To inspire a creative mathematics experience for children,
4. To pose an interesting problem,
5. To prepare for a mathematics concept or skill,
6. To develop or explain a mathematics concept or skill, and
7. To review a mathematics concept or skill. (p. 6)

Through the use of intriguing storybooks, children can see multiple purposes for the use of mathematics in everyday life (Whitin, 1992).

Benefits of Literature in Mathematics

The use of literature in mathematics can help teachers "take the numb out of numbers" (Whitin, 1992, p. 26). Instead of mathematical computations, story problems can provide explanations of the mathematics and stories behind problem solving. One use of storybooks in mathematics can help children: (a) gain a better understanding of concepts, (b) demonstrate the practical applications of mathematics (Whitin), and (c) illustrate how mathematical concepts are present in familiar settings that are appealing to students (Murphy, 1999). Teachers, who integrate literature into mathematics, can

develop important problem solving abilities in their students that will continue to assist them throughout life (Moyer, 2000). Additionally, many storybooks used in mathematics demonstrate a variety of situations that teach students how to: (a) solve personal problems, (b) cope with conflict, and (c) take responsibility (Hong, 1996).

Student Attitudes toward Classroom Environments

The use of literature in mathematics has been shown to improve student's attitudes toward mathematics (Hong, 1996; Mink & Fraser, 2002). Mink and Fraser conducted a study to analyze student attitudes toward classroom environments. The researchers concluded through their analysis of data that "using children's literature in the mathematics classroom empowers students to learn mathematical concepts" (p. 21). Changes in student attitude toward the subjects of mathematics, writing, and reading were also analyzed. Mink and Fraser found statistically significant ($p < 0.01$) differences in attitude, between pretest and posttest, for both mathematics and writing. However, attitudes toward reading did not show a statistically significant change. Mink and Fraser (2002) concluded that implementing literature into mathematics can improve student's perception of the classroom environment and change the students' attitudes toward reading, writing, and mathematics.

Preference of Literature in Mathematics

Integrating literature into mathematics can also increase students' opinions of mathematics. Similarly, Hong (1996) conducted a research study and found that the use of children's literature in mathematics can improve students' disposition toward mathematics. Hong's (1996) findings suggested that the use of storybooks in mathematics helped students to experience relevant mathematical problem solving and

provided connections between: (a) mathematics, (b) imaginative ideas in storybooks, and (c) real life situations. Hong demonstrated that a student's choice to voluntarily pursue mathematics learning through the use of centers can be increased with the use of children's literature.

Learning Difficulties and the Use of Literature

When literature is integrated into mathematics, mathematical concepts can be presented in a nonthreatening setting that is not intimidating for students who struggle with mathematics (Callan, 2004; Whitin, 1992). A nonthreatening learning environment increases the confidence of young mathematicians (Thrailkill, 1994; Whitin). The use of storybooks in mathematics is also an effective way to show concepts visually, which helps visual learners who have mathematical learning difficulties (Murphy, 1999). Murphy (1999) found that the visual representations in storybooks assisted some children in understanding difficult concepts when they were portrayed through the "context of a story and illustrated through diagrams, graphs, and other visual related displays" (p. 122).

In addition, the integration of literature into the mathematics curriculum allows a teacher to help students with learning difficulties by individualizing instruction and teaching to many ability levels in one lesson. Students are able to focus on their academic strengths and weaknesses in the classroom setting. The subtle differentiated instruction allows struggling students to not feel singled out with individualized lessons or teaching.

Detriments of Literature in Mathematics

The use of literature in mathematics, however, is not always beneficial. Whitin (2002), an author of numerous books and articles on the use of literature in mathematics, identified four factors that negatively influence the use of stories in mathematics:

1. Certain pieces of literature are poorly written,
2. Some books are narrowly prescribed for a particular grade level to teach a particular skill,
3. The potential for engaging children in interesting conversations about books is sometimes thwarted by teachers who decide in advance how the book is to be used, and
4. Teachers do not always mine the rich mathematical potential of good stories. (pp. 503-504)

Some books are identified as containing mathematical content but do not have an engaging story. Another detriment of mathematical literature is the use of a book for a specific grade level. Using the book for a specific grade level can hinder student learning if a teacher uses the book with too specific of an activity. However, an effective teacher can look beyond grade level and adapt a story for the appropriate content.

Often, teachers design or use a lesson plan based on a piece of children's literature with a particular discussion in mind. This narrow focus prevents students from exploring their own concepts, since the teacher might direct the conversation in ways that the students did not consider or find interesting. One benefit of discussing literature during mathematics is that students are able to decide where the conversation will go.

Finally, teachers are not always prepared for the complex mathematical conversations students may initiate after reading a good book. Before a lesson begins, teachers should anticipate the discussion extensions that may be presented. Teachers should be prepared to discuss complex mathematical concepts that may arise from a story and allot the necessary time for students to share personal experiences similar to the characters in the book.

Promotion of Communication in Mathematics

Mathematics should be thought of as a language; if students are to communicate the language of mathematics accurately, they must be able to understand and apply their knowledge (NCTM, 1989). Just as young children need to practice verbal communication often, they also need opportunities to apply their mathematical language. The daily verbal mathematical connections are necessary if children are to learn and speak mathematically (Moyer, 2000). The use of children's literature in mathematics encourages: (a) discussion, (b) debate, (c) questioning, (d) confirmation, and (e) extension of the main idea of the story (Whitin, 1992). The sharing of personal connections to the problems of a story enhances the discussion for the entire class and allows other students to make links to their daily lives (Callan, 2004). When students can relate to their peers' experiences, they often can think of a similar experience they have encountered. Whitin (2002) emphasized the importance of communication when he stated, "by using literature, we celebrate children's voices and build inquisitive mathematical communities" (p. 503).

Communication in mathematics is not just important for building social relationships in children. According to the members of the NCTM (1998),

> communication plays an important role in helping children construct links between their informal, intuitive notions and the abstract language and symbolism of mathematics; it also plays a key role in helping children make important connections among (a) physical, (b) pictorial, (c) graphic, (d) symbolic, (e) verbal, and (f) mental representations of mathematical ideas. (p. 26)

Additionally, a teacher plays a key role in leading mathematical discussions in class (Lewis, Long, & Mackay, 1993). A teacher can improve communication in mathematics by (a) asking students to clarify and justify their answers, (b) remaining neutral when

incorrect answers are given, and (c) encouraging students to comment on classmate's ideas.

Lewis et al. (1993) promoted communication integrated in mathematics and literature through the use of copycat books. Copycat books are stories the students write themselves, modeled after a mathematical storybook they have read recently. In a copycat book, the student will take a mathematical concept and create a storybook with a personal connection. Through the use of their language abilities, students can understand and apply mathematical concepts while writing and solving their own word problems.

