

# Penpals, Children's Books, and Learning Mathematics

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## Abstract

Faced with students at the elementary and college levels needing to learn mathematics well, I designed assignments for preservice teachers that would provide evidence of their understanding of mathematics while supporting the learning of first graders at an area elementary school. Preservice teachers were matched with first graders and asked to write two letters that included mathematical questions for the students to investigate with their classmates. Teachers at the elementary school used this as an opportunity to have children do mathematics and write letters back to their college penpals. Then, preservice teachers created mathematically rich children's books for their penpals. This assignment also built in a cross-curricular focus; students were to write children's books with accompanying notes to the reader, necessitating two very different forms of writing with two different purposes. This paper includes an explanation of the communication between preservice teachers and first graders, a description of the assignments, examples of the books and notes created, and a discussion of the benefits of the project.

The *Principles and Standards for School Mathematics* (NCTM 2000) describes a guide for high-quality mathematics teaching and learning. The mathematical knowledge that teachers need to possess, while not sophisticated mathematics, must be meaningful, flexible, and secure. Teachers need to be able to present mathematical ideas in a variety of contexts and to ask questions about the imbedded mathematics. To develop these capabilities and provide evidence of their mathematical knowledge, I had preservice teachers (PSTs) write letters, create children's books with accompanying "Notes to the Reader" and share their books with first-grade penpals. This paper lays out the expectations of the instructor for the PSTs, the relationship developed between the penpal pairs, examples of both book pages as well as material written for the reader or teacher to use to enhance the learning experience for children, and the kinds of learning the PST took away from the experience.

## Connecting Mathematics Learning with Teaching

During the first year of college, early childhood education students have little opportunity to investigate the wisdom of their career choice. In addition, they have little sense of what they need to know mathematically to teach young children beyond their own basic mathematics skills. Many are quite surprised to find that their Mathematics for Prospective Early Childhood Teachers courses require them to engage deeply with the content in a way with which they have no experience. This adds to the already existing anxiety many of them feel about mathematics.

As a way to invite PSTs into the venture of studying mathematics, I surmised that integrating this study with a task they looked forward to, reading books to children, could be worthwhile. If embedding mathematical thinking in children's books "enhances children's understanding of mathematics, promotes their enjoyment of the subject, and develops their conception of mathematics as an integral part of human knowledge" (Griffiths & Clyne 1991, p. 9), the notion of integrating mathematics and children's literature in my students' experience made sense. I had found this useful in the past when students incorporated using existing children's books into their lessons during their mathematics methods course [see Keen (2003)]. But I also needed this integration to help me assess the PSTs' ability to use mathematical vocabulary and concepts appropriately.

The plan I developed enhances the PSTs' appreciation for the complexity of the mathematics and provides a means for me to assess their ability to use the language and representations of mathematical concepts they study. I ask PSTs to write two letters and a children's book about specific topics studied during the term. [For a detailed description of the tasks and rubrics, see Keen (2004).] By pairing my PSTs with first graders at a local rural school, the letters and book gain a personal audience.

The term in which the letters and book are assigned is one in which the mathematical content includes study of statistics, probability, measurement and geometry, in this order. The PSTs are assigned a penpal early in the term and each is asked to write a letter to their first-grade penpal that includes an appropriate

question that the penpal can collect data on and report back to the PST. A few weeks later, a second letter is written which includes a probability experiment that the first-grade penpal is asked to complete with their family. PSTs are encouraged to create tasks for both the statistical question and the probability experiment that are focused and bounded.

As we begin the study of geometry, PSTs begin work on their children's books. They may select any geometry concept as the focus of their book. The critical issues for the story itself are that PSTs must be accurate and clear in their use of vocabulary as well as thoughtful as to the level of difficulty and appropriateness of the content for first graders. The "Notes to the Reader" pages must include a statement of the level of geometric understanding children reading the book should have as they begin their reading, questions that the teacher may ask to deepen children's understanding of the concept, and information about related children's books.

