

# NCTM Standards in Action

## The Process Standard: Communication

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NCTM's *Principles and Standards for School Mathematics* (2000) identifies 10 standards that form an essential and comprehensive foundation for students from Kindergarten to Grade 12 as they learn mathematics. The standards are divided into five content standards (number and operation, algebra, geometry, measurement, and data analysis and probability) and five process standards (problem solving, reasoning and proof, communication, connections and representation). This article focuses on one process standard: communication.

The *Alberta Program of Studies for K-12 Mathematics* has several main goals for students learning mathematics. These include preparing students to

- use mathematics confidently to solve problems,
- communicate and reason mathematically,
- appreciate and value mathematics,
- commit themselves to lifelong learning and
- become mathematically literate adults, using mathematics to contribute to society.

As indicated above, the focus in this article will be on an important process standard: communication.

Our teaching and learning of mathematics must shift away from having a single-minded focus on arriving at the answer to a problem to students being able to communicate effectively how an answer was obtained. This shift requires that students have the opportunity to read, explore, investigate, write, listen to, discuss and explain ideas in their own language of mathematics. Communication plays an important role in the construction and connection of ideas. But what is mathematical communication? What are the various forms of communicating mathematical thinking? What is the value of communication in mathematical learning? Teaching students to communicate mathematical ideas clearly and effectively, orally and in writing must be a conscious decision on

the part of the teachers; it must be woven into the lesson planning. Teachers need to ensure that students communicate with other students and themselves. It is critical that teachers see communication as an essential part of mathematics and mathematics education. The way in which it is woven into the lessons can and should take various forms, recognizing that as students progress through the grades, the mathematics that they communicate should become more complex and abstract. Teachers need to recognize and respect the diverse ways that students communicate, and students must come to understand the different ways that ideas can be presented to different audiences and for different purposes.

Teachers must make an important decision in their planning about using the teacher-student relationship to facilitate communication. Stories or student samples that can be used to facilitate student learning are all important considerations. Decisions about mathematical discourse are not only meant to make it meaningful for students but to encourage them to actively participate in constructing knowledge.

According to the NCTM standards, as laid out in *Principles and Standards for School Mathematics* (2000, 60), instructional programs from pre-Kindergarten through Grade 12 should enable all students to

- organize and consolidate their mathematical thinking through communication;
- communicate their mathematical thinking coherently and clearly to peers, teachers and others;
- analyze and evaluate the mathematical thinking and strategies of others; and
- use the language of mathematics to express mathematical ideas precisely.

The most prevalent form of communicating in mathematics classrooms in the past has been through listening. It is encouraging that students are now experiencing a more balanced approach, involving writing, reading and listening. Writing and reading are communication skills that have been used too infrequently in the mathematics classroom. We need to more frequently pose questions like: Why is your answer correct? What have you learned from this exercise? What is another method to find the solution? What have you learned about a particular topic today? How is this idea or concept related to what we have learned before? Posing these and other questions as activities, assignments or mathematics journal entries is just another way to facilitate communication and give students opportunities to reflect on their learning.

As teachers we need to, first of all, value the power of communicating mathematics. We need to clarify what strategies we want to use to assign, manage and assess students' journal writing; select appropriate reading/writing assignments that contribute to the learning of mathematics; encourage and facilitate reflective thinking; incorporate technology or other resources to enhance mathematical learning; and assess students' communication and understanding of mathematics.

Students must have opportunities to test their ideas with others in the mathematics classroom or elsewhere to see if their ideas can be understood and if they are confident about what they know. To foster these communication skills, students must feel secure and supported when expressing their ideas. When students graduate, their ultimate goal is to be confident in engaging in a dialogue about mathematics and to present their ideas clearly, completely and precisely. This goal will only be achieved if communication receives the emphasis that it deserves throughout the grades. Much of what students are exposed to in mathematics depends on their skill to write properly, yet little time is being devoted to teaching and practising that skill in mathematics. "The process of learning to write mathematically is similar to that of learning to write in any genre" (NCTM 2000, 62). Guided practice is important and so is our attention to teaching students the specifics of mathematical arguments, including the use and special meaning of mathematical language and

the representations and standards of explanation and proof.

Students also need to be exposed to the thinking of others who might view problems from a different perspective. This allows students to make sense of the thinking of others and to incorporate it into their own interpretive framework. Having students exposed to the thinking of others enhances their own critical thinking skills, which is important in mathematics.

As it is the goal to ultimately teach students the proper use of the mathematical language and the clear and precise expression of mathematical ideas, opportunities must be provided for students to practise this throughout the grades. This also implies that we need to teach students to become good collaborative workers so that they can exchange mathematical ideas effectively with others.

Teachers must help students develop skills in mathematical communication that will not only serve them well both inside and outside the classroom but also enhance their overall level of mathematical literacy.

The three articles that follow deal with the issue of communication in mathematics. Constructive and practical suggestions are being offered in these three articles for use by teachers in their classroom. The first article deals with the question, How can we communicate in the language of mathematics? The second article demonstrates how open-ended tasks are being used to allow students to select their own approaches and to communicate mathematical ideas. The third article talks about using communication to develop students' mathematical literacy. It suggests that allowing students to develop skills in communicating mathematically is pivotal to becoming mathematically literate.

## Bibliography

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