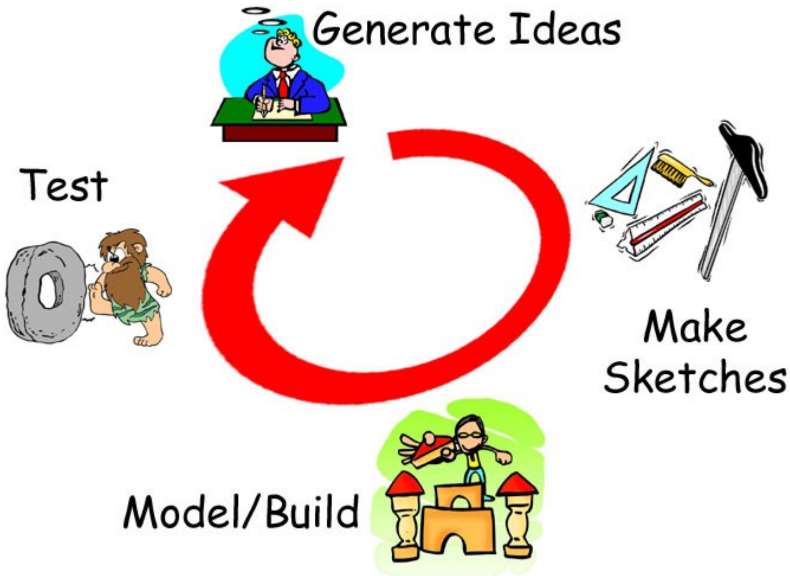
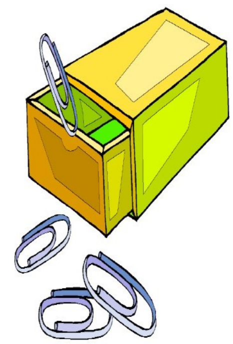


Sample Design Problems for Integrated STEM Education

Teaching Design and Problem Solving in the Elementary Classroom

Paper Clip Spill Activity

Design Challenge



Your teacher just got a new box of paper clips. The box fell off her desk and now the paper clips are all over the floor. The paper clips need to be picked up quickly before someone steps on them and falls. When this occurred in the past, it took five minutes to pick all of the paper clips up and put them back in the box. Design and construct a tool that will help you to quickly pick up the paper clips and put them back into the box.

Resources:

1 box of 100 paperclips   1 plastic spoon   2 small pieces of oak tag (4" squares)
1 small magnet   12" string/yarn   3" of tape
1 pair of scissors   clock or timer

Limitations:

You may only use the materials in listed above to create your tool.
You can not use anything that is not listed in the resources above.
You must be able to pick up all of the paperclips and put them in the box in less than 5 minutes.
You must work with a partner to design and construct your solution.

Process:

1. Work with a partner/group to develop a plan.
2. Complete a technology log to document your thinking and sketch at least two solutions.
3. Select your best solution and build your tool.
4. Estimate how long it will take to pick up the paper clips with your tool.
5. Test your tool. (record the amount of time it takes to pick up all of the spilled paper clips.)
6. Make changes in your tool to make it work better. (re-test your tool if there is time.)
7. Evaluate your solution using the rubric.
8. Share your solution with the teacher and other students in your class.

Note:

You may only use the materials in your "tool kit" to create your tool. You do not have to use all of the materials in the "tool kit" but you can not use anything that is not in the "tool kit". You must be able to pick up all of the paperclips and put them in the box in less than 5 minutes

