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Winifred Mallam
Texas Woman's University, Denton, WMallam@twu.edu

Georgia A. Cobbs
University of Montana, Missoula, georgia.cobbs@mso.umt.edu

Ann Wheeler
Texas Woman's University, Denton, awheeler2@twu.edu

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Winifred Mallam
Texas Woman's University

Georgia A. Cobbs
University of Montana

Ann Wheeler
Texas Woman's University

Teaching mathematics can be a fun and engaging task. However, with many elementary preservice teachers (PSTs) not enjoying mathematics, one tries to be creative in teaching them mathematical methods. As mathematics educators, we model good teaching methodologies and require assignments from our PSTs, so they can learn to create similar assignments for their students. Often, the content of these assignments includes standards-based (NCTM, 2000) concepts that help students to see past procedural algorithms and spark their problem-solving capabilities. One such example is creating a mathematics activity that is based on children's literature, where the focus could be fiction or nonfiction, which may include a mathematics themed book or a book that does not have an outward flair for mathematics.

As background for our research, we reviewed literature under three headings:

1. National Standards for Teaching Mathematics and Literature,
2. Integrating Children's Literature during Mathematics Instruction, and
3. Assessing Student Narratives.

National Standards for Teaching Mathematics and Literature

When teaching mathematics and language arts in elementary and middle school, the content and strategies implemented are influenced by national and state standards. The Common Core State Standards (CCSS) are national standards that provide direction for what should be taught in K-12

mathematics and English language arts and literacy (ELA). In the United States of America, the CCSS have been adopted by 41 states, the District of Columbia, four territories, and the Department of Defense Education Activity (DoDEA) (National Environmental Education Foundation, 2022).

The CCSS for Mathematics (CCSSM) for elementary and middle school are generally outlined according to operations and algebraic thinking, number and operations, measurement and data, and geometry. Statistics and probability are additional domains in grades 6-8. These domains relate to the content, whereas the Common Core State Standards for Mathematical Process (CCSSMP) refer to the process that teachers use as they put the standards into action. When teachers are implementing the CCSSM, they are expected to encourage their students to apply their mathematics skills as they solve real world problems.

Along with other skills, the CCSS-ELA stress that reading and writing should be integrated with other subjects, for example, mathematics (CCSSI, 2010a). In grades 3 to 5, the fourth Reading Standard for Informational Text K-5 in the CCSS-ELA-Literacy emphasizes this, for example, the fifth grade CCSS-ELA-RSIT5.4 states that students should:

> Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area (CCSSI, 2010a, p. 14).

Likewise in the middle school, reading in other subjects is evident in the following standards, CCSS-ELA-Literacy.RST6-8.4:

> Determine the meaning of symbols, key terms and other domain-specific words and phrases as they are used in a … technical context relevant to grades 6-8 … topics (CCSSI, 2010a, p. 62).

Similarly, ELA-Literacy.WHST.6-8.4 focuses on writing across the curriculum. The standards for writing in grades five to eight state that students should:

> Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience, for example, (CCSSI,

2010a, p. 66).

It is evident that the standards promote the integration of mathematics and English language arts. Integrating these mathematics and literacy skills in our mathematics methods course will prepare our PSTs for their future teaching careers.

Integrating Children's Literature During Mathematics Instruction

Reading in the content area is a teaching skill that has evolved over the years. It focuses on helping students to comprehend how to read content specific subject matter. Harold Herber was a pioneer in the field when he published his book *Teaching Reading in Content Areas* in 1970 (2012). A second edition of the book was published in 1978. Brown (1981) recommended Herber's book as a source for teaching reading skills. Herber's (1978) book includes examples that focus on implementing reading strategies during mathematics instruction. The lesson structure consisted of three components: preparation, guidance, and evaluation (Herber, 1969.) Preparation could include teaching vocabulary or terms. During the guidance stage, students could be given a structured overview that depicts how the terms being taught are related. Evaluation could include vocabulary puzzles. Since the 1970's, Reading in the Content Area has been the pedagogy for integrating reading skills in other subject areas. Incorporating reading in the mathematics content area provides opportunities for students to improve their discussion skills, collaborate, solve problems, and enhance their research and citation skills (School Specialty, 2021). The course may be offered using different titles, for example, Literacy and Learning across the Curriculum, Reading and Language Arts across the Curriculum, Literacy Strategies for Middle and Secondary School Content Areas, or Content Area Literacy Instruction.

