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Abstract:
Helping pre-service teachers to feel competent and courageous about the mathematics they will find themselves teaching as elementary school teachers is a critical component of any math methods course. This paper addresses this aim by highlighting a process that involves pre-service teachers in creating original mathematics literature books. This process assumes a social practice theory of learning based on a relationship among one's own thinking, the activity, and the thinking of other interested persons (Rogers, 1974). My stance is that creating such books offers ways for pre-service teachers to gain new mathematical understandings, connect the math they will be teaching to other life situations, identify pedagogical practices that support student thinking, integrate artistry into the teaching of content, and understand more deeply the multidisciplinary nature of mathematics.

> Artistry in teaching represents high levels of pedagogical performance. Artistry depends on sensibility, it uses imagination, it employs technique, it takes pride in its craft. Teachers as artists are sensitive to the tempo of the classroom, to matters of timing, and to the quality of their own performance and the ways in which it can be shaped to be appropriate for the occasion. Such considerations are in no way prescribable from scientific research. (Eisner, 2003)

Helping pre-service teachers to feel competent and courageous about the mathematics they will find themselves teaching as elementary school teachers is a critical component of any math methods course. One way in which I address this aim is to involve pre-service teachers in creating original mathematics literature books. Writing children's mathematics literature books in the process of learning to teach mathematics assumes a social practice theory of learning based on a relationship among one's own thinking, the activity, and the thinking of other interested persons (Rogers, 1974). My stance is that creating such books offers ways for pre-service teachers to gain new mathematical understandings, connect the math they will be teaching to other life situations, identify pedagogical practices that support student thinking, integrate artistry into the teaching of content, and understand more deeply the multidisciplinary

and complex nature of teaching mathematics. I have found that, via such participation in the process of creating an original story to be used by children to further math learning, pre-service teachers experience the value of aesthetic education as an outgrowth of their own expressions of math concepts. Such reflection and expression enhances "cognitive, perceptual, emotional, and imaginative development …as part of the human effort to seek a greater coherence in the world." (Greene 2001:7).

Mathematics as a body of knowledge is deeply intertwined with human activities. The social experience of learning offers pre-service teachers a way to see themselves in relationship to mathematics methodologies and content, the activities in which they and others are engaged, and their own mathematics learning histories. In so doing, students begin to reconceptualize their notions of the meaning of mathematics and what it means to be mathematically empowered.

Children's literature offers teachers a human perspective on the teaching of mathematics (Whitin & Wilde, 1995). The usefulness of mathematics becomes part of our lives through stories, whether the story is about dividing cookies ("The Doorbell Rang"), measuring a bed ("How Big is a Foot?"), walking on the beach ("Sea Squares"), or eating together ("Eating Fractions"). Ursula LeGuin claims, "The story - from 'Rumplestiltskin' to *War and Peace* - is one of the basic tools

invented by the human mind, for the purpose of gaining understanding. There have been great societies that did not use the wheel, but there have been no societies that did not tell stories."

Future teachers grow best when they are helped by teacher educators to embrace the complexities of practice and eschew endorsing simplistic pedagogical strategies they are told will solve their classroom problems. As teachers ourselves, we know that teaching is embedded in layers of dilemmas to tackle, as well as unsuspected challenges that call for unprecedented solutions. Researchers identifying key characteristics of successful professional development plans aligned with the *Principles and Standards of School Mathematics* (NCTM, 2000) specified that teachers need opportunities to study student mathematical thinking (Driscoll & Moyer, 2001; Schifter & Riddle, 2004). The task before us as mathematics educators is complex. It involves helping students to appreciate more fully the notion that teaching is a complex endeavor demanding a multitude of decisions. For example: when to tell or ask, and how to engage and support. Preparing teachers to teach involves more than content and pedagogy overviews. Rather, leading mathematics educators seek to assist teaching neophytes to coalesce a multitude of teaching facets into a whole that resembles more a symphony than disconnected notes. Our role as teachers of mathematics is to help our students to

think about student learning in terms broader than right and wrong, to encourage them to ground the learning experience with student interests, to teach math content in meaningful ways, and to help young children to develop mathematics courage and understanding rather than rote compliance.

How do we help pre-service teachers embrace teaching as a complex endeavor that sees math content as not what is to be "delivered" in the classroom but is redefined as an interrelationship between the content, the pedagogy and student engagement? For example; geometry is bigger than the study of geometric shapes and Geoboards. Tangrams will not singularly solve the problem of how to teach geometry. Yet many education methods classes often leave students concluding that knowing how to teach with manipulatives is sufficient.