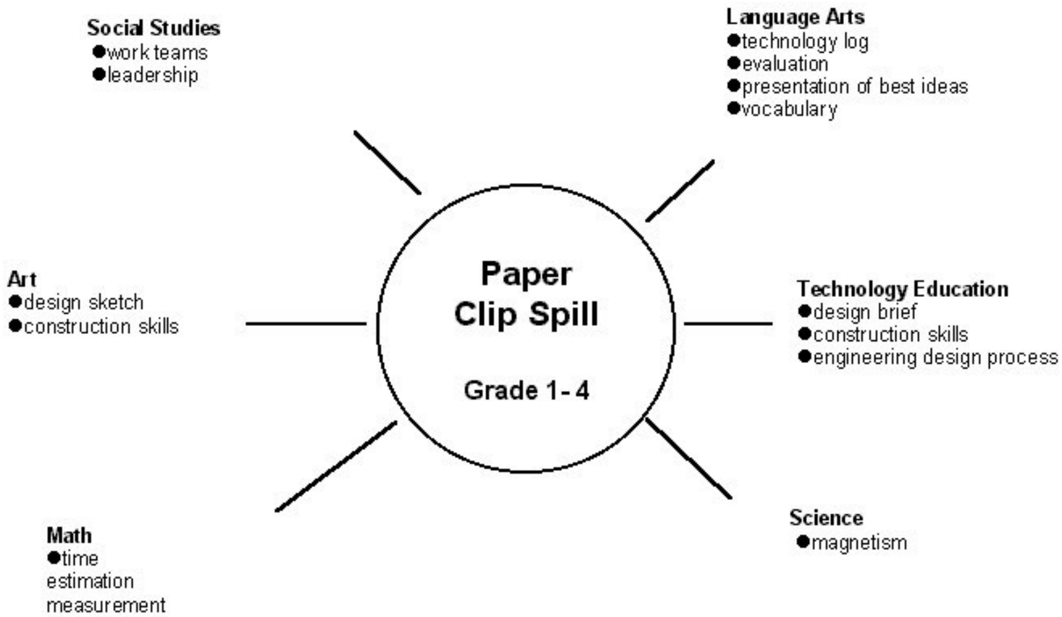
Paper Clip Spill Activity (cont.)

Evaluation

1. Test your solution and refine your design.
2. Document, evaluate and record your solution in your Design Log.
3. Present and demonstrate your solution to the class.
4. Each member of your team must evaluate your solution using the design activity rubric.

Background Knowledge/Experiences:
1. Types and characteristics of tools
2. Magnets and how they work
3. Telling time - 5 minutes and less than 5 minutes (clock or timer)
4. Importance of tool to people in the classroom

Curriculum Standards:
Mathematics (Stand. 3 & 5), language Arts (Stand. # 2 & 3), Science (Stand. #13)



Paper Clip Spill Activity (cont.)

Assessment Rubric

Name: ______________________________ Date: _______________

***Rating:* 5 = Excellent/1 = Needs improvement**

Technology Log					
A. Design sketches	5	4	3	2	1
B. Documentation of thinking	5	4	3	2	1
C. Self Evaluation	5	4	3	2	1

Tool					
C. Use of materials	5	4	3	2	1
D. Function	5	4	3	2	1
E. Time	5	4	3	2	1
F. Reliability	5	4	3	2	1

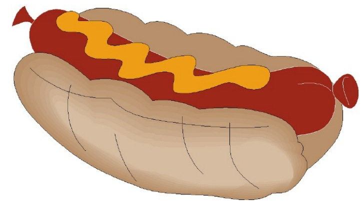
Team					
G. Organization	5	4	3	2	1
H. Cooperation	5	4	3	2	1
I. Presentation	5	4	3	2	1

Overall Assessment					
Overall Challenge Assessment	5	4	3	2	1

Comments/Observations:

Hot Dog Carrier Activity

Situation/Challenge



Little Critter and his grandmother go to the beach. (Book: *Just Grandma and Me* by Mercer Mayer) While at the beach, Little Critter and Grandma get hungry. Little Critter goes to get lunch but drops the hotdogs and rolls in the beach sand on his way back to the beach blanket where his Grandma is sitting.

Challenge:

Little Critter and Grandma do not like to eat gritty sand covered hotdogs. Build a hotdog carrier that will keep the hot dogs and rolls warm and sand free when Little Critter carries them to the beach blanket. Little critter is small so the carrier should be as small and light weight as possible.

Resources:

Styrofoam trays	egg cartons	cardboard tubes
tape/glue	yarn	string
plastic margarine tubs	pipe cleaners	tag board
paper fasteners	plastic knives	aluminum foil
plastic wrap		

Limitations:

1. Work with a partner or group to develop a plan and create a hot dog carrier.
2. Complete a Design Portfolio to document your thinking and develop a solution.
3. Design and build a hotdog carrier that keeps the hot dog warm.
4. Design and build a hotdog carrier that keeps the hot dogs from falling on the ground.
5. Design and build a hot dog carrier that is no bigger than 12"x12"x12".
6. Design and build a hot dog carrier that weighs no more than 1 pound.

Evaluation:

1. Test your hot dog carrier and refine your design.
2. Evaluate and record your solution in your Design Log.
3. Present and demonstrate your solution to the class.

Curriculum Standards:

Technology Education (Stand. #10), language arts (Stand. # 3), Science (Stand. #11), Mathematics (Stand. #5)

continued...

Hot Dog Carrier Activity (cont.)