Choice of Appropriate Trade Books

The use of trade books in mathematics has gained popularity with teachers (Hellwig, Monroe, & Jacobs, 2000). Storybooks in mathematics can be used to present exciting stories that children can relate to and draw connections between their life in the classroom and at home. Trade books are story books that can be purchased at a general retail store. Although some trade books marketed to mathematics teachers are engaging and relevant stories, others resemble glorified textbooks. In other words, all trade books are not created equal. Therefore, all trade books are not suitable for effective mathematical instruction.

It is important that time and effort is put into mathematical trade book selection. Whitin (2002) agreed that "good books enrich our daily living and deepen our appreciation of what it means to view the world mathematically" (p. 503). Therefore, it is necessary for teachers to select high quality trade books for a successful integration of literature into mathematics. Any storybook can be twisted into the mathematical

curriculum (Hurst, 1996), but it is important that books are chosen selectively when trade books are bought from the general retail store.

When choosing books, there are four general types of trade books to choose from. Gailey (1993) described four categories of trade books for mathematics instruction:

1. counting books - counting books are colorful picture books that have a subtle message used to develop and reinforce counting and number concepts.
2. number books - number books are used to increase number sense and demonstrate to students that numbers have a specific meaning.
3. miscellaneous storybooks - miscellaneous storybooks are books that were not written to be used in mathematics, but contain a mathematical concept.
4. concept books - concept books, also known as informational books, are used to explore a specific mathematical process. (Gailey, 1993)

When choosing books, it is important to carefully evaluate texts before classroom use. Hellwig et al. (2000) developed an evaluation scale for the selection of trade books for mathematics. The evaluation scale consists of the following criteria: (a) accuracy, (b) visual and verbal appeal, (c) connections, (d) audience, and (e) the Wow Factor.

Accuracy is an important factor; teachers must determine whether, the facts are presented accurately, and whether the concepts are represented and labeled correctly. Additionally, a book with strong accuracy should have illustrations that complement the text, rather than distract from the reading. If a book contains inaccurate information, teachers can use the inaccurate information as a teachable moment by asking students to identify the errors.

The next criteria, visual and verbal appeal, is necessary for an exciting book to use in mathematics instruction. A book that is considered visually and verbally appealing should have interesting pictures that follow the text as well as clear and engaging text.

One of the main reasons to integrate literature into the mathematics curriculum is to build connections and meaningful relationships between mathematics and the real world.

The connections presented in children's literature must be "authentic, not contrived; they should help children learn to think about mathematical ideas as ways of expressing relationships rather than as discrete bits of information to be memorized and retrieved" (Hellwig et al., p. 141).

Books read during mathematics instruction must be appropriate for the specific audience. Although students of any age might enjoy the story, the mathematical concepts might not be relevant to all students.

Finally, the Wow Factor is the final criteria for the selection of a quality trade book. Hellwig et al. described a successful book as an "unexpected freshness and appeal to the content. These books draw the reader to new heights, stir new ideas, and add rich, multilayered connections to existing knowledge" (p. 142).

Teachers should always evaluate books before using new materials with students. Book lists, recommendations, and other publications are often helpful for providing suggestions for good materials but teachers know their students the best. It is important to choose stories that accurately portray mathematical concepts that will engage the particular audience. Additionally, it is important that the material is timely and fits in with current curriculum.

Chapter Summary

As demonstrated in this chapter, the integration of literature into the mathematics curriculum is a successful way to increase: (a) understanding, (b) motivation, (c) relevance, (d) achievement, (e) interest, and (f) problem solving skills in upper

elementary students. The use of children's literature in the mathematics curriculum is an effective and pleasant way to break up the monotony of numbers and introduce communication into mathematics through the use of: (a) discussion, (b) debate, (c) personal connections, (d) storytelling, and (e) the recreation of stories.

The literature (e.g., Whitin, 2002; Hellwig, Monroe, & Jacobs, 2000) suggests there is a great need for more integration of literature in the mathematics curriculum. The use of storybooks in mathematics is a natural way to present problem solving situations and to demonstrate the steps involved to solve a complex problem. In Chapter 3, this researcher describes the method, target audience, goals, and procedures used to develop the handbook presented in Chapter 4.

Chapter 3

METHOD

The purpose of this project was to develop a handbook to help elementary teachers integrate children's literature in their upper elementary mathematics lessons. The handbook, presented in Chapter 4, shows teachers how to effectively integrate literature into the mathematics curriculum; it also includes appropriate literature recommendations aligned with Colorado Mathematics Content Standards for the upper elementary grades.

Target Audience

This project was designed for teachers with students in the upper elementary grades. Teachers who teach mathematics, teachers who are interested in the use of interactive approaches to teaching mathematics, and teachers who appreciate problem solving instruction in mathematics can benefit from this project.

Goals and Procedures

The goal of this project was to provide teachers with a handbook to introduce and enrich mathematics units in the upper elementary curriculum. The purpose was not to provide complete lessons but rather illustrate how literature can be used as a weekly supplement to: (a) enrich the curriculum, (b) create relevance, (c) promote discussion, and (d) increase problem solving skills.

Peer Assessment

The handbook was assessed by three colleagues through informal feedback, recommendations, and suggestions for further research. Each colleague was asked to review the curricular guide for: (a) accuracy, (b) ease of use, (c) relevancy, (d) age appropriateness, and (e) academics as aligned to curriculum. Each colleague provided comments and suggestions on the hard copy.

Chapter Summary

By using children's literature in mathematics, teachers can help children see that life is really a story problem. Through this project, the researcher used knowledge gained from a review of literature and colleagues to create a handbook to supplement the upper elementary mathematics curriculum. In Chapter 4, the detailed handbook is presented for the use of teachers. Discussion and colleague reviews are presented in Chapter 5.

