

# Writing to Communicate Mathematically in the Elementary School Classroom

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Linda Shelley Thompson, Towson University

*In this article, Linda Thompson shares a variety of practical, classroom-ready ideas for incorporating writing meaningfully into mathematics instruction - both as a learning tool for students and as an assessment tool for teachers.*

## Introduction

Most teachers would agree that when it comes to teaching mathematical concepts in elementary school, effective communication skills are essential. But, in order for students to learn and understand mathematics more deeply, communication needs to be a “two-way street” in which students, as well as teachers, communicate ideas, concepts, and strategies to each other.

One of the most effective and valuable tools to help students develop a deeper and richer understanding of mathematics, both in and outside the classroom, is writing. Writing can help students to organize and clarify their mathematical thoughts as they reflect on their learning, while providing teachers with an important means of assessment (NCTM, 2000). Marilyn Burns, a well known proponent of mathematics education reform, wrote: “Their writing is a window into what they [the students] understand, how they approach ideas, what misconceptions they harbor, and how they feel about what they’re discovering” (Burns, 1995, p. 40).

In the past, writing was a skill that students learned in English class, and very little was used in mathematics instruction (Borasi & Rose, 1989). However, over the last few decades, the National Council of Teachers of Mathematics (NCTM) began to provide fresh new guidance for educators who for too long had been relying on rote instruction focusing primarily on recall

and mastery of facts. Today’s students need more frequent classroom communication, including discussing and writing about problems and ideas, that will have a more positive impact on their learning. The most recent NCTM standards (NCTM, 2000) call for instructional programs that should enable students in grades K-12 to:

- organize and consolidate their mathematical thinking through communication;
- communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- analyze and evaluate the mathematical thinking and strategies of others;
- use the language of mathematics to express mathematical ideas precisely.

It is through the act of communicating mathematical ideas that students’ thinking becomes clearer, and students become more engaged in learning (NCTM, p. 214). Clearly, “...the NCTM values writing in mathematics...” (Frank, 1977, p. 4).

## Benefits of Writing

When students write to communicate mathematically, it “encourages active learning” while also strengthening students’ writing skills. Additionally, students who write in elementary school typically perform better on tests and develop important critical thinking skills (Gammill, 2008).

“Writing helps students stop and think about the process that they are using to

solve a problem. When students write to learn, it encourages them to organize, summarize, communicate, and extend their thinking. It also provides a visible record that can be reflected on and discussed with others. Writing is a “powerful” tool for students “because it uses both hemispheres of the brain” (Freitag, 1997). Also, many people find that the act of writing can increase their retention of concepts (NCTM, 2000).

Another benefit of communicating through writing is its positive impact on English Language Learners (ELLs). These students need to be given extra support as they learn not only the English language, but the language of mathematics. ELLs can create “personal math dictionaries,” in which they can write new terms with pictures, definitions and examples. These can be especially helpful to students when learning mathematical terms that have more than one meaning such as: foot, sum, difference, division (Van de Walle, 2007, p. 102).

Teachers can also help their English Language Learners by having them write answers with supporting explanations for problems and compose their own word problems. As these students learn to better communicate mathematically, they also develop valuable language arts skills (Wiest, 2008). Students who are given the opportunity to write may also show increased confidence and participation (Countryman, 1992). And those students who do not willingly participate in class discussions may reveal more of what they know through their writing.

In one recent study involving 293 school students, results showed that students’ attitudes toward writing in mathematics class were basically “positive,” and even struggling learners “indicated that they were much more in favor of mathematics classes that use writing” (Reilly, 2007). And middle schoolers who were interviewed in a

1997 project expressed that writing “helped them remember what they had learned,” and this led to “increased understanding of mathematical concepts” (DiPillo, 1997, p. 311).

### Writing and Problem Solving

Many researchers feel that writing plays an important part in problem-solving, and may “help students increase their problem-solving ability in mathematics” (Pugalee, 2001). In order for students to write mathematically, they must “stop and think about the process that they are using to solve a problem” (Frank, 1977).