Assessment Rubric

Name: ______________________________ Date: ________________

Rating: 5 = Excellent/1 = Needs Improvement

Technology Log

A. Design sketch	5	4	3	2	1
B. Documentation of problem solving	5	4	3	2	1
C. Self-evaluation	5	4	3	2	1

Hot Dog Carrier

D. Creative use of materials	5	4	3	2	1
E. Size of carrier	5	4	3	2	1
F. Weight of carrier	5	4	3	2	1
G. Heat Maintenance	5	4	3	2	1
H. Function	5	4	3	2	1

Team

H. Organization	5	4	3	2	1
I. Cooperation	5	4	3	2	1
J. Presentation	5	4	3	2	1

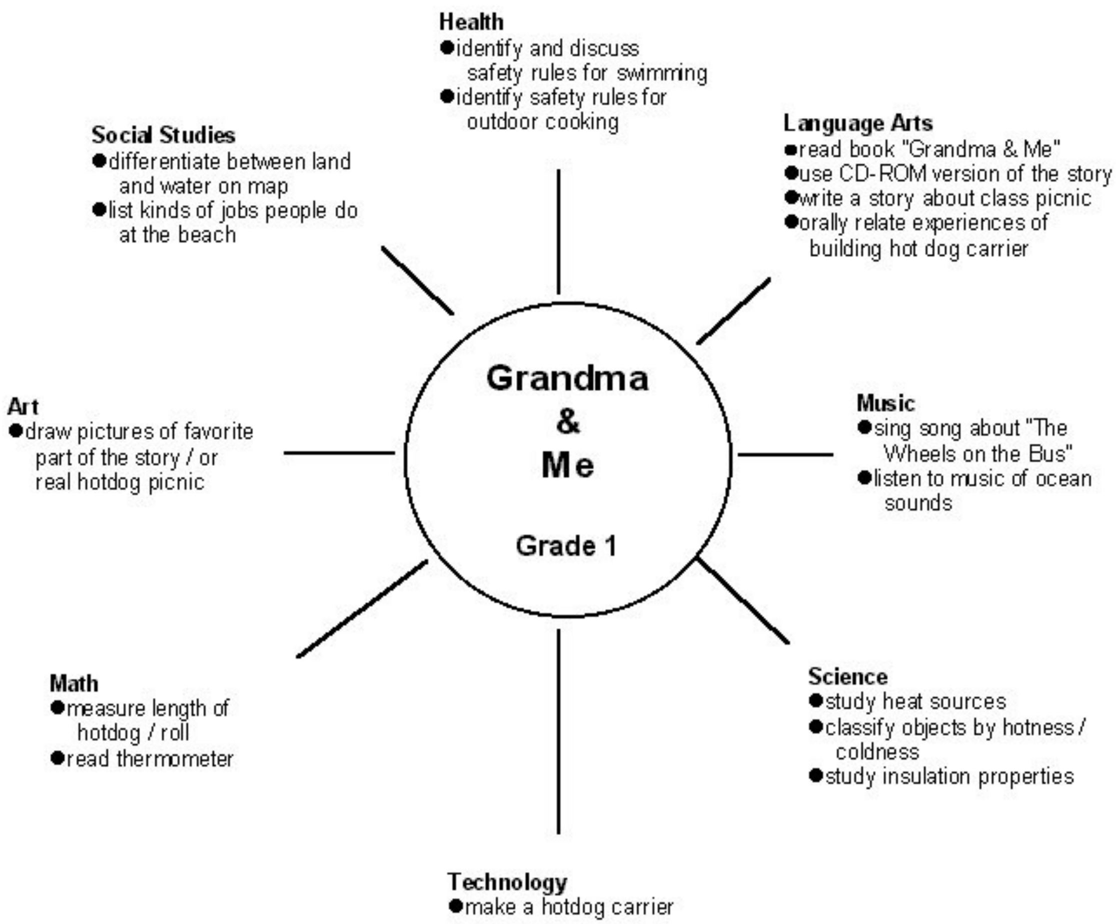
Overall Assessment

Overall Challenge Assessment	5	4	3	2	1

Comments/Observations:

Hot Dog Carrier Activity (cont.)

Interdisciplinary Connections



Pencil Sharpener Challenge

Situation/Challenge

You work in the school store and recently have had a lot of complaints about the quality of the pencil sharpeners you are selling. You need a better product or the students in your school are going to buy their school supplies at another store. You want to be sure that the pencil sharpener is a product that looks good as well as one that quickly, easily and effectively sharpens pencils. It must also be reasonably priced and should not create a mess when used. A company has sent you six sample pencil sharpeners to evaluate, proceed to the challenge section below to find out how you must proceed.