In recent years, reading in the content area has branched out to creating and solving problems based on children's literature. Wheeler and Mallam (2020a) identified a five-stage problem solving task model for incorporating literature during mathematics instruction. The stages are **S**elect Children's Literature, **D**evelop Problem Solving Task, **C**ritique Problem Solving Tasks of Other PSTs, **R**evise Problem-solving Task, and **S**ubmit Task for Grading. Bresser (2004) and Burns and Sheffield (2004) were pioneers in the field of integrating mathematics and literature when they published a series of books with mathematics lessons that were based on children's literature. Integrating children's literature during

mathematics instruction can boost the achievement of elementary and secondary school students (Hong, 1996; Jennings et al., 1992; Kisker et al., 2012; Thomas & Feng, 2015). Working with preschool children, McGuire et al. (2020) developed a curriculum, *Booked on Math*, which introduced children to mathematics concepts via interactive read-alouds. They found that students made the greatest progress with quantifying, shapes, spatial relationships, and knowledge of patterns. In Hong's study with kindergarteners, the experimental group read storybooks that incorporated mathematics and modeled the activities with manipulatives, whereas for the control group mathematics and children's literature were taught as two unrelated subjects. Findings indicated that children in the experimental group liked the mathematics corner and spent more time there than the control group. Furner (2018) promoted incorporating literature during elementary and secondary school mathematics instruction as it may arouse students' interest in mathematics and lower mathematics anxiety. In his article, he suggested mathematics activities that include children's literature. Harding et al. (2017) supervised elementary PST as they prepared and then taught mathematics lessons based on children's books that had a focus on mathematics and were multicultural. Based on their observation of the multicultural mathematics lessons that were taught in elementary school classrooms, they developed The Learning Purposes and Teaching Strategies for Integrating Multicultural Mathematics Picture books Framework that demonstrates the integrated nature of Furthering Mathematics Knowledge, Scaffolding, and Monitoring.

With a different view, Brodzik et al. (1996) stated that when thematic units are implemented, students do not master the mathematics, reading and writing skills. This implies that the teaching will be superficial. Similarly with respect to integrating language arts into mathematics instruction, Zambo and Cleland (2005) found that teachers in grades 5-6 were less likely to integrate the two subjects. Despite these observations, incorporating literature during mathematics instruction can enhance the lesson and motivate the students to learn the mathematics skills.

When teaching PSTs how to incorporate children's literature during mathematics instruction, Wilburne and Napoli (2008) noted that when mathematics and literature are intertwined, the content and pedagogical knowledge

of preservice teachers are enhanced. They included a set of eight focus group questions in their article. Likewise, Franz and Pope (2005) promoted the integration of mathematics and children's literature with preservice and in-service teachers. They saw the process as a way to bridge mathematics with the real world. Edelman (2017) found that although the mathematics concepts may be explicit in the book, preservice teachers may still not be able to teach an effective lesson. They need solid mathematical backgrounds before they can comprehend how to develop a topic. This implies that PSTs should have passed their core mathematics courses before taking a mathematics education course.

Assessing Student Narratives

Prior to analyzing student narratives, Suresh et al. (2019) used transcription of teacher-student audio to classify mathematics discussion via the Talk-Back application. The application had 7 levels. They are:

0-None.
1-Keeping Everyone Together
2-Getting students to relate
3-Restating
4-Revoicing
5-Pressing for accuracy
6-Pressing for reasoning.

