Standard 7—Interdisciplinary Problem Solving Elementary

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- **analyze science/technology/society problems and issues that affect their home, school, orcommunity, and carry out a remedial course of action.**
- **make informed consumer decisions by applying knowledge about the attributes of particular products and making cost/benefit tradeoffs to arrive at an optimal choice.**
- **design solutions to problems involving a familiar and real context, investigate related science concepts to inform the solution, and use mathematics to model, quantify, measure, and compute.**
- **observe phenomena and evaluate them scientifically and mathematically by conducting a fair test of the effect of variables and using mathematical knowledge and technological tools to collect, analyze, and present data and conclusions.**

This is evident, for example, when students:

▲ develop and implement a plan to reduce water or energy consumption in their home.

▲ choose paper towels based on tests of absorption quality, strength, and cost per sheet.

▲ design a wheeled vehicle, sketch and develop plans, test different wheel and axle designs to reduce friction, chart results, and produce a working model with correct measurements.

▲ collect leaves of similar size from different varieties of trees, and compare the ratios of length to width in order to determinet whether the ratios are the same for all species.

Strategies

2. Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

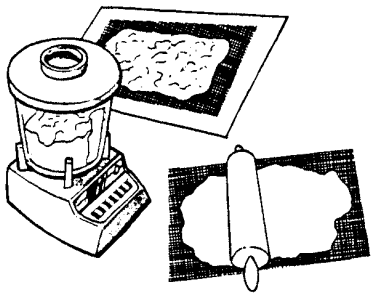
- **work effectively**
- **gather and process information**
- **generate and analyze ideas**
- **observe common themes**
- **realize ideas**
- **present results**

This is evident, for example, when students, addressing the issue of solid waste at the school in an interdisciplinary science/technology/society project:

▲ use the newspaper index to find out about how solid waste is handled in their community, and interview the custodial staff to collect data about how much solid waste is generated in the school, and they make and use tables and graphs to look for patterns of change. Students work together to reach consensus on the need for recycling and on choosing a material to recycle—in this case, paper.

▲ investigate the types of paper that could be recycled, measure the amount (weight, volume) of this type of paper in their school during a one-week period, and calculate the cost. Students investigate the processes involved in changing used paper into a useable product and how and why those changes work as they do.

▲ using simple mixers, wire screens, and lint, leaves, rags, etc., students recycle used paper into useable sheets and evaluate the quality of the product. They present their results using charts, graphs, illustrations, and photographs to the principal and custodial staff.



Key ideas are identified by numbers (1).
Performance indicators are identified by bullets (•).
Sample tasks are identified by triangles (▲).

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Skills and Strategies for Interdisciplinary Problem Solving

Working Effectively: Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identify and managing responsibilities of team members; and staying on task, whether working alone or as part of a group.

Gathering and Processing Information: Accessing information from printed media, electronic data bases, and community resources and using the information to develop a definition of the problem and to research possible solutions.

Generating and Analyzing Ideas: Developing ideas for proposed solutions, investigating ideas, collecting data, and showing relationships and patterns in the data.

Common Themes: Observing examples of common unifying themes, applying them to the problem, and using them to better understand the dimensions of the problem.

Realizing Ideas: Constructing components or models, arriving at a solution, and evaluating the result.

Presenting Results: Using a variety of media to present the solution and to communicate the results.

Sample Problem/Activity

How much of Earth's water is readily available for human consumption?

Student Worksheet

Category	Percentage of Total Water in the World	Freshwater/Salt Water
freshwater lakes	0.0090	freshwater
saltwater lakes	0.0080	salt water
rivers	0.0001	
groundwater	0.6250	
sea ice and glaciers	2.1500	
atmospheric water vapor	0.0010	
oceans	97.2000	

1. As you conduct your library research, complete the chart above by filling in the Freshwater/Salt Water column with either the term "freshwater" or the term "salt water."

