Full text of O L O W Science And Technology conference

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Science and Technology

Please add ocean content under the appropriate standard

http://books.nap.edu/html/nses/

Developing Student Understanding

Item 1 **Peter Tuddenham** *Oct 22, 2004 20:04*

Developing Student Understanding

K-4

http://books.nap.edu/html/nses/6c.html#st

The science and technology standards connect students to the designed world, offer them experience in making models of useful things, and introduce them to laws of nature through their understanding of how technological objects and systems work.

This standard emphasizes developing the ability to design a solution to a problem and understanding the relationship of science and technology and the way people are involved in both. This standard helps establish design as the technological parallel to inquiry in science. Like the science as inquiry standard, this standard begins the understanding of the design process, as well as the ability to solve simple design problems.

Children in grades K-4 understand and can carry out design activities earlier than they can inquiry activities, but they cannot easily tell the difference between the two, nor is it important whether they can. In grades K-4, children should have a variety of educational experiences that involve science and technology, sometimes in the same activity and other times separately. When the activities are informal and open, such as building a balance and comparing the weight of objects on it, it is difficult to separate inquiry from technological design. At other times, the distinction might be clear to adults but not to children.

Children's abilities in technological problem solving can be developed by firsthand experience in tackling tasks with a technological purpose. They also can study technological products and systems in their world--zippers, coat hooks, can openers, bridges, and automobiles. Children can engage in projects that are appropriately challenging for their developmental level--ones in which they must design a way to fasten, move, or communicate. They can study existing products to determine function and try to identify problems solved, materials used, and how well a product does what it is supposed to do. An old technological device, such as an apple peeler, can be used as a mystery object for students to investigate and figure out what it does, how it helps people, and what problems it might solve and cause. Such activities provide excellent opportunities to direct attention to specific technology--the tools and instruments used in science.

Suitable tasks for children at this age should have clearly defined purposes and be related with the other content standards. Tasks should be conducted within immediately familiar contexts of the home and school. They should be straightforward; there should be only one or two well-defined ways to solve the problem, and there should be a single, well-defined criterion for success. Any construction of objects should require developmentally appropriate manipulative skills used in elementary school and should not require time-consuming preparation and assembly.

See the example entitled "Weather Instruments"

Over the course of grades K-4, student investigations and design problems should incorporate more than one material and several contexts in science and technology. A suitable collection of tasks might include making a device to shade eyes from the sun, making yogurt and discussing how it is made, comparing two types of string to see which is best for lifting different objects, exploring how small potted plants can be made to grow as quickly as possible, designing a simple system to hold two objects together, testing the strength of different materials, using simple tools, testing different designs, and constructing a simple structure. It is important also to include design problems that require application of ideas, use of communications, and implementation of procedures--for instance, improving hall traffic at lunch and cleaning the classroom after scientific investigations.

Experiences should be complemented by study of familiar and simple objects through which students can develop observation and analysis skills. By comparing one or two obvious properties, such as cost and strength of two types of adhesive tape, for example, students can develop the abilities to judge a product's worth against its ability to solve a problem. During the K-4 years, an appropriate balance of products could come from the categories of clothing, food, and common domestic and school hardware.

A sequence of five stages--stating the problem, designing an approach, implementing a solution, evaluating the solution, and communicating the problem, design, and solution--provides a framework for planning and for specifying learning outcomes. However, not every activity will involve all of those stages, nor must any particular sequence of stages be followed. For example, some activities might begin by identifying a need and progressing through the stages; other activities might involve only evaluating existing products.

5-8

http://books.nap.edu/html/nses/6d.html#st

Students in grades 5-8 can begin to differentiate between science and technology, although the distinction is not easy to make early in this level. One basis for understanding the similarities, differences, and relationships between science and technology should be experiences with design and problem solving in which students can further develop some of the abilities introduced in grades K-4. The understanding of technology can be developed by tasks in which students have to design something and also by studying technological products and systems.

In the middle-school years, students' work with scientific investigations can be complemented by activities in which the purpose is to meet a human need, solve a human problem, or develop a product rather than to explore ideas about the natural world. The tasks chosen should involve the use of science concepts already familiar to students or should motivate them to learn new concepts needed to use or understand the technology. Students should also, through the experience of trying to meet a need in the best possible way, begin to appreciate that technological design and problem solving involve many other factors besides the scientific issues.

In the middle-school years, students' work with scientific investigations can be complemented by activities that are meant to meet a human need, solve a human problem, or develop a product...

Suitable design tasks for students at these grades should be well-defined, so that the purposes of the tasks are not confusing. Tasks should be based on contexts that are immediately familiar in the homes, school, and immediate community of the students. The activities should be straightforward with only a few well-defined ways to solve the problems involved. The criteria for success and the constraints for design should be limited. Only one or two science ideas should be involved in any particular task. Any construction involved should be readily accomplished by the students and should not involve lengthy learning of new physical skills or time-consuming preparation and assembly operations.

See the example entitled "The Egg Drop"

During the middle-school years, the design tasks should cover a range of needs, materials, and aspects of science. Suitable experiences could include making electrical circuits for a warning device, designing a meal to meet nutritional criteria, choosing a material to combine strength with insulation, selecting plants for an area of a school, or designing a system to move dishes in a restaurant or in a production line.

