# Standard 6—Interconnectedness: Common Themes Elementary

## Systems Thinking

**1. Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.**

**Students:**
- **observe and describe interactions among components of simple systems.**
- **identify common things that can be considered to be systems (e.g., a plant population, a subway system, human beings).**

## Models

**2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.**

**Students:**
- **analyze, construct, and operate models in order to discover attributes of the real thing.**
- **discover that a model of something is different from the real thing but can be used to study the real thing.**
- **use different types of models, such as graphs, sketches, diagrams, and maps, to represent various aspects of the real world.**

*This is evident, for example, when students:*
- ▲ compare toy cars with real automobiles in terms of size and function.
- ▲ model structures with building blocks.
- ▲ design and construct a working model of the human circulatory system to explore how varying pumping pressure might affect blood flow.
- ▲ describe the limitations of model cars, planes, or houses.
- ▲ use model vehicles or structures to illustrate how the real object functions.
- ▲ use a road map to determine distances between towns and cities.

### Sample Problem/Activity

**WHAT ARE SOME IMPORTANT PROPERTIES OF SOILS?**
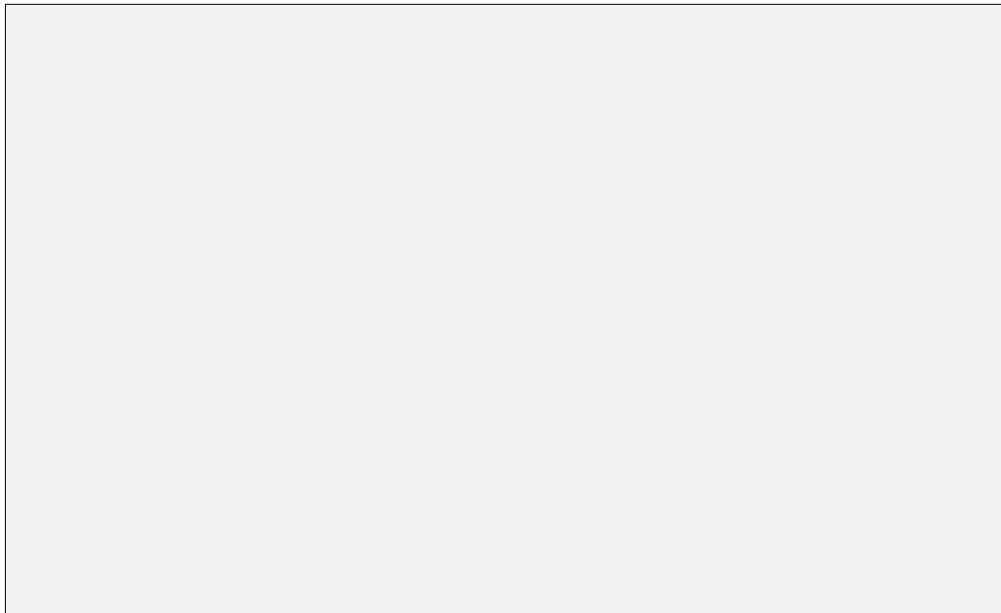
# Standard 6—Interconnectedness: Common Themes Elementary

## Patterns of Change                    Optimization

**5. Identifying patterns of change is necessary for making predictions about future behavior and conditions.**

**Students:**
- **use simple instruments to measure such quantities as distance, size, and weight and look for patterns in the data.**
- **analyze data by making tables and graphs and looking for patterns of change.**

*This is evident, for example, when students:*

▲ compare shoe size with the height of people to determine if there is a trend.

▲ collect data on the speed of balls rolling down ramps of different slopes and determine the relationship between speed and steepness of the ramp.

