Children's Engineering

Design and Technology

Grades K-5

Prepared by Marcia Hickey, 2006

Highlights in Children's Engineering

1988
The first U.S. teacher training is provided though a joint effort between The College of New Jersey and UK.

Design & Technology is a required subject area of the United Kingdom's National Curriculum.

May 5, 2003
News Release
New Jersey Governor signs bill A21169, which makes technology education part of the state's core curriculum standards.

July 2003
Virginia proudly presents
Children's Engineering: A Teacher Resource Guide for Design and Technology in Grades K-5.

Technology is…

- Everything in our environment that has been **human made** or **human altered**.

- How people have **modified** their environment to meet their **needs and wants**.

Technology is…

- The **application** of knowledge, creativity and resources to solve problems and to extend human potential.
- Human **innovation** in action.

Technology satisfies human needs and wants through the design process.

Science explains nature so that humans can understand their environment.

Two Complementary Instructional Methods

Scientific Method	Technological Method
State the Problem	State the Problem
Gather Information	Brainstorm Solutions
Suggest an Answer-Hypothesis	Select the “Best” Solution
Perform an Experiment	Create (Build) the Solution
Record and Analyze Data	Test the Solution
State Conclusions	Evaluate the Solution
	Make It Better

Why Should Children Study Technology?

- Make **connections** between the natural and man-made world.
- Develop **critical thinking** skills.
- Develop **problem solving** skills.
- Have experiences with the true **application of knowledge.**
- Gain **ownership** of essential knowledge.
- **Bridge the gap** between memorization of facts and the understanding of skills and processes.

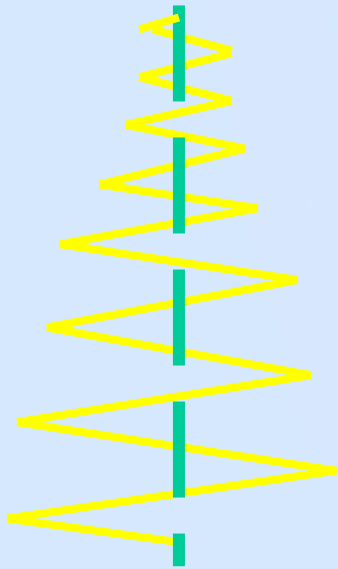
Conceptual Models for Design & Technology Teaching & Learning

Hazy impressions

Speculating & exploring

Clarifying & validating

Critical appraisal



Discussion, drawings, sketches, diagrams, notes, graphs, numbers

Solid modeling to predict or represent reality

Prototyping or finished product

REFLECTION

ACTION

Drawn from work if Technology Education Research Unit Of the University of London, Goldsmiths College
Courtesy Ron Todd, Phd. The College of New Jersey

In the Elementary Classroom

Technology Design Loop

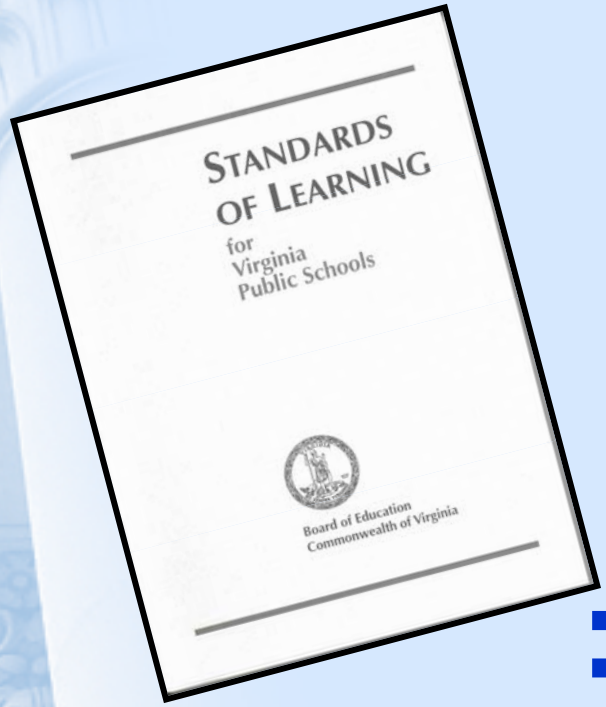
1. **What is the problem?**

2. **Brainstorm solutions.**
   - Use your productive thinking talent to list many, varied, and unusual ideas.

3. **Create the solution you think is best.**
   Make sure that you have a plan for how you will create your solution.
   - What things will you need to create your solution?
   - How will you build it? A sketch might help.
   - List the problems that might keep you from building your solution.