Chapter 4

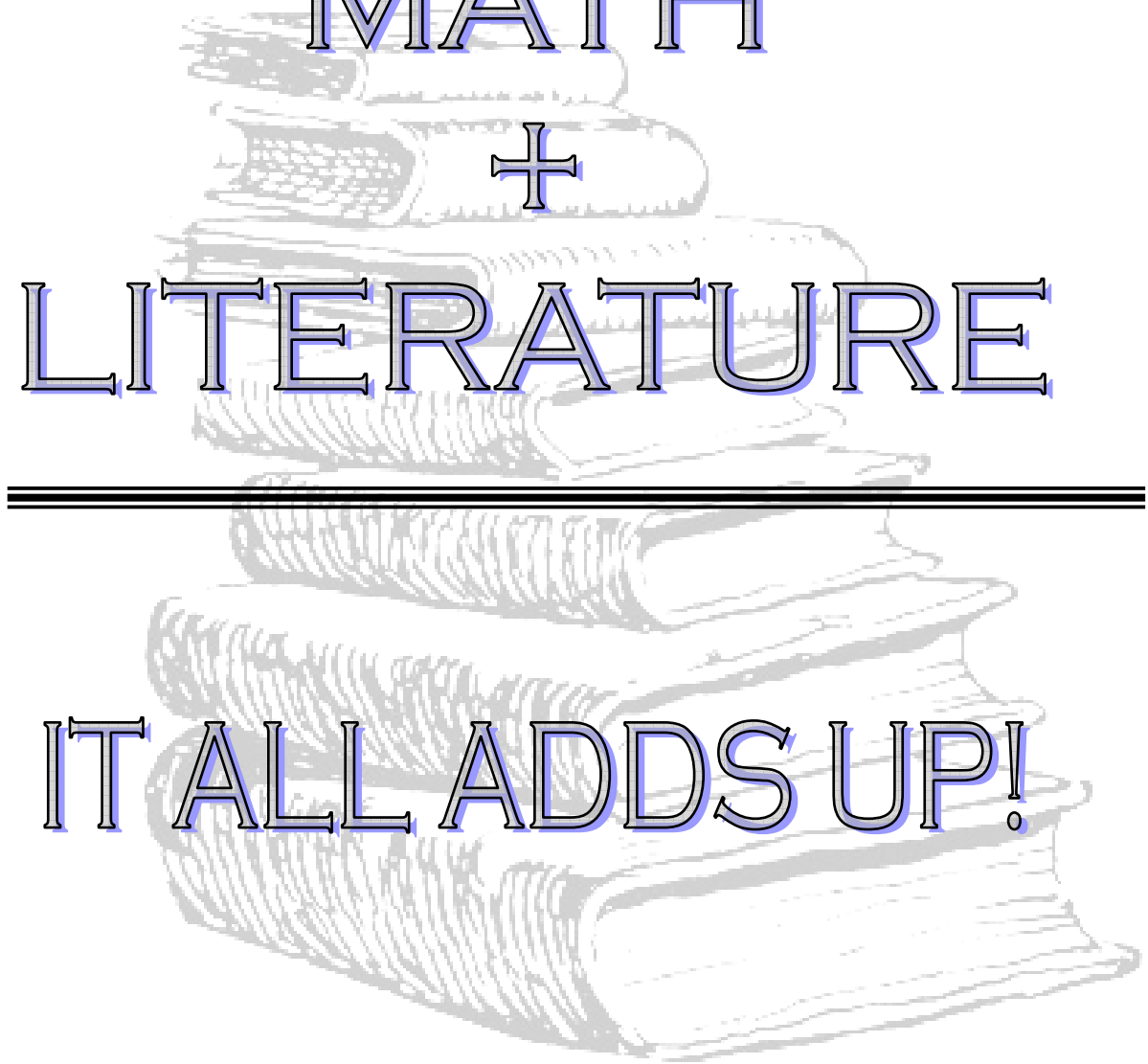
RESULTS

Mathematics instruction has been plagued with drill and skill instruction, lecture and worksheets. However, mathematics can also be taught through exciting curriculum using literature in daily lessons. Through the integration of literature and mathematics, teachers can use storybooks to demonstrate mathematical concepts in relevant contexts, where the characters in storybooks can model problem solving strategies students can then use on their own. The use of literature in mathematics can (a) create relevance in mathematics (Hong, 1996), (b) promote classroom discussion and communication between peers (Whitin, 1992), (c) assist students with learning difficulties in mathematics (Callan, 2004), and (d) encourage critical thinking by looking at problem solving from different perspectives (Haury, 2001).

Handbook

The following handbook was developed to help elementary teachers integrate children's literature in upper elementary mathematics lessons while teaching to the Colorado Mathematics Content Standards. The author of this project demonstrates how teachers can effectively use children's literature in mathematics lessons to create real world connections and motivation in mathematics. Background information about literature and mathematics, activity lists, and tips are provided as an introduction to the handbook, and then fifteen storybooks to use in upper elementary mathematics classrooms are recommended. By including a summary of the story, standards the book

can be aligned to, possible discussion topics, and activity suggestions, teachers can use this handbook as a guide while designing lesson plans that incorporate literature into the standardized mathematics curriculum. This handbook can be used to introduce and enrich mathematics units in the upper elementary curriculum. This curriculum should not be the sole teaching material for mathematics but a weekly supplement to: (a) enrich the curriculum, (b) create relevance, (c) promote discussion, and (d) increase problem solving skills.



MATH + LITERATURE

IT ALL ADDS UP!

A Teacher Guide
Created By
Jaime Elrath Goldstein
2007

Table of Contents

Books are for Reading!
Isn't Math about Numbers?

Why Should We Use Literature in Mathematics?

We can use children's literature in math as a fun way to teach children math! Most students love to be read to and listening to a story is a more interesting way to learn about a mathematical concept.

Additionally, we very rarely encounter a math problem in our daily life as a simple algorithm. Most of the time, we are required to analyze an event and decide which mathematical operation is needed. Therefore, the use of literature in mathematics presents a word problem that needs to be solved.

Mathematically speaking,
Life is a word problem!

How to Effectively Use Children's Literature in Math

Do:

- use children's books in math to introduce, enhance, emphasize, or reinforce a concept
- use children's books to create relevance in mathematics
- use children's books in math to encourage discussion and to allow students to talk about personal experiences with the concepts
- use children's books in math as an opportunity for student-centered instruction
- use children's books during number talks in math class
- use children's books in math as a different way to learn math

Don't:

- use children's books as the sole mathematics curriculum
- pigeon-hole/over-plan where the discussion should go
- overuse children's books in mathematics

MATH ACTIVITIES
TO USE WITH CHILDREN'S BOOKS

- Copy Cat Books/Make Your Own Book
- Games
- Crafts
- Artwork
- Riddles
- Outdoor Activities
- Physical Education Activities
- Math Manipulative Activities
- Building Blocks
- Cooking
- Party Planning
- Grade Calculating
- Solve Problems in the Books

Standards, Literature, and Mathematics... It all works out!

Although teachers are required to teach to state standards, they still can use children's literature in mathematics. The books in this guide are all aligned with the standards on the following page.

David Whitin
Researcher, Author, and Professor, who has numerous articles on the subject of Literature and Mathematics said,

"There is no more powerful vehicle for meeting new goals in mathematics than the use of children's literature in the classroom" (2004)

and

The use of literature in mathematics can help teachers "take the numb out of numbers" (1992)

7 Ways to Use Stories in Math

- To provide a context or model for an activity with mathematical content,
- To introduce manipulatives that will be used in varied ways (not necessarily as in the story)
- To inspire a creative mathematics experience for children
- To pose an interesting problem
- To prepare for a mathematics concept or skill
- To develop or explain a mathematics concept or skill
- To review a mathematics concept or skill

Welchman-Tischler, R. (1992). How to use children's literature to teach mathematics. Reston, VA: National Council of Teachers of Mathematics.