Such work should be complemented by the study of technology in the students' everyday world. This could be achieved by investigating simple, familiar objects through which students can develop powers of observation and analysis--for example, by comparing the various characteristics of competing consumer products, including cost, convenience, durability, and suitability for different modes of use. Regardless of the product used, students need to understand the science behind it. There should be a balance over the years, with the products studied coming from the areas of clothing, food, structures, and simple mechanical and electrical devices. The inclusion of some nonproduct-oriented problems is important to help students understand that technological solutions include the design of systems and can involve communication, ideas, and rules.

The principles of design for grades 5-8 do not change from grades K-4. But the complexity of the problems addressed and the extended ways the principles are applied do change.

9-12

http://books.nap.edu/html/nses/6e.html#st

This standard has two equally important parts--developing students' abilities of technological design and developing students' understanding about science and technology. Although these are science education standards, the relationship between science and technology is so close that any presentation of science without developing an understanding of technology would portray an inaccurate picture of science.

In the course of solving any problem where students try to meet certain criteria within constraints, they will find that the ideas and methods of science that they know, or can learn, can be powerful aids. Students also find that they need to call on other sources of knowledge and skill, such as cost, risk, and benefit analysis, and aspects of critical thinking and creativity. Learning experiences associated with this standard should include examples of technological achievement in which science has played a part and examples where technological advances contributed directly to scientific progress.

Students can understand and use the design model outlined in this standard. Students respond positively to the concrete, practical, outcome orientation of design problems before they are able to engage in the abstract, theoretical nature of many scientific inquiries. In general, high school students do not distinguish between the roles of science and technology. Helping them do so is implied by this standard. This lack of distinction between science and technology is further confused by students' positive perceptions of science, as when they associate it with medical research and use the common phrase "scientific progress." However, their association of technology is often with environmental problems and another common phrase, "technological problems." With regard to the connection between science and technology, students as well as many adults and teachers of science indicate a belief that science influences technology. This belief is captured by the common and only partially accurate definition "technology is applied science." Few students understand that technology influences science. Unraveling these misconceptions of science and technology and developing accurate concepts of the role, place, limits, possibilities and relationships of science and technology is the challenge of this standard.

The choice of design tasks and related learning activities is an important and difficult part of addressing this standard. In choosing technological learning activities, teachers of science will have to bear in mind some important issues. For example, whether to involve students in a full or partial design problem; or whether to engage them in meeting a need through technology or in studying the technological work of others. Another issue is how to select a task that brings out the various ways in which science and technology interact, providing a basis for reflection on the nature of technology while learning the science concepts involved.

In grades 9-12, design tasks should explore a range of contexts including both those immediately familiar in the homes, school, and community of the students and those from wider regional, national, or global contexts. The tasks should promote different ways to tackle the problems so that different design solutions can be implemented by different students. Successful completion of design problems requires that the students meet criteria while addressing conflicting constraints. Where constructions are involved, these might draw on technical skills and understandings developed within the science program, technical and craft skills developed in other school work, or require developing new skills.

Over the high school years, the tasks should cover a range of needs, of materials, and of different aspects of science. For example, a suitable design problem could include assembling electronic components to control a sequence of operations or analyzing the features of different athletic shoes to see the criteria and constraints imposed by the sport, human anatomy, and materials. Some tasks should involve science ideas drawn from more than one field of science. These can be complex, for example, a machine that incorporates both mechanical and electrical control systems.

Although some experiences in science and technology will emphasize solving problems and meeting needs by focusing on products, experience also should include problems about system design, cost, risk, benefit, and very importantly, tradeoffs.

Because this study of technology occurs within science courses, the number of these activities must be limited. Details specified in this standard are criteria to ensure quality and balance in a small number of tasks and are not meant to require a large number of such activities. Many abilities and understandings of this standard can be developed as part of activities designed for other content standards.

9-12 Abilites of technological design

Item 2 **Peter Tuddenham** *Oct 22, 2004 20:05*

9-12 Abilites of technological design

5-8 Abilities of technological design

Item 3 **Peter Tuddenham** *Oct 22, 2004 20:05*

5-8 Abilities of technological design

K-4 Abilities of technological design

Item 4 **Peter Tuddenham** *Oct 22, 2004 20:06*

K-4 Abilities of technological design

9-12 Understanding about science and technology

Item 5 **Peter Tuddenham** *Oct 22, 2004 20:06*

9-12 Understanding about science and technology

5-8 Understanding about science and technology

Item 6 **Peter Tuddenham** *Oct 22, 2004 20:07*

5-8 Understanding about science and technology

Response 6:1 **Susan Snyder** *Oct 26, 2004 13:25*

Content topic: Much has been learned about the science of marine organisms, ocean bottom topography, and currents by using technologies (eg. satellites, submersibles, remotely controlled vehicles, buoys, computers).

K-4 Understanding about science and technology

Item 7 **Peter Tuddenham** *Oct 22, 2004 20:07*

K-4 Understanding about science and technology

K-4 Abilities to distinguish between natural objects and objects made by humans

Item 8 **Peter Tuddenham** *Oct 22, 2004 20:08*

K-4 Abilities to distinguish between natural objects and objects made by humans

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K-12 Other topics

Item 9 **Peter Tuddenham** *Oct 22, 2004 20:09*

K-12 Other topics
