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Mathematical Communication in the Classroom: A Teacher Makes a Difference

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The National Council of Teachers of Mathematics (NCTM) states that "Communication is an essential part of mathematics and mathematics education" (2000, p. 60). In fact, communication is one of the five process standards emphasized by NCTM. The communication standard highlights the importance of young children communicating their mathematical thinking coherently to peers and teachers. This standard also states that young children should use math language to express mathematical ideas (Baroody, 2000; Ginsburg, Inoue, & Seo, 1999; NCTM, 2000; Rubenstein & Thompson, 2002; Whitin & Whitin, 2003). Teachers must create a link between mathematics and language (Rubenstein & Thompson, 2002; Stigler & Hiebert, 2004). This article focuses on the informal strategies used by Melissa (a kindergarten teacher) that promoted the use of math language. The strategies were identified during a 3-month observational period in her classroom at Clinton Elementary (pseudonym). Clinton Elementary is located in a low-income neighborhood of a southern city that has a population of approximately 450,000. The neighborhood population is predominantly African-American (Davis, 1994).

KEY WORDS: mathematical communication; teacher role; informal strategies; Kindergarten; math curriculum.

The National Council of Teachers of Mathematics (NCTM) states that "Communication is an essential part of mathematics and mathematics education" (2000, p. 60). In fact, communication is one of the five process standards emphasized by NCTM. The communication standard highlights the importance of young children communicating their mathematical thinking coherently to peers and teachers. This standard also states that young children should use math language to express mathematical ideas (Baroody, 2000; Ginsburg, Inoue, & Seo, 1999; NCTM, 2000; Rubenstein & Thompson, 2002; Whitin & Whitin, 2003). Although some children come to school with great communication skills, others need help in this area (NCTM, 2000; Smith, 2001). Young children who are in classrooms where they are given support, encouragement, and opportunities to engage in oral communication learn to communicate mathematically (NCTM, 2000; Whitin & Whitin, 2003). Hence, teachers must create a link between mathematics and language (Rubenstein & Thompson, 2002; Stigler & Hiebert, 2004). This connection is best reflected when teachers help children communicate their ideas by elaborating upon what they already know (Kennedy, Tipps, & Johnson, 2004; Schmidt, 2004; Smith, 1999). Such interactions help young children clarify their thinking and sharpen their understanding as they try to make sense of their world through communication (Baroody & Wilkins, 1999; NCTM, 1989).

This article focuses on the informal strategies used by Melissa (a kindergarten teacher) that promoted the use of math language. The strategies were identified during a 3-month observational period in

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her classroom at Clinton Elementary (pseudonym). Clinton Elementary is located in a low-income neighborhood of a southern city that has a population of approximately 450,000. The neighborhood population is predominantly African-American (Davis, 1994).

There were 20 students in Melissa's class. Nine of them were girls. Two of the children were European-American and 18 were African-American. Sixteen of the children lived in the immediate or surrounding neighborhood.

Melissa used six informal strategies to enhance her students' use of math language. Each strategy is discussed below.

PROVIDE OPPORTUNITIES FOR SELF-EXPRESSION INFORMALLY

Melissa provided many opportunities for the students to talk to her and to each other. Frequently, after center time (a time period where the teacher provides an environment for children to work either individually or in groups with materials of their choice), she gave the children an opportunity to tell her and their classmates about the activities they participated in. She often used the information given by the students, during the informal conversations, to review previously learned concepts.

During one discussion, Kimberly said, "I put pattern blocks in a row from left to right." Melissa asked, "What kind of a line is that?" Many of the children replied "horizontal." Another day, Shantrell reported, "I made a square on a geoboard." Melissa asked, "Can you tell me something about the sides of a square?" Allee responded, "They are all alike." Melissa then asked, "What do you mean they are all alike. Are they all blue?" Allee replied, "They are the same length."

The children were usually eager to participate in these informal conversations. Melissa encouraged them to express themselves by accepting what each child had to say. Often, she said, "Say whatever you want to." On those few occasions when one or two of the students were hesitant to speak, she did not pressure them for a response.

SERVE AS A FACILITATOR DURING CENTER TIME

As the children explored the various materials available for selection during center time, Melissa listened to their conversations in an attempt to facilitate their construction of mathematical ideas and language. In one such case, Jan and Jeffrey were playing with Unifix Cubes. The following dialogue shows how Melissa seized the moment to expand the children's knowledge of counting.

Melissa: What are you making?
Students: We made "trains" of tens.
Melissa: How many "trains" did you make?
Students: 10.
Melissa: Do you know how many Unifix Cubes you have?
Students: No.
Melissa: Let's find out.

Melissa walked over to the cabinet and took a Unifix track out. The children had not been introduced to the Unifix track. Unassembled, the track was separated into links of 10's. Additionally, the links were either gray or white. As Melissa helped the children assemble the track, she asked questions that related to the children's knowledge of numbers and patterns to accomplish this task. Such questions included "Do you know what comes after forty?" and "Look at the links, do you see a pattern? Which color do you think comes next?" After the track was assembled, Melissa asked the children what number the track stopped on. Jan and Jeffrey replied, "100." She then asked Jan and Jeffrey how many cubes were in each "train." When they replied "10," she suggested that they place the 10 "trains" on the track. As she and the children placed each "train" on the track, they counted by 10's. When they finished, Melissa asked how many cubes were in the 10 "trains." The children said, "100."

