

Mathematical Processing Skills

PROBLEM SOLVING

All students K-5 will:

- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving.

K-2

In order to help students achieve these expectations teachers should:

- Involve a variety of contexts from problems related to daily routines to mathematical situations that arise from stories.
- Give students opportunities to use and extend their knowledge of concepts in each of the content standards.
- Generate new questions in a problem context.
- Pose problems/generate questions in problem context guiding students to organize thoughts.
- Incorporate children's literature for setting a context for both student-generated and teacher-posed problems.
- Give students sharing opportunities to hear new ideas and compare them with their own.
- Ask students to reflect, explain and justify their answers so that problem solving both leads to and confirms students' understanding of mathematical concepts.

3-5

In order to help students achieve these expectations teachers should:

- Provide students with frequent experiences that interest, challenge, and engage them in thinking about important mathematics.
- Provide problems and problem-solving tasks that encourage reflection and communication and can emerge from the students' environment or mathematical contexts. These tasks should include multi-step and real world problems.
- Provide tasks that have a clearly defined mathematical purpose.
- Embed problem solving in the study of mathematics to provide a context in which concepts and skills are learned.
- Allow students to reflect on different ways of thinking about and representing a problem solution allowing comparisons of strategies and consideration of different representations.
- Help students develop and use a variety of strategies and to ask questions that extend problems.
- Ask students to reflect, explain and justify their answers so that problem solving both leads to and confirms students' understanding of mathematical concepts.

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REASONING AND PROOF

All students K-5 will:

- Recognize reasoning and proof as fundamental aspects of mathematics
- Make and investigate mathematical conjectures
- Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

K-2

In order to help students achieve these expectations teachers should:

- Encourage students to make conjectures.
- Give time to search for evidence to prove or disprove their thinking.
- Expect students to explain and justify their ideas.
- Make decisions about which conjectures are mathematically significant for students to pursue by taking into account the skills, needs, and understandings of the students and the mathematical goals for the class.

3-5

In order to help students achieve these expectations teachers should:

- Provide opportunities for students to reason about the relationships that apply to the numbers, shapes, or operations they are studying.
- Require students to explain and justify their thinking, detect a fallacy and critique others' thinking.
- Provide opportunity for students to apply their reasoning skills and justify their thinking in mathematics discussions.
- Look for opportunities for students to revise, expand, and update generalizations they have made.
- Make decisions about which conjectures are mathematically significant for students to pursue by taking into account the skills, needs, and understandings of the students and the mathematical goals for the class.

Mathematical Processing Skills

COMMUNICATION

All students K-5 will:

- 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
- Use the language of mathematics to express mathematical ideas precisely

K-2

In order to help students achieve these expectations teachers should:

- Explicitly model, teach, and discuss how to talk about mathematics, explain their answers, and describe strategies.
- Encourage active listening, questioning others' strategies and results, and asking for clarification so the students' mathematical learning advances.
- Provide experiences that allow varied forms of communication: verbal, manipulating objects, diagrams, charts, explaining answers in writing, and expressing ideas with mathematical symbols.
- Help students develop grade-appropriate mathematical terms that will enable them to communicate mathematically.

3-5

In order to help students achieve these expectations teachers should:

- Explicitly model, teach, and discuss effective and ineffective communication strategies.
- Integrate opportunities for sharing thinking, asking questions, and explaining and justifying ideas within the classroom environment.
- Provide experiences that allow varied forms of communication: verbal, manipulating objects, diagrams, charts, explaining answers in writing, and expressing ideas with mathematical symbols.
- Help students develop grade-appropriate mathematical terms that will enable them to communicate mathematically.
- Work to build the capacity of students to think, reason, solve complex problems and communicate mathematically.
- Refine their listening, questioning and paraphrasing techniques, both to direct the flow of mathematical learning and to provide a model for student dialogue.

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CONNECTIONS

All students K-5 will:

- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

K-2

In order to help students achieve these expectations teachers should:

- Help students see and experience the interrelation of mathematical topics, relationships between math and other subjects, and the way that mathematics is embedded in the students' world.
- Ask questions that direct thinking and present tasks that help students see how ideas are related.
- Ensure that links are made between routine school activities and mathematics.

3-5

In order to help students achieve these expectations teachers should:

- Help students make connections within mathematics, connections between mathematics and everyday experiences, and connections between mathematics and other disciplines.
- Ask questions that encourage and challenge students to explain new ideas and develop new strategies based on mathematics that they already know.

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REPRESENTATION

All students K-5 will:

- Create and use representation to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena

K-2

In order to help students achieve these expectations teachers should:

- Provide opportunities for students to use informal representations, such as drawings or manipulatives, to represent and understand ideas.
- Teach, model and discuss a variety of representations so students will become competent in selecting what they need for a particular problem.
- Encourage students to share their different representations to help them consider other perspectives and ways of explaining their thinking.

3-5

In order to help students achieve these expectations teachers should:

- Provide opportunities for students to use informal representations, such as drawings, to highlight various features of problems; they should use physical models to represent and understand ideas, and learn to use equations, charts, and graphs to model and solve problems.
- Portray representations as useful tools for building understanding, for communicating information, and for demonstrating reasoning.
- Teach, model, and discuss a variety of representations so students will become competent in selecting what they need for a particular problem.
- Encourage students to share their different representations to help them consider other perspectives and ways of explaining their thinking.