MATH CONTENT STANDARDS

Standard One: Number sense

Students develop number sense, and use numbers and number relationships in problem-solving situations. They are able to communicate the reasoning used in solving these problems.

Standard Two: Algebra, patterns, and functions

Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.

Standard Three: Statistics and Probability

Students use data collection and analysis, statistics, and probability in problem solving situations and communicate the reasoning used in solving these problems.

Standard Four: Geometry

Students use geometric concepts, properties, and relationships in problem solving situations and communicate the reasoning used in solving these problems.

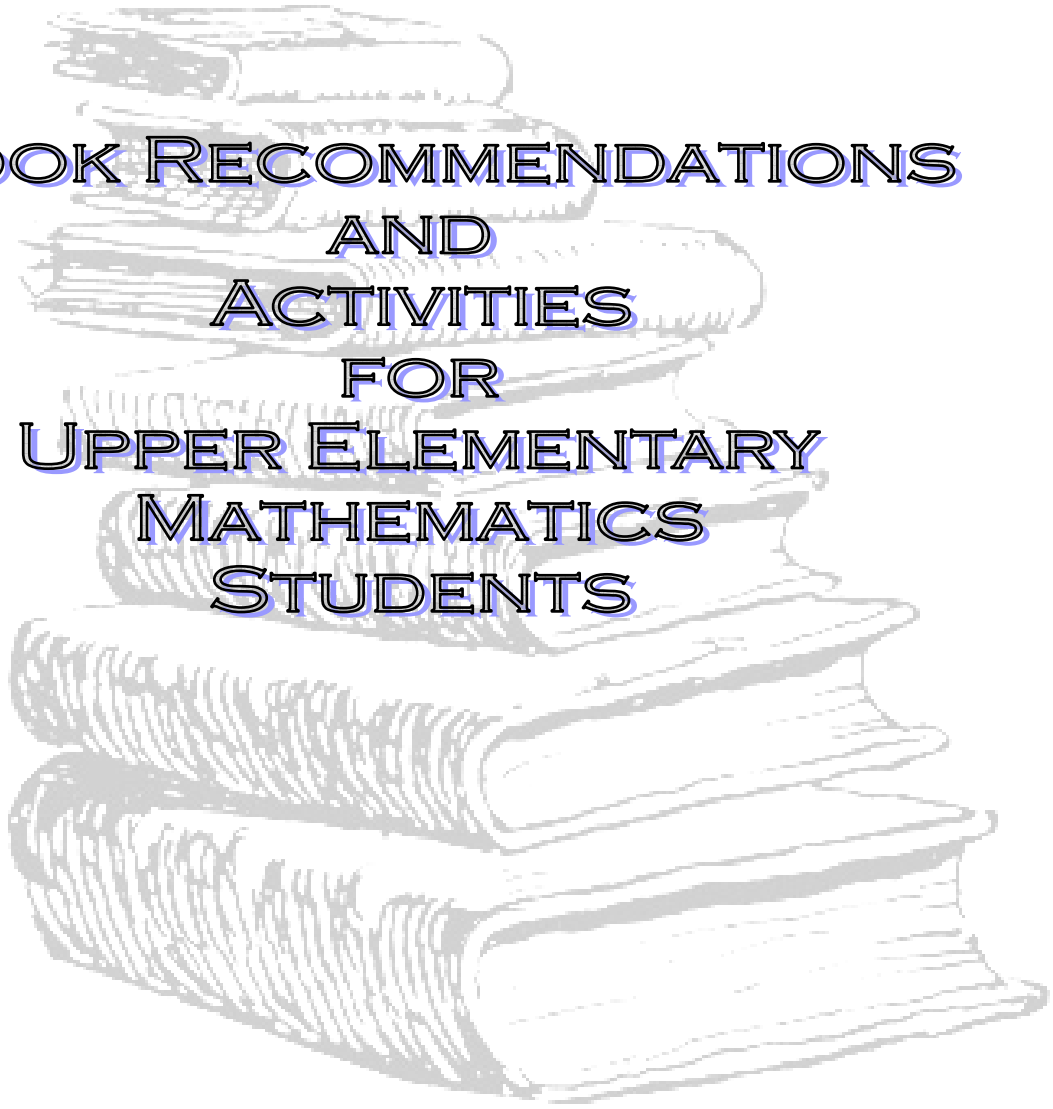
Standard Five: Measurement

Students use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.

Standard Six: Computational Techniques

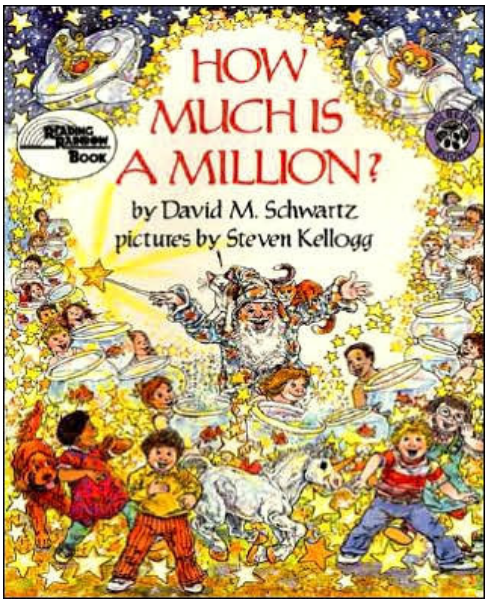
Students link concepts and procedures as they develop and use computational techniques, including estimation, mental arithmetic, paper-and-pencil, calculators, and computers, in problem-solving situations and communicate the reasoning used in solving these problems.

St. Vrain Valley School District Math Standards Grade 5:
http://www.stvrain.k12.co.us/academicsPrograms/Standards_2005/5_Math.pdf



Book Recommendations and Activities for Upper Elementary Mathematics Students

How Much Is A Million?