PROVIDE OPPORTUNITIES FOR STUDENTS TO CONNECT NEW UNDERSTANDINGS TO PRIOR KNOWLEDGE

One day, before presenting a lesson on measurement in which the children were going to weigh a variety of objects, Melissa introduced the balance scale by asking the children if they had noticed anything on the playground that looked like the scale. Many of the children said "Yeah, a seesaw." Then, she guided the children's understanding of how a balance scale works by leading them to make connections between their prior knowledge of a seesaw and the scale. The following dialogue occurred.

Teacher: What happens on a seesaw?
Students: You go down and come back up.

Teacher: What happens if Tony gets on the seesaw and no one is on the other side?
Students: He goes straight down.
Teacher: Tony, if you want to go up, what do you need?
Tony: I'll need a friend.
Teacher: Okay, you'll need someone to get on the —
Students: Other end.
Teacher: Now, what happens if Tony's friend is bigger than he is?
Tony: Then he goes down and I go up.
Teacher: What happens if a little bitty baby is on the other end?
Students: The baby goes up.

The lesson continued with the children selecting items of various sizes in their efforts to balance the scale. Melissa's use of their prior knowledge of a seesaw enhanced their understanding of the balance scale. The children were excited and eager to participate in the activity. Later, many of the children continued to explore the balance scale as a center activity (materials or games that the teacher introduced the children to during an earlier activity were put out for them to continue to explore during center time).

CONNECT ADMINISTRATIVE TASKS/CLASSROOM ROUTINES TO MATHEMATICS

Melissa's practice of incorporating mathematical concepts into many of the activities in the classroom also promoted math language. The integration of mathematics began with the administrative task of taking attendance. Each morning the children counted-off to determine how many students were present. Often, Melissa asked them how many children were absent. She employed the mathematics strategy of counting off to verify which of the suggested answers were correct.

Other times, the attendance was taken while the children counted off and simultaneously added a Unifix Cube to a "train." Attendance was taken in a similar manner for the whole week. The color of the Unifix Cube that the children attached represented their gender. For example, the girls attached a red cube while the boys attached a white cube. Each day, while displaying the Unifix Cubes, Melissa asked questions that required the students to compare the present data to previous attendance data collected during the week. She asked such questions as were more children present yesterday or today and were more girls or boys present yesterday.

Additionally, Melissa related telling time to daily classroom routines such as changing classes, naptime, and going to lunch. She pointed out to the students where the hands of the clock would be during these times. To further increase the students' awareness of the clock, she often asked them to remind her when it was time to change classes, take a nap, or go to lunch. The students took this responsibility seriously and glanced at the clock occasionally as they went about their regular routine.

ASK A VARIETY OF QUESTIONS

Melissa asked many questions to stimulate the children's thinking and learning. She encouraged the children to verbalize what they discovered while manipulating and exploring the various materials in the classroom during center time. Usually, Melissa initiated the discussions about the children's discoveries, using both divergent and convergent questions. She asked such questions as:

Can you tell me something about _____?
How many shapes did you use altogether?
How many will you have if you put them together?
Will a _____ fit there?
Can you tell me something about the numeral _____?
Did you notice anything else?
How is this one different from that one?
Who has less?

These and similar questions helped the children to describe what they were doing, using mathematical terms. For example, Tasiana and Missy had just started to make a pattern when Melissa said, "Tell me about your pattern. What colors do you have in your pattern?" The girls responded "Yellow, green, red, and yellow." Melissa asked, "If you were going to continue the pattern, what color would you use next?" Missy replied, "Green." Melissa walked over to another group of children for a few minutes. When she returned, the girls were continuing the pattern. She asked another question that prompted Tasiana and Missy to not only observe the colors that were in their pattern but also to relate these colors to other things that they were familiar with. The question Melissa asked was, "What do these colors remind you of?" Missy said, "Christmas time."

The interaction above occurred between Melissa and the girls during center time. However, she used similar strategies during whole group activities.

During a lesson on the concepts "more and less", she gave Larry and Jan 10 Unifix Cubes and told them to build a tower. The students sat with their backs to each other. After they built their towers, the following conversation occurred between Melissa and her students.

Melissa: What can you tell me about the towers?
Kendal: They are not the same.
Melissa: How are they different?
Missy: One has more.
Melissa: Who has more?
Kendal: Jan.
Melissa: How many more does she have?
Tony: 1.
Melissa: How many cubes are in Larry's tower?
Eddie: 4.
Melissa: How many did he have altogether?
Jeffrey: 10.
Melissa: Let's put 10 fingers up. Now put 4 fingers down. How many fingers are up?
Cortland: 6.
Melissa: Okay, Larry should have 6 left on his plate. Does he have 6 more?
Students: Yes.
Melissa: How many are in Jan's tower?
Dwayne: 5.
Melissa: How many do you think she has left?
Missy: 5.
Melissa: Why?
Missy: Because 5 + 5 = 10.