### Visiting Penpals

Late in the semester, I arrange for the use of vehicles to transport the PSTs to the elementary school where their penpals attend first grade. With the increase in appreciation and support for service learning in university life, PSTs receive credit for contributing outside the university and the trip to the elementary school receives assistance in the form of vehicles. The proximity of the school enables our visit to be completed within a single two-hour class period.

PSTs are directed to the appropriate classroom to find their penpal, with penpals often being in two different classrooms. Each PST wears a self-decorated nametag that includes their names as well as the name of their penpal. Child and PST pairs move to a location in the classroom where they can exchange greetings and get to know each other a bit before the PST shares the book they have written with the first grader. A gentle hum of activity spreads through the rooms as the PST proudly reads their book to their penpal. Questions that were included in the "Notes to the Reader" provide authors with material to ask about, helping the PSTs to see value in the effort they put into creating the "Notes."

When books are completed, the penpal may show the PST their desk or work around the classroom. The PST is encouraged to ask the first grader about the results of their data collection and probability experiment. If possible, the PST and penpal carry out the probability experiment together and talk about the results.

The thirty-minute visit usually goes by quickly and the penpal pairs say their goodbyes. When we return to campus there is just enough time to hear a few anecdotes before class is over.

### Extending Experiences

One semester a first-grade teacher used the penpal relationship and the letters sent to her students as an opportunity to integrate the first-grade mathematics and language arts curricula. Using the data collection task each PST sent in their first letter, the teacher had her first-grade students create data recording sheets with their penpal's question on the top (e.g., see Figure 1). The sheets were placed on each student's desk. Then, all class members rotated around the classroom, placing a tally in the appropriate place on their peer's data sheet. After the recording was complete, each student took their data and created a bar graph to display their data. The teacher then had them write a letter to their college penpal sharing what they found out about the question. PSTs were able to save these for their future professional portfolios.

Another semester, due to the numbers of PSTs and first graders, one PST was the penpal for a whole class. This was a very special experience for the PST, resulting in her reading her book to the whole class and receiving a large "Thank You" note signed by all of the children.

What is your favorite color?
Red
Blue
Green
Yellow

Figure 1

Some books have been written using the penpal as a character in the story. When making the child a part of the story, the child responded warmly and attentively to the PST's creation.

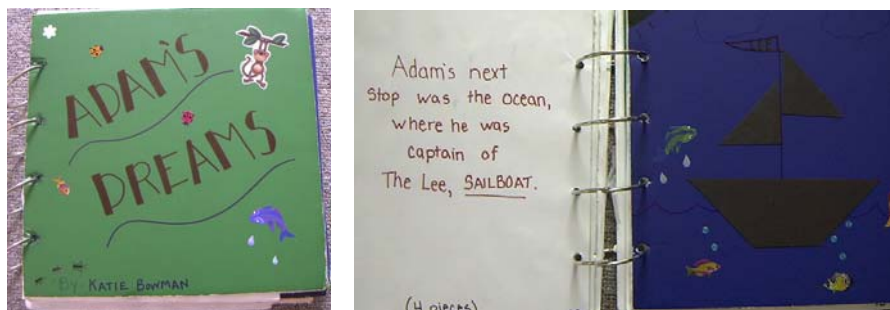


Figure 2

For many, this was the first time anyone had prepared something especially for them. PSTs also incorporated manipulatives into their books. Figure 2 shows the cover and a page from a PST's book prepared for her penpal Adam. The PST cut magnetic rubber sheets into tangram pieces

and had her penpal create various figures that were a part of the story she created about the penpal's dream.

### Learning from the Experience

The PSTs gained important insights into both mathematics and learning mathematics through the writing and sharing processes involved in this project. In addition, I was able to assess their ability to write mathematics accurately and clearly. They shared many experiences in class discussions, relating comments and questions their penpals shared. These served to both confirm suggestions I had made about children's mathematical thinking and to make the assignment more meaningful for all students. For example, I had suggested that first graders should not be expected to understand the terms "right angle" or "90°." So they might describe a square as a quadrilateral with four sides the same length and four angles the same size. A student who had not heeded this advice had the following experience. Her book included a description with the term "right angle" and she was delighted when, after reading the book to her penpal, the student looked around the room and pointed to a figure with a right angle and said, "Oh, look! A right angle." The PST smiled, thrilled that her book had helped the student with that concept. She smiled until the child excitedly added, "Oh, look! There's a left angle." After sharing this experience with her PST-classmates, we had a good discussion about being attentive to the grade-level expectations and vocabulary.

