

Chapter 3

Communicating in Mathematics Class

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Thirty students to one teacher? With this ratio in mind, the teacher needs to become the facilitator in the learning environment. The students need to become active participants in order to construct mathematics concepts. A facilitator and participants function well in a cooperative group-learning situation.

These statements express well this chapter's focus on

1. learning environments,
2. the teacher as facilitator,
3. cooperative-learning groups,
4. problem solving and the writing process,
5. writing implementation in class,
6. learning logs, and
7. math storybooks.

These foci are coherently and insightfully related to NCTM's Curriculum and Evaluations Standards for School Mathematics.

The chapter also includes an annotated bibliography.

Communicating in Math Class?

Keith bent his head in frustration. He glanced at his math textbook and stared at the almost blank page in his scribbler. He looked at his calculator. Mrs. Lewis, his Grade 7 math teacher, stopped to see if he needed help solving word problems. He shook his head to indicate that he did not. How could he possibly admit to Mrs. Lewis that he could not read or understand many of the word problems?

Jenny glanced across the aisle to see how Keith was doing. He looked as puzzled as she felt. She had followed all of Mrs. Lewis's

directions. She had underlined key words and data. She had an idea of how to set up an equation to solve the problem. However, she was confused and did not know how to continue. Mrs. Lewis was too busy to help her. If only she could ask David, who sat behind her, to give her a hint. Jenny was sure that with a little help she could continue solving the problems.

David wondered why Jenny kept turning to look at his answer page. Did she need some help? He would help her if he could, but Mrs. Lewis did not permit talking between students. He continued working at the problems—they were easy! He wanted to be the best math student in the class.

Mrs. Lewis surveyed the 30 Grade 7 students in her classroom. She had been teaching for 10 years but felt that she needed to learn and to grow in order to help her students. If she could be more aware of their individual math concerns and questions, she felt that she could tailor her lessons to meet their specific needs. She could teach the problem-solving process more effectively by allowing her students to use a variety of mathematical skills and concepts. How could she accomplish this with so many students and such limited time?

The dilemma of Mrs. Lewis and her math class is common. Many students have difficulty in reading and then solving word problems from textbooks. As a result, the levels of frustration for student and teacher are high. What can be done to teach problem solving effectively in the classroom?

To assist teachers and students, the National Council of Teachers of Mathematics (NCTM) has developed the *Curriculum and*

Evaluation Standards for School Mathematics (1989). This document explores the curricular goals of the mathematics program and suggests methods by which progress toward these goals may be assessed. This chapter considers the social and technological changes occurring in society and how these changes have affected mathematics teaching and learning in schools.

Thirty students to one teacher? With this ratio in mind, the teacher needs to become the facilitator in the learning environment. The students need to become active participants to construct mathematics concepts. A facilitator and participants function well in a cooperative group-learning situation. The teacher models the problem-solving process desired, and the students gain practice by solving problems in groups. Students will learn to deal with new or unknown vocabulary. They will learn to test strategies and validate solutions and will develop mathematical power. The teacher as facilitator has created a learning environment that allows students to develop mathematical reasoning, understanding and communication.

Students need to be able to explain their strategies and reasoning in writing as well as speech. Writing enables the students to

1. reflect on personal thinking (it is now visible on a page),
2. express understanding in a private way (a student may be uncomfortable in an oral situation),
3. formulate ideas and organize thoughts,
4. make abstract ideas more accessible,
5. connect math to the real world,
6. work out a problem individually (to have a debate with oneself), and
7. expose learning problems, concerns, conjectures and questions.

This writing process can be linked directly to the problem-solving process in math as illustrated in the following chart:

<i>Writing Process</i>	<i>Problem-Solving Process</i>
1. Prewriting	1. What is being asked? Underline the key words, key data.
Exploratory Talk	
2. Writing	2. Decide on a plan of action. Solve the problem. (Calculate)
3. Revising, editing	3. Check back to see if your answer makes sense.

By analyzing students' written work, the teacher will understand how well students are coping in the problem-solving situation. Some groups and individuals may require additional instruction.

New approaches to teaching mathematics call for new methods of evaluation as well. Observations, interviews and student learning logs (journals) are encouraged to promote communication in mathematics. Different views of student understanding are presented.

A specific assessment tool is the student learning log, outlined as follows:

1. The student keeps an ongoing record of learning in a specific notebook or journal. This writing is informal unless a preset goal has been established.
2. The student may respond to specific process questions by writing in the learning log.
3. The student may record thoughts, feelings, questions and observations as he or she progresses through a problem.
4. The student can organize and test ideas through writing in the learning log. Ongoing dialogue with the teacher is created.
5. The student may be introduced to—or reminded of—a topic in math through

using the learning log as a diagnostic tool (for example, ratio and proportion, area, perimeter).