Author: David M. Schwartz

Illustrator: Steven Kellogg

Concepts:
Place Value: Million and Billion

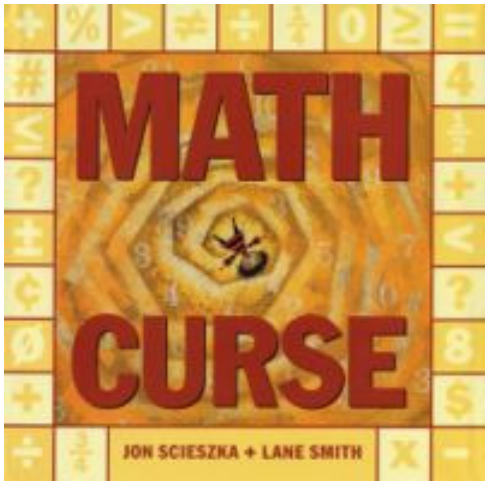
Standard 1: Number Sense

Summary:
This book is full of beautiful illustrations to help students (and adults) conceptualize the numbers million and billion which we often use but do not understand their size. For example, if a goldfish bowl held a million goldfish- it could hold a whale! You will also learn how long it would take to count to a million, how tall a million kids would be and many other cool facts!

Possible Discussion Topics:
It is so often we mention we have a million things to do! Do we ever really have a million things to do? This story puts into perspective how large the number one million really is.

Activity Suggestions:
Try to calculate a million of something through multiplication or division (the back of the book explains the calculations that were used in the book).

Math Curse



Authors:
Jon Scieszka and Lane Smith

Illustrator: Lane Smith

Concepts: Problem Solving

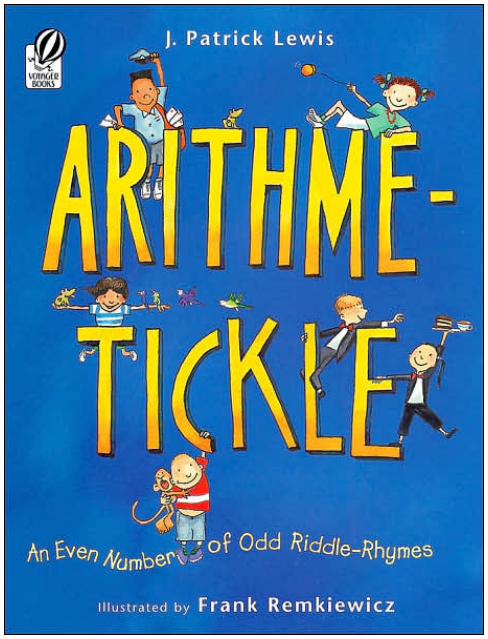
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
The teacher mentioned that you could think of everything as a math problem and the next morning the narrator wakes up plagued with the math curse! Math is everywhere! This funny book exaggerates how much math is in our life by creating math problems out of all the numbers encountered that morning.

Possible Discussion Topics:
This is a great story to start a discussion about how much math is around us and how often we use math in our lives. Also use this opportunity to discuss examples in the story that are not mathematically correct and/or possible.

Activity Suggestions:
A great classroom activity to use with Math Curse is to make a copycat book. Each student will make and solve their own story problem where they have or could encounter math in real life. They must make the problem challenging, solve the problem, and create an illustration for their math curse problem. If the teacher chooses, the problems could be bound into a classroom Math Curse book.

Arithme-Tickle



Author: J. Patrick Lewis

Illustrator: Frank Remkiewicz

Concepts: Problem Solving

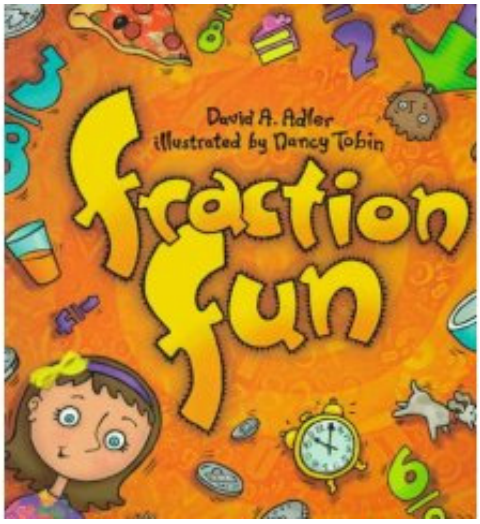
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
This rhyming book says it has "an even number of odd riddle rhymes" which is a good description of the funny stories it tells. The clever riddles and great illustrations make the riddles fun to solve!

Possible Discussion Topics:
The logic puzzles in this story bring up a lot of discussions as you go so be prepared to re-read the riddles a few times!

Activity Suggestions:
Fun problem solving activities for the students to solve in groups or individually!

Fraction Fun



Author: David A. Adler

Illustrator: Nancy Tobin

Concepts: Fractions

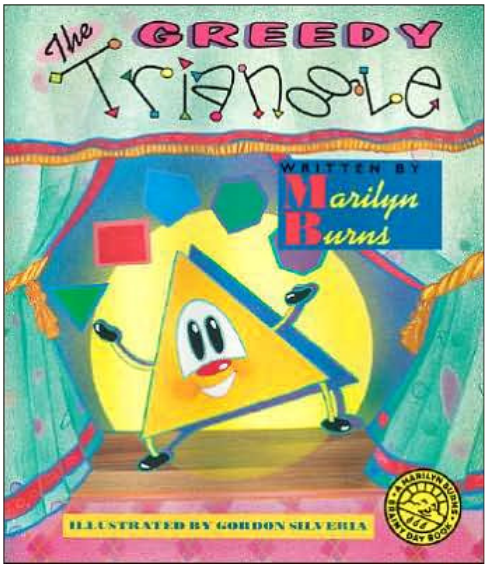
Standard 2: Algebra, Patterns, and Functions
Standard 4: Geometry
Standard 5: Measurement

Summary:
This fraction story shows students that we use fractions all the time! By giving examples of all the fractions in our life, Fraction Fun is extremely specific with ideas kids can relate to such as food, age, and money.

Possible Discussion Topics:
This book will create a lot of discussions based on personal experiences the kids have encountered. Specifically, they will want to talk about sharing food, how old they are, their experiences with money, and other examples the book discusses.

Activity Suggestions:
The book actually gives project ideas and tells students how to see fractions using paper plates, money, scales, and food.

The Greedy Triangle



Author: Marilyn Burns

Illustrator: Gordon Silveria

Concepts: Geometry

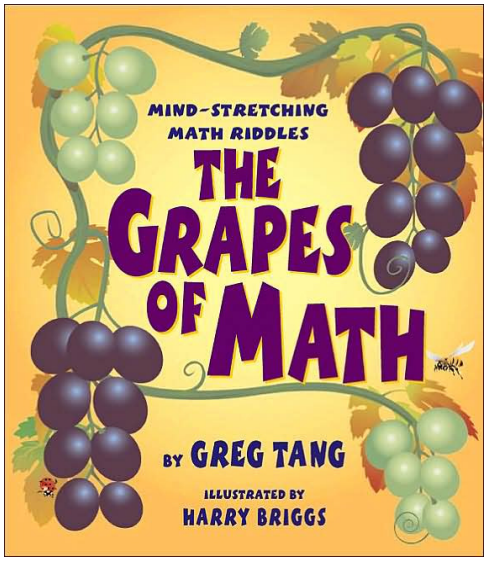
Standard 2: Algebra, Patterns, and Functions
Standard 4: Geometry

Summary:
The Greedy Triangle was not happy being a triangle and wanted another side! So she got another side but was still not satisfied. Follow this colorful story as the polygon changes shapes and sees what other shapes are out there in the world.