Challenge:
Evaluate and select the best pencil sharpener from the group of samples provided to you and then design a new, improved pencil sharpener. Convince the company to make your new design and for you to sell in your store.

Resources:
Assorted pencil sharpeners (with part costs)
1 standard sharpened model pencil
1 small plastic bags for trash
1 Data sheet
8-10 Paper towels to collect pencil shavings
Stop watches (visible clocks)
7-8 unsharpened pencils
7-8 colored pencils
1 Evaluation sheet

Limitations:
1. Rate each pencil sharpener and record the data in the evaluation log.
2. Complete a pencil sharpener evaluation sheet and determine which pencil-sharpener from the six samples given to you is the "best" sample.
3. Explain your selection and why you did not select the other pencil sharpeners.
4. With the new knowledge you have about pencil sharpeners, make design changes in the company's best pencil sharpener that would make it even better product.
5. Label the improvements you've made in the pencil sharpener and give it a new product name

Evaluation:
6. Test your new pencil sharpener solution and refine your design.
7. Document, evaluate and record your solution in your Evaluation Log and Data Table.
8. Present and demonstrate your solution to the class.
9. Each member of your team must evaluate your solution using the design activity rubric.

Pencil Sharpener Challenge (cont.)

Evaluation Log

Evaluate each of the pencil sharpeners in the space below

Looks/Qualities

Name of Sharpener	Best qualities (size, shape, color)
1.	
2.	
3.	
4.	
5.	
6.	

Speed

Name of Sharpener	Time it took (minutes/seconds) to sharpen
1.	
2.	
3.	
4.	
5.	
6.	

Point Quality

Name of Sharpener	Measured length of pencil point (compare to model)
1.	
2.	
3.	
4.	
5.	
6.	

Least Mess

Name of Sharpener	Time it took (minutes/seconds) to clean up mess
1.	
2.	
3.	
4.	
5.	
6.	

Cost

Name of Sharpener	Price
1.	
2.	
3.	
4.	
5.	
6.	

Pencil Sharpener Challenge (cont.)

Data/Questions

Sharpener	Looks	Speed	Point	Mess	Cost	Total Points
Example: The Boston	5	4	6	2	4	21

Construct a bar graph (on the reverse side of this page) that shows the results of your pencil sharpener evaluations.

1. Title your graph
2. Label the axes on your graph
3. Make sure the scale is correct
4. Plot the data accurately

Which pencil sharpener would be the best buy for the store?

Draw the selected pencil sharpener and label the key parts (on the reverse side of this page).

Why did you select this sharpener and not the other pencil sharpeners?

Now that you know a great deal about pencil sharpeners, perhaps you can make some improvements. Draw a pencil sharpener with improvements to make it a better product. Make sure you label all of the improvements you have included in your new design.

Describe why will the improvements make the pencil sharpener a better product (pretend that you are attempting to sell you new pencil sharpener)?

Give the pencil sharpener a new product name:

Based on your pencil sharpener evaluations, write a letter to the pencil company persuading them to make your design changes in their product. Make sure your letter includes:
A heading, a greeting, a body, a closing and your signature.

Pencil Sharpener Challenge (cont.)

Assessment Rubric

Student Name: ______________________________________ Date: ____________

Rating: 5 = Excellent/1 = Needs Improvement

Team					
Cooperation	5	4	3	2	1
Problem solving ability	5	4	3	2	1
Presentation of findings	5	4	3	2	1
Data					
Observations	5	4	3	2	1
Measurement	5	4	3	2	1
Record keeping	5	4	3	2	1
Evaluation					
Rating system	5	4	3	2	1
Addition	5	4	3	2	1
Record keeping	5	4	3	2	1
Bar Graph					
Title	5	4	3	2	1
Labeled axes	5	4	3	2	1
Scale	5	4	3	2	1
Accurately plotted data	5	4	3	2	1

Pencil Sharpener Challenge (cont.)

