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It figures: Language and mathematics add up through children's literature

During the last decade the role of language in learning content subjects has been increasingly explored and its centrality to understanding emphasized (e.g., Bean, 2000). The difficulty students encounter in understanding the content of mathematics presents its own special concerns. Language factors may be foremost among these concerns.

Among the theorists who have helped us shape our thinking about the role of language in learning during recent decades are Benjamin Lee Whorf, a great linguist and social scientist, and Lev Vygotsky, a noted cognitive psychologist. Whorf developed two widely circulated hypotheses regarding language and the learner. Simply stated, these hypotheses are: (a) Language is required for higher level thinking, and (b) a person's language structure molds how he[*she*] understands the world (Carroll, 1956). Complementary, although not identical, to Whorf's views are the ideas of Vygotsky regarding the role of language in learning (Wertsch, 1991). Vygotsky (1962) theorized that the development of children is dramatically affected by interaction with language. From a Vygotskian perspective, "human communicative processes give rise to mental functioning in the individual" (Wertsch, 1991, p. 13); thus, children's understanding of the world results from interaction with others through language (e.g., Reutzel & Cooter, 1996).

Evidence that "students' understanding of mathematics is dependent on their knowledge of

both mathematics as a language and the language used in mathematics" (Miller, 1993, p. 311) has been documented. In recent years the National Council of Teachers of Mathematics (NCTM) and other organizations and individuals committed to improving the teaching and learning of mathematics have addressed this issue. **Curriculum and Evaluation Standards for School Mathematics** (NCTM, 1989), a document that has helped to guide the direction of mathematics education during the last decade, identified "learning to communicate mathematically" as one of the five general goals for all students and provided guidelines for working toward this goal. The role of language in learning mathematics was further elaborated in the **Professional Standards for Teaching Mathematics** (NCTM, 1991), with three of the six teaching standards relating directly to discourse in mathematics.¹ **Principles and Standards for School Mathematics**, distributed by the NCTM in 2000, continues the emphasis on learning the language of mathematics: "Instructional programs from prekindergarten through grade 12 should enable all students to ... use the language of mathematics to express mathematical ideas precisely" (p. 60).

Because the language of mathematics is not only central to understanding mathematical content but also is notably abstract and difficult to learn (e.g., Miller, 1993; Schell, 1982), its development cannot be left to chance. For such specialized content, research suggests that "providing students with multiple sources of information and oppor-

tunities to use the words [language] in meaningful communication situations results in superior word [language] learning” (Blachowicz & Fisher, 1996). In this article, we discuss children’s literature as a context for communicating mathematically, with examples, and provide an annotated bibliography of selected resources that we have found to be helpful to teachers.

DEVELOPING THE LANGUAGE OF MATHEMATICS

THROUGH CHILDREN’S LITERATURE

Children’s trade books, when carefully selected and meaningfully shared, provide a rich context for learning the language of mathematics. They engage students in mathematical content and communication. The visual representations in picture books provide motivation and information. The story lines invite the children to question, guess and check, and try different strategies. The text and illustrations draw upon their informal knowledge developed outside of school and often connect in a variety of ways.

Mathematical journeys through literature are a wonderful way to explore concepts of numeracy. In many cultures, early numeracy learning is fostered through nursery rhymes and other counting jingles such as “One, two, buckle your shoe,” where the response is rote. With time and experience and through interaction with carefully selected trade books, children develop rational counting, including one-to-one correspondence.

Many other mathematical ideas are also developed and reinforced through children’s trade books. Relationships such as first, last, same, and different; shapes such as circle, square, and triangle; and concepts of time, money, and measurement are all presented in simple nursery rhymes and playground chants and are reinforced through children’s books. In the context of well-written stories, students intuitively begin to consider the mathematical concept presented on the pages, whether comparing sizes, learning different number systems, developing time lines, seeing geometric patterns, or solving a problem. By using literature, the beauty of the language is infused into the learning task, providing a rich context for understanding and remembering.

Examples

In such wonderful books as **Market!** (Lewin, 1996), cited by the **New York Times Book Review** as one of the best illustrated books of 1996,

children are not only involved in informative text but beautiful illustrations as well. As they learn about commodities sold in markets around the world, the students can study the currency of the different countries, compare actual prices of various produce and livestock, and estimate their market value. This book is a source for authentic number problems in the context of excellent multicultural art and literature.

