1999

Integrating literature-based language arts and mathematics

Lora L. Irvine
University of Northern Iowa

Integrating literature-based language arts and mathematics

Abstract

The National Counsel of Teachers in Mathematics in 1989 developed a list of 13 mathematical standards that would lead to a more effective way to teach mathematics. Before they began their list of standards, they made a list of goals. These goals stressed the importance of making learning relevant to the learner.

The goals that the NCTM developed are similar to the theoretical formulations that support instruction in the language arts. Many leading authorities in language arts advocate an instructional program that extends literature-based language arts across the curriculum. The content areas provide content and experiences with the functions of language.

This paper presents the ways teachers can connect children's literature, the language arts and the content area of mathematics in kindergarten-grade 4. The NCTM standards create a view of mathematical instruction that allows the teacher to make mathematics real and inviting, just as children's literature does.

Integrating Literature-Based Language Arts and Mathematics

A Journal Article

Submitted to the

Department of Curriculum and Instruction

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

UNIVERSITY OF NORTHERN IOWA

by

Lora L. Irvine

December 1999

This Journal Article by: Lora L. Irvine

Entitled: Integrating Literature-Based Language Arts and Mathematics

has been approved as meeting the research article requirement for the

Degree of Master of Arts in Education.

10/7/99	Jeanne McLain Harms
Date Approved	Director of Research Project
10/7/99	Jeanne McLain Harms
Date Approved	Graduate Faculty Adviser
10/8/99	Rick C. Traw
Date Approved	Graduate Faculty Reader
10/8/99	Rick C. Traw
Date Approved	Head, Department of Curriculum and Instruction

Abstract

The National Counsel of Teachers in Mathematics in 1989 began to work toward a more focused way to present mathematics instruction. They developed a list of 13 mathematical standards that would lead to a more effective way to teach mathematics. Before they began their list of standards, they made a list of goals. These goals stressed the importance of making learning relevant to the learner.

The goals that the NCTM developed are similar to the theoretical formulations that support instruction in the language arts. Many leading authorities in language art advocate an instructional program that extends literature-based language arts across the curriculum. The content areas provide content and experiences with the functions of language.

This paper presents the ways teachers can connect children's literature, the language arts and the content area of mathematics in kindergarten—grade 4. The NCTM standards create a view of mathematical instruction that allows the teacher to make mathematics real and inviting, just as children's literature does.

The role of the classroom teacher is complex because it includes educating children from many backgrounds. The teacher's awesome job is to guide students through a curriculum that is meaningful for each individual. Quality children's literature can offer powerful support to the teacher in developing such a curriculum. Literature has commonly been the base for instruction in reading and language arts. Recently, much has been made over literature-based instruction in science and social studies. Teachers have been more hesitant to use the same holistic approach to mathematics instruction, even though literature experiences can assist in making mathematics instruction relevant to students in the same way it has in other areas of the curriculum (Routman, 1991).

Literature-based instruction can enrich a school program in many ways. Books representing many genres provide experiences that allow students to create meaning for themselves (Harms & Lettow, 1992). In order for students to have such a learning experience, they must find the material relevant to their own personal experiences. Including trade books rather than just textbooks can not only increase student interest but can give more extensive information and ideas that cannot be found in the very best textbook. This broader approach to learning can nurture a changing web of interrelated knowledge (e.g., patterns, strategies,

and information) for students as they engage in a learning experience (Galda, Cullinan & Strickland, 1997).

Langer (1995) suggests that people have more than a literary experience when they are reading literature. Each person brings his/her own experiences and perspective, often referred to as prior knowledge, to a piece of literature. As new material is read, readers extend their knowledge base for future reference.

Student learning is enhanced when reading and writing are integrated throughout all of the content areas of instruction. The human mind works in units that are interrelated which is in opposition to the singular subject approach often used in classrooms. Subjects that are integrated allow students to make connections naturally. Literature-based language experiences extended across the curriculum give students opportunities to interpret concepts and make connections to their world by reflecting and discovering relevant ideas (Galda et al., 1997).

Schools are often criticized for not producing students who are problem solvers and critical thinkers. Literature-based language experiences included in a curriculum can give students opportunities to think critically and creatively in a much more natural way than the

exercises in worksheets and repetitive instruction (Huck, Hepler, Hickman, & Kiefer, 1997).