▲ take data they have collected and generate tables and graphs to begin the search for patterns of change. **and**
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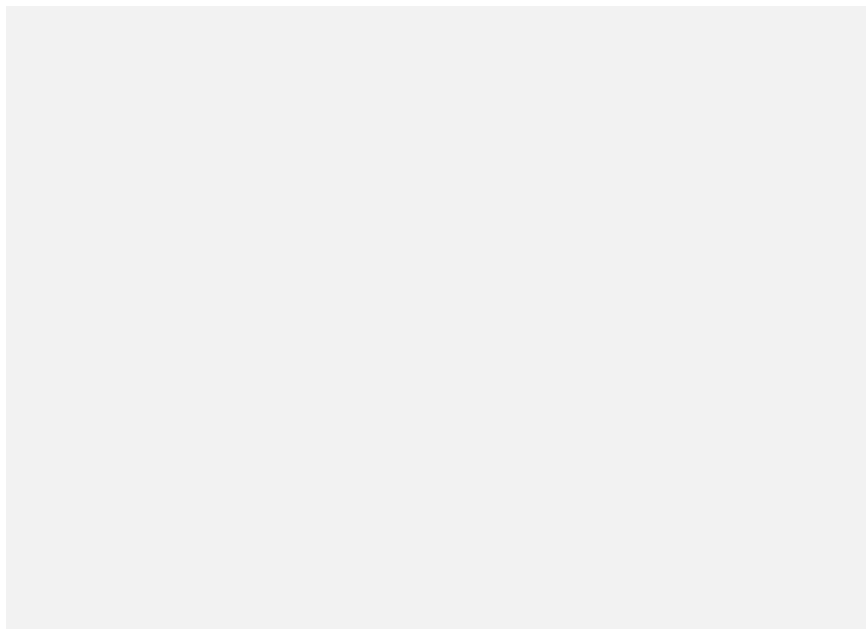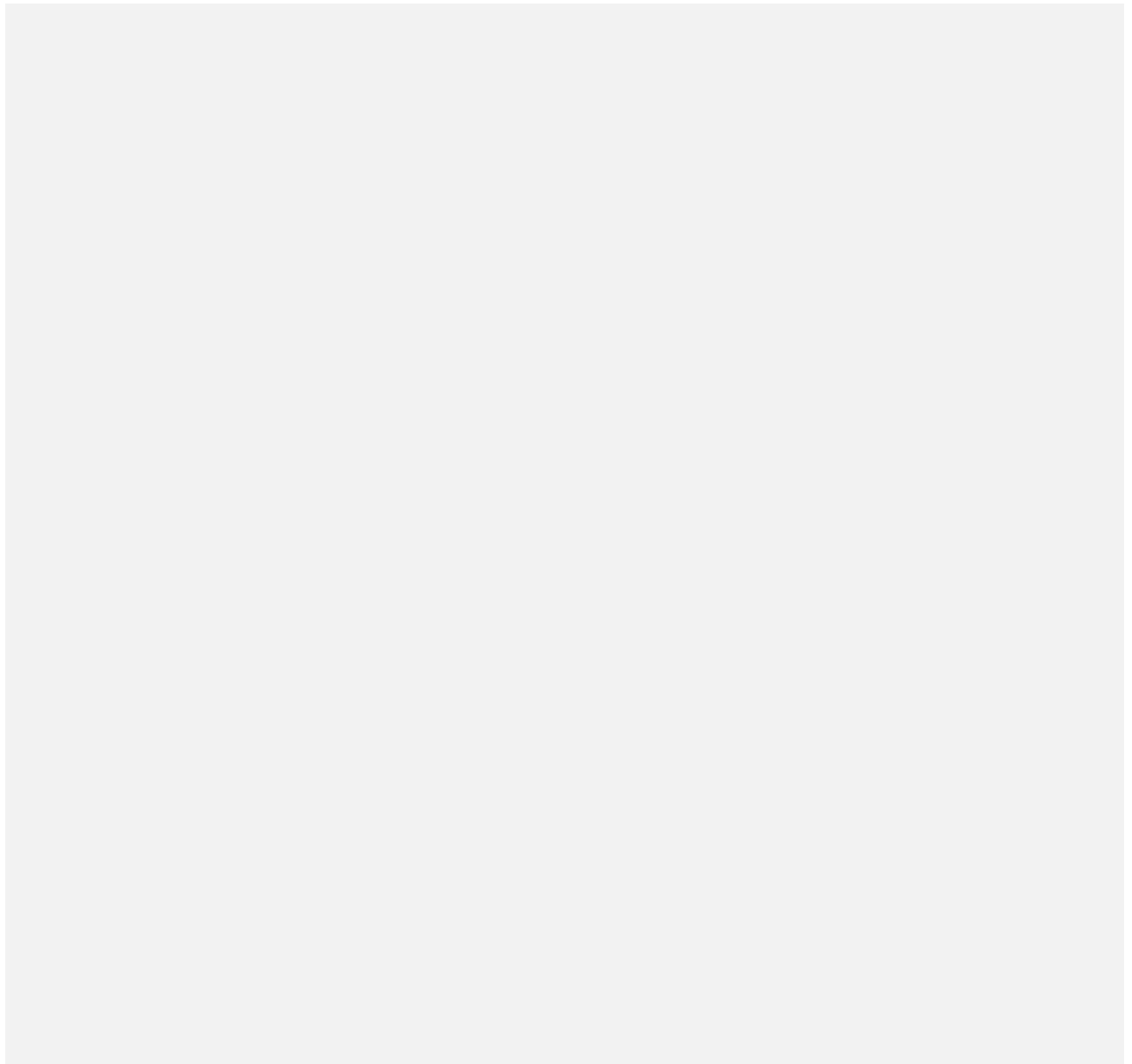
**Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.**

