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Preface

Jane W.: My children say I live in a different world—a mathematics world!

Jane K.: My family says I live in a different world—a young child world!

Mary N.: My friends say I live in a different world—a children's book world!

We have brought our three worlds together in response to the requests of teachers of young children. As we have listened to our teacher friends talk about their mathematics experiences, as children and as educators, we recognize ourselves. Many teachers resemble Jane W., who enjoys thinking about numbers and patterns; she plays with mathematical possibilities simply for the joy of engaging in the process. Many teachers tell us they resemble Jane K., who enjoys thinking with young children; she plays with the child perspectives simply for the joy of engaging in the process. Many teachers tell us they resemble Mary N., who enjoys thinking with storybook characters and contexts; she plays with literature responses simply for the joy of engaging in the process.

The three of us bring similar but different mathematical lenses to our work with teachers and children. Jane K. wishes she had learned about meaningful mathematics when she was a child. Many decades ago, she learned mathematics was memorizing procedures to get the one right answer. Now, Jane K. knows that young children construct knowledge about mathematics all through their early lives.

Jane W. wishes everyone could see and understand that mathematics is around us all of the time. Many decades ago, she learned mathematics was a way of contributing to the world as a means to solve problems, reason logically, and prove numeric and geometric relationships. Now, Jane W. knows young children with mathematical knowledge and problem-solving skills will learn to reason and apply critical thinking all through school and contribute solutions to world problems as adults.

Mary N. wishes all children could enjoy the authentic mathematics that surround characters in storybooks. As a first-grade teacher, she learned that connecting content knowledge to storybooks enhanced children's interest and comprehension. Now, Mary N. knows storybook characters can provide children with access to mathematical knowledge that will extend out into the 22nd century.

What Is the Role of Storybooks in Mathematics?

Storybooks bring children into imaginative worlds where fascinating things happen. They appeal to children's emotions and capture their interest through vivid illustrations, stimulating plots, and exciting characters. By linking mathematics within storybooks, teachers are able to contextualize mathematics by associating it with circumstances and things that occur in the storybook worlds and in children's real worlds. Placing mathematics in a meaningful context helps children relate to mathematics and make sense of the mathematics. Thus, the mathematics becomes real to them, even though it is presented in story. Storybooks speak to children in a way that sparks their curiosity and stimulates their intellect.

What Is Authentic, Meaningful Mathematics for Young Children?

Mathematics is the "search for sense and meaning, patterns and relationships, order and predictability" (Copley, 2000, p. v.). Mathematics is not repetitively enacting a procedure to get a right answer to an irrelevant question. It involves actively engaging young learners in constructing new ideas and helping them reflect on what they are doing and why. Meaningful mathematics entails having young children use manipulatives and number charts to see how numbers and facts are related and help them discover patterns and rules. Mathematics should focus on having children talk about their thinking and have them experience opportunities where they apply reasoning and logic to solve problems. Meaningful mathematical activities mean children make sense of problems and apply various strategies to solve the problems. The problems can be real or imaginary and deal with situations that are meaningful to children. When children can relate to a problem or a character in a story faced with a problem, they are able to think mathematically and see the usefulness of the mathematics.

When Do Children Begin to Think Mathematically?

Infants engage in the process of making sense of the world around them. In order to make sense and meaning, infants must deal with number, shape, size, and patterns. Toddlers know more from less, count, play with toys that provide them practice in evaluating sizes and shapes, and sort items based on classifications such as edible and non-edible (although everything most likely does end up in the mouth!). Preschoolers use mathematical thinking to work imagined and real-world problems by sharing, dividing equally, and figuring out pegboard patterns. Similarly, prekindergarten (pre-K) through Grade 3 children solve real life problems as well as assigned mathematics problems. Even more important, young children explore, examine, discover, alter, accommodate, adapt, and question constantly. As they do so, they are searching for meaning, patterns, and interrelationships. In other words, they are engaging in mathematical thinking.