The Swiss mathematician, George Polya, developed a four phase model for solving a word problem. In order, they are: 1) understanding the problem; 2) deciding what to look for; 3) carrying out a plan; and 4) reflecting or looking back (Steele, 2007). Stated more simply, one could say: “See, Plan, Do and Check” (M. Krach, Personal Communication, 2009).

Interestingly, the very thought processes used for writing involve the same thought processes as solving a word problem (Bell and Bell, 1985). Suggestions for ways that students can combine writing with Polya’s problem-solving phases are found later in this paper.

### Writing as an Assessment Tool

Writing assignments can be a powerful tool for assessment of student understanding, whether used formally or informally, and can supplement test and quiz scores which should not be the sole means of assessment (NCTM, 2000). Even before starting a unit, teachers can ask their students to write what they know about a topic as a means of pre-assessment (Burke, 1994).

Students’ written communications provide a much more accurate picture of their conceptual knowledge than the mere num-

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ber of correct answers on a test. Their written explanations reveal the depth of their understanding, and how well they are connecting ideas (Van de Walle, 2007). When students write out their thought processes, it enables teachers to “recognize and diagnose the nature of students’ conceptual problems” (Drake & Amspaugh, 1994). “Writing often reveals gaps in learning and misconceptions, which can be of great help to teachers in their instructional planning and intervention strategies” (Janzen, 2000-2005, p. 1). Evaluating student writing also can reveal a student’s strengths, as well as their ability to express themselves (Burns & Silbey, 2001; Russek, 1998).

As teachers give students opportunities to write mathematically in a variety of ways throughout the school year, they should save student work in a portfolio that will allow students and their parents to see their growth over a period of time as they read their writing samples.

### Writing Strategies

While there are many fun and challenging writing activities to engage students more deeply in mathematics, there are several strategies to consider before students begin to write.

First, it is helpful to share with students that there is a purpose for their writing in mathematics. Students need to know that their writing will enhance and support their learning, and will also help their teacher get a better idea of what they are thinking about with respect to mathematics. Teachers should also display and publish student writing samples, as well as ask students to read their papers aloud. Listening to what fellow students write can be inspirational, and help other students see that there is more than one way to solve a problem (Burns, 1995). The following are some effective writing strategies and prompts that are being used successfully by

teachers today.

### Journals

The use of mathematics journals has grown significantly in popularity in recent years, and is seen to be one of the most effective ways that students can reflect on and communicate about what they are learning. Journals help students keep track of their reasoning (Burns & Silbey, 2001). The author of *Writing to Learn Mathematics* comments “journal writing is a way to have continuing dialogues with students.” Journals “increase confidence, participation, encourage independence, monitor progress, record growth, and enhance communication between teacher and student” (Countryman, 1992, pp. 42-43).

As an assessment tool, journal entries provide rich insights into student learning because they reveal which students have a true understanding of mathematical concepts, and which students do not. “It showed me the children who could take information and process it, and those children who just got information and spit it back out, and when they spit it back out, they really didn’t know what they were saying” (DiPillo, 1997).

Because journals reveal so much about learning outcomes, they are extremely helpful to teachers in assessing the need to change their instructional approach for future lessons. One teacher found that “journals helped direct her reteaching of particular concepts” because they ensure “that everyone is on the same wavelength” (DiPillo, 1997).

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**Today ...**

**I learned .....**

**I was surprised that .....**

**I discovered .....**

**(Russek, 1998)**

As teachers respond to their students' journal entries, they will begin to see how "... journals can create a new form of dialogue between the teacher and each student, thus allowing for more individualized instruction and a supportive classroom atmosphere" (Borasi & Rose, 1989, p. 347).

