Dimension 8: Students' Mathematical Communication

There are different forms of communication in the mathematics classroom including

- oral communication, both speaking and listening
- written communication, both reading and writing which includes symbolic and graphical, or pictorial communication
- physical communication, through active involvement with concrete materials such as manipulatives

Communication is seen as both a way to learn mathematics and a way to articulate ideas. It facilitates further development of mathematical thought and makes mathematical thinking observable.

ORAL COMMUNICATION

Purposes of Oral Communication

Students benefit from oral communication during mathematical activities, as it helps them

- better understand a mathematical situation
- work through a mathematical problem
- re-examine and clarify their mathematical thinking
- reflect on their learning
- develop an appreciation for precision in discussing mathematical ideas
- learn from their peers by sharing strategies

Fostering Oral Communication

Good oral discussion comes from group situations, rich tasks, and good questioning.

Promoting quality student talk requires teachers to listen and respect students' ideas. To elicit thoughtful responses from students, teachers need to regularly engage them in focused group discussion of mathematical tasks, provide more wait time after a question is posed, avoid immediately reacting to or evaluating a student response, consistently encourage students to explain and make sense of their ideas, and remind students not to rely on the teacher as the sole authority in the classroom. Tasks and questions should be rich enough to allow for a variety of responses.

In an oral setting, teachers can prompt individuals or small groups of students with probing questions, to promote communication about mathematical ideas and stimulate mathematical thinking. (See pages 29 and 30 in Dimension 5.) Students must also learn to question and challenge each other and respond to questions.

Creating a Community of Learners

In a community of learners, students are aware of and act to support each other's learning.

To support classroom discourse effectively, teachers must build a community of learners who feel free to communicate by asking questions, expressing their ideas, and who value reasoning and sense making. Students should be encouraged and expected to question one another's ideas and to explain and support their own ideas that may be challenged by others.

WRITTEN COMMUNICATION

Different language is often used to talk about math than is used to write about it. For example, when we talk, we are much more likely to say, "2 and 3 are 5;" when we write, we are much more likely to record, "$2 + 3 = 5$." This different level of formality and symbolism is a barrier for written communication for some students, particularly younger students. This is why written communication becomes an increasingly more significant part of the communication between teachers and students or among students, as students get older.

Purposes of Written Communication

Writing, as opposed to oral communication, is used for many purposes:

- It allows for the creation of a more permanent record which enables students, or the teacher, to look back and see the progress of thought.
- It is slow enough to allow for considered reflection and organization.
- It is deliberate enough that students can focus on details.
- It provides sensory feedback as the hand is engaged in the writing, fostering better memory of the material.
- It is efficient since everyone in the class can be engaged simultaneously.
- It allows students to feel progress even if a problem is not completely solved.
- It is a "safer" venue for shy students.
- It can be a vehicle for learning. In the process of completing a writing assignment, students might have to ask questions of their peers and teacher to find out more information.
- For students with sufficient command of the language, it provides the teacher with a different insight into student thinking than oral communication because the student is forced to stop and think, and to not depend on the teacher's visual cues to decide what to say next.

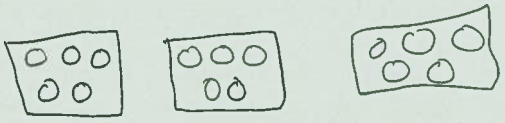
Types of Written Communication

Some of the different kinds of writing students should have opportunities to do in mathematics are

- personal writing; for example, what number do you find easiest to multiply? Explain.
- descriptive writing; for example, tell where you have seen patterns at home.
- process writing; for example, what steps did you use to solve that problem?
- creation of word problems
- creative writing; for example, create a poem that tells about the number 100.
- explanatory writing to explain procedures, concepts, or relationships; for example, how would you divide 46 by 3?

The only way to get students to write for a variety of purposes is to assign tasks that require them to use different forms of writing.

Describe what multiplication is all about.



you use multiplication to shorten your work. you use it to find the answer. you use it when you can not add, sudtract or divide. Multiplication is a shorter way to add.

Student Response
This student communicates some good thinking about multiplication. However, it will be necessary to probe deeper, orally, to find out what the student means by "You use it when you cannot add, subtract, or divide."

Fostering Written Communication

The most important consideration when assigning a written task in mathematics is to ensure that the task is rich and the communication is suitable. Some excellent question formats for framing such tasks are

- What do you think...means?
- Tell everything you can about... .
- Tell about a time when....
- Why is it easy to...?
- How would you explain...to a classmate?
- When do you...?
- How do you know that...?
- What can you say that is true about...?
- Tell about a different way to... .

MATHEMATICAL LANGUAGE

Math language is a factor in both oral and written mathematical communication. Mathematical terms and symbols allow students to communicate more effectively and precisely. Often, the mathematics cannot really be understood without reference to the appropriate term or symbol.

There are many ways teachers can reinforce the proper use of mathematical language and communication. For example, teachers can

- consistently model appropriate language, both orally and in writing
- incorporate assessment of communication regularly
- use a word wall, where math terms and symbols are posted as reminders
- have students create math glossaries, with math terms and symbols
- teach communication skills
- integrate math and language arts, for example, using math terms for spelling

Teachers should draw attention to student use of mathematical language, both appropriate and inappropriate, during oral discussion and in written tasks.

PHYSICAL COMMUNICATION

An important part of communication in the math classroom involves physical actions. Not only do physical actions describe what students do with manipulative materials, but also many mathematical concepts are defined by physical action, such as addition by the action of joining and subtraction by the action of taking away. Opportunities can be created to allow students to act out some of these ideas dramatically.

Students communicate some of their mathematical thinking by performing actions concretely. For example, one of the meanings of division is called "sharing." Suppose students are asked to solve the problem in the margin. If students physically share 15 counters among 5 groups, they are communicating that they understand that this as a division situation.

SAMPLE PROBLEM

There are 15 children to arrange in 5 equal groups. How many children will be in each group?

The use of manipulative materials also fosters communication. For many students, the materials provide a language to wrap their descriptions around. For example, as a student is explaining how he or she adds three-digit numbers by adding first the ones, then the tens, then the hundreds, he or she can use the language of the blocks to describe what is happening. The student does not need sophisticated place value language, but merely describes his or her actions with the materials.

Other times, the mere presence of the concrete materials fosters communication. One student might ask another, "Did you use these to add before? What did you do?" or "I learned the neatest thing with these pattern blocks. Let me show you." or "Did you know that you can use these to divide, too?"

Students can communicate physically through active involvement with concrete materials such as manipulatives.

HOW THE ADMINISTRATOR CAN SUPPORT THE TEACHER

The administrator can help the teacher in this dimension by

- setting aside a location in the school for highlighting mathematical communication, in hallways and display cases
- occasionally team teaching with a teacher to give her or him more time to listen to students talking in groups
- encouraging and supporting professional development activities and resources that focus on communication in mathematics

LINKING THE NCTM PRINCIPLES AND STANDARDS

This dimension links most strongly to the following NCTM principles and standards (see pages 4–7 in Section 1):

- *Teaching* by recognizing the importance of a supportive classroom environment and the assignment of rich tasks worthy of communication
- *Learning* by acknowledging that student participation is essential to understanding and is fostered through communication
- *Communication* by providing opportunities for students to consolidate thinking through communication, learn to communicate clearly, and analyze and evaluate others' mathematical thinking

PRIMECONNECT

- *Guide to Using the Developmental Map*
- *Background and Strategies*

The *Guide to Using the Developmental Map* for each strand provides specific information about communication in each developmental phase.

The *Background and Strategies* book contains general information about communication in mathematics.

(See page vii.)