What Can Teachers Do to Enhance Children's Mathematical Thinking?

Children are very inquisitive and want to know about their world. One way teachers can stimulate children's mathematical thinking is by posing open-ended questions that require children to explain or describe a process rather than just give an answer. Limiting the number of lower level questions posed in the classroom and focusing more on higher level questions helps to stimulate their higher order thinking skills. Promoting classroom discourse by having children dialogue with the teacher and with fellow students is also a valuable way to engage children in thinking about their knowledge and understanding. When children are presented with problems that are cognitively demanding, they need to think about the mathematics they know and how it can help them solve the problems. Thus, it is important for all teachers to give children many opportunities to become mentally engaged with the mathematics to develop children's mathematical thinking skills.

The Aim of the Book

This book is written for prospective as well as experienced pre-K–3 teachers who are interested in stimulating children's mathematical thinking by teaching mathematics in a way that encourages children to think about mathematical relationships and solve problems beyond those that emphasize routine procedures. We show how teachers can use storybooks as the context for mathematical problems and questions that are rich and meaningful to children and engage them enthusiastically in mathematical thinking. We also describe the value of teaching mathematics through storybooks and provide examples of how storybooks with playful and imaginative language can promote children's problem-solving skills. Although there are many other subject areas that can be integrated, this book focuses on early literacy, language, and mathematics because many early childhood educators are struggling to meet the demands of these subjects. Our aim is to help prospective and experienced teachers understand

- The need to connect mathematics and emphasize mathematical thinking both within and outside of the allotted time in the day for mathematics
- The ease with which they can connect any storybook to the mathematics curriculum
- The joy and excitement students experience when they are engaged in mathematical problem solving through the context of storybooks

The strategies and examples we provide throughout the book have been implemented in pre-K–3 classrooms and have resulted in positive experiences for both the teachers and students. We hope this book will benefit other pre-K–3 teachers and help them gain confidence with posing mathematical problems and looking for mathematical connections when reading storybooks.

Structure of the Book

The book is divided into two sections: 1) Mathematics and Storybooks and 2) Instructing with Storybooks. Chapter 1 describes mathematics and where we find mathematics. The highlight of the chapter is the true story of one early childhood educator's "aha" moment when she realized that mathematics is all around her and her world. She talks about putting on a new pair of lenses, mathematical lenses, to see patterns, shapes, numeric relationships, and even spatial objects in her everyday life. Chapter 2 focuses on the importance of teaching mathematics beyond skills, computation, and procedures and emphasizes mathematical thinking, reasoning, and problem solving. The chapter addresses key mathematical concepts identified in the National Council of Teachers of Mathematics *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence* (2006) and describes how these concepts can be emphasized in storybooks. Chapter 3 describes the role of storybooks and their ability to connect mathematics to children's lives and to their fantasy worlds. It also describes how to select quality storybooks and where to find such books. Chapter 4 discusses how teachers at our workshops struggled to find the mathematics in storybooks and how motivated they were to construct mathematical problems once they were introduced to some approaches we will share in the book.

Section II describes three approaches to using storybooks to pose mathematical problems. Chapter 5 describes the need to emphasize higher level thinking questions and how to pose higher level questions by providing the criteria for higher level questions and showing teachers how to construct higher level questions using Bloom's Taxonomy as a guide. Chapter 6 describes the storybook element approach where teachers use the plot, characters, objects, time frame, setting, and theme of a storybook to set the context for mathematical problems. The chapter includes sample lessons for pre-K–3 in which teachers construct mathematical problems around a storybook.

Chapter 7 describes the curriculum standards approach where teachers identify the curriculum standards they want to address with problems they construct through storybooks. There are two lessons provided for each grade, pre-K–3, with sample teacher scripts. Sample questions and classroom discourse are provided to demonstrate the mathematical ideas explored.