A popular topic in children’s literature is the history of quilts in various cultures. The stories told by the geometric patterns is evident in the ways triangles, circles, squares, and rectangles are arranged. In addition to incorporating these mathematical concepts, the literature often tells of chronological events that lend themselves to the development of a time line detailing a family or community history. Two very popular children’s books that involve the history of quilts are: **The Seasons Sewn: A Year in Patchwork** (Paul, 1996), also cited by the **New York Times Book Review** as one of the best illustrated books of 1996, which connects quilt patterns to historical phenomena; and **The Keeping Quilt** (Polacco, 1988), an intergenerational story of a Russian immigrant family that connects the significance of a quilt to family events such as weddings, births, and funerals.

Beautiful illustrations carry much of the story line in **One Grain of Rice: A Mathematical Folktale** by Demi (1997). Trying to teach a greedy raja a lesson in a rice farming province of India, a wise girl asks that a single grain of rice be doubled each day for 30 days. At the end of this period, she had more than a billion grains of rice! A grid is displayed showing the result of each day’s doubling, translating into a mathematics lesson on exponential growth. Other versions of this story are **The King’s Chessboard** (Birch, 1988) and **The Rajah’s Rice: A Mathematical Folktale from India** (Barry, 1994).

A teacher of middle school students might integrate children’s literature, social studies, and mathematics in teaching latitude and longitude by using **Pedro’s Journal: A Voyage with Christopher Columbus** (Conrad, 1991) in conjunction with **The Longitude Prize**² (Dash, 2000). **Pedro’s Journal** is a fictional account of a ship’s boy who accompanied Columbus on his journey to the New World. **The Longitude Prize** is a biography of John Harrison, a British clockmaker who worked for 40 years to invent a time machine that accurately determined longitude at sea. Had this instrument been available to Columbus, the

decisions he made during his expeditions—and the conclusions he reached—might have been greatly different!

Resources available

A wealth of resources has been published to help teachers select and use children's books in the mathematics classroom. Following is a short annotated bibliography of books that may be particularly helpful to classroom teachers. (For a comprehensive listing, visit: <http://mse.byu.edu/ted/monroe/bibliography.html>.)

Burns, M. (1992). **Math and Literature, K-3**. CA: Marilyn Burns Education Associates.

This book provides classroom-tested ideas for linking mathematics and children's literature in the primary grades. Part 1 includes 10 classroom lessons using children's literature, described in detail. Part 2 gives 21 additional children's literature selections, with instructional ideas for each. A bibliographic reference for each selection is cited.

Chatton, B., & Collins, N. L. (1999). **Blurring the edges: Integrating Curriculum through Writing and Children's Literature**. NH: Heinemann.

This source presents approaches for integrating writing and literature in science and mathematics instruction. Chapter Four focuses on mathematics and provides a brief bibliography of books, poems, counting songs, and chants that deal specifically with mathematical topics. The authors include suggestions and examples regarding how to use these sources within the context of a counting unit. They also give ideas for alternative forms of assessment to be employed when using children's literature.

Griffiths, R., & Clyne, M. (1991). **Books You can Count on: Linking Mathematics and Literature**. NH: Heinemann.

This reference is particularly helpful in locating books for children between the ages of 5 and 12 years. Some of the books, e.g., **The Very Hungry Caterpillar** by Eric Carle (1987), are appropriate for children at even younger ages. The authors provide ideas and activities for integrating mathematics and specific children's literature selections; they also include an extensive bibliography of books that integrate mathematics concepts.

Kaczmarek, K. (1998). **Exploring Math with Books Kids Love**. CO: Fulcrum.

The author uses 28 "major titles" [author's term] from the genre of picture books, chapter books, nonfiction books, folk tales/mythology, poetry, architecture, and "other" as a basis for mathematics lessons. In addition, the author provides a list of 116 related books to use in mathematics instruction.

Schiro, M. (1997). **Integrating Children's Literature and Mathematics in the Classroom: Children as Meaning Makers, Problem Solvers, and Literary Critics**. NY: Teacher's College Press.

