



Incorporating language arts into the mathematics curriculum: a literature survey. Rosemaire Kolstad, L.D. Briggs and Karen Whalen.

Education v116.n3 (Spring 1996): pp423(9).

Full Text: COPYRIGHT 1996 Project Innovation

Recent educational philosophy has supported the whole language and integrated curriculum approaches. The National Council of Teachers of Mathematics (NCTM) has recommended that the mathematics curriculum include development of language and symbolism to communicate mathematical ideas and relationships (Grossman, Smith, & Miller, 1993). In order to bring language skills and mathematics closer together, educators have been searching for effective teaching methods and strategies to incorporate reading, writing, and oral language into mathematics. The purpose of this article was to evaluate methods and strategies being implemented to incorporate reading, writing, and oral language into mathematics lessons.

Many educators today describe themselves as whole language teachers. According to Reutzel and Cooter (1992), whole language teachers are those who believe in reading literature in the classroom and who attempt to integrate listening, speaking, reading, and writing across the curriculum. Literature and language skills, however, are often neglected in the mathematics area of the curriculum. Educators are now discovering ways to incorporate reading into mathematics through the use of children's literature.

Stories Provide Meaningful Contexts

Books are advantageous because they help students explore mathematical ideas in natural, familiar, and meaningful contexts (Griffiths & Clyne, 1991; Whitin, 1994). Literature can spark students' interest in a math lesson, if the story is first read and enjoyed for its literary content (Whitin & Gary, 1994). If students can relate to and enjoy the plot, setting, and characters of a story, the new math skill will be associated with the meaningful contexts.

Several educators refer to the picture book, *The Doorbell Rang*, by Pat Hutchins (1986) as a valuable resource for math teachers (Conaway & Midkiff, 1994; Hopkins & Dorsey, 1992; Nichols, 1993; Thraillkill, 1994). This story puts the mathematical concept of division into the familiar context of sharing. Two children are preparing to share a dozen cookies when the doorbell rings and two more children enter the house. As soon as the four children decide how many cookies each person will get, the doorbell rings once more, and the cookies have to be divided again. The pattern continues until the book's surprise ending. Thus, the book introduces students to the mathematics concept of division in the familiar context of sharing and eating cookies. After hearing the story, students can practice division in similar situations. *The Doorbell Rang* is one example of how picture books can be useful for putting mathematical concepts into a meaningful context for students.

Stories Model Mathematical Ideas

Griffiths and Clyne (1991) suggested that children can take math ideas from stories and use them in their own situations, and that stories pose problems that children are intrinsically interested in solving. One example given by Conaway and Midkiff (1994) demonstrates how picture books can be effective in modeling fractional concepts. Children are attracted to the pictures in the book *Eating Fractions*, by Bruce McMillan (1991), because there are photographs of children eating fractional parts of foods, such as halves of a banana and fourths of a pizza. Simple recipes for the foods shown in the pictures are located in the back of the book. Therefore teachers can help students model fractions in a fun and enjoyable way, using the same portions of foods mentioned by the children in the book (Conaway & Midkiff). Stories can provide a literature link to math by modeling concepts in ways that can be recreated using objects or manipulatives shown in books. In addition to modeling math ideas, *Eating Fractions* also puts the fraction concept into a meaningful context.

Stories Challenge Students

Ohanian (1989) asserted that *A Grain of Rice* by Helena Clare (1992) is a story that develops a meanful concept. In this tale, a farmer saves the life of the emperor's daughter. He asks that his reward be one grain of rice on the first day, and for the amount to be doubled each succeeding day. After predicting how many grains of rice the farmer would have received by the 25th day, students might feel challenged to solve the problem for themselves. They would be quite surprised to learn that on the 25th day, the emperor would pay the farmer 16,777,216 grains of rice (Ohanian). Griffiths and Clyne (1991) described a similar story, *King Kaid of India*, in which the king wishes to reward the man who invented the game of chess. The inventor asks for one grain of corn on the first square of the chessboard, double that on the second square, double that on the third square, and so on. While students are attempting to solve the problem of how much corn will be needed to pay the reward, they are involved in a number of mathematical processes, such as developing and testing hypotheses, searching for patterns, utilizing various methods of recording, multiplying, adding, and using calculators (Griffiths & Clyne). *The King's Chessboard* by David Birch (1993) is another retelling of this story which might also be used to introduced this challenge to students (Ohanian).