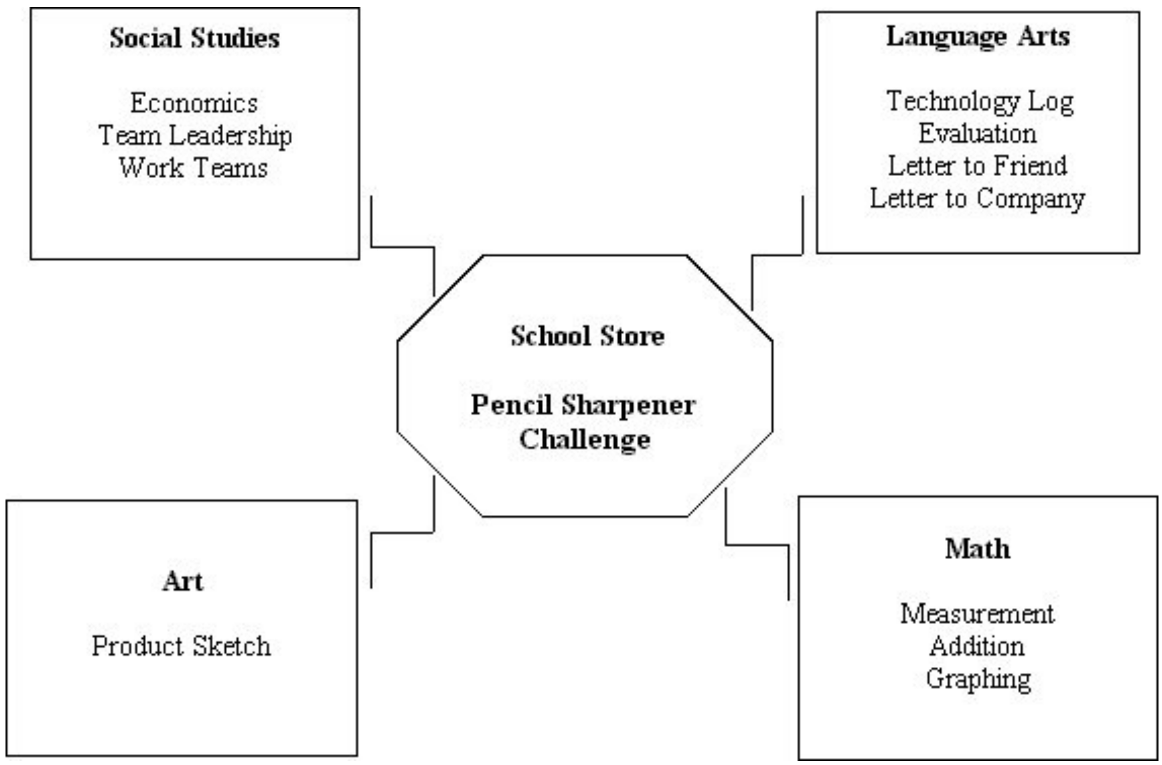
Assessment Rubric

Improvements					
Shape	5	4	3	2	1
Size	5	4	3	2	1
Color	5	4	3	2	1
Ease of use	5	4	3	2	1
Speed	5	4	3	2	1
Sharpness	5	4	3	2	1
Mess	5	4	3	2	1
Cost	5	4	3	2	1
Presentation					
Sharpener selection and rationale	5	4	3	2	1
Clear/loud voice	5	4	3	2	1
Questions answered	5	4	3	2	1
Letter					
Heading	5	4	3	2	1
Greeting	5	4	3	2	1
Body	5	4	3	2	1
Closing	5	4	3	2	1
Signature	5	4	3	2	1

Total Points:

Pencil Sharpener Challenge (cont.)

Interdisciplinary Connections



Resources

Books: Teachers

Davis, Meredith, Peter Hawley, Bernard McMullan, and Gertrude Spilka. (1997). *Design as a Catalyst for Learning*. Alexandria, VA: Association for Supervision and Curriculum.

Dunn, Susan, and Rob Larsen. (1990). *Design Technology: Children's Engineering*. Philadelphia: The Falmer Press.

National Research Council. (2000). *How People Learn: Bridging Research and Practice*. Washington, DC: Author.

Ney, Catherine R.(1996). *Using Literature to Unite the Curriculum*. Blacksburg, VA. BEM Publishing, Inc.

TSA. (2000). *The Great Technology Adventure: Technology Learning Activities Guide*. Reston, VA: Technology Student Association.

WGBH Educational Foundation. (2000). *Building Big Activity Guide*. Boston, MA: WGBH Edu cational Print and Outreach.

Williams, Pat and David Jinks. (1991). *Design and Technology* (for ages) *5-12.* Philadelphia: The Falmer Press.

Wright, Phyllis and Ryan Brown. (2001). *Kids Inventing Technology (KITS).* Series. Reston, VA: ITEA

Books: Students

Blashfield, Jean F. and Wallace B. Black. (1991). *Recycling*. Chicago: Childrens Press.