Schiro demonstrates a strategy for teaching literacy and mathematics simultaneously, describes criteria for choosing and assessing literature for use in mathematics instruction, and provides ideas on how to have students edit incorrect presentations of mathematics in literature.

Sheffield, S. (1995). **Math and Literature, K-3, Book Two**. CA: Marilyn Burns Education Associates.

A variety of lesson ideas based on selections from children's literature is provided. Lessons include geometry, measurement, problem solving, graphing, and computation. The author also includes samples of student work.

Theissen, D., Matthias, M., & Smith, J. (Eds.). (1998). **The Wonderful World of Mathematics: A Critically Annotated List of Children's Books in Mathematics** (2nd ed.). VA: National Council of Teachers of Mathematics.

This indispensable resource reviews more than 550 children's trade books in mathematics for preschool through grade 6. The books reviewed were in print at the time of writing, with some high quality out-of-print books listed in introductions to subsections of chapters. The major divisions are Early Number Concepts, Number-Extensions and Connections, Measurement, Geometry and Spatial Sense, and Series and Other Resources. Each review describes: the content of the book with an assessment of its accuracy; illustrations and their

appropriateness; writing style; whether activities for the reader are included; and ISBN numbers, with prices when available. Books are rated according to usefulness in teaching mathematics concepts: highly recommended, recommended, acceptable, or not recommended.

Welchman-Tischler, R. (1992). **How to Use Children's Literature to Teach Mathematics**. VA: National Council of Teachers of Mathematics.

The author discusses various uses for children's literature in mathematics: provide a context, introduce manipulatives, model a creative experience, pose a problem, prepare for/develop a concept or skill, provide a context for review. For each use, she gives sample children's literature selections and activities in some detail. Additional books are also included, along with suggestions in more abbreviated form.

Whitin, D. J., & Wilde, S. (1992). **Read Any Good Math Lately? Children's Books for Mathematical Learning, K-6**. NH: Heinemann.

The authors list children's literature selections and provide activities that support various mathematical topics, grades K-6. They also include examples of ways to use these books in integrating mathematics across the curriculum. Selections include both fiction and nonfiction.

Whitin, D. J., & Wilde, S. (1995). **It's the Story that Counts: More Children's Books for Mathematical Learning, K-6**. NH: Heinemann.

This book is a sequel to the authors' 1992 publication but, instead of being organized around mathematical topics, it is divided into two major parts. "Part 1, Children, Teachers, and Authors, is about the people who use mathematically oriented children's books and two of the authors who create them. ... Part 2, Books, Books, and More Books, focuses on the books themselves" (p. xiii). Included in the second part are discussions of books on various topics that were not treated, or treated less thoroughly, in the earlier publication. The authors include a bibliography of more than 300 recently published books, grouped by mathematical topics.

In addition to a sizable selection of resource books, a plethora of journal articles is available for teachers to consult in selecting and using children's trade books for mathematics instruction. One notable source is **Teaching Children Mathematics**, available from the National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091 [(800) 235-7566]. This journal includes refereed articles regarding the use of children's literature in mathematics instruction. Also helpful is the semi-regular section entitled "Links to Literature," which features selected trade books with accompanying ideas and activities for use in teaching mathematics. In a recent issue of **Teaching Children Mathematics**, Hellwig, Monroe, and Jacobs (2000) provided guidelines for selecting children's mathematics trade books. In the "Links to Literature" section of the subsequent issue of the same journal, Long and Crocker (2000) described the use of a children's mathematics trade book in working with the attributes of standard shapes and measuring the area and perimeter of these shapes with nonstandard units. (For a comprehensive listing of articles available for linking children's literature and mathematics instruction, visit: <http://mse.byu.edu/ted/monroe/Bibliography.html>)

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FOOTNOTES

¹ These teaching standards are identified as follows: Standard 1: Worthwhile Mathematical Tasks; Standard 2: Teacher's Role in Discourse; Standard 3: Student's Role in Discourse; Standard 4: Tools for Enhancing Discourse; Standard 5: Learning Environment; and Standard 6: Analysis of Teaching and Learning.

² This book was a Robert F. Sibert Informational Book Award Honor Book for 2001 as well as a Horn Book Award winner for 2000.