Level 0 is used when the teacher does not use communication to solicit student talk, for example, the teacher said "Okay" or "Yes." The other six teacher talk levels are grouped into 3 categories: *Accountability to the learning community*, *Ensuring purposeful coherent and productive group discussion*, and *Accountability to rigorous thinking*. *Accountability to the learning* includes Levels 1 and 2 of Suresh et al.'s model. For Level 1 the teacher may ask, "What did she just say?" while for Level 2 the question could be "Who agrees and who disagrees?" The second category, *Ensuring purposeful coherent and productive group discussion*, relates to Levels 3 and 4. The teacher asks students to rephrase what they heard. The third category, *Accountability to rigorous thinking*, includes Levels 5 and 6. For Level 5, the teacher may ask students to explain the steps they took to arrive at their answer, while for Level 6, students may be asked to explain how the ideas are connected. An analysis of the Talk Back sessions revealed that the teacher used Level 0 most of the time. Levels 3, 4, and 5 were used the least.

Rather than transcribing text, which can be a cumbersome task, analyzing written text can be an alternative for assessing student comprehension of mathematics material. Heibert and Grouws (2007) used the terms explicit attention to concepts (EAC) and students'

opportunity to struggle (SOS) to define how students interact with written text. EAC relates to how students learn their concepts during instruction, while SOS refers to how students respond when solving mathematics questions.

Using the two terms, EAC and SOS, Stein et al. (2017) devised a 2 by 2 box with 4 quadrants that they used when observing teachers. See Figure 1. Quadrant 1 is a high-quality problem that provides opportunities for students to struggle and is referred to as Doing Math. On the extreme, Quadrant 4 provides procedurally driven instruction and is labeled Memorization. In between are Quadrant 2 (Procedures with Connection) and Quadrant 3 (Procedures without Connection).

As Wheeler and Mallam (2020) intended to use Stein et al.'s model with preservice elementary and middle school teachers, they translated the Stein et al.'s model to words using expressions for written work. Preservice teachers used the matrix to assess books that they had written. See Figure 2. The books are PowerPoint slides that are assembled as pages to form a book (Wheeler et al, 2020).

	Opportunities for Student Struggle		
Explicit Attention to Concepts		High	Low
	High	Quadrant 1 High EAC High SOS	Quadrant 2 High EAC Low SOS
	Low	Quadrant 3 Low EAC High SOS	Quadrant 4 Low EAC Low SOS

Figure 1. 2 x 2 matrix displaying Stein et al.'s (2017) model

Quadrant 1: A high quality (conceptually based) task where readers have productive struggle to determine the solution. The book includes a thought-	**Quadrant 2**: A low quality (procedurally based) problem, where the authors try to make connections for the readers to the formula(s) given.

provoking problem where the reader must think critically about the information given to be able to be successful with the problem. In addition, the task given is often a multi-step, multi-dimensional problem.	
Quadrant 3: A high quality (conceptually based) problem, but the reader does not have the necessary background information/ knowledge to successfully solve the problem. The problem is challenging, but there is some disconnect between what the author wants the reader to do and what can be accomplished with the given information.	**Quadrant 4**: A low quality (procedurally based) problem where the reader does not need to think for himself/herself to complete the task. It is a problem where the reader substitutes into a formula to arrive at an answer without any connections to why the procedures work. You do not have to fully understand the problem to calculate the solution.

Figure 2. Wheeler and Mallam (2020) model

In the past, Wheeler and Mallam (2020) assigned a writing assignment where PSTs had to use non-mathematics themed children's literature to create a mathematics text but felt that mathematics themed literature could also potentially provide benefits to PSTs. Therefore, the purpose of this project was for preservice elementary and middle school teachers to create a mathematics activity based on children's literature that provided a mathematics background in the work. More specifically, our research questions centered on the following three research questions:

Research Question 1: For what grade and Common Core State Standard for Mathematics (CCSSM, 2010b) do preservice teachers prefer to design lessons?

Research Question 2: For what Common Core State Standards for

Mathematical Practice (CCSSMP) (CCSSM, 2010b) do preservice teachers prefer to design lessons?