Literature Encourages Investigation

Children's literature gives students the opportunity to test important mathematical concepts in a nonthreatening arena. *Counting on Frank* by Rod Clement (1990) tells of a boy who explores his environment in a humorous and mathematically inclined way (Whitin & Gary, 1994). Students are intrigued by Frank's calculations that ten humpback whales would fit into his house, but that only one-tenth of his father would fit inside a portable television (Griffiths & Clyne, 1991). If children are encouraged to question these calculations, their investigations will require hypothesizing, estimating, measuring, and computing. These investigations could possibly lead students to create and solve new problems of their own.

Another example of a literature selection which encourages children to investigate their surroundings is *The Line-up Book* by Marisabina Russo (1986) (Whitin & Gary, 1994). Sam, the main character, makes a line from his room to the kitchen using various objects as measuring tools. Whitin and Gary noticed that during the story, students suggested objects from the illustrations for Sam to use in his line up. Students predicted like readers, while they estimated like mathematicians. Gary, when using this book with her class, encouraged the students to investigate measurements in the classroom, using other objects as the units of measure (Whitin & Gary). Therefore, children's books, such

as *The Lineup Book* and *Counting on Frank* (Clement, 1990), can prove to be good starting places for exploration and investigation.

Children's Books Illustrate Concepts

Eating Fractions by Bruce McMillan (1991) literally illustrates the concepts of fractions through its pictures (Conaway & Midkiff, 1994). Nichols (1993) asserted that visual images, such as these pictures, can help students see connections between mathematical signs and symbols and the real world. Another book that many teachers value is David M. Schwartz's (1987) book, *How Much is a Million?*, because it contains wonderful illustrations that depict numbers too large for most students to comprehend. Nichols praised Schwartz's use of humor and everyday experiences to give meaning to numbers that are often mysterious to young people. In her article "Math Concept Books: What We Have, What We Need," Nichols stated that many math concept books are in the picture-book format because visual images help illustrate abstract mathematical principles.

Disadvantages of Using Literature in Math

Despite the many advantages of using children's literature to encourage interest in mathematics, Griffiths and Clyne (1991) admitted that there are concerns that teachers may dissect or trivialize literature for the sake of mathematics. Teachers, however, can give students time to enjoy books for their intrinsic value, then allow the math connections to arise slowly. Whereas some research suggests that children's literature is only useful in the early primary grades, Griffiths and Clyne stated that students in upper grades are also highly motivated by stories. Mathematical connections to literature exist in higher level books and can serve to motivate older students to investigate and explore math concepts.

Conversely, books are limited in their ability to convey three dimensional information. Students learn best by manipulating concrete, three-dimensional objects. Therefore, the math concepts presented in children's literature must be extended through hands-on activities if students are to master them (Nichols, 1993). If teachers combine literature with concrete manipulatives, math instruction becomes more meaningful and exciting for their students. Furthermore, incorporating reading into math is a valuable strategy for improving students' attitudes and increasing their knowledge of mathematical concepts.

Integrating Writing and Mathematics

Integrating writing into mathematics enables students to communicate about math and to help clarify their understanding of various math concepts (Wood, 1992). By requiring reflection, analysis, and synthesis of information, writing involves many of the thought process utilized in mathematics (Davison & Pearce, 1988). Not surprisingly, educators have successfully begun to incorporate different types of writing into the math curriculum.

Writing to Record and Categorize Information

Learning involves the integration of ideas. Writing is often a useful tool in learning because it helps students organize and record information in meaningful ways. Writing can be integrated into the math curriculum in three ways: (a) by creating word webs, (b) by organizing notes in a notebook, and (c) by categorizing concepts on the basis of common elements.

First, a word web is a thought-organization and clarification strategy that can be utilized with students across the curriculum (McGehe, 1991). The value of webbing occurs when students start to associate words and phrases with key math terms and begin to categorize information. Being able to categorize and make connections among related math concepts as essential to learning and retaining information. Consequently, word webs can be useful for introducing a new unit, or reviewing for a test, because the webs help students brainstorm what they already know about a particular math concept (McGehe).

Second, Wood (1992) asserted that a categorization strategy called List-Group-Label and Write (LGLW) is an appropriate way to consolidate learning after a math lesson or unit. This strategy is similar to the webbing activity mentioned previously. After brainstorming all the terms and concepts studied in a previous unit, students work in pairs or small groups to classify the terms by the elements they have in common. After classifying the information, the students choose a category on which to write a paragraph (Wood). While synthesizing the information into a paragraph, students must sequence ideas, develop relationships, and plan solutions. Therefore, the LGLW strategy gives students practice in these critical thinking skills, while at the same time they review important mathematical terms and concepts.