Interestingly, the children modeled Melissa's questioning technique when they helped each other with a task. One day, Tasiana did not finish her calendar. She decided to work on it during center time. While working, she said softly, "I need some help." LaToya, who was working nearby, said immediately "I'll help you." She pointed to the numbers printed in some of the squares on the calendar and told Tasiana to "begin counting." When Tasiana got to 12, the next square was blank. LaToya asked, "What comes next?" LaToya continued asking similar questions until Tasiana finished. Then she told her, "Write your name on the bottom, draw a picture at the top, and go show it to Mrs. Jones (Melissa)."

ENCOURAGE THE USE OF APPROPRIATE MATH TERMS

Melissa's use of developmentally appropriate strategies to introduce math terms to kindergartners is especially noteworthy. The strategies included activities that highlighted the early geometric skills of recognizing, naming, and describing shapes. Terms such as rhombus, trapezoid, hexagon, horizontal and vertical were used frequently in this classroom. Initially, the children were introduced to rhombuses, trapezoids, and hexagons through play with attribute blocks. Then, Melissa focused on one attribute at a time to familiarize them with these shapes. The first attribute emphasized was color. Even though color is not a mathematical attribute, she used it to make associations with shapes. After the children learned the various colors of the shapes, she directed their attention to the fact that the shapes had varying numbers of sides.

Many of the children understood the relationship between the number of sides and the names of geometric shapes. One day, while several students were working with shapes, Melissa walked over and held up a hexagon and asked what it was called. One of the four children said, "rhombus." Melissa asked how many sides it had. Daryl counted the sides and said, "Oh, that's a hexagon."

Melissa encouraged the children to look for similarities and differences between the shapes. During one observation, after making a trapezoid on one geoboard and a square on another, she asked the children, "What is special about a square?" She and the children then discussed the differences between a trapezoid and a square.

Often, the children used these terminologies while working individually or in a group during center time. For example, while completing a puzzle of shapes, Brent looked at an empty space and said, "I need a trapezoid." He reached over and picked up a trapezoid and completed the puzzle.

Many of the children have incorporated these math terminologies into their vocabularies to the extent that they use them frequently during class discussions. On one such occasion, Melissa asked the children how they would make the numeral one on a geoboard. Jeffrey replied, "We would make a vertical line."

Jeffrey's mother, a fifth-grade teacher at Clinton Elementary, was amazed that he recognized a hexagon. One morning, she told the principal and Melissa about an incident that occurred the day before. She, Jeffrey, and her daughter, who was in the sixth grade, were driving home. Jeffrey was sitting in the back seat looking in his sister's math book. He said, "Look at that hexagon." His mother asked, "What did you say, Jeffrey?" Jeffrey replied, "Look, Mom! There is a hexagon in here. It has six sides."

The children were excited sometimes when they engaged in the various activities. Often, they were

eager to "show" or "explain" to Melissa what they were doing. Melissa took the time to listen and respond to each child. For example, Solomon, who was using different shapes and designing figures on the overhead projector, ran over to Melissa and asked her in an excited voice to look at what he made. She walked over to the overhead and said, "Everybody look at what Solomon made! I think he did a good job. Solomon, tell me about your picture." Beaming from ear to ear, Solomon responded that he made a house. Melissa asked Solomon to tell her about some of the shapes he used. He replied, "Two squares, one trapezoid, one triangle, and one diamond." When asked if he knew another name for a diamond, Solomon said, "rhombus." Melissa praised him by saying he did a good job and "That's what we have been talking about."

Through her interaction with the students, Melissa sent them a powerful message. Her smiles, praise, and conversations conveyed the message that they were important and they had something to say. Consequently, the children felt important and spoke with confidence.

Often, they gave suggestions during the course of a lesson that related to mathematical concepts. Melissa readily accepted the suggestions. During one observation, the children were skip-counting by standing in pairs. When it was time for LaTonya to stand, Bernard said, "LaTonya doesn't have anyone to stand up with Mrs. Jones (Melissa). You could stand with her and we could finish skip-counting to 20." Melissa said, "That's a good idea, Bernard." She stood with LaTonya and the children finished skip-counting to 20.

CONCLUSIONS

Early childhood teachers can foster math language by creating a comfortable, inviting classroom environment that encourages students to interact with them and other students. They can act as models as they use math language. Moreover, strategies such as providing materials for young children to explore and asking them math-related questions should be utilized to generate verbal participation. Additionally, use of appropriate questions can stimulate children's reasoning abilities as they respond to your inquiries while exploring objects in their world. Children should be encouraged to use math language in their responses.

Children come to school with a variety of experiences (Baroody, 2000). Many of these experiences can be related to mathematics (i.e., relating children's understanding of a seesaw to a balance scale). Therefore, teachers need to provide opportunities for young children to make connections between new and prior math experiences (Gallenstein, 2003). Encouraging children to discuss and share ideas can enhance the assimilation of new and old experiences as well as facilitate the use of appropriate, informal mathematical communication.

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