Research Question 3: What category of Stein et al.'s (2017) Task Analysis Guide (TAG) model do preservice teachers select when composing lessons?

Method

Demographics of Participants

This research project occurred over one semester in a mathematics methods course for grades 5-8 in an intermountain university. The course is taken in the senior year of their elementary education program and in the final semester before the PSTs student teach. In order to be accepted in the Teacher Education Program, the students must have completed 9 semester credits of mathematics. Typically, these are taken in our mathematics department and include 3 courses, 3 credits each semester. Each course is designed to teach K-8 mathematics content using student-centered and hands-on methods. Some students may have had other mathematics courses in addition to these, but not required. All students were enrolled in the elementary education K-8 licensure program.

Data was collected from the students enrolled in this mathematics methods course. There were 16 PSTs in this course, 2 males and 14 females. The males were non-traditional students: one being a graduate student (in his late 20's) with a mathematics degree in his undergraduate program; the second male (in his mid-40's) was a second career student getting his undergraduate degree after being in the hotel managerial business for 15 years. The 14 female students ranged in ages from a typical senior age at 21 years of age to later 20's, with one as a single mother in her early 30's.

Background of the teacher education program

This mathematics course focuses on grades 5-8 and is one of 5 different courses PSTs take in the semester before they student teach. The other four courses include classroom management and teaching and assessing methods in science (K-8), social studies (K-8),

and reading (4-8). The PSTs had methods in early numeracy and literacy 2 semesters prior. They were also exposed to the CCSSM (2010b), various teaching methods, and lesson plans. The semester is structured such that PSTs are on campus for weeks in these 5 courses, then placed, by teams of 2, in K-8 classrooms in the vicinity of the university for the last 5 weeks of the term. Supervision of these teams is done by their university instructors. As this is the last semester before PSTs' fourth and final field experience (student teaching), most are highly motivated and want to perform well in their course work and in their third field placement.

Mathematics lesson plan assignment

The 16 PSTs were given an assignment during their mathematics methods course to develop a lesson using a children's literature book with a mathematics focus. A template for their lesson plan (see Appendix B) was provided to help them in the creation of their lesson. The PSTs chose their book from the instructor's library, making sure it centered around a mathematics concept found in grades K through 8. (Fourteen books were selected, See Appendix A for the list). PSTs used the provided template which included the requirement of higher order questions. It was not the desire of the instructor to have lessons asking for definitions of terms or rote memorization, rather the focus was to include an application or an analysis of the mathematics concept being taught. So the required lesson must include at least two higher cognitive level questions asking elementary students to at least apply the concept to a real-life situation or analyze the concept being taught, that is, using a higher cognitive demand of the students (see K. Hess matrix).

Timeline for Assignment

The assignment was briefly mentioned during the first week of class, but formally assigned during the second week of class and was due in 10 days. Some preservice teachers turned their plan in early; however, most were on time with one being over a month late. With COVID-19 and other life challenges, late papers were accepted.

Limitations

No formal modeling of high cognitive demand (HCD) was shared, but a link to a document describing each level was provided for the PSTs to use as a reference.

Results and Discussion

Each of the three researchers independently classified the 16 lessons using the Wheeler and Mallam (2020) model described earlier. Then, the researchers

discussed discrepancies and resolved differences to 100 percent agreement.

Research Question 1: CCSSM (2010b) Domains

Table 1 summarizes our findings from the PSTs' lessons in regard to the 2010 CCSSM Domains covered in each lesson. Of the 16 PSTs, one PST did not include CCSSM Domain specific standards, so the table only illustrates 15 participants. As can be seen from the data, 8 lessons were 5th grade, 6 lessons were 6th grade, and 1 was Kindergarten. Even though the course is for grades 5-8, the one K level lesson plan was accepted because of COVID placement issues. Besides listing the grade level of the lesson, PSTs also stated the CCSSM standard their lessons covered. The most popular 5th grade CCSSM Domain utilized by PSTs was *Number and Operations*, while the most popular 6th grade CCSSM Domain was *Expressions and Equation*s.