Routman (1991) states that mathematics instruction has been traditionally skills-oriented and hierarchically driven over the years. Teachers have had difficulty separating themselves from the textbook for fear of missing a skill. Routman (1991) quotes Principal Beth Lazerick, "Kids have been rewarded in math for getting the right answer, not for developing strategies for arriving at the answer" (p.290). Students have held onto the crutches of traditional mathematics instruction as much as their teachers. Children have a difficult time accepting the possibility of open-ended problems and at times become frustrated when there is not a correct response to a problem. Literature allows both the teacher and the students to see mathematics as a way of thinking rather than as parts that are learned through meaningless facts and skills (Whitin & Wilde, 1992).

In a move to enhance mathematics instruction in the elementary and secondary schools, the National Council of Teachers of Mathematics in 1989 presented a list of 13 curriculum and evaluation standards for mathematics instruction in both the elementary and secondary schools (NCTM, 1989). The standards focus on mathematics as a means of communicating through a language

system. Instead of looking at mathematics as a series of isolated skills, the NCTM standards present mathematics instruction as an integrated whole, in much the same way as the holistic approach in the language arts.

Schools face the challenge of preparing students for the future, and proper mathematical instruction is a key element to their success. The changes in society's needs are in opposition to the traditional mathematics instruction that relies on fact practice and memorization. The NCYM standards' outline of elements for mathematics instruction encourages students to learn to think and think to learn. Mathematics should be taught through exploration and group work that fosters communication (Bosom & Guth, 1995).

The NCTM standards address the need for change in the contemporary American culture; these standards are attempting to provide equity to all students, not only to the gifted elite, and to develop mathematically literate citizens who function as an informed electorate. The need for workers with minimum competencies has ended; today's factories require workers with complex knowledges, skills and technical training. Businesses no longer need workers with strong physical characteristics and basic arithmetic skills. Productive workers must be mathematically literate to solve complex problems. To be able to solve

these problems, workers must have strong understandings of mathematical processes to decide on the proper operation, apply the mathematical idea, and value the strength of mathematics. Workers should also be able to work with others to solve a problem.

Before developing the standards for mathematical instruction, the NCTM outlined five important goals to promote mathematical literacy: (1) Students should learn the value of mathematics, (2) students should become confident in their mathematical ability, (3) students should evolve into problem solvers, (4) students should communicate mathematically, and (5) students should reason mathematically (NCTM, 1989). The fulfillment of these goals should allow students to be exposed to many mathematical experiences that are interconnected with many subjects. Mathematics programs should give students the opportunities to read, write, and communicate with mathematics, thus giving them their own mathematical power.

Children's literature can provide the connectedness that the NCTM goals have elicited. Bosma and Guth (1995) compare children's literature and the content curriculum to a fine tapestry. The basic content knowledge provides the threads running lengthwise and children's literature provides the connecting horizontal threads. The better the quality of the children's book the stronger the connection will

be. Quality literature acts as a thread to interrelate one piece of curriculum to another.

The first four standards listed by the NCTM are: mathematics as problem solving, mathematics as communication, mathematics as reasoning, and mathematical connections. Literature offers many opportunities to expand on these standards. Trade books allow students to see many points of view on a topic and to read different types of text. They can give children exposure to more critical thinking experiences by involving them in the interpretation of meaning (Galda et al., 1997). Langer (1995), however, warns that some trade book experiences have "missed their mark" (p.132). In this case, literature has been added as a supplement to the curriculum. To receive the full benefit of literature experiences, they must be presented as the curriculum instead of in the curriculum.

Standard Two--Mathematics as Communication--is especially interesting as it connects the language arts and mathematics as communication. In language arts instruction, literature experiences can create a composition-comprehension connection. The same appears to be true in mathematics (Galda et al., 1997). Effective mathematics instruction can facilitate a mathematics-language connection. Cooperative learning groups can be organized in which students can

share their ideas and the processes they have used to find meaning (Routman, 1991).

Many of the mathematics tasks are similar to reading processes. Mathematics is a way to communicate data and to study pattern and order in the world. The reading process in which the reader's knowledge and textual information act together to produce meaning can connect with the mathematics process as these common tasks are applied: cause and effect, form and function, and motive and action (Braddon, Hall, & Tayler, 1993).