I noticed that several students had "defined" parallel lines in a rather unmathematical way – "Parallel lines continue on in the same direction forever." This definition did not include being coplanar or non-intersecting. When I made note of this on PSTs' books, they referred me to their textbook that had, in fact, presented this description of parallel lines. This prompted a discussion of the difference between describing and defining in mathematically appropriate ways.



By creating a flap to cover the answer to a question, this book becomes interactive.

Figure 3

Students discovered the value of multiple representations and tactile qualities. Several used foam shapes or textured objects in their books and found that the children responded very well to these, referring back to them when they used the vocabulary that had been introduced in the books.

Books that were colorful but not overly cluttered were seen to attract the children’s interest and to provide easier access to the ideas. Figures 3 & 4 show several examples of techniques used by

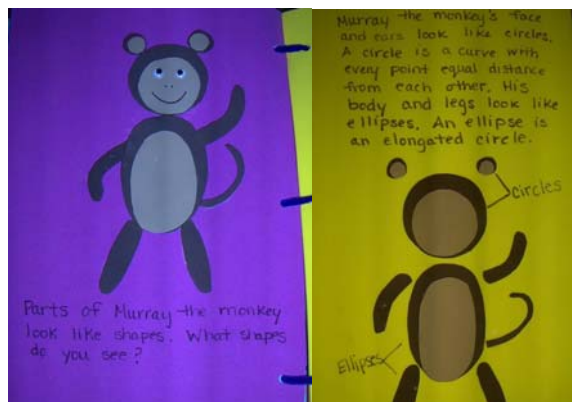


Fig.4 Here a student takes a figure made of circles and ellipses and “explodes” it to show the shapes.

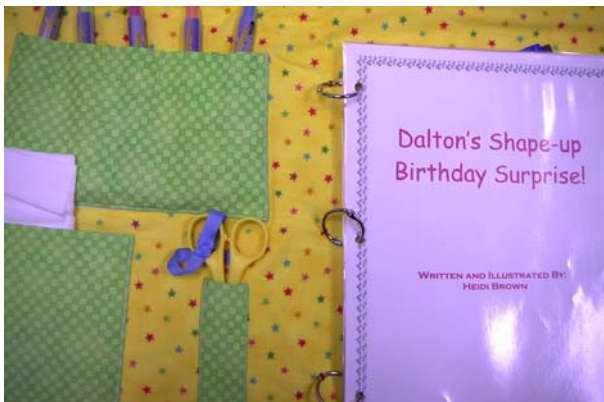


Fig 4 This student included tools for her penpal to use throughout her book about his birthday surprise.

students to enhance their penpal’s experience.

PSTs came to understand that a richer personal meaning for the concepts grew out of their thinking about how to present the content to their penpal. The expectation that the content of the book would be related to our State standards not only gave the students somewhere to go to determine what to write about but also made the task more professionally connected to them as prospective teachers. They recognized the value of the “Notes” that they had been required to prepare in the back of their books. In addition, the questions that they had generated to assist the reader helped them to assess the importance of different attributes and issues surrounding a concept. Having questions that required more than a one-word answer were valued for what they told the PSTs about their penpal’s understanding.

**Assessing the Learning**

The questions and notes were particularly helpful in determining whether the PSTs had developed a clear sense of what the mathematical aspects of the concept they wrote about

“The book I created is meant for children that are in first or second grade. Prior to reading this book, the student does not have to have any knowledge of shapes. This book will help the child to learn and be able to recognize shapes in the outside world. Although definitions are necessary for recognition it’s another way to learn the shape along with a visual. The definitions help with characteristics of the shapes.

The National Geometry Standards for grades kindergarten through second grade that my book accomplishes are the child will be able to recognize, name, draw, compare, and sort two-dimensional shapes. After reading the book the child will be able to recognize and compare the different shapes from a group of shapes. The other national standard that my book accomplishes is the child should be able to describe attributes and parts of two-dimensional shapes. ...