2. Represent the information in the first two columns by constructing either a two- or three-dimensional model.

Comments:

Standard 7—Interdisciplinary Problem Solving Intermediate

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- **analyze science/technology/society problems and issues at the local level and plan and carry out a remedial course of action.**
- **make informed consumer decisions by seeking answers to appropriate questions about products, services, and systems; determining the cost/benefit and risk/benefit tradeoffs; and applying this knowledge to a potential purchase.**
- **design solutions to real-world problems of general social interest related to home, school, or community using scientific experimentation to inform the solution and applying mathematical concepts and reasoning to assist in developing a solution.**
- **describe and explain phenomena by designing and conducting investigations involving systematic observations, accurate measurements, and the identification and control of variables; by inquiring into relevant mathematical ideas; and by using mathematical and technological tools and procedures to assist in the investigation.**

This is evident, for example, when students:

- ▲ improve a habitat for birds at a park or on school property.
- ▲ choose a telescope for home use based on diameter of the telescope, magnification, quality of optics and equatorial mount, cost, and ease of use.
- ▲ design and construct a working model of an air filtration device that filters out particles above a particular size.
- ▲ simulate population change using a simple model (e.g., different colors of paper clips to represent different species of birds). Timed removals of clips from plastic cups represents the action of predators and varying the percentage of the return of clips to cups represent differences in reproductive rates. Students apply mathematical modeling techniques to graph population growth changes and make interpretations related to resource depletion.

Strategies

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Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

- **work effectively**
- **gather and process information**
- **generate and analyze ideas**
- **observe common themes**
- **realize ideas**
- **present results**

This is evident, for example, when students, addressing the issue of auto safety in an interdisciplinary science/technology/society project:

- ▲ use an electronic data base to obtain information on the causes of auto accidents and use e-mail to collect information from government agencies and auto safety organizations. Students gather, analyze, and chart information on the number and causes of auto accidents in their county and look for trends.
- ▲ design and construct a model vehicle with a restraint system to hold a raw egg as the passenger and evaluate the effectiveness of the restraint system by rolling the vehicle down a ramp and into a barrier; the vehicle is designed with crush zones to absorb the impact. Students analyze forces and compute acceleration using F=ma calculations. They present their results, including a videotaped segment, to a driver education class.

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Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Skills and Strategies for Interdisciplinary Problem Solving

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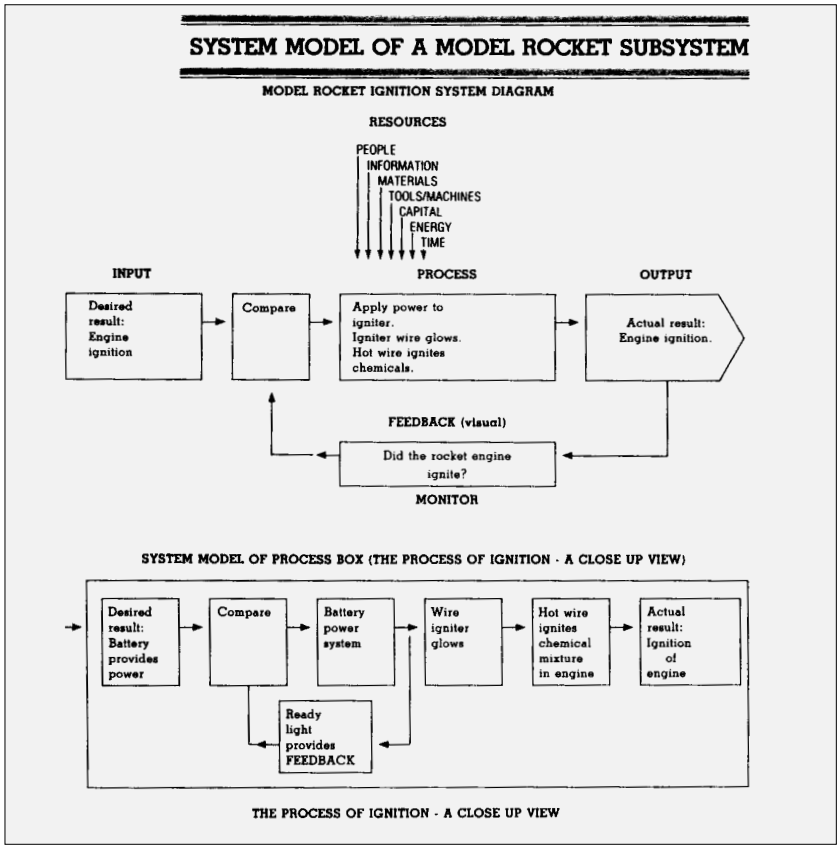
Presenting Results: Using a variety of media to present the solution and to communicate the results.

