MSAD#54 Mathematics Curriculum/Process Standards

Our vision for mathematics education in MSAD #54 is for students to understand and use mathematics in everyday life. All of our students must have equal opportunities to become mathematical thinkers. Embedded in our mathematics curriculum are the standards recommended by the National Council of Teachers of Mathematics (NCTM), published in 2000. It quickly served as the framework for mathematical reform throughout the country.

The first of the five NCTM standards are addressed in our written curriculum. The curriculum standards are:

1. Numbers and operations
2. Algebra
3. Geometry
4. Measurement
5. Data analysis and probability

The next five standards address the process of mathematics. These process standards are:

6. Problem solving
7. Reasoning and proof
8. Connections
9. Communication
10. Representation

The process standards are inextricably linked to all the content standards as established in both the NCTM standards and the Maine Learning Results. One cannot solve problems without using mathematical content. Explaining geometric knowledge calls for reasoning. The concepts of algebra can be examined and communicated through representations.

The five process standards must become a major focus embedded in all mathematical instruction. To meet the criteria set in our curriculum, the process standards must be taught in conjunction with all curriculum objectives. Thus, you will not find specific references and resources for the process standards in any one, isolated part of our curriculum. Here we have defined the five process standards for your understanding and implementation.

PROBLEM-SOLVING

Problem-solving means engaging in a task for which the solution is not known in advance. In order to find a solution, students must draw upon prior knowledge and connect it with the problem at hand. Through systematic problem-solving, students will often develop mathematical understanding of concepts, improved knowledge base and higher cognitive skills. Problem solving should be embedded in all mathematical instruction. Students often grasp concepts when placed in real-world situations. Students also more effectively comprehend computational operations when provided with a purpose through word problems.

When offering students the opportunity to problem solve, considerations should be given to:

- All students being able to read the problem.

- Allowing fair time to solve the problem (individually or small group).
- Students sharing solutions, preferably by showing.
- Engaging all students in examining a peer's process.
- The teacher sharing a process, in addition to student's sharing.
- Asking students which process makes the most sense.
- Repeating the type of problem with different numbers or by altering the scenario.

REASONING AND PROOF

Reasoning is essential to building a lasting understanding of mathematics. Young children often start school with considerable reasoning skills on which to build mathematical knowledge and skills. Teachers can lead students to reason analytically by providing opportunities to note patterns, structures and relationships among real world situations and symbolic objects. In the elementary grades, students must be brought to the realization that mathematics makes sense and that answers can be examined using reason and logic in preparation for developing formal mathematical proofs. Creating and describing patterns offer important opportunities to make conjectures and give reasons for their validity. The ability to reason systematically and carefully develops when students are encouraged to make conjectures, are given time to search for evidence to prove or disprove conjectures, and are expected to explain and justify solutions.

In grades 3 through 6, formulating conjectures and assessing them on the basis of evidence should become the norm. Reasoning mathematically is a habit of mind that must be developed through consistent use in all mathematical content. Activities may include writing a letter to a sick classmate to explain a solution for the problem of the day, journaling to present the evidence and explain proof of a solution, or defending a solution in a debate or mock trial. There are wide ranges of reasoning activities. Algebraic, geometric, proportional, probabilistic, and statistical are but a few.

We encourage teachers to consider the following aspects of reasoning and proof in mathematics instruction. Students should be able to:

- Recognize that reasoning and proof are fundamental components of mathematics.
- Make and investigate conjectures.
- Develop and evaluate mathematical arguments and proofs.
- Select and apply various types of reasoning strategies and methods of proof.

COMMUNICATION

Language, both written and verbal, is a powerful tool and should be used to foster the learning of mathematics. By listening and discussing the ideas of peers, students can understand different perspectives and strategies that will expand their repertoire of content knowledge and reasoning skills that makes sense to them. Students must be provided with the opportunities to clarify, question, proof, and extend their thinking through classroom discussions and collaborations. The discourse is not a goal in itself,

but should focus on the bigger idea of making sense of mathematics, thus improving problem solving skills. Students learn as they communicate.

Teachers need to assist students with learning mathematical language appropriate for the clear and coherent communication of mathematical ideas and conjectures to peers, teachers, and others. The Scott Foresman Vocabulary kit contains the important vocabulary for mathematics learning with effective activities to facilitate the learning of mathematical language. Students need to also learn other techniques for communicating their thinking, such as with pictures, charts, graphs, diagrams, and symbols.

As students begin to articulate their mathematical understanding in the lower grades, they use everyday, familiar language. This provides a base on which to build a connection to formal mathematical language. In the middle grades, students should understand the role of mathematical definitions and should use them in mathematical work.

Opportunities for communication must be embedded in all mathematical content areas.

CONNECTIONS

Mathematics is not a collection of separate strands, units or chapters. The notion that mathematical ideas are connected must permeate the mathematical experience of all our students. New mathematical content should be an extension of previously learned mathematics. Young children often connect new mathematical ideas with old ones by using concrete objects. Young students quickly connect counting to the representation of a number of objects. Elementary students often return to previously mastered strategies to solve problems because it makes sense.

Teachers must provide opportunities for students to connect mathematics with other disciplines. Geometry can play an important role in art. Data analysis and graphing has a prominent role in social studies. Problem solving, conjecturing, exploring and investigating are vital components in the study of science.

REPRESENTATION

Representation refers both to process and product, in other words, to the act of capturing a mathematical concept or relationship in some form. A child who writes her age on paper using a number is formulating a representation. Other representations are the use of physical models to represent and understand ideas such as the four operations and place value. Equations, graphs, and charts are representations to model and solve problems.

Representations also help students communicate their thinking to others. Students use both external models, ones they can construct, change and inspect, as well as mental models. When provided with ample opportunities to develop the habit of representing their ideas, students have a set of strategies that significantly expands their capacity to think mathematically.

In K-2, the use of concrete representations is the foundation for the later use of symbols. Seeing similarities in the ways to represent different situations is an initial

toward abstraction. A major responsibility of teachers is to create a learning environment that fosters the use of multiple representations that makes sense to students.

Throughout grades 3-6, students need to continue the habit of representing problems and ideas to support and extend their reasoning. Students represent ideas when they create a table of data about weather problems, when they describe in words or with a picture the important features of an object such as a cylinder, or when they translate aspects of a problem into an equation. Good representations fulfill a dual role: they are tools for thinking and instruments for communicating.