Finally, Chapter 8 describes how mathematical thinking, reasoning, and problem solving can be emphasized in books other than storybooks. This chapter gives information about the use of informational texts and how they can be used to pose mathematical problems. The chapter includes some sample lessons and questions teachers constructed.

We have enjoyed putting together a book that provides opportunities for teachers to make mathematics engaging and meaningful for young children. We hope this book helps you see the value and joy in combining the world of storybooks with the essence of mathematical thinking and understanding.

References

Copely, J.V. (2000). *The young child and mathematics*. Washington, DC: National Association for the Education of Young Children.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through Grade 8 mathematics: A quest for coherence*. Reston, VA: Author.

Kindergarten

Kindergarten Curriculum Focal Points

- **Numbers and Operations:** Representing, comparing, and ordering whole numbers and joining and separating sets
- **Geometry:** Describing shapes and space
- **Measurement:** Ordering objects by measurable attributes

t the kindergarten level, the curriculum focuses on counting activities, creating and comparing sets, ordering numbers, and classifying objects into sets. Simple readiness activities for addition and subtraction and identifying and counting coins are emphasized as well. Simple concepts are taught. Students begin to understand measurement by learning that a measurement can be expressed as a number and objects can be compared by their height or weight. Geometry activities are designed to help students learn vocabulary and how to identify and describe simple two- and three-dimensional shapes.

One kindergarten teacher in our workshop planned a lesson around units of money that focused on enhancing her children's use of mathematical language. She integrated various storybooks into her reading block and developed mathematics centers using the books and mathematical manipulatives such as play money, counting bears, and number tiles. She read stories such as *A Chair for My Mother* by Vera Williams (1982) to embed mathematical language into storytime. Her children engaged in learning about the value of money as they connected to the characters and the language in the story. The teacher discovered that by becoming engaged in conversations about the story, her children also developed important processes of reasoning and explaining mathematical relationships. In short, the kindergarten children were enhancing their understanding of mathematics through communication.

LESSON PLAN: Kindergarten Example

BOOK: Chen, C.-Y. (2004). *Guji Guji.* La Jolla, CA: Kane/Miller. (Cover art reproduced by permission.)

SYNOPSIS: When a crocodile egg rolls into a duck nest, the emerging baby, Guji Guji, is raised by a mother duck and plays happily with brother and sister ducklings. One day some scary, snarling, creatures inform Guji Guji that he is not a duck but a misplaced crocodile. Also, the crocodiles insist that Guji Guji bring all the ducks to the crocodiles so that they might enjoy a meal of duck. Instead, Guji Guji thinks and thinks and figures out a way to save his duck family.

NUMBERS AND OPERATIONS: Representing, comparing, and ordering whole numbers and joining and separating sets

MATERIALS: Cutouts of rocks with numbers 1–12 on them

Guji Guji does not look like the other baby ducks. What does Guji Guji look like? There were other baby ducks, some with stripes and some with spots. Guji Guji tried to count them all and said he counted 12 ducklings. Let's see if we can all count to 12.

Children count to 12.

Guji Guji wants to know if we can help him figure something out. He counted three ducklings with spots and four ducklings with stripes, and he wants to know if there are more ducklings with stripes or spots? How could we find this out? Can you show this with your counters?

Children work on comparing the numbers 3 and 4. The teacher can pose other similar questions with different pairs of numbers.

Guji Guji counts 12 ducks on the bridge. He knows that each duck wants to sit on one of those heavy rocks near the bridge. The rocks are numbered from 1 to 12. I have cutouts of ducks with numbers 1 to 12 on them and cutouts of rocks with numbers 1 to 12 on them. Work with your partner to match each duck's number with the same number on the rock.

Children take time to pair the ducks and rocks. The teacher can have a Velcro version to demonstrate or use an interactive board with 12 ducks and 12 rocks numbered.