In addition to these strategies, traditional note-taking in an organized notebook can be a simple means of recording information. In fact, word webs and LGLW activities could be recorded along with factual information that has been copied into a notebook for future reference. Davison and Pearce (1988) insisted that note-taking is more effective when students know the notebook will be checked regularly, that it will be helpful as a study tool in preparing for tests, and that they can use the notebook during periodic quizzes. Although requiring fewer processes, this type of writing reminds students of the importance of writing to convey information. This information could be used in additional writing assignments which do involve more steps of the writing process.

Writing to Translate Math Terms and Symbols

Traditionally, most elementary mathematics instruction has been an exact science, where only precise definitions and procedures are acceptable. Yet, in many other curriculum areas, students may use their own words to describe or summarize information in a meaningful way, which they are much more likely to remember than simple memorization of textbook definitions or explanations. Because of this, many math teachers are exploring ways to incorporate writing into math to make mathematical terms and symbols easier for students to understand and remember.

In a study conducted to determine if students could use writing to help them learn math, Evans (1984) required students to write their own definitions for math vocabulary words. Although their definitions lacked the precision of those found in the textbook, the students could understand and could more easily remember the vocabulary words they had defined using familiar terms. Additionally, these definitions provided valuable feedback for the teacher about how well the students understood the concepts being addressed.

Capsule Vocabulary, another strategy, uses writing as a means to learn math vocabulary (Wood, 1992). This strategy was developed to reinforce new vocabulary while promoting participation and communication skills in the classroom. It begins with a list of key terms and concepts, and whole class discussion of each new term's definition. Then, students talk to a partner using as many of the terms as possible. Finally, students compose a

can learn from writing. These types of writing assignments are valuable in the mathematics classroom because they help students clarify information and broaden their personal understanding of various math terms and processes. Another important reason for writing is to convey information to another person. Before information can be shared successfully, it must be pondered, reflected upon, and summarized. These skills reinforce mathematical concepts as they develop higher level thinking and organizational skills.

One example of writing to convey information is a short paper focusing on important people and events in the history of mathematics (Davison & Pearce, 1988). Although this writing assignment may not directly relate to the acquisition of math skills, it does encourage students to explore and convey information related to mathematical concepts. Learning new information through a research project broadens the background experiences students need when dealing with related math concepts in the future.

A second type of writing assignment is called a Reaction Guide (Wood, 1992). During this strategy, students work in pairs or small groups. They are given a series of five to eight statements about a mathematical concept that may be true or false. Students are to find and write down evidence which either confirms or refutes each statement. The guides are then referred to during a class discussion about each statement and later used as study aids.

Mayotte and Moore (1992) described another example of writing to convey information, which they called Technical Writing. They suggested that the class members work together to create a book on how math works. The book would include step-by-step directions to solve various type of problems, such as how to solve simple addition problems or how to check division problems using multiplication. These ideas were compiled in a book patterned after *The Way Things Work* by David McAuley. Therefore, students were thinking and analyzing mathematical procedures as they described them in writing, which was an effective way to see how well they understood the process about which they were writing.

Finally, students can convey information about math concepts through math limericks. Although this is quite different from technical research writing, limericks provide a fun and creative way for a pair of students to summarize information about a math topic. Again, students have the opportunity to practice the steps of the writing process as they edit and perfect their mathematical limericks. Also, students learn to recall important math concepts as they memorize and recite their own limericks as well as each other's (Mayotte & Moore, 1992).

Despite the fact that writing to convey information often takes the form of a traditional research paper, there are other formats through which students can summarize and share math related information, as well as become more prolific writers.

Using Oral Language Activities in Math

The NCTM asserts that communication helps children construct links between their informal, intuitive notions and the abstract language and symbolism of mathematics (Grossman, Smith, & Miller, 1993). This is in line with the whole language movement which stresses the use of all modes of language. Therefore, in addition to reading and writing in math class, teachers are now discovering ways to incorporate oral language in mathematics as well.

Class Discussions

Vacca (1993) emphasized the value of group discussions to help students apply prior knowledge to problem-solving situations while receiving feedback from others. In her article "Teaching and Learning Mathematics through Classroom Discussion," she offered suggestions for teachers about how to create an environment that encourages participation and how to initiate meaningful classroom discussions. The strategies for starting discussions include asking a question, referring to a common experience, introducing a controversial issue, and listing specific concerns about a particular math concept. Once the teacher has established an inviting atmosphere and has learned to initiate meaningful discussions, s/he should focus on teaching students how to learn from discussions in order to benefit from class discussions students need to seek clarification when something is unclear and to be willing to talk about their own ideas. They must also be able to listen to, respond to, and build upon other people's ideas, while being sensitive to their feelings (Vacca). The benefits of talking about math are an increased mathematics vocabulary and a better understanding of the concepts and processes discussed in class. Also, the use of oral language enables students to become active questioners, problem creators, and problem solvers.