## Magnitude and Scale

## Equilibrium and Stability

**3. The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems.**

**Students:**
- **cite examples of how different aspects of natural and designed systems change at different rates with changes in scale.**
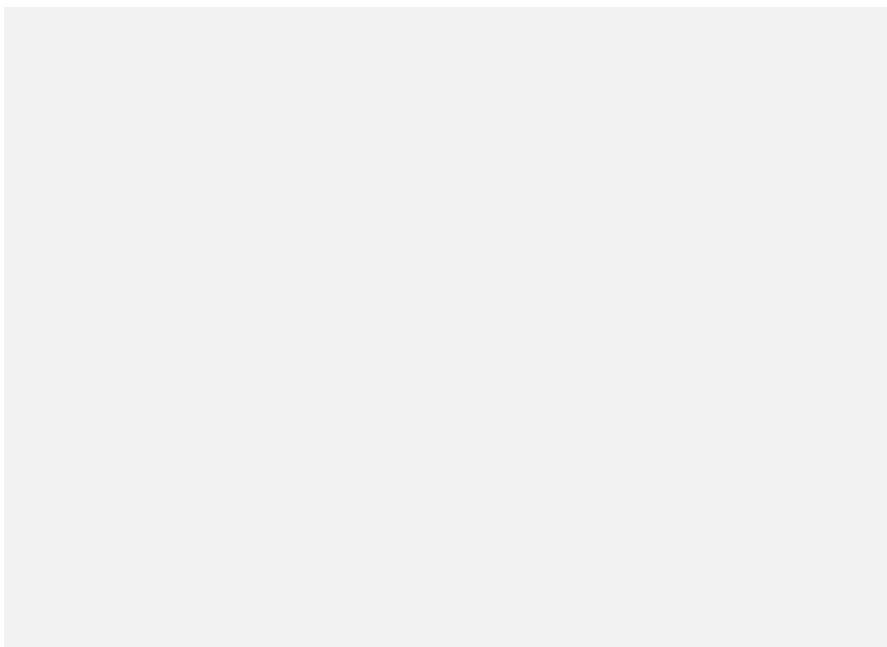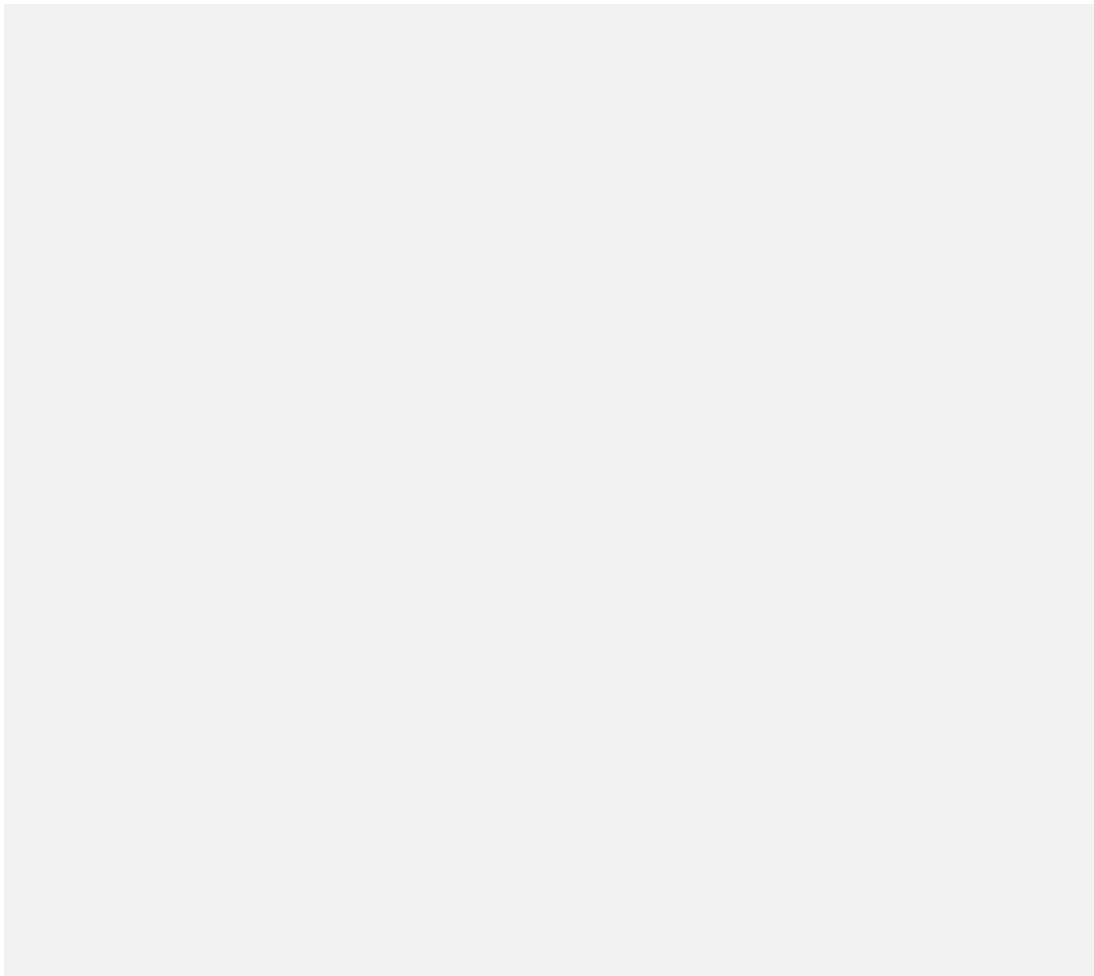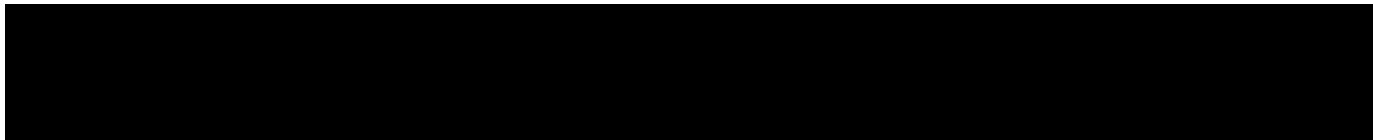
# Standard 6—Interconnectedness: Common Themes <span style="font-size:small">Commencement</span>

