

Science and Technology

Content Standard E:

As a result of the activities in grades K-4, all students should develop

- Abilities of technological design
- Understandings about science and technology
- Abilities to distinguish between natural objects and objects made by humans



Content Summary

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| National Science Education Content Standards | K-4 | 5-8 | 9-12 |
| | <p>Abilities to distinguish between natural objects and objects made by humans</p> <p>Abilities of technological design</p> <p>Understandings about science and technology</p> | <p>Abilities of technological design</p> <p>Understandings about science and technology</p> | <p>Abilities of technological design</p> <p>Understandings about science and technology</p> |
| | <p>Abilities to distinguish between natural objects and objects made by humans</p> <p>Abilities of technological design</p> <p>Understandings about science and technology</p> | <p>Abilities of technological design</p> <p>Understandings about science and technology</p> | <p>Abilities of technological design</p> <p>Understandings about science and technology</p> |

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|--------------------------------|--|---|--|---|
| Minnesota Graduation Standards | Primary Level | Intermediate Level | Middle Level | High School Level |
| | <p>Group Resources: Manage resources as a team to produce a product or service</p> <p>Writing: Write for a variety of academic and technical purposes, situations and audiences</p> <p>Technical Reading: Comprehend technical information from documents or electronic media</p> | <p>Technical Systems: Apply knowledge, skills and tools of technological systems to extend human capabilities while preserving ecological functions</p> <p>Technical Applications: Apply mathematics to solve technical problems</p> <p>New Product Development: Research, develop and test a new product</p> <p>Technical Reading: Read and apply technical information from documents or electronic media</p> <p>Technical Writing: Write for a variety of technical purposes, situations, and audiences</p> | <p>Group Resources: Manage resources as a team to produce a product or service</p> <p>Writing: Write for a variety of academic and technical purposes, situations and audiences</p> <p>Technical Reading: Comprehend technical information from documents or electronic media</p> | <p>Technical Systems: Apply knowledge, skills and tools of technological systems to extend human capabilities while preserving ecological functions</p> <p>Technical Applications: Apply mathematics to solve technical problems</p> <p>New Product Development: Research, develop and test a new product</p> <p>Technical Reading: Read and apply technical information from documents or electronic media</p> <p>Technical Writing: Write for a variety of technical purposes, situations, and audiences</p> |
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Focus K-12

| Grade | Early | Late |
|-------------|--|--|
| K-4 | The focus of instruction early in this grade range is on providing opportunities for all students to investigate designed products and begin to develop the ability to design a solution to a problem. | The focus of instruction later in this grade range is on providing all students opportunities that continue to develop the abilities to design solutions to problems using situations and materials the students encounter in their daily lives. |
| 5-8 | The focus of instruction for all students early in this grade range is on establishing an awareness of the distinctions between science and technology and increasing students' abilities in design, using familiar science contexts. | The focus of instruction later in this grade range is on developing all students' understandings about similarities and differences between science and technology and using their abilities of technological design to solve problems in a variety of contexts. |
| 9-12 | The focus of instruction for all students at the high school level is on deepening students' understanding of the close relationship between science and technology and providing opportunities for them to apply science content and use their abilities of technological design to solve complex problems. | The focus of instruction for students pursuing further study is on providing opportunities for independent problem solving experiences which involve the full range of abilities and understandings of technological design. |

Close-up K-4

The focus of instruction early in this grade range is on providing opportunities for all students to investigate designed products and begin to develop the ability to design a solution to a problem.

Investigating the designed world through the examination of familiar and simple objects such as zippers, pencil sharpeners, and hand-operated can openers can begin a study of technology. The teacher may present students with a mystery object, such as an old apple peeler or spaghetti portioner, and have students try to figure out what it does and how it is useful. Students should participate in design activities that take advantage of their natural curiosity about the world around them. They can understand and carry out design activities earlier than they participate in inquiry activities but they cannot tell the difference between the two, nor is it important that they do. Tasks for students at this level should be straightforward and include only one or two solutions for the problem. Students can use a series of pictures or simple directions to complete a product. It is very important that design tasks be appropriate to early-primary students' developmental abilities, and that the tasks relate to the other content standards. Tasks could include designing ways to fasten objects, move materials, or communicate ideas. Students and teachers observe established science safety procedures.

The focus of instruction later in this grade range is on providing all students opportunities that continue to develop the abilities to design solutions to problems using situations and materials the students encounter in their daily lives.