Capps and Pickreign (1933) supported the use of oral language and classroom discussions to enhance math instruction. They suggested that students should verbalize and discuss ideas aloud when they are working with manipulatives. By talking with and listening to their peers, students will connect their prior knowledge to new mathematical terms and concepts. In addition, when students use manipulatives and talk about what they are doing, teachers have an invaluable opportunity for assessment.

Another way discussion can be used effectively is in developing a math vocabulary. Students learn new math terms when the teacher asks the class to brainstorm what comes to mind when they hear certain vocabulary words. For example, many words used in math, such as plane, degree, or operation, have everyday interpretations quite different from how they are used in math (Capps & Pickreign, 1993). Discussing the multiple meanings of these words helps students understand and use mathematical terms correctly.

Another variation of classroom discussion is to have students involved in paired or group retellings. Wood (1992) suggested that students be grouped in threes, and then each be given a different problem dealing with the same topic or operation. Each student solves his or her problem and talks aloud about the processes involved while pointing to an enlarged, big book version of the problem as other students suggest alternative ways to solve the problem. Therefore, regardless of the number of participants, discussions can facilitate higher level thinking skills and understanding of math concepts, processes, and vocabulary.

Songs, Poems, and Folk Tales

Although a classwide discussion may be the most obvious strategy for incorporating oral language into mathematics, Hurst (1992) suggested that songs, poems, and folk tales can also inspire math activities. Counting songs, such as "The Ants Go Marching," cumulative songs like "The Old Lady who Swallowed a Fly," and action songs like "In a Cabin in a Wood" are wonderful resources for teaching math because their predictability and humor capture students' attention while providing a basis for numerous math activities (Hurst).

Poetry with mathematical connections is another way to incorporate oral language into math class. Hurst (1992) suggested that Jack Prelutsky's poem "The Ants at the Olympics" could be used as the basis for many calculations related to the ant Olympics, such as how long an ant takes to travel one foot, and for various calculations based on actual Olympic records.

Finally, Hurst (1992) promoted the use of folk tales in their original oral form to enhance math instruction. She pointed out that folk tales often include numbers, especially the number three, as in the Three Little Pigs and Three Billy Goats Gruff. These tales can form foundations for mathematical activities and computations.

Although these activities are less structured than some previously mentioned strategies, incorporating music, poetry, and folk tales into math instruction can serve to inspire and motivate students through the use of oral language.

Summary

Research on including reading, writing, and oral language in math instruction is very positive. Not only do the students benefit as mathematicians, they develop as readers, writers, and speakers from the additional opportunities to practice these skills. Practicing language arts skills across the curriculum is in line with the whole language movement, as well as with the integrated curriculum approach. The benefits of including literature and reading experiences throughout the curriculum have been expanded upon by whole language researchers. Research by Grossman Smith, and Miller (1993) and Evans (1984) strongly supports the benefits of using writing for improving student performance in mathematics. In order to uphold the NCTM recommendations, students must learn to communicate mathematically, in writing and through oral language (Capps & Pickreign, 1993).

Research supports the benefits of incorporating reading, writing, and oral language into mathematics instruction to help students convey mathematical information in familiar words and to assist them with their thinking processes, as they work through math calculations and problem solving situations. Another reason writing is a valuable asset in mathematics instruction is that the teacher is better able to evaluate students' understanding of math concepts and processes based upon what the children have written. A teacher can also evaluate students by what they say. By including oral language activities in math lessons, students' abilities to communicate mathematically will improve. Thus, a teacher will be better able to evaluate and clarify students' thought processes, while building students' confidence in their own abilities to discuss mathematics. Therefore, based upon the many benefits and the number of emerging strategies for implementing language arts into mathematics instruction, the teacher should begin incorporating reading, writing, and oral language activities into mathematics lessons on a regular basis.

Despite the valuable strategies and teaching techniques now being used, more research needs to be conducted on the benefits of incorporating language arts into the math curriculum, and teachers need more suggestions and additional resources to ensure the success of a language - rich math program.