Writing in mathematics is an important addition. Routman (1991) relates that writing allows the child to develop more in-depth understandings of mathematical concepts. Writing nurtures children's reflection on what they are learning. Journal writing provides children with opportunities to organize their thoughts and then to share them with others, thus extending their mathematical understandings. Writing can be used as a qualitative assessment tool through journals, teacher observation, checklists, and portfolios (Galda et al., 1997).

Abilities in the areas of the curriculum do not develop in isolation. Teachers face the challenge of nurturing students for the real world. Children need to learn to be problem solvers and critical thinkers. Making a connection with children's literature, language arts, and

mathematics instruction seems to be one way to work toward the achievement of this goal.

The following discussion presents the first five NCTM standards and suggests works of children's literature that could easily be applied in instruction. These references were used in selecting specific literature works: The Wonderful World of Mathematics (1998), by Thiessen, Matthias, & Smith; Read Any Good Math Lately? Children's Books for Mathematical Learning K-6 (1992), by Whitin and Wilde; and It's the Story That Counts: More Children's Books for Mathematical Learning K-6 (1995), by Whitin & Wilde. The standards discussed are focused on kindergarten through grade 4.

Standard One—Mathematics as Problem Solving

Problem solving should be looked at as the underlying strand to all mathematics. According to the NCTM (1989), students in grades Kindergarten through Grade 4 should be able to use a variety of strategies to solve problems. Students should be able to apply these strategies in their everyday lives as well as mathematical situations. Problems that arise out of the everyday circumstances have the possibility to become a much more authentic learning experience.

Children should also be able to look back at the original problem and justify the outcome as being reasonable. As with any learning

experience, students must be able to think through a problem and look at the results to see if it makes sense. In reading, this ability is called comprehension. The most important perspective children as problem solvers can have is confidence that they have the ability to use mathematics. When children develop true problem-solving skills, they are able to think on a higher level in all areas of the curriculum.

Children's literature presents many possibilities for connecting with problem solving activities. For example, The Math Curse, by John Scieszka and Lane Smith, is one such book. The story is about a child who believes his teacher has placed a curse on him so that everything he experiences becomes a math problem. The child's day begins with a problem involving time and is quickly followed by problems involving his wardrobe. Throughout the entire day, the child visualizes a math problem in everything he does. The curse is finally broken the next day when he wakes up, asks himself a math-related problem, and can answer it. He knows that he can solve anything now.

The Math Curse is a wonderful way to invite children to look at their world in a different way. It takes everyday occurrences and makes them into a problem. Problem solving is not one particular element of mathematics; it is the inter-relatedness of all of mathematical processes (NCTM, 1989). The Math Curse includes problems in telling time,

counting money, estimation, number sense, and addition and subtraction, in addition to many others. The problems presented range in complexity from basic addition and subtraction to the higher level skills, such as probability.

For a first grade class, the problems from the story could be easily simplified to be developmentally appropriate. The organization of the math problems throughout the story, representing many mathematical processes, make it easy to refer back to the book when introducing a new skill. The authenticity of the problems allows the children to see the skill from a real world situation.

One problem the child in the story encounters is counting children as they get on the school bus. It would be simple to use this format to write new number problems. The children can act out or illustrate the problem to involve both addition and subtraction. Another problem from the same page of the book deals with collecting data and graphing to make numerical observations. For example, children can collect data on their birthdays and graph and record the results on a graph. Ideas on each page in this book can be presented in some form to make a connection to the real world and the mathematical problems faced each day.

Other Books for Problem Solving:

Anno, Mitsumasa (1977). Anno's Counting House. New York: Crowell.

Dee, Ruby (1988). Two Ways to Count to Ten. New York: Holt.

Giganti, Paul (1992). Each Orange had 8 Slices. New York: Scholastic.

Hamm, Diane (1991). How Many Feet in the Bed? New York: Simon & Schuster.

McMillan, Bruce (1991). Eating Fractions. New York: Scholastic.

Merriam, Eve (1993). 12 Ways to Get to 11. New York: Aladdin.

Russo, Marisabina (1988). Only Six More Days. New York: Greenwillow.