## Systems Thinking

**1. Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.**

**Students:**
- **explain how positive feedback and negative feedback have opposite effects on system outputs.**
- **use an input-process-output-feedback diagram to model and compare the behavior of natural and engineered systems.**
- **define boundary conditions when doing systems analysis to determine what influences a system and how it behaves.**

*This is evident, for example, when students:*
- ▲ describe how negative feedback is used to control loudness automatically in a stereo system and how positive feedback from loudspeaker to microphone results in louder and louder squeals.
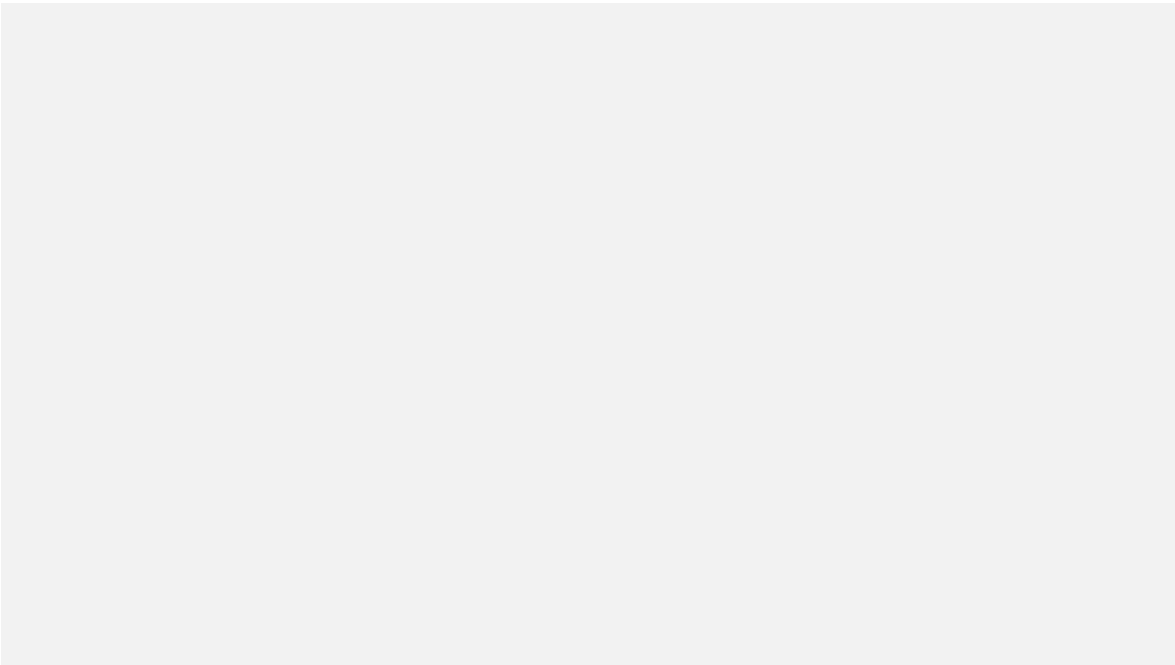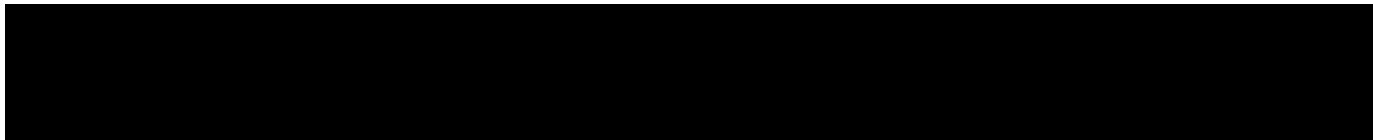
## Models

**2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.**

**Students:**
- **revise a model to create a more complete or improved representation of the system.**
- **collect information about the behavior of a system and use modeling tools to represent the operation of the system.**
- **find and use mathematical models that behave in the same manner as the processes under investigation.**
- **compare predictions to actual observations using test models.**