Throughout the book the shapes are made out of foam paper. The purpose of this is to reinforce the ideas and to involve other senses with the recognition of the shapes. This will help the child to distinguish which shapes they are supposed to be finding.”

involved. I also could tell whether students had referred to the State standards for guidance. Some students added extension activities that indicated the depth to which they had thought about the concept and how to connect it to the experiences of learners. (See Figure 5.)

One PST created a book of figures made out of specific shapes; for example, in Figure 6 we



Figure 6

see a figure made out of hexagons. In the “Notes”, she included, “Would these creatures be able to eat each other’s snacks? (Possible answer: Mr. Tangle would be able to eat Mr. Box’s snacks because a square is also a rectangle.) Would you ever want to have a mouth a certain shape? What would it be? What kind of foods could you eat with a mouth this shape?” Then as an extension the author suggested, “When you are eating a snack/meal next, ask the child to identify what shaped mouth a creature would have to have to eat that certain food.” The PST carried her topic throughout the questions and extensions so that they worked together as a piece to give me a sense of her thinking about the figures, their attributes, and their inter-relationships.

### **Last Thoughts**

The penpal project provided opportunities for my students to examine content closely, to consider how to represent it, and to create an example of their ability to communicate mathematical ideas. The penpals and their teachers expressed great satisfaction with the experience. I was able to use the products as a gauge of my students’ understanding of a piece of mathematical knowledge needed for teaching. The task engaged the students and created an environment in which they felt comfortable playing with mathematical ideas.

The most supportive evidence that this was meaningful for the students and that they felt good about what they had done came at the end of one of the books by a student who had been in an earlier course I teach in which they are expected to create a counting book. The student’s final page is shown in Figure 7. What a positive expression of her pride in her work.

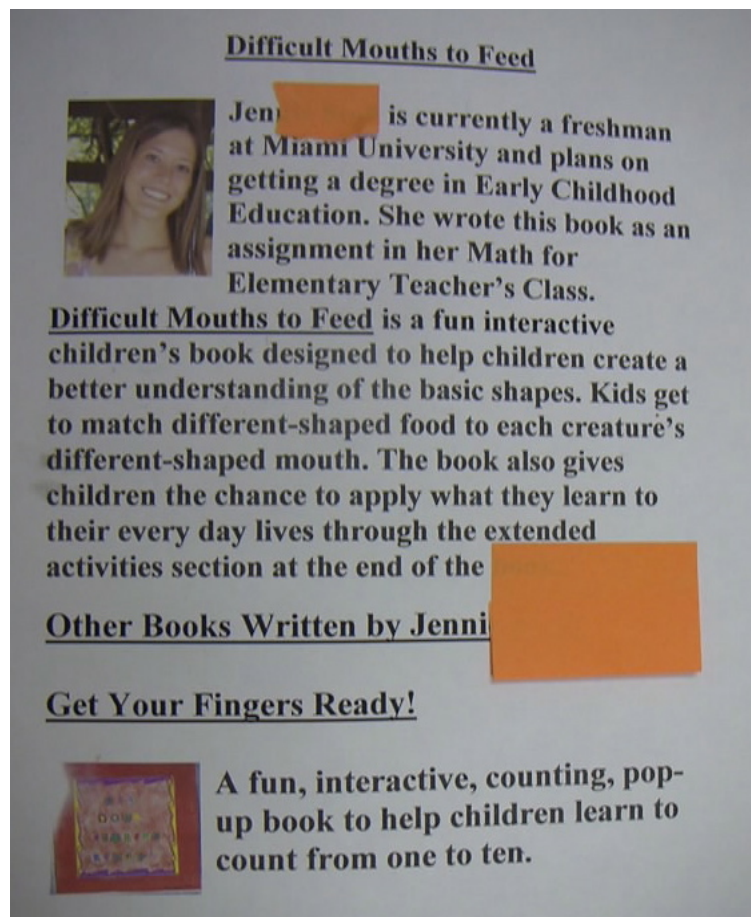


Figure 7

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