Standard Two: Mathematics as Communication

The NCTM believes mathematics is a language that is developed in the same way that conversational language is developed. Children are natural communicators; through discussion and practice, they become fluent. As mathematical communicators, children in grades K-4 should acquire skills that allow them to make relationships between their everyday experiences and mathematical ideas. Children should be able to use pictures, diagrams, and manipulatives to represent an idea. They should be able to ponder the ideas they

develop and elucidate their thinking. Children should also utilize all communication skills including representing, discussing, reading, writing, and listening while learning and using mathematics (NCTM, 1989).

Oral communication that includes discussion based on probing questions gives children a chance to make connections from informal thoughts to actual mathematical symbols. Teachers need to encourage children to think beyond the information in a problem to find the correct answer. Being able to talk about mathematical ideas allows children to create meaning and find new ways to think about an idea through interaction with peers.

Children need to work with many tangible objects and create representations of a given problem in order to give it meaning. Through oral communication, children can share their knowledge with peers. Teachers can elicit responses and assess the level of learning that may be occurring. Mathematics is given a chance to speak and come alive to children.

Written communication in mathematics is also addressed by the NCTM. The standards advocate the use of journals during mathematics instruction. Children can use their math journals to express their personal feelings as they work through the meaning-making process.

Writing has often been overlooked during math instruction. By using writing, teachers can encourage children to reflect on their learning in a more private way than discussion requires. At the same time, writing allows the teacher to monitor children's understandings of the concept being studied. Other examples of written communication may include letter writing to explain what is being learned, and student-written books to extend a literature experience.

The NCTM emphasizes the presentation of children's literature experiences to foster the importance of communication in mathematics. An example is: How Big Is a Foot?, by Rolf Myller. In the story, a king wants to give the queen a very special birthday gift, but the queen already has everything. The king decides to give her a bed; beds had not yet been invented so no one has one. The problem is that no one knows how big a bed should be. The king measures the queen, using his own feet, as being six feet long and three feet wide. The king sends the measurements to the head carpenter who has his small apprentice make the bed. Unfortunately, the apprentice uses his own feet to measure the bed's size so the bed turns out to be much too small. The poor apprentice winds up in jail until he figures out the real problem is the size of a foot.

As children listen to this story, they have to think about the problem the apprentice has and how to solve it. By discussing the events and even acting out the story, they can communicate the problem and find a solution to it. Children can use their own feet as a nonstandard measurement to measure other objects and illustrate the results. The visual representations can be shared in small groups to further the discovery of the value of standard measurement.

Other Books That Encourage Communication:

Crews, Donald (1968). Ten Black Dots. New York: Greenwillow.

Hutchins, Pat (1986). The Doorbell Rang. New York: Greenwillow.

Lionni, Leo (1960). Inch by Inch. New York: Mulberry.

Nathan, Cheryl and Lisa McCourt (1998). The Long and the Short of It. New York: Bridgewater.

Standard Three: Mathematics as Reasoning

Another major NCTM goal is to create a sense of power as mathematics is used in any situation. Children can gain that power through problem solving, communicating, and applying reasoning skills. Reasoning should include the ability to explain answers in a logical way. Children should be able to use models, attributes, and relationships to justify their thinking. Patterns and relationships are

important skills needed to analyze problems that occur in mathematics. Most importantly, mathematics needs to make sense.

These skills cannot be attained in isolation. Children need to be exposed to many situations that allow them to work through a situation and develop their thinking processes. Mathematical relationships need to unfold naturally as children have experiences. Children should not see mathematics as just finding an answer; it should be the process of finding the answer that is emphasized. As children work, they should be encouraged to justify their thinking in a reasonable way. As children use patterns and properties, they can begin to form relationships that lead to the development of reasoning skills.

The Button Box, by Margarette Reid, is an example of a book that can focus children's attention on reasoning skills. In the book, a young boy enjoys sorting through his grandma's box of buttons. He has a systematic way of classifying the buttons by specific attributes, such as number of holes, texture, and color. The boy explains each of his sorting strategies.