By having students respond through learning logs, the teacher is better able to see what students are learning and to understand student concerns and problems. Enrichment and remedial strategies may be used as required to meet individual student needs.

Mathematics is now seen as a problem-solving process. It is something that students do. Students explore, examine, interpret and use data. Students use problem-solving strategies independently or in small cooperative-learning groups. Students communicate through talking and writing about mathematical reasoning to form and evaluate conjectures and arguments. Students construct personal meaning from mathematics experiences. The teacher assists students in the mathematical studies process (refer to Appendix 1).

Teachers such as Mrs. Lewis want to give students mathematical power. They are willing to act as small-group facilitators and to encourage communication in mathematics. Their classroom learning environments will become interactive and noisy. When evaluating writing, teachers will have to ignore mechanics and grammar and concentrate on content. They will have to write themselves to show their students that writing is important. They will have to relax and have fun with their attempts and their students' attempts to communicate about mathematics in writing.

Mrs. Lewis will learn more about why Keith cannot read and so cannot solve math word problems from the text. She will learn that Jenny needs a few hints now and then. She will learn that David is an excellent problem solver who is willing to help others. She will learn about herself and the needs of her students. After making changes, Mrs. Lewis's mathematics class will become student-centred.

Writing in Mathematics Class!

"Writing in Math!? Who ever heard of that? It is probably just another one of those

fads." As a math consultant and classroom teacher, I often hear such comments when I discuss using writing in mathematics class. Students and adults find this approach to learning math concepts new and different. After discussing the writing process and its benefits to understanding mathematical concepts, educators and learners accept this valuable learning strategy.

Why Use Writing in Math?

Writing in math provides an opportunity for students to become active participants in acquiring knowledge. If children write about their experiences with math and reflect on the learning process that has occurred, then they are able to clarify their thinking and incorporate the ideas and concepts into their own belief systems. Through the writing process, the learner is incorporating mathematical terms into personal everyday language. In addition, writing is a vehicle for learners to use if they are uncomfortable in oral situations; the written environment is less threatening for some learners.

As a classroom teacher, I observed that learning and understanding took place when a student was able to explain and write to another student what was done to solve a problem. By writing like this to classmates, students are reflecting on their own thought processes as well as communicating information and strategies to others. Through writing in math, we are helping learners develop the belief that they have the power to do mathematics and that they have control over their own success or failure.

Learning specific to mathematics needs to make sense and be logical and enjoyable, not simply memorizing rules and procedures. Richard Skemp (1989) believes that there are two types of understanding: instrumental understanding (rules without reasons) and relational understanding (knowing what to do and why). Unfortunately, instrumental understanding is more popular because it seems easier to achieve. However, in the long run, relational understanding

has the power we are looking for in creating mathematical knowledge. For example, through relational-type activities, learners are able to adapt easily when presented with new situations. Also, the information remains with learners longer; thus mathematical reasoning can occur during a lifetime. The use of writing in math encourages relational understanding to occur.

Through the writing process, learners are able to organize, internalize, clarify and reflect on the knowledge that they have created, experienced and explored. In other words, learners are experiencing relational understanding. By observing my students participating in writing, I found that they tended to become more confident in their ability to reason and communicate mathematically. It also became evident that they were more prepared to discuss and justify their thinking.

Many articles have been written dealing specifically with why we would use writing in mathematics class. However, the question still remains, "How are teachers going to implement the writing process in class?"

Implementing Writing in Mathematics Class

Learning Logs

Meaningful learning in math class can be facilitated through writing. One method I found extremely helpful for enhancing communication was using learning logs. A learning log is excellent for keeping an ongoing record of learning as it occurs. There are several approaches to using learning logs. One is to have the students respond to process questions. For example, in my mathematics class, students would write responses to process questions such as

1. What did you understand in class today?
2. What didn't you understand?
3. At what point in the lesson did you get confused?
4. What activity did you like doing?

It is important to note that the writing in the learning log is informal and is not

being grammatically evaluated by the teacher, unless a preset goal has been established.

For young students who are unable to write, I have found it useful for them to draw pictures or representations in their learning logs about their thoughts.

By having students respond to this type of questioning, teachers are able to see what students are learning as well as better understand student concerns and problems. In effect, teachers are able to provide for individual differences in how the students can be helped or how the program can be enriched.

Another approach to learning logs is to have students jot down predictions or expectations of a new topic. In this way, the teacher is looking for the background knowledge of the learner to use in individualizing lesson planning.

I have also used one learning log for a whole class. Each day a different student writes down or draws a representation, or both, about the math activities that took place that day. The student assigned to do the learning log a particular day must observe class activities and be able to put forth his or her interpretation of the day's happenings.

Problem Solving

Problem solving is an essential component of communication in math. Through problem solving, the learner discusses, reads, writes and listens to mathematical ideas and constructs knowledge. Through the problem-solving vehicle, the student becomes mathematically literate.