Beginning teachers frequently focus on their own teaching practices rather than on what their students are learning. Yet it is asserted that they need to be able to figure out what they do and do not yet understand about how their students are performing and what they might do about it (Entwistle, 1991). They need to be able to ask themselves and others questions to guide their learning and decision-making. In other words, they need to go "meta" about their own practice. The more they embrace the complexities of teaching and

learning the better equipped they become to shape their teaching to meet the needs of their students.

The Process

Each pre-service teacher enrolled in one of my mathematics methods courses participates in a multi-step process to craft an original story illuminating at least one mathematics concept. An old Chinese proverb, "Even a nine story pagoda must be built up level by level," emphasizes a key course philosophy. The book project spans 15 weeks, with assignments and check points throughout the semester. The course syllabus incorporates the following ten-step process that provides an accounting of each step. Student comments, taken from class assignments and self evaluations will be quoted in order to more fully represent the process.

Step 1: *Choosing a math topic for the book*

Each student is asked to identify an area of mathematics about which she/he wants to deepen understandings during the semester. This might be an area in which she considers herself weak or possibly a mathematics topic that has always fascinated her. Topics include counting, number sense, equivalent fractions, and positive and negative numbers.

> Being that as a student teacher I taught multiplication and division to my third graders, it became clear to me that this was the right direction I should go in; therefore I wanted to write my book on that topic. Student Self Evaluation

Step 2: *Identifying appropriate grade levels for this math topic*

Students are asked to decide upon a grade level toward which they want to target their story. I encourage the students to choose grade levels in which they have experience or a desire to teach in the future. This helps the students to connect the research about their math topic to the classroom.

Step 3: Examining key pedagogy strategies from the Van De Walle text for this grade level and topic.

Students use the Van De Walle text to think more deeply about their math topic and the teaching strategies suggested there to help build understanding in this mathematics area. Many students indicate that they have never thought about teaching or learning mathematics in ways that differ from how they were taught. The notion that one might teach meaningful math understandings in formats other than direct instruction is a surprise to many.

Reading Van De Walle's section in the text about division helped me think about my topic. He was stressing how important it is to teach multiplication and division closely together so the students can see that the concepts are related. Van De Walle states that 'words, pictures, and numbers are really important' when solving problems such as division. I made sure in my book that I not only wrote about a concept of division, but I also used pictures and numbers to visually show what I set out to teach. Student Self Evaluation

Step 4: *Locating research articles that detail aspects of teaching or learning this topic.*

Students are asked to locate at least two research articles related to the teaching and learning of the math topic they have chosen. Students are to note what they learned from reading the articles and how this will help them in writing their books.

Example 1

Article summary

Hands on Subtraction

Audrey C. Rule

Mathematics Teaching. Derby: June 2005., Is. 191; pg 19, 3 pp.

This article discusses the importance of manipulatives when teaching mathematics. Children often struggle with the concept of the operation of taking away. The article shows different ways to perform subtraction without using the operation of take away. Furthermore, it stresses that students should be able to pick and choose their own problems to solve. By using the manipulatives and problem solving on their own, students can return to the problems in the future and discover different ways to solve the same problem. The material that can be used in the problems must catch children's eyes as well as be colorful and creative.

The problem that stuck out to me the most was the gift purchases with coins. I believe that I can use the idea of manipulatives and combine this problem in my book. Since I am gearing the book towards first grade, I think that after reading this article incorporating manipulatives would make the book more appealing. I can attach a Ziploc bag of manipulatives.

Example 2

Article: Through the Aesthetic Realism Teaching Method Addition and Subtraction Oppose Prejudice" Colavito, L. (1999).

In the article Colavito focuses on how students learn mathematics in a way that is friendly to them. "Adding and subtracting are opposites and they are everywhere, including in ourselves."

While I'm writing my book, I'm going to remember to incorporate instances that will be relevant to the lives of the students. Since I'm doing my book on addition, I'm going to focus on the world and environment in which we live. This will give the students an idea about real life situations that in turn may enhance the learning process.

One statement in the article made by a child that struck me as interesting was when the teacher asked students how they use math in their everyday lives. A student replied, "We lose baby teeth and grow new ones." This shows the importance of mathematics in the lives of children and how mathematics can be explored through real life experiences.

Example 3

Article:

Teaching Addition and Subtraction Facts: A Chinese Perspective

Wei Sun, Joanne Y. Zhang. Teaching Children Mathematics. Reston Sep 2001.

This article discusses the different methods that US and Chinese teachers use to teach students and the different ways the children interpreted two digit numbers. According to the author, US children tend to think in terms of ones, while Chinese children tend to think in terms of tens plus a grouping of ones. American teachers often teach that a certain number is one more than the last, while Chinese teachers teach children to think of numbers in grouping of tens. For example, 8+3 is taught as finding groups of ten by Chinese teachers, whereas US teachers would have students add up 8+3 using the concept of ones.