Finally, because the basis for language arts activities should be literature, the research supports the recommendation by Nichols (1993) that more math concept books, illustrating a wider range of math topics, are needed. In addition, middle school and high

school teachers need more math concept books written specifically for students in the upper grades. Such books would provide students with the meaningful contexts and visual representations they need to comprehend the increasingly abstract skills of higher mathematics.

References

- Birch, D. (1993). *The king's chessboard*. New York: Penguin USA.
- Brown, N.M. (1993). Writing mathematics. *Arithmetic Teacher*, 41, 20-21.
- Capps, L.R., & Pickreign, J. (1993). Language connections in mathematics: A critical part of mathematics instruction. *Arithmetic Teacher*, 41, 8-12.
- Claire, H. (1992). *A grain of rice*. New York: Bantam Doubleday.
- Clement, R. (1990). *Counting on Frank*. Milwaukee, WI: Gareth
- Conaway, B., & Midkiff, R.B. (1994). Connecting literature, language and fractions. *Arithmetic Teacher*, 41, 430-434.
- Davison, D.M., & Pearce, D.L. (1988). Using writing activities to reinforce mathematics instruction. *Arithmetic Teacher*, 36, 42-45.
- Evans, C.S. (1984). Writing to learn in math. *Language Arts*, 61, 828-835.
- Fairbairn, D.M. (1993). Creating story problems. *Arithmetic Teacher*, 41, 140-142.
- Griffiths, R., & Clyne, M. (1991). The power of story: Its role in learning mathematics. *Math Teaching*, 135, 42-45.
- Birch, D. (1993). *Kings Chestboard*. New York, Penguin, U.S.A.
- Brown, N.M., (1993). Writing Mathematics. *Teaching Arithmetic*, 41, 20-21.
- Grossman, F.J., Smith, B, & Miller, C. (1993). Did you say write in mathematics class? *Journal of Developmental Education*, 17, 2-4.
- Hopkins, M.H., & Dorsey, C.M. (1992). Math is everywhere - if only we could find it! *Preventing School Failure*, 37, 10-13.
- Hurst, C.O. (1992). Oral language and math. *Teaching PreK-8*, 22, 45-48.
- Hutchins, P. (1986). *The doorbell rang*. New York: Greenwillow Books.
- Mayotte, G., & Moore, C. (1992). Writing, thinking and math. *Teaching Prok-8*, 22, 49-51.
- McAuley, D. (1988). *The way things work*. Boston: Houghton Mifflin.
- McGehe, C.A. (1991). Mathematics the write way. *Instructor*, 100, 36-38.

- McMillan, B. (1991). *Eating fractions*. New York: Scholastic.
- Nichols, D. (1993). Math concept books: What we have, what we need. *School Library Journal*, 39, 41-42.
- Ohanian, S. (1989). Readin', 'rithmetic-using children's literature to teach math. *Learning*, 18, 32-35.
- Reutzel, D.R., & Cooter, R.B. (1992). *Teaching children to read: From basals to books*. New York: Macmillan.
- Russo, M. (1986). *The line-up book*. New York: Greenwillow Press.
- Schwartz, D.M. (1987). *How much is a million?* New York: Scholastic (Big Book).
- Stix, A. (1994). Pic-jour math: Pictorial journal writing in mathematics. *Arithmetic Teacher*, 41, 264-269.
- Thrailkill, C. (1994). Math and literature: A perfect match. *Teaching PreK-8*, 24, 64-65.
- Vacca, N.N. (1993). Teaching and learning mathematics through classroom discussion. *Arithmetic Teacher*, 42, 225-226.
- Waterman, D.C. (1991). Whole language: Why not? *Contemporary Education*, 62, 115-119.
- Whitin, D.J. (1994). Exploring estimation through children's literature. *Arithmetic Teacher*, 41, 436-441.
- Whitin, D.J., & Gary, C.C. (1994). Promoting mathematical explorations through children's literature. *Arithmetic Teacher*, 41, 394-399.
- Wood, K.D. (1992). Fostering collaborative reading and writing experiences in mathematics. *Journal of Reading*, 36, 96-103.

Source Citation: Kolstad, Rosemaire, L.D. Briggs, and Karen Whalen. "Incorporating language arts into the mathematics curriculum: a literature survey." *Education* 116.n3 (Spring 1996): 423(9). *Expanded Academic ASAP*. Thomson Gale. DISCUS. 12 Oct. 2006
<<http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A18434934&source=gale&srcprod=EAIM&userGroupName=scschools&version=1.0>>.

Thomson Gale Document Number:A18434934

© 2005 Thomson Gale, a part of The Thomson Corporation.
Thomson and Star Logo are trademarks and are registered trademarks used herein under license