Foster, Joanna.(1991).*Cartons, Cans, and Orange Peels*. New York: Clarion Books.

Gibbons, Gail. (1992). *Recycle: A Handbook for Kids*. New York: Little, Brown and Company.

Langone, J. (1999). *How Things Work: Everyday Technology Explained*. Washington, D.C.: National Geographic Society.

Middleton, N. (1989). *Atlas of World and Environmental Issues*. New York, NY: Facts on File, Inc.

Owen, Oliver. (1993). *Eco-solutions: It's In Your Hands*. Edina, MN: Abdo+Daughters

Showers, Paul. (1994). *Where Does Garbage Go?* New York: Harper Collins Publishers.

Publications:

Technology and Children. Technology Education for Children Council of the International Technology Education Association

A Guide to Develop Standards-Based Curriculum for K-12 Technology Education. ITEA.

Resources

Video: Teachers

Technology Education: A Global Imperative. ITEA

Technology Is Elementary. ITEA (1991)

Video: Students

Designing Toys. Barnaby, BC: Classroom Video.

Our Environment: Everyone's Responsibility. Pittsburg, KS: PITSCO

Computer Software: Students

Classroom Store Works. Tom Snyder Productions. 80 Coolidge Hill Road, Watertown, MA 02472-5003
Graphers. Sunburst. 101 Castleton Street, PO Box 100, Pleasantville, NY 10570
Hot Dog Stand: The Works. Sunburst.101 Castleton Street, PO Box 100, Pleasantville, NY 10570
Ice Cream Truck. Sunburst.101 Castleton Street, PO Box 100, Pleasantville, NY 10570
Paws in Jobland. Careerware.808 Commerce Park Dr., Ogdensburg, NY 13669-7930
Rockets. Tom Snyder Productions. 80 Coolidge Hill Road, Watertown, MA 02472-5003
Work and Simple Machines. Tom Snyder Productions. 80 Coolidge Hill Road, Watertown, MA 02472-5003
Electric Current. Tom Snyder Productions. 80 Coolidge Hill Road, Watertown, MA 02472-5003
Inertia. Tom Snyder Productions. 80 Coolidge Hill Road, Watertown, MA 02472-5003

Internet Resources:

Building Big: http://www.pbs.org/wgbh/buildingbig/index.html
History of Invention Timeline: http://www.cbc4kids.ca/general/the-lab/history-of-invention/default.html
How Stuff Works Express: http://express.howstuffworks.com/default.htm
How Stuff Works: http://www.howstuffworks.com
NASA Explores: http://www.nasaexplores.com/cgi-bin/index.pl
Technology-Enhanced Teaching: http://www.education.umn.edu/edutech
Technology Student Association: http://www.tsaweb.org
International Technology Education Association: http://www.iteawww.org
PITSCO Science and Technology: http://www.askanexpert.com
Tour of M+M factory: http://www.m-ms.com/factory/tour/index.html
US Patent and Trademark Office - kids page:
http://www.uspto.gov/go/kids/kidsearch.html
Valiant Technology Ltd. http://www.valiant-technology.com

Resources

No R.E.S.P.E.C.T.

The Problem

Sylvia recently completed her bachelor's degree in elementary education and accepted a teaching position at Samson Elementary School (home of the "Giants'). Being short in stature, Sylvia began experiencing what she perceived to be a lack of respect from her students who were almost all taller than her. Being a very creative teacher, Sylvia decided that this lack of respect presented a great teaching opportunity. She was determined to illustrate to the students that human height really doesn't matter and that a lower center-of-gravity does have its benefits. To teach the lesson, Sylvia created the technology design problem below.

The Challenge:
Working in small teams, use the supplied materials to develop platform shoes that will elevate one member of your team to the greatest height possible.

Resources:
Cardboard, masking tape, foam board, paper, other miscellaneous materials.

Limitations:
Teams will be required to remain within the following design parameters while completing the design challenge:

1. Teams must complete the four steps included in the Design Log (next page) prior to beginning construction of the platform shoes.
2. The completed prototype platform shoes must fit on the feet of one member of the team. Teams may build upon existing shoes.
3. The prototype platform shoes should be constructed in a neat fashion (no one wants to purchase untidy shoes).
4. The team member wearing the completed prototype platform shoes must walk at least ten feet, turn around, and walk an additional ten feet wearing the completed shoes.
5. Shoes meeting the above requirement will be measured (in increments of inches) from the sole of the foot to the floor surface.
6. Teams will have a total of ***five minutes*** to complete the Design Log, construct the prototype shoes, conduct a trial of the shoes, measure the shoes and record the data in the Assessment Rubric.