While thinking about my book, I feel it is important to have students understand the concept of groups as well as having the students add using tens instead of ones. In my book I will incorporate pages with blocks and have students circle the groups of ten. Hopefully, this way will provide students with different ways to count and add.

Step 5: *Developing a theme and story-line for the book that will interest children of particular grades and ages.*

In class we brainstorm a list of topics that might interest children of different

needs or grade levels. Students share ideas from their own lives, experiences with children, and readings in journal articles and the text. Students are asked to visit the local library or bookstore to peruse a collection of books for the population of children they want to target in order to gather additional theme ideas.

> The project made us put ourselves in the place of the child and gave us an opportunity to really think about teaching math from a child's perspective. Student Self Evaluation

Step 6*: Writing several drafts.*

Students are given the assignment to draft a storyboard for their book. Since this is the initial draft of the manuscript, they are not expected to produce a detailed storyboard, but rather a page-by-page sketch of the story. Students make decisions such as choosing a theme for the book and deciding on a physical structure, including size, binding, artwork, and text font. They also consider linguistics, child development, and presentation styles. They consider how much text should go on the page, which pages might not have text or illustrations, and the length of the book. The focus is to get a sense of the flow of the story line and the way the text and illustrations enhance the story and

any additional pages they might be considering. The second draft occurs after a peer critique and takes into account any newly accepted suggestions or ideas. The second draft also contains more detail regarding the font size and type, colors, and graphic design.

> I learned the role of revision and patience in doing my work.
>
> Student Self Evaluation
>
> I learned from my peers as they critiqued my first draft. You have taught us not to give direct answers. My peers told me I didn't need to use the book to lecture on the way to find percents, but, rather, let children think through some of it on their own. Student Self Evaluation

Step 7*: Illustrating the book.*

It is the rarest among us who believe they are talented artistically. Students stress the most over the illustrations for their books. And I do not allow them to use clip art icons for their illustrations. We spend a great deal of time discussing other possibilities: children doing the art work, collage, using simple drawings, repeating a character with different clothes or size to reduce the amount of time spent illustrating, and not drawing everything in detail. This one aspect of the process delights

students most in their finished products. Each student prefaced the reading of her book to the class with words such as, "I'm not an artist, but it turned out ok." This speaks to the notion that Ron Berger describes so well in his *Ethics of Excellence* (1999). The expectation was that every student was capable of producing a finished product of excellent quality. Each lived up to the expectation.

> My favorite part of this whole class was making our math storybooks. I will be honest—at first I thought this was going to be a pain to come up with an idea and to create a book. And I'm not an artist - I can't begin to imagine how to illustrate a book. I was wrong. I had so much fun making the book and getting all my ideas together. It was a real pleasure. It took me some time to get my thinking together and create the book, but I loved every minute of it. It made me realize how much you can enjoy math. While everyone was reading their stories, I realized how fantastic they all were and the amount of work each person put into the project. I was impressed by their efforts and the excitement they had to read their stories to the class. I hope the children will donate the books to get as much enjoyment from them as we did making them.
>
> Student Self Evaluation

Step 8: *Participating in a peer critique process.*

After the first draft of the book, students are asked to sit in small groups of three to share their initial drafts with each other. It is important to note that each author has control of the critique process. It is the author who determines what help he/she is looking for. Maybe the ending of the story is still problematic; possibly help is needed in illustrating a particular page or determining the length of the story. Students write peer reviewer comments that detail any of their suggestions to the author, and then the author comments on any suggestions that he/she may consider for the next draft. Below are three examples of the critique process:

1. Comments of peer reviewer:

I really like the idea of using a toy chest, because kids will be able to relate to it. My only suggestion would be to make your story a little shorter so the children won't lose interest by the end.

Suggestions you as author will use in your revision:

I think I will take your suggestion and make it shorter. I had actually added pages to make it bigger, but I think you are right-it is too long.

2. Comments of peer reviewer:

Creative, Unique.

Students will like the bear characters and the fact that they are personified.

For when you are adding up the scores, maybe put the total answer on the next page so the students have to think about the answer.

Suggestions you as author will use in your revision:

I will use that suggestion because it will give the students a chance to think about what the numbers add up to before seeing the answer.

3. Comments of peer reviewer:

If your story line spans a school week, then I think you need to make the fractions equal the day. So if you do five days and start with one/two hundredth, you could go down by a half each day. For the five days, this would be one/two hundredth, one/one hundredth, one/fiftieth, one/twentyfifth…You can show the relationship between halves.