Table 1. 2010 CCSSM domains

2010 CCSSM Domain	Grade Level	Frequency (n =15)	Percent
Counting and Cardinality	K	1	6
Numbers and Operations in Base Ten	5	3	19
Numbers and Operations-Fractions	5	2	13
Measurement and Data	5	1	6
Operations and Algebraic Thinking	5	2	13
Expressions and Equations	6	4	25
Geometry	6	1	6
Statistics and Probability	6	1	6

Research Question 2: 2010 CCSSMP types

With the 2010 CCSSMP, only 14 of the 16 PSTs reported. Of the 14 reported, PSTs could list multiple standards they felt were utilized within their lessons. As can be seen

from Table 2, 50% of the PSTs utilized the Mathematical Practice standard of *Reason Abstractly and Quantitatively*.

Research Question 3: Classifications of Lessons

As seen in Table 3, the majority of PSTs (69%) created lessons classified as *Procedures with Connections*, while none made lessons with *Doing Math* tasks.

Table 2. 2010 CCSSMP with frequency and percent breakdowns

2010 CCSSMP	**Frequency (n=14)**	**Percent**
Make sense of problems and persevere in solving them	5	31
Reason abstractly and quantitatively	8	50
Construct viable argument and critique the reasoning of others	0	0
Model with mathematics	7	44
Use appropriate tools strategically	0	0
Attend to precision	3	19
Look for and make use of structure	4	25
Look for and express regularity in repeated reasoning	3	19

Table 3. TAG (Stein et al., 2017) classifications for each PST lesson

TAG Category	**Frequency (n=16)**	**Percent**
Doing Math	0	0.00
Procedures with Connections	11	68.75
Procedures without Connections	4	25.00
Memorization	1	6.25

In the following paragraphs, we will detail examples of mathematics activities from the TAG categories.

Procedures with Connections

Sixty-nine percent of PSTs created lessons categorized as *Procedures*

with Connections. These lessons included tasks that were procedural in nature but required students to connect their work back to the concepts underlying the rote tasks. One such example was based on the mathematics-themed children's book entitled *Apple Fractions* (Pollatta, 2002). In his book, Pollatta discusses some popular kinds of apples and fractional ways to partition the fruit depending on the number of people who want to share them. The lesson involves students drawing fractional amounts of apples that are depicted in the book (see Figure 1 for sample student work), as well as the teacher asking students for verbal help in cutting actual apples and oranges. As part of the exit ticket, students were to answer various questions, including creating two fraction equations, four fractions with juice cups of varying amounts, and representing $\frac{1}{8}$ in a pie picture.

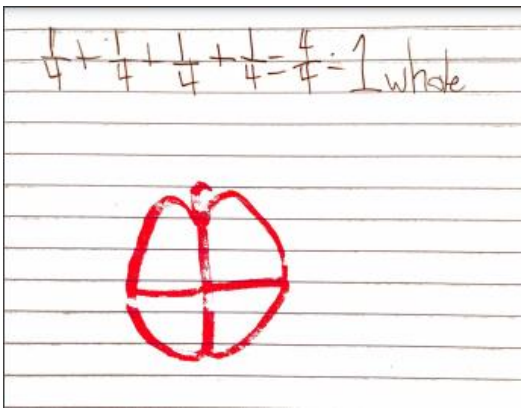

Figure 1. Sample student work about dividing an apple into fourths

We classified this lesson as *Procedures with Connections* because the students were to complete fairly straightforward procedural work, but the inclusion of pictures helps students to understand the fractional relationships.

Procedures without Connections

Procedures without Connections based lessons accounted for 25% of the activities. These lessons consisted of procedurally-based work with no real connection to the mathematical concepts. An example of this lesson can be found in the task inspired from the book entitled *A Place for Zero: A Math Adventure* by Angeline LoPresti (2003). In the book, Zero is trying to find his place in the world and ends up making all different types of numbers, such as 10 and

100. The PST created an activity where students use a tub of Base 10 Blocks and wrote two numbers based on the blocks and subsequently added and multiplied the numbers (see Figure 2).