In the story, there are crocodiles that show up and have their eyes on the ducks. The crocodiles think the ducks might make good dinner. Guji Guji wants to make sure that the crocodile teeth do not bite his family of ducks. So, Guji Guji calls a dentist to ask if the crocodile teeth could be made less sharp so the ducks could be kept more safe. Of course, the dentist would want to know how many teeth each crocodile has. The dentist would probably also want to know the total number of teeth. Let's see how many teeth we see in the pictures. How could we find out how many teeth each crocodile has and also the total number of teeth the dentist would have to fix? Let's write the numbers on a Post-it note and add to this page in the book so that the next time we read it, we will know exactly how many teeth to worry about.

GEOMETRY: Describing shapes and space

MATERIALS: Pattern blocks, three-dimensional objects, die-cut shapes (optional)

Did you notice in the story that the crocodiles were sharpening their teeth on the trees in the neighborhood? Maybe Guji Guji could think of some way to trick the crocodiles. Maybe he knows that some shapes have very sharp corners, and maybe he could glue the shapes to the trees. Maybe the shapes are made of metal or wood. Do you think that they might hurt a little if a crocodile bit down on a sharp corner? Each time the crocodile would bite the sharp shape

on the tree, the corner might hurt the crocodile's mouth a little. Maybe you could help Guji Guji figure out which shapes have sharp corners that he could tie or glue to the trees. Would a circle have a sharp corner? How about a triangle? How about a rectangle? Square? What about a cone? Cylinder?

The teacher can hold up different shapes from pattern blocks, die-cuts, or three-dimensional objects to pose the questions.

MEASUREMENT: Ordering objects by measurable attributes

MATERIALS: String, straws, measuring tape, paper, pencils or crayons

I wonder if Guji Guji ever wondered why he was so much bigger than his other family members. Let's pretend that we happened to be visiting the lake where Guji Guji sat down to think. Maybe he is thinking he wants us to help him find out if he is really a duck or really a crocodile. Do you think we would say something about how tall he was compared with his duckling brothers and sisters? I am holding up some strings, some are as tall as Guji Guji, some are as tall as the ducklings with spots, and the other are as tall as the ducklings with stripes. Which string do you think is as tall as Guji Guji? How do you know?

Children should be able to determine that the longer string is the one that represents Guji Guji.

I'm going to pass these strings out, and I would like you to search for things around the room that are as long as your string. Then we can tell Guji Guji that he and the ducklings are as tall as the objects you find that are the same lengths.

Have the children find objects in the classroom that are the same length as the strings. The teacher can have three strings taped to the board that represent the two ducklings and Guji Guji. Students can tell the teacher what to write next to each string that they find in the room as the same length.

Now, Guji Guji wants to know if he is taller than the distance around your head. This long string is the one we said is as long as Guji Guji. Here is one string for each pair of students. Use the string to determine if Guji Guji is taller than the distance around your head.

Children can compare the length of the string (representing Guji Guji's height) and the distance around their head. Next you can have them see if Guji Guji is taller than the distance from the floor to their belly buttons.

What would we say if Guji Guji said that he did not want to be a big, bad crocodile? We could show him that we are all bigger than ducks too, and we could tell him that we are good people. What if he would want to know how big we are? We could measure ourselves—our height, neck, leg, mouth—right?

The teacher could have tape measures or straws to represent tall blades of grass or thin branches of trees—the perfect size for measuring.

What if Guji Guji lived where there were no big rocks? Do you think we could help Guji Guji find some way to convince the crocodiles to move to some other place to live? Do you think that a wise old owl might come along and remind the crocodiles that the water is deeper and better for hiding in the lake 2 miles away? How far do you think 2 miles is? Guji Guji wants to know how far it is from the school to your home. He wants you to make a map of the route from your home to the school to show him how far it is. Let's work on drawing a map of the route from your home to the school, and let's estimate how far it is. Draw your map and put the estimated number of miles you think it is between your home and school on the bottom.