Possible Discussion Topics:
This story shows students the shapes in our world. It is fun to point out the different shapes in the classroom, in books, and all over!

Activity Suggestions:
There are many activities that you could do with this book but one activity would be to create a shape book where the students have to find each shape in real life and then draw that shape on the page of their book. In the story, a bridge is a triangle, a lady's dress is a triangle, the floor tiles are hexagons, etc. You will be amazed what the kids will find!

The Grapes of Math



Author: Greg Tang

Illustrator: Harry Briggs

Concepts: Problem Solving (Addition, Subtraction, Multiplication, Division)

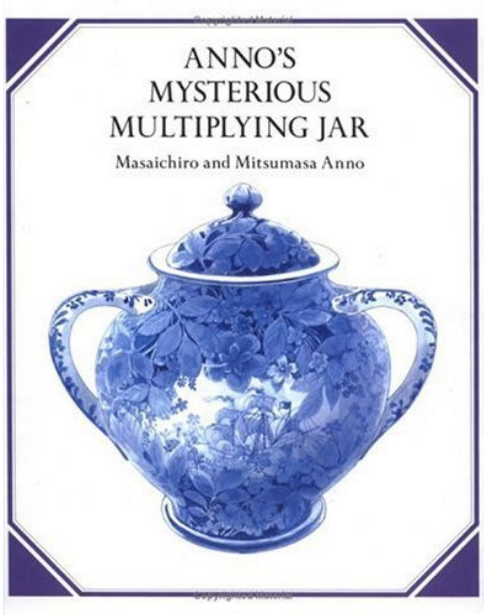
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
These clever riddles teach children how to use patterns to count a large number of items quickly. Colorful pictures and fun rhymes help boys and girls get into the problems to make problem solving fun!

Possible Discussion Topics:
This is a fun book because the rhymes just roll off your tongue and the kids love talking and laughing about it. Lots of discussion will come of this story!

Activity Suggestions:
Copycat books are a great activity after this book! The counting games and rhymes are fun to copy because they are a blast to draw and write!

Anno's Mysterious Multiplying Jar



Authors:
Masaichiro and Mitsumasa Anno

Concepts: Multiplication (Factorials)

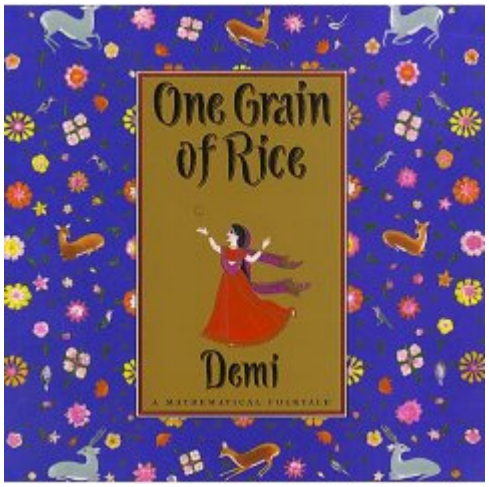
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
This story starts out about a simple jar. However, the story becomes quite complex. Inside the jar was water that becomes a sea with an island. Soon, the island has two countries with three mountains and four villages. This counting book becomes a story that explains the complex mathematical term of factorials.

Possible Discussion Topics:
This book is bound to become a complicated discussion and might be too difficult for some classes. Teachers should read the book and become familiar with the concept of factorials before using the book in the class and make sure an entire class period is dedicated to the story.

Activity Suggestions:
Teachers should experiment with the activities in the back of the book before class and brush up on factorials before teaching this complicated lesson!

One Grain of Rice



Author and Illustrator: Demi

Concepts: Multiplication

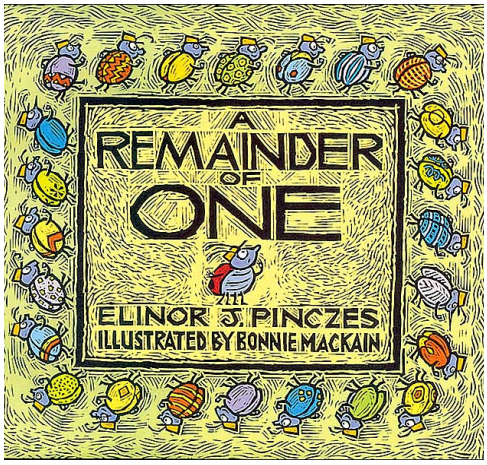
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
This beautiful Indian folktale is a story about a greedy Raja who keeps all the rice for himself while his country is suffering from a famine. Red and gold illustrations help tell the story of a young girl who convinces the Raja to give her one grain of rice on the first day and give her double the amount each day for 30 days. The Raja figured that was harmless and agreed to her request. On the 30^{th} day, the Raja gave Rani 536,870,912 grains of rice. Over the month he gave her a total of over a billion grains of rice.

Possible Discussion Topics:
The doubling principle in mathematics is bound to create very valuable discussions in your classroom. It seems like a simple request but turns into a large number in just 30 days!

Activity Suggestions:
The best activity is to have students calculate how many dollars they would earn if they could convince someone to give them a penny one day and to double the amount each day for ten days. It turns out to be 512 cents after 10 days, 524, 288 cents after 20 days. The doubling answers are in the back of this book up to 30 days!

A Remainder of One



Author: Elinor J. Pinczes

Illustrator: Bonnie MacKain

Concepts: Division

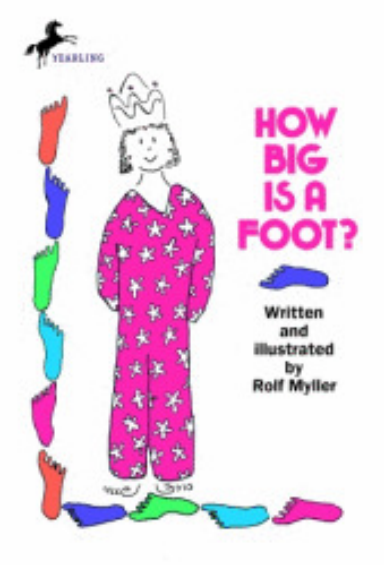
Standard 1:Number Sense
Standard 6:Computational Techniques

Summary:
A cute story about marching bugs that keep trying to divide themselves into lines so that they do not have a remainder! A good introduction to dividing with remainders.