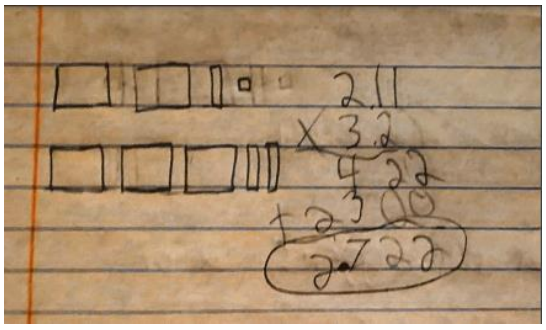

Figure 2. Sample student work about a multiplication task

We classified this lesson as a *Procedures without Connections* because the students could methodologically write the numbers based on the size of the blocks without really thinking about how the flat is 10 times bigger than the rod and 100 times bigger than the unit. If the PST had asked questions about the different representations as part of the task, we would have classified it as *Procedures with Connections*.

Memorization

An example of one such PST *Memorization* lesson was the 5th grade activity based on Adler's (2016) book entitled *Place Value*. In the book, Adler details the concept of place value using the alphabet and money. The PST had students perform simple tasks, such as define different place values terms, identify which number is bigger, give an example of a number between two numbers, and expand decimal numbers (see Figure 3 for sample student work).

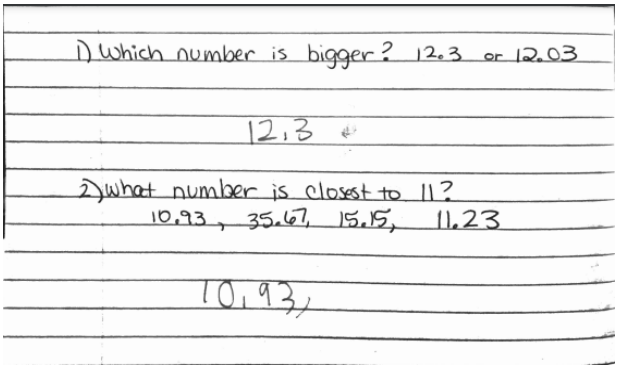

Figure 3. Sample student work involving decimals

This lesson was considered a *Memorization* lesson because of the PST's focus on memorization-based tasks. Students generally completed quick, memorization mathematics questions.

Two of the authors (Wheeler & Mallam, 2020) conducted similar research to this current study utilizing classes of preservice elementary and middle school students, but the PSTs in that study created lessons based on non-mathematics-based children's books. With both studies, most PSTs were able to make *Procedures with Connections* lessons. We found that the PSTs with non-mathematics-based books struggled greatly trying to make mathematics lessons with books that were not inherently mathematics themed. In a sense, we were having PSTs "recreate the wheel," which often was very difficult for many PSTs who often had low self-confidence in mathematics. Producing original work based on books that seemingly had no mathematics ties seemed an overwhelming task to undertake.

With this current work, having PSTs at least being able to utilize the "help" from the mathematics-theme in the task could be the little boost an anxious PST might need to be successful in undertaking any mathematics assignment. Incorporating children's literature into a mathematics lesson has many advantages. As previously stated, such lessons can reduce mathematics anxiety, can provide connections to real-life and provide context for learning various mathematical concepts.