### ***Writing in Problem Solving***

Teachers can help students better understand a word problem by first having them re-write the problem in their own words. This way, students will know what they need to look for and what is being asked. They can also write the methods and strategies they use to solve a problem, along with their thoughts. As students reflect back on a problem, they may also write about an alternative approach or solution for solving a problem (M. Krach, Personal Communication, 2009). Lastly, another valuable step is to encourage students to write their own related word problems (Wilburn, 2006).

### ***Mathography***

In a brief paragraph, students can describe their feelings about and experiences in mathematics, both in and out of school. This is a wonderful way for a teacher to become familiar with students' attitudes about mathematics. "What I like most (or least) about math is ..." (Using Writing in Mathematics, p. 2). Or, students can describe what they remember from mathematics instruction when they were younger. When students write about their own experiences with learning mathematics, it offers students an opportunity to communicate strengths, fears, weaknesses, and beliefs to the teacher. "It is a good idea to have students write their own autobiographies at the beginning of the school year, to help open up dialogue and understanding between teacher and student" (Countryman, 1992, pp.21-26).

*Having students complete a brief, open-ended question about what they learned in a lesson for that day can be extremely helpful to teachers in assessing student learning*

The following link gives an extensive list of mathography prompts for teachers: <http://www2.ups.edu/community/tofu/lev2/journaling/writemath.htm>.

### ***Writing about Learning***

Every writing task doesn't have to focus exclusively on explaining a problem or a math concept (Burns, 1995). Teachers may sometimes ask students simply to write about a favorite mathematics unit, concept, or skill, and what made it so appealing.

#### **Math-Writing**

**"What writing does for me is it unlocks my brain and it lets me think. But if I didn't write, I would be getting nowhere. I wouldn't learn anything. I mean I wouldn't think so hard if I didn't write... But when you write it just makes you think."**

**(Burns, 1995)**

### ***Exit Passes***

Having students complete a brief, open-ended question about what they learned in a lesson for that day can be extremely helpful to teachers in assessing student learning, as well as assessing the teacher's instruction. "When students think about how they learn, they practice metacognition – thinking about thinking.... One of the easiest ways to give students the opportunity for metacognition is by using exit slips" (Thompson, 2007, p. 270). However, not only do exit passes reveal student understanding, and the teacher's instruction, they can also reveal student attitudes towards mathematics, as well (M. Krach, Personal Communication, 2009).

### ***Think-Write-Pair-Share***

Kawas mentions that “some students are reluctant to write at first, and benefit from practice sharing thoughts with a partner, and hearing that partner put thoughts into words” (Kawas, 2006). Once students are comfortable with the “Think-Pair-Share” concept, they are more apt to feel comfortable moving on to the “Think-Write-Pair-Share” strategy which adds the element of writing. This technique can also be used in conjunction with other writing prompts (M. Krach, Personal Communication, 2009).

### ***Math Vocabulary Walls***

Teachers can post lists for the various topics their students are studying in mathematics throughout the year. Students can place new vocabulary words along with their definitions in the correct column that correlates with their word, i.e. fractions, decimals, congruence, etc.. This is similar to the “word wall” that is used by many teachers to help students build and strengthen their vocabulary (Burns, 1995). However, teachers should allow students to rewrite definitions in their own words (M. Krach, Personal Communication, 2009). Doing this allows them to make connections with what they already know. “The more connections a student can make, the better he remembers the word” (Stahl, Nagy, 2006, p.64).

At least one study has shown “how composing a definition after experiences with a mathematical concept can assist students to build understanding. The definition is an important language form in the register of mathematics” (Shield, 2004, p. 25-28).

### ***Biographies***

Students can research and write a report on the life of a famous mathematician from the past or present. Names of people who have made significant contri-

butions to the field of mathematics would include: Sir Isaac Newton, Galileo, Albert Einstein, Steven Hawkins, Sofia Kovalevs-kaya, Emmy Noether, and Grace Hopper, to name a few.