This book can be presented at the beginning of a lesson. Then children can classify groups of objects, work out their own strategies of classification, and come up with reasons for their groupings. Classification allows children to explore properties of objects in a

concrete way. Teachers can also use properties to create guessing games that allow children to practice responding with logical answers. By giving specific clues to the attributes of an object the children can assess a group of objects and eliminate what does not belong until a reasonable answer is formed. Creating patterns is also a natural outcome of this activity.

Other Books That Allow Mathematical Reasoning:

Anno, Mitsumasa (1987). Annos' Math Games. New York: Philomel.

Hoban, Tana (1981). More Than One. New York: Greenwillow.

Hoban, Tana (1984). Is It Rough? Is It Smooth? Is It Shiny? New York: Greenwillow.

Lobel, Arnold (1970). "The Lost Button" in Frog and Toad are Friends. New York: Harper & Row.

Pittman, Helena C. (1986). A Grain of Rice. New York: Hastings House.

Standard Four: Mathematical Connections

This standard promotes children's views of mathematical ideas as being connected to one another. Traditional mathematics instruction often addresses each strand of mathematics independently; children are taught computational skills, geometry, and measurement in

separate units. In order for mathematics to make sense, connections between each strand must be made. Concepts and skills that are taught in isolation require children to remember too much information and does not allow them to see the relevance of the principles involved in all mathematics. Standard Four promotes the idea that once a concept is taught it is incorporated into class instruction whenever possible; therefore, a natural flow from idea to idea is created. Utilizing everyday experiences helps children make connections between the real world and the usefulness of mathematics.

In addition to connections between concepts and processes, the NCTM suggests that the K-4 curriculum should include connections between mathematics and other areas of instruction and children's everyday lives (NCTM, 1989). Any content area can be connected to mathematical ideas. Teaching science and mathematics together is a useful way to make connections. Science involves many real world experiences and many opportunities to solve problems and apply mathematical ideas.

B. G. Hennessey's book, The Dinosaur Who Lived in My Backyard, takes a proportional view of a child's backyard and the no-longer-available-to-observe dinosaur. Based on fact, the dinosaur is one that would have inhabited that particular area. In the book, a child

imagines what a dinosaur would look like compared to objects in his backyard. For example, the child compares the dinosaur's egg to the size of a basketball. Throughout the book, concrete objects are suggested for comparison with the actual size of the dinosaur.

An exploration of dinosaurs that inhabited the local area is a fun way for children to engage in research and integrate measuring and problem-solving skills. As a result, children can learn about their area and make connections to the past. At the same time, they must apply the concept of measurement and make logical comparisons. Many of the NCTM standards can be applied in such a learning experience as well as creating a high level of interest among the students.

Other Books to Make Mathematical Connections:

Carle, Eric (1969). The Very Hungry Caterpillar. New York: Putnam.

Jonas, Ann (1983). Round Trip. New York: Scholastic.

Krauss, Ruth (1945). The Carrot Seed. New York: Harper & Row.

Viorst, Judith (1978). Alexander Who Used to be Rich Last Sunday. New York: Macmillan.

Zaslavsky, Claudia (1980). Count on Your Fingers African Style. New York: Crowell.

Standard Five: Estimation

Children in grades K-4 should have instruction in estimation that includes exploration, use in the appropriate situations, decision making for reasonability of an answer, and the application of estimation in counting, computing, measuring, and problem solving (NCTM, 1989). Estimation has become an increasingly important mathematical skill. The availability of calculators has made students depend less on computational skills and more on the ability to accept an answer as reasonable. The ability to estimate gives a child this decision-making tool.

The NCTM emphasizes that even young children should begin learning the value of making estimates because they naturally make estimates throughout the day. Do I have enough milk for cereal? How long will it take me to get to school? Can I afford this candy bar? Making an estimate is a way to make sense of a situation. Teaching children to be good estimators enhances their ability to think flexibly in their problem-solving experience.

Children's literature is a means to explore estimation. Stories can highlight the ways estimation can be used in their lives and suggest new ways to make estimations. The picture book, Counting on Frank, by Rod Clement, offers many excellent examples of someone in the

process of estimating. The book is about a boy and his dog, Frank. In the story, the boy looks at his world from a mathematical point of view. As he views his surroundings, he makes estimates of length, volume, time, and capacity. He estimates such things as how long a line would be for the life of one pen, how long it would take to fill the bathroom with water, and how many Franks it would take to fill his bedroom. This book is also helpful to young people because it shows some strategies for making an estimate and how to think mathematically.