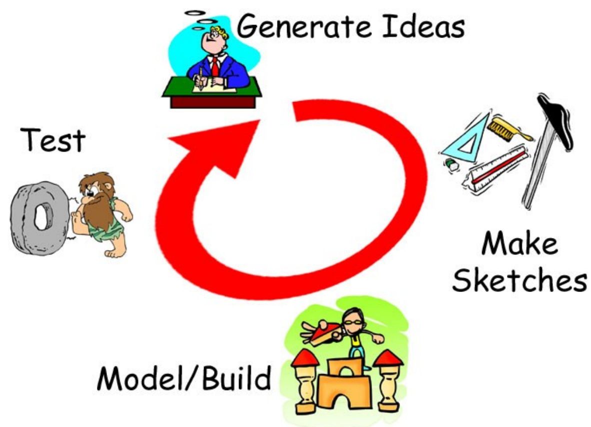
Objectives:
- After completing the lesson, students will illustrate a greater understanding of the role of balance, center of gravity as well as the role of society (humans) in the development of new technologies.
- After completing the lesson, students will be able to lead a discussion related to the impact of technology on human wants and needs, the role of society in relation the perpetuation of height as a status symbol.

Curriculum Standards:
Standards for Technological Literacy (Stand. #6, #8)

No R.E.S.P.E.C.T. (cont.)

The Design Log

Complete each of the steps outlined below as you work with your team to design a prototype set of platform shoes.



Generate Ideas:
Carefully consider the challenge that you have been given. Generate and record as many ideas as possible during the limited time you have been provided. Record your initial ideas in the spaces below:

Sketches: Using the initial sketches generated by all members of your team, create a final drawing that includes the best ideas from all of the initial ideas.

Modeling/Testing: Use the sketch (above) to construct the prototype. Test your product.

No R.E.S.P.E.C.T. (cont.)

Assessment Rubric

Team Names: ______________________________ Date: _______________

Rating: 5 = Excellent/1 = Needs Improvement

1. Completion of Design Log	5	4	3	2	1
2. Neatness of final Product	5	4	3	2	1
3. Shoe height (1 pt. for each inch achieved)	5	4	3	2	1
4. Functionality of final product	5	4	3	2	1
5. Time (Did the team complete product/5 min)	5	4	3	2	1
6. Test (Did a team member walk required dis.)	5	4	3	2	1
7. Discussion (individual part. in discussion)	20	15	10	5	1

Total Points: _________________

Standards for Technological Literacy

Elementary Benchmarks

Students will develop an understanding The Nature of Technology. This includes acquiring knowledge of: (Standards 1-3)

Standard 1: The characteristics and scope of technology.
(Grades K-2)
Benchmark A: The natural world and the human-made world are different.
Benchmark B: All people use tools and techniques to help them do things.

(Grades 3-5)
Benchmark C: Things that are found in nature differ from things that are human-made in how they are produced and used.
Benchmark D: Tools, materials, and skills are used to make things and carry out tasks.
Benchmark E: Creative thinking and economic and cultural influences shape technological development.

Standard 2: The core concepts of technology.
(Grades K-2)
Benchmark A: Some systems are found in nature and some are made by humans.
Benchmark B: Systems have parts or components that work together to accomplish a goal.
Benchmark C: Tools are simple objects that help humans complete tasks.
Benchmark D: Different materials are used in making things.
Benchmark E: People plan in order to get things done.

(Grades 3-5)
Benchmark F: A subsystem is a system that operates as part of another system.
Benchmark G: When parts of a system are missing it may not work as planned.
Benchmark H: Resources are the things needed to get a job done, such as tools and machines, information, energy, people, capital, and time.
Benchmark I: Tools are used to design, make, use and assess technology.
Benchmark J: Materials have many different properties.
Benchmark K: Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
Benchmark L: Requirements are the limits to designing and making a product or system

Standard 3: The relationships among technologies and the connections between technology and other fields.
(Grades K-2)
Benchmark A: The study of technology uses many of the same ideas as other subjects.

Standards for Technological Literacy

Elementary Benchmarks

(Grades 3-5)
Benchmark B: Technologies are often combined.
Benchmark C: Various relationships exist between technology and other fields of study.