### ***K-W-L Chart***

While these are usually done in the framework of a teacher-led discussion, teachers may elect to have their students fill in or create their own K-W-L chart independently, for what they already know, what they want to know, and what they have learned about a mathematical concept or skill (Kawas, 2006). The K-W-L chart gives students the opportunity to see if what they originally thought they knew about a topic is correct. The K-W-L Plus Chart takes this a step further by allowing students to “continue their exploration of a subject, and provides an opportunity to do research (Gammill, 2006, p. 755).

### ***Creative/Expressive Writing Activities***

There are many creative and expressive writing activities that teachers can integrate into mathematics. Using vocabulary terms from a current unit, students can write a paragraph, or a missing number story to be shared later in class with fellow students. Students may also generate their own word puzzles and poetry substituting terms that the teacher wants them to learn. Pen-pal letters are yet another way that students can use mathematical vocabulary terms in a fun and creative way to write letters to other students. Students may even enjoy writing lyrics for a rap song to help them both understand and remember a potentially confusing concept like place value.

### ***Brief Constructed Responses (BCRs)***

Brief constructed responses (BCRs) are a common method of writing in elementary school mathematics, which is especially helpful for younger students who are not

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yet proficient writers. This form of writing reveals students' understanding as they describe data, make a prediction, or write explanations to describe their thought processes in solving a problem. One student's BCR might look like this: "When adding fractions you do not add the denominators because you don't change the parts of the whole" (Frank, 1977).

### Conclusion

Writing helps students become aware of what they know and don't know in terms of mathematical concepts (Burns, 1995). It is an excellent way for students to organize their thoughts, and communicate their mathematical ideas with others, while helping educators to better plan for tomorrow's lessons.

I am absolutely convinced that integrating writing into my own mathematics instruction will benefit my future students, as well as me personally. The fourth graders whom I have worked with at a local public elementary school have already shown me the level of their understanding through the written explanations on their exit passes after a lesson on comparing and ordering decimals.

When you order decimals you look at the whole number. If the whole number is the same look at the tenths place to compare. Use zeros for a place holder (Female Student).

When you compare decimals if there is a whole number start by the whole number. Tens go first, then ones, then tenths, then hundredths (Male Student).

At the same time, however, the exit passes clearly revealed to me those students who lacked sufficient understanding of the con-

cepts presented that day, and how my instruction could be improved or adjusted for certain students. When added to a few brief problems on ordering and comparing decimals, their written explanations revealed more than any computational answers.

Some teachers who want to incorporate writing into their mathematics lessons may struggle with how often to use it. Marilyn Burns comments that this could depend on "the math they're studying, the purpose of their writing, and their comfort with writing." As an experienced teacher, she sometimes has her students write on a daily basis, but at other times, she may just have her students use writing in the context of problem solving "once or twice a week..." (Burns, 1995).

Whether students write to communicate their attitudes about mathematics, their strategies for problem solving, or to help them better understand and retain a concept, writing helps students understand on a deeper level the mathematical concepts they have been taught, which is the focus of mathematics instruction in the 21st century. As an assessment tool, writing is beneficial for letting teachers know how deeply their students understand. When writing is effectively interwoven into mathematics instruction, learning is certain to be enhanced in the elementary school classroom, enabling students to become more "mathematically powerful." Ω

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Linda Shelley Thompson is a senior at Towson State University in Towson, Maryland, and currently student teaches second grade

at Halethorpe Elementary School. After graduating in May, she hopes to teach early elementary grades in the Baltimore area. A former legal secretary and home schooling parent, Linda currently resides in Ellicott City, Maryland with her husband of 25 years, and two grown children.

## Think About It!

### THE POWER OF PATTERN GENERALIZING

**“To become fluent in a language, children must have analyzed the speech around them, not just memorized it. ... The triumph of language acquisition is even more impressive when we consider that a talking child has solved a knotty instance of the problem of induction: observing a finite sample of events and framing a generalization that embraces the infinite set from which the events are drawn.”**

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**“In 1969, the Canadian psychologist Allen Paivio demonstrated that subjects remembered concrete words such as “piano” much more easily than abstract words such as “justice,” which are much harder to visualize.”**

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