Children can take anything that is familiar to them and think of it mathematically. The classroom and the class day present many opportunities to make estimates as the boy did in Counting on Frank. Through exploration and practice, children can perfect their estimation skills and enhance their overall thinking skills. Teachers should give students many chances to make estimates each day. Books are an inviting way to get them started.

Other Books That Encourage Estimation:

Matthews, Louise (1979). Gator Pie. New York: Dodd, Mead.

Podendorf, Illa (1970). Many is How Much? Chicago: Children's Press.

Russo, Marisabina (1986). The Line-Up Book. New York: Greenwillow.

Schwartz, David (1985). How Much is a Million? New York: Lothrop, Lee & Shepard.

Conclusion

Since the NCTM standards were written in 1989, many changes in education and general society have taken place. For example, technology has made an enormous impact on classroom instruction. The availability of computers and the Internet in schools has had a definite effect. In 1989 the NCTM encouraged the use of calculators in the mathematics instruction. In 1999 the NCTM realized that computers may now be used in many ways for mathematics instruction.

Technology has also caused great changes in the workplace. People need to think analytically and to make logical decisions. In response to this constant change, the NCTM is in the process of writing Principles and Standards for School Mathematics. The document is still in draft form and has been written to reinforce the basic standards presented in Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989).

The original document laid the foundation for all other NCTM documents. In the latest document, which is in the process of being drafted, the principles for mathematics instruction are presented in a more developmentally appropriate sequence. The emphasis of this

document is on the integration of one mathematical process with another. One difference in this latest document is that the content standards are listed prior to the process standards to give greater emphasis on the mathematical processes and their importance to the children's knowledge base. However, it is stressed that the two functions of mathematical instruction cannot be separated. Teachers must incorporate content and process standards to make mathematical instruction relevant and meaningful to the children.

Even though the latest document addresses some of the current issues in mathematical instruction, it still relies heavily on the strength that the original standards produced. The need for authentic and meaningful instruction is still the most effective way to nurture knowledgeable students. Quality children's literature allows a teacher to develop just such a scenario.

References

Professional References

Austin, P. (1998). Math books as literature--which ones measure up? New Advocate, 11, 119-133.

Bosma, B. & Guth, N. D. (Ed.). (1995). Children's literature in an integrated curriculum: the authentic voice. New York: Teachers College.

Braddon, K.L., Hall, N. J., & Taylor, D. (1993). Math through children's literature: making the NCTM standards come alive. Englewood, CO: Teacher Ideas.

Galda, L., Cullinan, B. E., & Strickland, D. S. (1997). Language literacy and the child. Fort Worth, TX: Harcourt.

Harms, J. M. & Lettow, L. J. (1992). Literature and expressive activity. (3rd ed.). Minneapolis, MN: Burgess.

Huck, C. S., Hepler, S., Hickman, J., & Kiefer, B. Z. (1997). Children's literature in the elementary school. (6th ed.). Dubuque, IA: Brown & Benchmark.

Langer, J. A. (1995). Envisioning literature: literary understanding and literature instruction. New York: Teachers College.

National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: NCTM.

Routman, R. (1991). Invitations: changing as teachers and learners K-12. Portsmouth, NH: Heinemann Educational.

Thiessen, D., Matthias, M., & Smith, J. (1998). The wonderful world of mathematics. (2nd ed.). Reston, VA: NCTM.

Whitin, D. J. & Wilde, S. (1992). Read any good math lately? Children's books for mathematical learning, K-6. Portsmouth, NH: Heinemann.

Whitin, D. J. & Wilde, S. (1995). It's the story that counts: More children's books for mathematical learning, K-6. Portsmouth, NH: Heinemann.

Children's Books

Clement, R. (1991). Counting on Frank. Milwaukee, WI: Gareth Stevens.

Hennessey, B. G., illus. Davis, S. (1998). The dinosaur who lived in my backyard. New York: Puffin.

Myller, R. (1962). How big is a foot? New York: Dell.

Reid, M. S., illus. Chamberlain, S. (1990). The button box. New York: Puffin.

Scieszka, J., illus. Smith, L. (1995). The math curse. New York: Viking.