Conclusion & Implications

This research illustrates how PSTs attempted to create compelling mathematical lessons using mathematics themed books. Comparing the results to (Wheeler & Mallam, 2020) study, the PSTs improved in their use of using the book to teach mathematics. However, our results indicate much more guidance is needed. Using a children's literature book with a mathematics focus had the mathematics connections from the start. As mentioned earlier, PSTs created thoughtful lesson plans. Yes, the plans were more procedural with connections, but the PSTs did develop creative ways to teach. Edelman's (2017) findings may still run true. PSTs are still learning how to develop an engaging, effective lesson; specifically, one that falls under Quadrant 1 (Wheeler & Mallam, 2020). Hopefully, using children's literature, PSTs would have less anxiety in the teaching of mathematics. With more guidance in the mathematics methods course, stressing the use of manipulatives and implementing higher cognitive demand, PSTs can learn to develop

more engaging mathematics lessons with higher level questions and ultimately help their elementary students see connections and applications with many mathematical concepts in everyday living.

Since teaching reading, not math, is a favorite area for many PSTs, mathematics educators work diligently to help elementary majors understand and like the teaching of mathematics more than when they enter our classes. Our research results indicated most PSTs were able to create 5th and 6th grade mathematics lessons using children's literature that fall under the category Procedures with Connections. Bringing in the plethora of children's literature around mathematics concepts and teaching PSTs how to develop strong mathematics lessons using this literature can help them develop stronger mathematics content and teaching skills. As mathematics educators, we still have much work ahead, including more guidance to model in the teaching of mathematics. PSTs need to understand the complexity of creating a strong mathematics lesson and allowing elementary students to actually perform mathematical tasks, or as the category states, Do Math.

Winifred Mallam, *Ph.D., is a Professor in the Division of Mathematics at Texas Woman's University, Denton, TX 76204. She may be contacted at* WMallam@twu.edu.

Georgia A. Cobbs, *is a Professor in the Mathematics Department at the University of Montana, Missoula, MT 59812. She may be contacted at* georgia.cobbs@mso.umt.edu.

Ann Wheeler, Ph.D., *is a Professor in the Division of Mathematics at Texas Woman's University, Denton, TX 76204. She may be contacted at* awheeler2@twu.edu.

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Appendix A

Books used in the Research

Book Title	Author(s)
Anno's Counting Book	Mitsumasa Anno
Apple Fractions	Jerry Pollotta
How Much is a Million?	David M. Schwartz
An Introduction to Algebra Using Mystery Math: A First Book of Algebra	David A. Adler
It's Probably Penny	Loreen Leedy
Math Curse	Jon Scieszka and Lane Smith
One Grain of Rice	Demi
A Place for Zero: A Math Adventure	Angeline LoPresti
Place Value	David. A. Adler
Spaghetti and Meatballs for All	Marilyn Burns
Venn Diagrams	Robert Froman
The Wishing Club, A Story About Fractions	Donna Jo Napoli
Women in Science	Rachel Ignotofsky
You Can Count on Monsters	Richard Evan Schwartz

Appendix B

Children's literature Lesson Plan

Topic/title of lesson	
Domain & Critical Area	
Standard(s)	List the standard(s) addressed in your lesson, including coding and wording.
Mathematical Practices	List the Standard for Mathematical Practice(s) addressed in your lesson, including coding and wording.
Book Title & Author	
Meet with Professor	Include date of meeting
Rationale (from text)	Explain why you are using this method? Pull from our text the support to use this method for this concept.
Use of visual	Explain how you will use any visuals or why you did not

Mini-Lesson Overview ***Critical Questions from resources***	• Describe the mini-lesson and how you will sequence the activity, and include prompts/questions that you will use during your teaching: ● Does it tie in with an activity from our text? If so, include title & pg. #. ● What is your hook to introduce the activity? What directions will you give? ● Describe how the visuals of the book enhance your lesson? Give at least one example. If there are none, ● How will you sequence the activity in terms of content complexity? ● What critical **questions/prompts** will you ask during the mini lesson to probe thinking, clarifying thinking, assess understanding of content, etc.? Any from the Resources on Moodle? Assessing: How will you know your students learned the concept? Exit ticket?
Real-life connection	Describe how this concept connects to real life.
Resources	List materials you need for the activity, including manipulatives, technology, etc. Also be sure to include any supporting documents (ex. written prompt, task cards, graphic organizer, recording sheet, etc.) by adding at the bottom of this document or uploading separately.