Sample Problem/Activity



Standard 7—Interdisciplinary Problem Solving Commencement

Connections

1. The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

Students:

- **analyze science/technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action.**
- **analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost/benefit and risk/benefit tradeoffs made in arriving at the optimal choice.**
- **design solutions to real-world problems on a community, national, or global scale using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution.**
- **explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (and if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results.**

This is evident, for example, when students:

▲ analyze the issues related to local energy needs and develop a viable energy generation plan for the community.

▲ choose whether it is better to purchase a conventional or high definition television after analyzing the differences from quantitative and qualitative points of view, considering such particulars as the number of scanning lines, bandwidth requirements and impact on the frequency spectrum, costs, and existence of international standards.

▲ design and produce a prototypical device using an electronic voltage divider that can be used to power a portable cassette tape or CD player in a car by reducing the standard automotive accessory power source of approximately 14.8 volts to a lower voltage.

▲ investigate two similar fossils to determine if they represent a developmental change over time.

Strategies

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This is evident, for example, when students, addressing the issue of emergency preparedness in an interdisciplinary science/technology/society project:

▲ are given a scenario—survivors from a disaster are stranded on a mountaintop in the high peaks of the Adirondacks—they are challenged to design a portable shelter that could be heated by the body heat of five survivors to a life sustaining temperature, given an outside temperature of 20°F. Since the shelter would be dropped to survivors by an aircraft, it must be capable of withstanding the impact. Students determine the kinds of data to be collected, for example, snowfall during certain months, average wind velocity, R value of insulating materials, etc. To conduct their research, students gather and analyze information from research data bases, national libraries, and electronic communication networks, including the Internet.

▲ design and construct scale models or full-sized shelters based on engineering design criteria including wind load, snow load, and insulating properties of materials. Heat flow calculations are done to determine how body heat could be used to heat the shelter. Students evaluate the trade-offs that they make to arrive at the best solution; for example, in order to keep the temperature at 20 degrees F., the shelter may have to be small, and survivors would be very uncomfortable. Another component of the project is assembly instructions—designed so that speakers of any language could quickly install the structure on site.

▲ prepare a multimedia presentation about their project and present it to the school's ski club.

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Sample Problem/Activity

Where Does Electricity Come From?

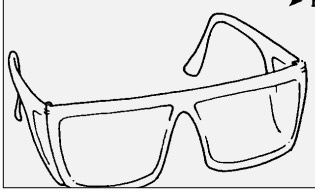
Students will be able to explain how electricity is generated and how the rate at which electricity is generated is related to the appliance being operated.

Interdisciplinary Connections

These activities focus on the ways in which electricity is generated:

➤ **Technology:** Technology is used not only to generate electricity but also to transmit it to where it is used. Find out what technologies are important in the transmission of electricity; of particular interest is the importance of electric transformers and electric insulation.

➤ **Social Studies:** Learn about the early history of the generation of electricity in the United States. In particular, you will want to learn about the role of Thomas Alva Edison, whose Pearl Street Station generated the first commercial electricity, and also about the roles of George Westinghouse and Nikola Tesla.



➤ **Language Arts:** When electricity was discovered, new words were developed to describe it. Make a list of all the words you can find that were developed specifically to describe electricity, and indicate which were "borrowed" and which were coined at that time.

➤ **Mathematics:** The electricity generated at power plants today is known as "alternating current," because it flows alternately in one direction and then in another (or is alternately positive and negative). A graph of alternating current in relation to time is known as a "sine curve." Find out more about the sine curve and its many other uses in mathematics, science, and technology.

➤ **Health:** Because life-sustaining equipment in hospitals is so reliant on the generation of electricity, hospitals have their own backup source of electric power to be used in case commercial generation of electricity is interrupted. Inquire about your local hospital's emergency generating system, including the amount of power it can generate and its duration.

➤ **Home and Career Skills:** Trace the transmission of power to your household from the power plant that generates it, or from a nearby major transmission substation. (In the event of a power failure, you will know that something went wrong along the line you have traced.)

➤ **Arts:** The alternating current generated in the United States has a frequency of 60 Hertz (Hz). This means that the direction of the current reverses from positive to negative and back to positive 60 times every second. Find out which aspects of the performing arts are dependent upon this frequency.

➤ **Foreign Languages and Cultures:** Choose another nation in the world. Find out how the voltage and frequency of alternating current generated in that nation differs from that in the United States.