To focus specifically on the writing process in problem solving, I have found it beneficial for students to write their own problems. Students are able to incorporate the concepts and ideas being covered in class in original problems. This also helps students become more aware of the information essential to solving problems.

Letter Writing

Yes, you can write a letter in math. Have your students write a letter to a classmate

telling him or her about something learned in math class. Through this form of communication, learners reflect on and organize their thoughts, while the receivers gain knowledge from their peers.

Storybooks

An exciting way to incorporate writing in math is to have children create math storybooks. The books can range from number books to stories about shapes and sizes. If you let the imagination of the learners take over, you will often be amazed at the writing that will take place with math as the overall theme. We have "young writers" in language arts, why not in mathematics?

Conclusion

The previously mentioned strategies are but a few of the ways that we as educators can incorporate writing into mathematics classes. A major goal of mathematics instruction is to help students develop the belief that they have the power to do mathematics and that they have control over their own success or failure. By using writing in our math classes, we provide opportunities for students to gain relational understanding and the power to do mathematics. Students will achieve increased knowledge about writing and become confident and knowledgeable math participants.

Appendix 1

Reference articles in the *Arithmetic Teacher* and the *Mathematics Teacher* journals that support the NCTM *Standards* document and its objectives for mathematics education are outlined here.

1. Wilde, S. "Learning to Write About Mathematics." *Arithmetic Teacher* 38, no. 6 (1991): 38-43.

This article explores using writing as a regular part of the mathematics curriculum. Creating word problems, using writing as a diagnostic tool and reflecting in math journals are discussed.

2. Davison, D. M., and D. L. Pearce. "Using Writing Activities to Reinforce Mathematics Instruction." *Arithmetic Teacher* 35, no. 8 (1988): 42-45.

This article features students engaged in writing activities in mathematics: direct use of language,

linguistic translation, summarizing, applied use of language and creative use of language.

3. Mumme, J., and N. Shepherd. "Implementing the Standards: Communication in Mathematics." *Arithmetic Teacher* 36, no. 1 (1990): 18-22.

This article looks at communication in the mathematics classroom. Examples of student writing are given.

4. Thompson, C. "Number Sense and Numeration in Grades K-8." *Arithmetic Teacher* 37, no. 1 (1989): 22-24.

This article examines the development sequence of number meanings through students' experiences linked to physical materials. The use of estimation is also examined in terms of the reasonableness of a proposed solution to a problem-solving situation. Activities dealing with whole numbers and decimals are provided.

5. Lindquist, M. "The Measurement Standards." *Arithmetic Teacher* 37, no. 2 (1989): 22-26.

This article examines the measurement process. The activities outlined use pattern blocks to explore the concept of area. Students examine geometrical shapes, such as the rectangle, parallelogram, hexagon, trapezoid, triangle and square. A tile floor is designed, and the angles are examined. Charts are made, and students draw conclusions from the data collected.

6. Howden, H. "Patterns, Relationships, and Functions." *Arithmetic Teacher* 37, no. 3 (1989): 18-24.

This article looks at explorations of patterns and functions. The student activities encourage describing, analyzing and creating patterns. Tables and graphs are interpreted. Functions and patterns are used to represent and solve problems.

7. Rowan, T. "The Geometry Standards in K-8 Mathematics." *Arithmetic Teacher* 37, no. 6 (1990): 24-28.

This article looks at geometry and spatial sense for students in the classroom. The students construct geometric shapes and three-dimensional models (tetrahedron, cube). Basic shapes, such as the rectangle, parallelogram and triangle, are used to discuss the concept of area.

8. Burrill, G. "Statistics and Probability." *Mathematics Teacher* 83, no. 2 (1990): 113-18.

This article looks at statistics and the collection, organization and interpretation of data. It offers teacher guidelines for lesson preparations.

References

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Skemp, R. *Mathematics in the Primary School*. London: Routledge, 1989.

Further Reading

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Carl, I. M. "Essential Mathematics for the Twenty-First Century: The Position of the National Council of Supervisors of Mathematics." *The Math Post* (1989): 9-11.

Davidson, N., ed. *Cooperative Learning in Mathematics: A Handbook for Teachers*. Menlo Park, Calif.: Addison-Wesley, 1989.

Frye, S. M. "The NCTM Standards—Challenges for All Classrooms." *Arithmetic Teacher* 36, no. 9 (1989): 4-7.

Mumme, J., and J. Weissglass. "The Role of the Teacher in Implementing the Standards." *Mathematics Teacher* 82, no. 7 (1989): 522-26.

Vacca, R. T., and J. L. Vacca. *Reading and Study Guides: Content Area Reading*. Toronto: Little, Brown, 1986.

Wertheimer, M., ed. *Productive Thinking*. Chicago: University of Chicago Press, 1982.