Students participate more fully in the design process which includes stating a problem, designing an approach to solve the problem, implementing a solution, evaluating the solution, and communicating the results to others. The teacher-designed activities for students at this age may involve only some stages of the process and do not need to follow any particular sequence. Sometimes, students might begin by identifying a need and progressing through the design stages, or they might evaluate existing products. Students at this age are able to participate in design tasks which incorporate one or two materials in one or two contexts. For example, students could compare two properties such as cost and strength of two types of adhesive tapes to judge the worth of the products against their ability to solve a problem. Tasks should relate to the other content standards and develop students' observational and analysis skills. When available and appropriate, community members who are engaged in technological design share their experiences with the design process. As visitors and students share their studies, students come to understand that they both follow similar design strategies. Students and teachers observe established science safety procedures.

On Location K-4

Students at this age are beginning to distinguish between the designed world and the natural world. This vignette has the students examining a designed object and then participating in the design process as they design one of their own, based on what they learned.

On a snowy January day, Mr. K's third graders are talking excitedly about the snow that fell over the weekend. "I wonder what it would be like to play with snow in July?" Mr. K asks.

This gets the imaginations of the children going as they anticipate snowball fights in their swimsuits and sledding under the sprinkler. After a few minutes of conversation, he asks, "How could we keep snow until July?" The students are eager to respond. "Put it in the freezer!" "Put it in a cooler!" "Wrap it in newspaper!" One student, who was reading a book by Laura Ingalls Wilder, describes the community ice house in which the people she read about kept ice.

Looking for more detail, he asks, "What conditions must there be in order for us to keep snow?" "It has to be cold!" "Or insulated!" "Or both!" the students respond. Mr. K asks, "What is insulation, and how does it work?" A discussion ensues and they list what they know about insulation on the board. Mr. K has some small coolers available for the students to examine and they work in groups to investigate how they keep things cold.

"Tomorrow," Mr. K announces, "you will work in small groups to design a way to keep a paper cup full of snow from melting for four hours." After discussing the criteria for evaluating their designs, the students meet with their groups to discuss possible designs. Mr. K has a wide variety of materials that the students might use in this design project, including many thicknesses and shapes of polystyrene and cardboard, old holiday tins, milk cartons, newspaper, and other packing material. Some students bring materials from home.

Excitedly, the students begin to construct their "coolers." As they work, they record the materials they are using, what the design looks like, and why they think that it will work. Later, they record how well their design kept the snow from melting. The activity continues for a week, with students trying their designs and then modifying them the next day. At the end of each day, they share their designs with the class and talk about what worked, what didn't, and make plans for improving their design.

On the last day, the students put a cup of snow in their final design, set them on the counter and check them every half hour. They collect data about their snow cups and anticipate which designs will keep the snow from melting. At the end of the day, they discuss what things were the same and different in the ones that worked and the ones that didn't. Then they all share "snow cones" and celebrate a "cool" day.

National Science Education Content Standards

K-4 Content Standard E

Abilities of Technological Design

- **Identify a simple problem.** In problem identification, children should develop the ability to explain a problem in their own words and identify a specific task and solution related to the problem.
- **Propose a solution.** Students should make proposals to build something or get something to work better; they should be able to describe and communicate their ideas. Students should recognize that designing a solution might have constraints, such as cost, materials, time, space, or safety.
- **Implementing proposed solutions.** Children should develop abilities to work individually and collaboratively and to use suitable tools, techniques, and quantitative measurements when appropriate. Students should demonstrate the ability to balance simple constraints in problem solving.
- **Evaluate a product or design.** Students should evaluate their own results or solutions to problems, as well as those of other children, by considering how well a product or design met the challenge to solve a problem. When possible, students should use measurements and include constraints and other criteria in their evaluations. They should modify designs based on the results of evaluations.
- **Communicate a problem, design, and solution.** Student abilities should include oral, written, and pictorial communication of the design process and product. The communication might be show and tell, group discussions, short written reports, or pictures, depending on the students' abilities and the design project.

Understandings About Science and Technology

- People have always had questions about their world. Science is one way of answering questions and explaining the natural world.
- People have always had problems and invented tools and techniques (ways of doing something) to solve problems. Trying to determine the effects of solutions helps people avoid some new problems.
- Scientists and engineers often work in teams with different individuals doing different things that contribute to the results. This understanding focuses primarily on teams working together and secondarily, on the combination of scientist and engineer teams.
- Women and men of all ages, backgrounds, and groups engage in a variety of scientific and technological work.
- Tools help scientists make better observations, measurements, and equipment for investigations. They help scientists see, measure, and do things that they could not otherwise see, measure, and do.

Abilities to Distinguish Between Natural Objects and Objects Made by Humans

- Some objects occur in nature; others have been designed and made by people to solve human problems and enhance the quality of life.
- Objects can be categorized into two groups, natural and designed.