*This is evident, for example, when students:*
- ▲ add new parameters to an existing spreadsheet model.
- ▲ incorporate new design features in a CAD drawing.
- ▲ use computer simulation software to create a model of a system under stress, such as a city or an ecosystem.
- ▲ design and construct a prototype to test the performance of a temperature control system.
- ▲ use mathematical models for scientific laws, such as Hooke's Law or Newton's Laws, and relate them to the function of technological systems, such as an automotive suspension system.
- ▲ use sinusoidal functions to study systems that exhibit periodic behavior.
- ▲ compare actual populations of animals to the numbers predicted by predator/ prey computer simulations.

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

## Patterns of Change

**5. Identifying patterns of change is necessary for making predictions about future behavior and conditions.**

**Students:**
- **use sophisticated mathematical models, such as graphs and equations of various algebraic or trigonometric functions.**
- **search for multiple trends when analyzing data for patterns, and identify data that do not fit the trends.**

*This is evident, for example, when students:*
- ▲ use a sine pattern to model the property of a sound or electromagnetic wave.
- ▲ use graphs or equations to model exponential growth of money or populations.
- ▲ explore historical data to determine whether the growth of a parameter is linear or exponential or both.

## Optimization

**6. In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.**
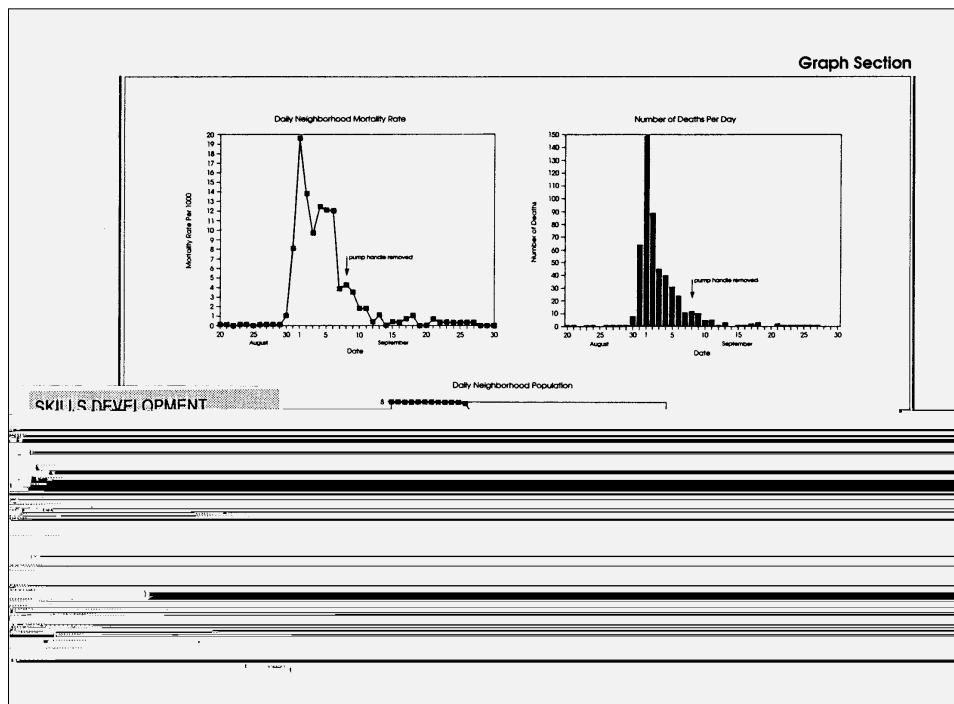
**Students:**
- **use optimization techniques, such as linear programming, to determine optimum solutions to problems that can be solved using quantitative methods.**
- **analyze subjective decision making problems to explain the trade-offs that can be made to arrive at the best solution.**

*This is evident, for example, when students:*
- ▲ use linear programming to figure the optimum diet for farm animals.
- ▲ evaluate alternative proposals for providing people with more access to mass transportation systems.

### Sample Problem/Activity



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