Possible Discussion Topics:
Students could discuss in small groups how they could know if there is going to be a remainder.

Activity Suggestions:
Small group discussion or activities with manipulatives are great for learning about remainders in division. Remainders are a difficult concept for many students and a visual representation helps students see the concept.

How Big is a Foot?



Author and Illustrator:
Rolf Myller

Concepts: Measurement, Non-Standard Measurements

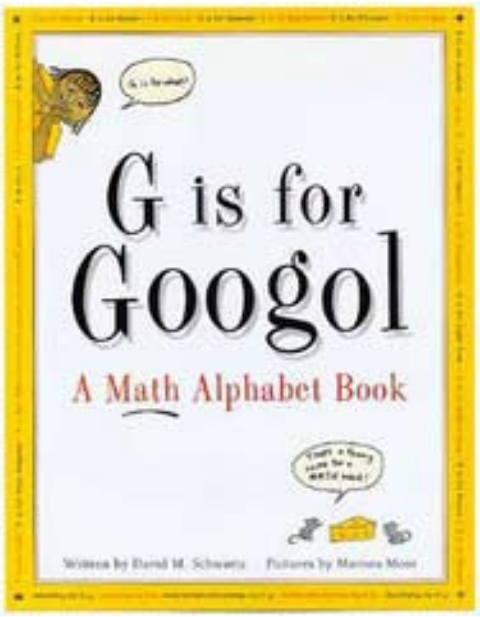
Standard 5: Measurement

Summary:
This fable tells the story of how big is a foot! The king wanted to buy a gift for the queen who had everything and finally decided to have a new bed built for her! He told his apprentice her measurements (3 ft. by 6 ft.) but the helper built the bed using his tiny feet as the standard for the measurement. When the bed arrives, it is too small for the queen but they decide that the standard for the foot measurement should be the king's.

Possible Discussion Topics:
This book is a great start to compare the difference in the size of feet between the teacher and the students and discuss why the error took place in the kingdom. It is great to discuss the need for standard measurements.

Activity Suggestions:
Any nonstandard measurement activity is fun with this book; students can use different size shoes to compare measurements around the room to see how the same item can result in the different answers.

G is for Googol



Author: David Schwartz

Illustrator: Marissa Moss

Concepts: Mathematical Terminology

Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 3: Statistics and Probability
Standard 4: Geometry
Standard 5: Measurement
Standard 6: Computational Techniques

Summary:
This unique alphabet book is not for the young but for older elementary and even adult students! Each page teaches students about a different mathematical concept and includes exciting information or problems to solve!

Possible Discussion Topics:
Each page could be used to start mathematical minds thinking! This is a great book to get math class started!

Activity Suggestions:
This book is great to use one page at a time weekly or on an occasional basis. It is also a fun activity to use for mathematical writing journals. Students can learn about the concept and solve the problems while completing a math-writing activity. A great book for big kids!

Each Orange Had 8 Slices

Author: Paul Giganti

Illustrator: Donald Crews

Concepts: Multiplication

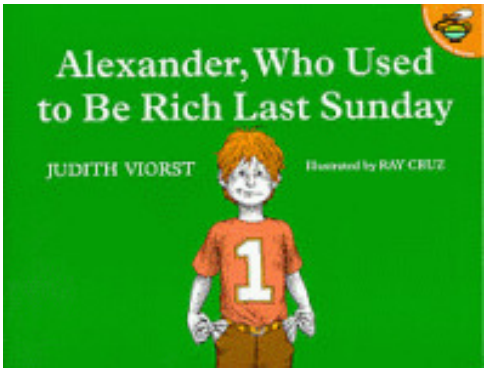
Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
Although this book may at first seem childish, once you begin reading, the math problems become quite complex! This story requires complicated multiplication problems to determine the questions asked of you!

Possible Discussion Topics:
This book asks a lot of questions so it might not spur a lot of separate discussions but the pages are quite busy so the illustrations might start side conversations.

Activity Suggestions:
The best activity for this book is to have the students solve the computations on the pages! They could count the items but all problems are much easier to multiply!

Alexander Who Used to Be Rich Last Sunday



Author: Judith Viorst

Illustrator: Ray Cruz

Concepts: Money, Budgeting

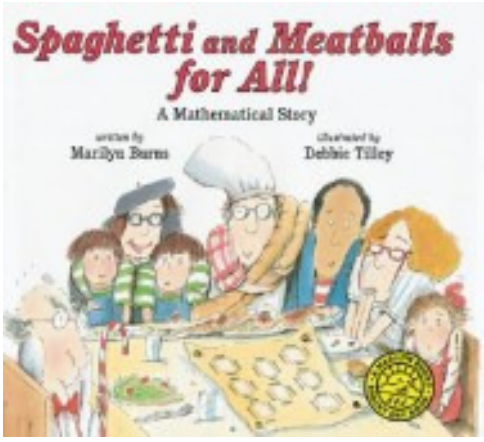
Standard 1: Number Sense
Standard 6: Computational Techniques

Summary:
Alexander's grandparents gave him a dollar and he was going to save it to buy something special but as the week went on Alexander started spending his money. This humorous story tells the struggles Alexander has with his brothers and how he copes with once being rich but now only having a few bus tokens left.

Possible Discussion Topics:
This book can begin discussions about saving money, budgeting money, and how students can earn money. Students will want to share their own personal stories about what they have done with their money and the foolish ways they have spent their money in the past.

Activity Suggestions:
Students can calculate the amount of money Alexander has throughout the book, calculate items in store circulars or take-out menus or discuss budgeting their money.

Spaghetti and Meatballs for All



Author: Marilyn Burns

Illustrator: Gordon Silveria

Concepts: Area, Perimeter, Multiplication, Division

Standard 1: Number Sense
Standard 2: Algebra, Patterns, and Functions
Standard 6: Computational Techniques

Summary:
The Comfort Family is planning a family reunion and there is math everywhere! The family has to calculate every possible configuration to fit all the relatives in the house.

Possible Discussion Topics:
The students will want to talk about times when they had parties or had to have a lot of people at their house. The teacher can try to ask them what they did about the situation and ask them mathematical questions using area and perimeter.

Activity Suggestions:
Using area, perimeter, multiplication, and division, the students should help plan the next class party. They can determine how many people can fit at each table, how many chairs can go where, how many stacks of plates, cups, etc.

Sir Cumference and the Sword in the Cone

Author: Cindy Neuschwander

Illustrator: Wayne Geehan

Concepts: Geometry

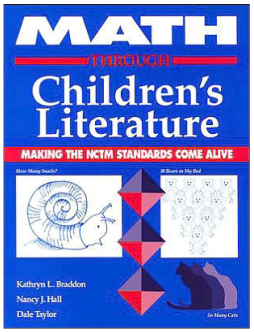
Standard 4: Geometry

Summary:
This funny story is about a kingdom with geometric names that sound like medieval names such as Sir Cumference and the Lady Di of Ameter. The kingdom is in search of the King's hidden sword; the knight who finds it will be the next king. The treasure map gives geometric clues to find the hidden sword. Students will learn geometric formulas while listening to the humorous story.

