Math Process Standards

2.1 Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding.

2.1(A) apply mathematics to problems arising in everyday life, society, and the workplace
2.1(B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution
2.1(C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems
2.1(D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate
2.1(E) create and use representations to organize, record, and communicate mathematical ideas
2.1(F) analyze mathematical relationships to connect and communicate mathematical ideas
2.1(G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication

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Guiding Questions

What's it about?
What math will I use?
What's my plan?
…for solving the problem?
How will I start?

Process Builder

Students know that in a given context they must use mathematical thinking and determine which concepts to use. When given a multistep problem, students determine what kind of math to use, validate that with other students, and require minimal support or direction from the teacher. This process involves making sense of a problem and discriminating important from extraneous information. Often times students will need to make sense of visuals included in problems that may or may not be similar to ones used in instruction.

After students understand the context of a problem, they must select a problem-solving approach that best fits the situation. Learners try optional strategies before asking for support, know that more complex problems can be solved multiple ways, and engage willingly in increasingly more difficult problems.

The *tools to know* standards require that students be able to gather information from a variety of visuals. Depending on the content, some or all of these stimuli may be appropriate.

Word Problem	Verbal Description	Chart/Table	Graph
Equation/ Expression	Manipulatives	Diagram/Image	Number Line
Base Ten Blocks	Measurement Tool	Formula	Geometric Figures

Instructional Implications

Teachers select problems that require decision-making and provide time for students to identify the kinds of math used, asking students to clarify and justify their decisions. Teachers often confuse relevance to the students' lives with application of mathematical context. Although it is important to use problems that are meaningful to students, the greater challenge is to help students think mathematically and understand the context of a problem.

This is an essential first step in selecting a problem-solving approach. Teachers should select problems with appropriate but varied stimuli; it is important to spend time on how to analyze and interpret visuals. Teachers provide time for students to share with others how they will formulate a plan to approach the problem and explore options for starting. Because mathematical process standards are the same for grades K-12, it is essential that schools/districts model a consistent approach to problem solving.

At a foundational level, teachers should:
- Evaluate instructional materials to determine the variety of stimuli/thinking
- Select problems that require the use of a problem-solving model
- Use instructional strategies to help students understand context
- Explore multiple ways to solve a single problem
- Model thinking for students

Learning from Mistakes

Students may make the following mistakes:
- Not evaluating the context of the problem
- Over relying on key words
- Attending to computation requirements rather than context
- Misreading the problem or misinterpreting the stimuli
- Using a single problem-solving approach even when inappropriate for a given problem
- Generating only first steps in multistep problems

2.1(D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate
2.1(E) create and use representations to organize, record, and communicate mathematical ideas
2.1(F) analyze mathematical relationships to connect and communicate mathematical ideas
2.1(G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication

Guiding Questions

How can I explain or justify my answer?
How will I show what I learned?

Process Builder

Students communicate what was learned in a variety of ways (pictorial, verbal, and mathematical expression) about the same concept/content. They must engage in three tasks to analyze the solution:

- Organize
- Record
- Communicate

Students determine solutions, evaluate them for reasonableness, and justify their thinking using mathematical language to describe the concepts they learned.

Students make connections between concepts and explain and justify their thinking. By explaining, defending, and justifying their thinking, they develop more in-depth conceptual understanding. Students refine answers based on feedback from others and choose more than one way to communicate what they learned. They use representations that were used in instruction and extend to other appropriate representations. Depending on the content, some or all of these stimuli may be appropriate.

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Instructional Implications

Teachers select problems that require decision-making and provide options for representation. When possible, teachers select problems with more than one possible solution to allow for depth of content/concept knowledge. The *ways to show* standards are about rigor and depth of thought and go well beyond arriving at answers.

Teachers should consider:

- Requiring pictorial, verbal, and mathematical expressions in student journals
- Asking students to represent their learning in more than one way (one may be required by the teacher)
- Requiring justification for their choices on representations, problem-solving processes, or lines of inquiry
- Having students analyze with each other before responding to the class/larger group
- Comparing their way to represent their learning with others
- Asking students to connect to another related piece of mathematical content

Learning from Mistakes

Students may make the following mistakes:

- Arriving at a solution but not being able to describe the process or justify the solution
- Relying on a single visual representation
- Not being able to see or describe the relationship between visuals that represent the same solution
- Over relying on computational language to justify their solution versus concepts related to the context