Students will develop an understanding of Technology and Society. This includes leaning about: (Standards 4-7)

Standard 4: The cultural, social, economic, and political effects of technology.
(Grades K-2)
Benchmark A: The use of tools and machines can be helpful or harmful.

(Grades 3-5)
Benchmark B: When using technology, results can be good or bad.
Benchmark C: The use of technology can have unintended consequences.

Standard 5: The effects of technology on the environment.
(Grades K-2)
Benchmark A: Some materials can be reused and/or recycled.

(Grades 3-5)
Benchmark B: Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.
Benchmark C: The use of technology affects the environment in good and bad ways.

Standard 6: The role of technology in the development and use of technology.
(Grades K-2)
Benchmark A: Products are made to meet individual needs as wants.

(Grades 3-5)
Benchmark B: Because people's needs and wants change, new technologies are developed, and old ones are improved to meet those changes.
Benchmark C: Individual, family, community, and economic concerns may expand or limit the development of technologies.

Standard 7: The influence of technology on history.
(Grades K-2)
Benchmark A: The way people live and work has changed throughout history because of technology.
Benchmark B: People have made tools to provide food, to make clothing, and to protect themselves.

Elementary Benchmarks

(Grades 3-5)
Benchmark B: People have made tools to provide food, to make clothing, and to protect themselves.

Students will develop an understanding of Design. This includes knowing about: (Standards 8-10)

Standard 8: The attributes of design.
(Grades K-2)
Benchmark A: Everyone can design solutions to a problem.
Benchmark B: Design is a creative process.

(Grades 3-5)
Benchmark C: The design process is a purposeful method of planning a practical solutions to problems.
Benchmark D: Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Standard 9: Engineering design.
(Grades K-2)
Benchmark A: The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
Benchmark B: Expressing ideas to others verbally and through sketches and models is an important part of the design process.

(Grades 3-5)
Benchmark C: The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
Benchmark D: When designing an object, it is important to be creative and consider all ideas.
Benchmark E: Models are used to communicate and test design ideas and processes.

Standard 10: The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
(Grades K-2)
Benchmark A: Asking questions and making observations helps a person to figure out how things work.
Benchmark B: All products and systems are subject to failure. Many products and systems, however, can be fixed.

Elementary Benchmarks

(Grades 3-5)
Benchmark C: Troubleshooting is a way of finding out why something does not work so that it can be fixed.
Benchmark D: Invention and innovation are creative ways to turn ideas into real things.
Benchmark E: The process of experimentation, which is common in science, can also be used to solve technological problems.

Students will develop Abilities for a Technological World. This includes becoming able to: (Standards 11-13)

Standard 11: Apply the design process.
(Grades K-2)
Benchmark A: Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
Benchmark B: Build or construct an object using the design process.
Benchmark C: Investigate how things are made and how they can be improved.

(Grades 3-5)
Benchmark D: Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.
Benchmark E: The process of designing involves presenting some possible solutions in visual form and selecting the best solution(s) from many.
Benchmark F: Test and evaluate the solutions for the design problem.
Benchmark G: Improve the design solutions.

Standard 12: Use and maintain technological products and systems.
(Grades K-2)
Benchmark A: Discover how things work.
Benchmark B: Use hand tools correctly and safely and name them correctly.
Benchmark C: Recognize and use everyday symbols.

(Grades 3-5)
Benchmark D: Follow step-by-step directions to assemble a product.
Benchmark E: Select and safely use tools, products, and systems for specific tasks.
Benchmark F: Use computer to access and organize information.
Benchmark G: Use common symbols, such as numbers and words, to communicate key ideas.

Standards for Technological Literacy

Elementary Benchmarks

Standard 13: Assess the impact of products and systems.
(Grades K-2)
Benchmark A: Collect information about everyday products and systems by asking questions.
Benchmark B: Determine if the human use of a product or system creates positive or negative results.

(Grades 3-5)
Benchmark C: Compare, contrast, and classify collected information in order to identify patterns.
Benchmark D: Investigate and assess the influence of a specific technology on the individual, family, community, and environment.
Benchmark E: Examine the trade-offs of using a product or system and decide when it could be used.

Students will develop an understanding of The Designed World. This includes selecting and using. (Standards 14-20)

Standard 14: Medical technologies.

Standard 15: Agricultural and related biotechnologies.

Standard 16: Energy and power technologies.

Standard 17: Information and communication technologies.

Standard 18: Transportation technologies.

Standard 19: Manufacturing technologies.

Standard 20: Construction technologies.