Possible Discussion Topics:
Students will want to laugh at the humorous names in the story and try to solve the mystery of the sword!

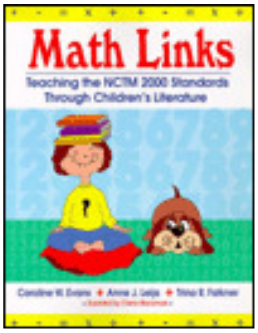
Activity Suggestions:
While reading the story, help the knights solve the mystery of the hidden sword.

Great resources for teachers who want to use literature in mathematics!



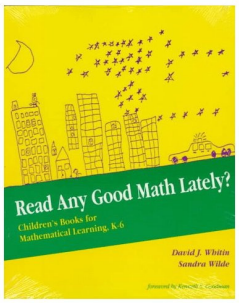
Math Through Children's Literature: Making the NCTM Standards Come Alive

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



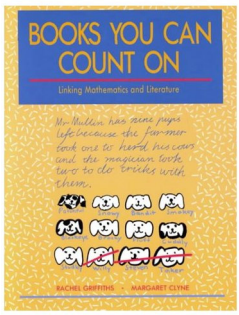
Math Links: Teaching the NCTM 2000 Standards through Children's Literature

By, Caroline W. Evans, Anne J. Leija, & Trina R. Falkner



Read Any Good Math Lately? Children's Books for Mathematical Learning K-6

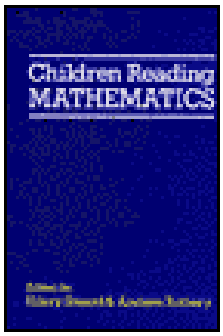
By, David J. Whitin & Sandra Wilde



Books You Can Count On: Linking Mathematics and Literature

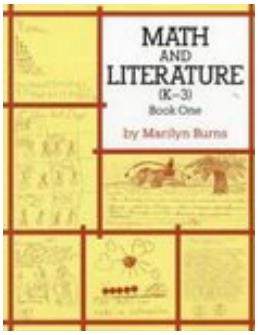
By, Rachel Griffiths & Margaret Clyne

More Great resources for teachers who want to use literature in mathematics!



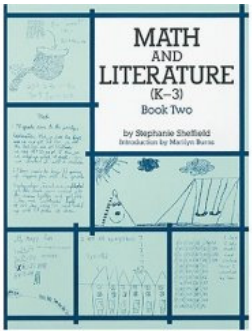
Children Reading Mathematics

Edited By, Hilary Shuard & Andrew Rothery



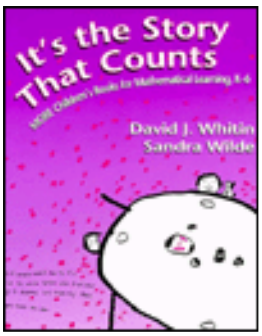
Math and Literature (K-3)

By, Marilyn Burns



Math and Literature (K-3) Book Two

By, Stephanie Sheffield, Introduction by Marilyn Burns



It's the Story That Counts

By, David J. Whitin & Sandra Wilde

Chapter Summary

Math + Literature = It All Adds Up! is a handbook developed by this author to assist upper elementary teachers with a smooth integration of literature into the mathematics curriculum. This fun supplement to the standard curriculum adds an interactive piece to instruction while promoting communication and discussion in mathematics.

In Chapter 5, the author discusses the contributions and limitations of this project. Recommendations for further research are also presented.

Chapter 5

DISCUSSION

The purpose of this project was to provide upper elementary teachers with a handbook to efficiently integrate literature into the standards based mathematics curriculum. The introduction to the handbook discussed background information about the integration of literature in the mathematics classroom as well as strategy and activity lists. The handbook included fifteen suggested stories to use in upper elementary classrooms, aligned to Colorado Mathematics Content Standards. Each literature recommendation included a book summary, possible discussion topics, and a classroom activity to be completed after the book was read. This handbook was designed to assist teachers while designing standards based lesson plans that incorporate literature into the mathematics curriculum.

Contributions of the Project

It was the goal of the author to develop a handbook to promote the use of literature in mathematics while maintaining a commitment to teaching to the Colorado Model Content Standards. It is the author's opinion that she accomplished the objectives set forth at the onset of this project. The author provided her readers with sufficient information through the Review of Literature section to support the use of literature in mathematics. Additionally, the handbook, located in Chapter 4, is in a practical format that is easy to use and applicable to upper elementary teachers.

Limitations of the Project

There are limitations in the area of the integration of literature into the mathematics curriculum. One limitation is the research available. Although there are many papers published on this topic, most are a few paragraphs citing David Whitin and Marilyn Burns and then merely bibliographies of books to use in mathematics. Additionally, there are very few research studies on the topic of literature and mathematics. Most articles are opinionated, editorials; few were actual, scientific research studies.

Recommendations for Further Research and Study

An interesting area of further study in the integration of literature and mathematics would be additional achievement research. This project was limited by a lack of quantitative, achievement data. Most data collection has been on literature and mathematics in regards to motivation. Supporting achievement data would be interesting;

Additionally, a gender based study using literature in mathematics is of interest to this researcher. Girls tend to enjoy literature and it would be interesting to see if the link of literature would help keep math motivation high.

Assessment

Three teachers reviewed this handbook and found it easy to use and teacher friendly. All three complimented the visual appeal, content, and layout. One reviewer mentioned that she liked how the handbook only included the basic information and teachers did not have to read through lengthy pages of text to find the important details for planning a lesson. All of the teachers who reviewed this handbook enjoyed the books that were chosen and agreed they were age appropriate for upper elementary students.

Additionally, all three teachers agreed that these discussions and activities would take one math period.

Suggestions from my colleagues for improving this handbook include activity modifications for struggling students as well as gifted students, adding more details to the discussion topics, and using literature as a spring board for number talks.

Chapter Summary

The use of literature in mathematics is a great way to increase problem solving relevance in the classroom. This project addressed the integration of literature into the mathematics classroom while maintaining a commitment to standards based teaching, which led to the design of the handbook presented in Chapter 4, Results. Using the research presented in Chapter 2, Review of Literature, teachers can see how the use of literature in mathematics increases relevance, improves motivation, enhances problems solving, and helps students with mathematical learning difficulties improve their mathematical communication. Through the use of this handbook, teachers can design standards based lesson plans for upper elementary students integrating literature into mathematics.

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