Suggestions you as author will use in your revision:

I will use the fraction number idea of using fractions that will not confuse the children. This will help students to first understand fractions before getting too complex.

The following is a student comment from the final self evaluation regarding the peer critique session:

We were very open with one another when it came down to sharing ideas or critiquing each other's work. I learned the role of revision and patience in doing my work.

Student Self Evaluation

Step 9: *Sharing finished products at an Author's Day celebration.*

On the final day of class, each author brought his/her book to share. We sat in a huge circle and took turns reading our stories. Such a diversity of themes, topics, presentations, and story lines. The day was a celebration of our own diversity and talents.

This project helped me to see a whole new way of looking at math. As much as I got out of doing my own book, I got just as much out of listening to other people's stories. The books varied in every possible way. I think the diversity of the books just goes to show how many different ways that people's minds work. Student Self Evaluation

I enjoyed the fact that we had the opportunity to share our book and listen to others read theirs. We were able to see how each of us brought our own ideas into this classroom, and each of us brought something different. We were able to see multiple ideas about what people wrote and how they chose to do it. Even in elementary school classes, sharing is beneficial and brings with it significant learning and also a sense of pride to the students. After the

completion of my book, I was very prideful because it was something that took a lot of time to complete, and I put a lot of effort into making it my best. Student Self Evaluation

Step 10: *Donating the children's book to an elementary school*

The books are given to schools lacking resources that others enjoy. Each semester I locate a city school in need and bring the books to the teachers to use with their children. One semester we sent the books to a new school in Ghana that had no books for children. Creating something that other children will use to learn with was a powerful motivator for the pre service teachers and gave them a sense of pride in their own accomplishment.

Being able to create our own children's book was exciting and a fun project. To know there will be children out there reading my work and learning from it is something I will never forget. Student Self Evaluation

I keep thinking about how we are sending our books to a school in need and what a wonderful idea that is. Our class helped a school in need and that alone meant so much to me that we are putting in effort for a good cause. Student Self Evaluation

I believe this class has impacted not only my learning but my life and the lives of others. We reached out to a school that needed help, and that will forever remain in my heart. For one class to come

together and work together for an entire semester while completing a project for students in need really means a lot about the education program here. I believe each one of us will treasure this class, the project, and the way we impacted our community forever. Student Self Evaluation

One part of this course I truly enjoyed was creating my own story book. Looking back, I can still recall all of the stories my mother used to read to me and how much they helped me to relate things in school. It was a pleasure to create a story that I know will do the same with other children. Student Self Evaluation

Final Thoughts

By the evidence from our activities, I can safely conclude that pre-service teachers gained new mathematical understandings; connected the math they will be teaching to everyday life situations; developed strategies for teaching mathematics; integrated creativity into their mathematics consciousness; included a social justice component; and developed a new consciousness about themselves as learners of mathematics. Following are several students' overall course feedback:

Writing the children's book has made me feel much more prepared to teach math. The project made me put myself in the

place of the child and gave me an opportunity to really think about teaching math.;

I think that the United Negro College Fund got it correct when they stated that, "A mind is a terrible thing to waste." I deem that the book assignment demonstrated to me that being a constructivist teacher is by far more complicated than we think, but I believe that the book writing project has motivated me and built my confidence for teaching in my own classroom.
As for our class project, that was a valuable learning experience that I will always remember. At first when we were told that we were going to make children's books, I felt a little unsure about I,t due to the fact that it seemed like a rather difficult task. However, when we started working on it, I realized the experience alone enhanced my learning capacity. First of all, we were making this book for a struggling school, and we were giving back to the community. Since we were the authors, we had the chance to write our book about anything we wanted to. I know that I directed my book with the aim of teaching children that you don't always have to win to have fun. I just thought that this was a good message to revolve my book around, because sometimes you see children that are so competitive,

> and you really want to teach them that there is no need for such strong competition. Our books looked as if they were made by professionals. I believe we all brought individuality into our classroom with all of our different books.

Although I am passionate about the power of helping pre-service mathematics students write children's books, I am sure there are other ways to support them in reaching similar goals. The vital question is, how do we engage future teachers to more reasonably and sensitively understand mathematics? How do we help pre-service teachers to learn how to think about new ideas on their own, to study an area of mathematics and shape the math content knowledge so it supports what they are en route to believing are sound teaching practices, and to think about ways to empower students to learn about mathematical ideas that are consistent with cutting edge approaches to professional development (Carpenter, et al., 2004). Our responsibility as teacher educators remains rooted in the continual quest to seek ways to offer students learning autonomy that encourages them to shape their own teaching ideas and conceptual understandings in order that they might bring their newly developed thinking into their teaching practice (Entwistle, 1991).

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