4. **Test your solution.**

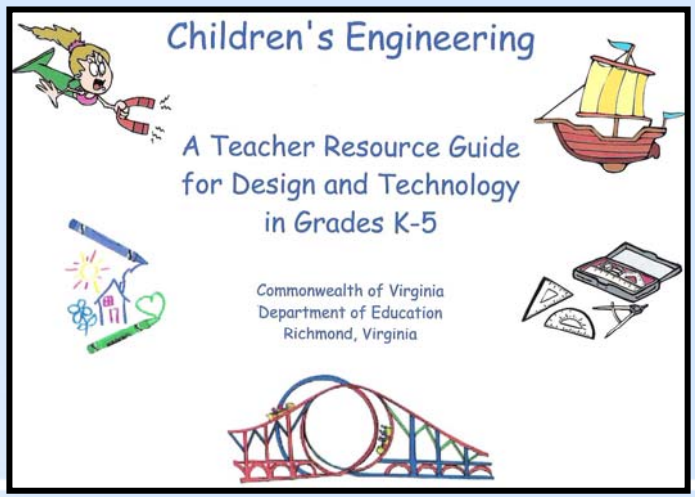
5. **Evaluate your solution.**
   - Was it the best solution?
   - What would you have done differently?
   - Can you add to it to make it better?


STANDARDS
OF LEARNING
for
Virginia
Public Schools
Board of Education
Commonwealth of Virginia

+


Standards for
Technological
Literacy
Content for
the Study of
Technology

=


Children's Engineering
A Teacher Resource Guide
for Design and Technology
in Grades K-5
Commonwealth of Virginia
Department of Education
Richmond, Virginia

Foreword

Children's Engineering: A Teacher Resource Guide for Design and Technology in Grades K-5 identifies technology-based experiences that enhance the content of selected Standards of Learning in English, mathematics, science, and history and social science. The experiences enable teachers to introduce children in grades K-5 to the technological world around them. The document is designed to be a companion to the Standards of Learning and a resource for enhancing the locally developed curriculum.

Each experience is intended to reinforce specific Standards of Learning. Additionally, these experiences have been correlated to the *Standards for Technological Literacy: Content for the Study of Technology.* The experiences promote critical thinking and problem-solving abilities, and they build upon a child's capability to retain content described in the Standards of Learning.

The resource guide is arranged by grade level. Each grade level contains four experiences; each experience is focused on a different subject area. The supporting resources in each experience consist of a design brief, a teacher resource page, a guided portfolio, and an assessment rubric.

This document provides teachers with the instructional materials they need to implement each experience. The majority of the supplies and materials that are needed to implement the experiences are readily available in most elementary classrooms. The instructional pages are child-friendly and ready to copy. Target and supporting Standards of Learning are specified on all materials to illustrate the academic strength inherent in K-5 technology education experiences. The document has been carefully written to ensure the experiences are age appropriate. Each experience has been crafted to build increasingly sophisticated concepts, knowledge, and ability as children mature. We hope you will enjoy using this document and that it will be a worthwhile experience for all children in grades K-5.

George R. Willcox
Program Specialist
Technology Education Service

"The experiences promote critical thinking and problem-solving abilities, and they build upon a child's capability to retain content described in the Standards of Learning."

The Design Brief

Third Grade
Mathematics
Design Brief

Geometric Creatures

Background: We have been learning about geometric shapes, such as squares, triangles, rectangles, circles, cubes, rectangular solids, spheres, pyramids, cones, and cylinders.

Design Challenge: Design and build an imaginary geometric creature using both plane and solid geometric shapes. Your geometric creature must stand by itself and have at least two moving parts.

Criteria:
Your creature must

- have at least five plane shapes
- have at least three solid shapes
- have two moving parts (use levers, pneumatics, and/or pulleys)
- stand by itself
- be attractive.

Materials: You may select from the items below.

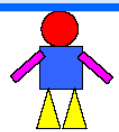
- rulers
- construction paper
- brads
- poster board
- craft sticks
- cardboard cylinders
- glue
- straws
- tag board
- plastic tubing
- empty containers
- 12 inches of string or yarn
- spools
- paint
- general art supplies
- syringes
- 12 inches of tape
- balloons

Targeted Standard of Learning: Mathematics 3.18
Supporting Standards of Learning: Mathematics 3.14
Science 3.1, 3.2
English 3.1, 3.2, 3.4

Targeted Standard for Technological Literacy: 9
Supporting Standards for Technological Literacy: 8, 10, 11

Guided Portfolio—1
Name _____

Geometric Creatures



Group Members: _____

_____ _____ _____

1. What is the problem? State the problem in ***your own words.***

_____

_____

_____

_____

_____

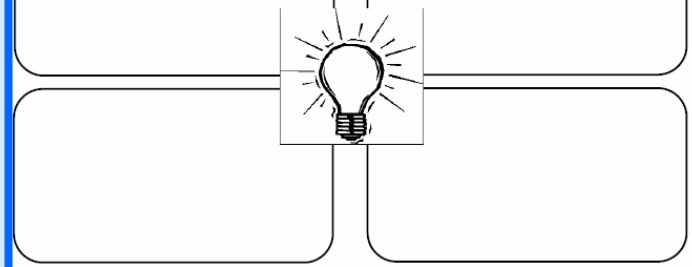
Targeted Standard of Learning: Mathematics 3.18
Supporting Standards of Learning: Mathematics 3.14, Science 3.1, 3.2, English 3.1, 3.2, 3.4

Targeted Standard for Technological Literacy: 9
Supporting Standards for Technological Literacy: 8, 10, 11

After reading the design brief, the students restate the problem.

Guided Portfolio—2
Name _____

2. Brainstorm solutions.
Draw or describe some possible solutions.

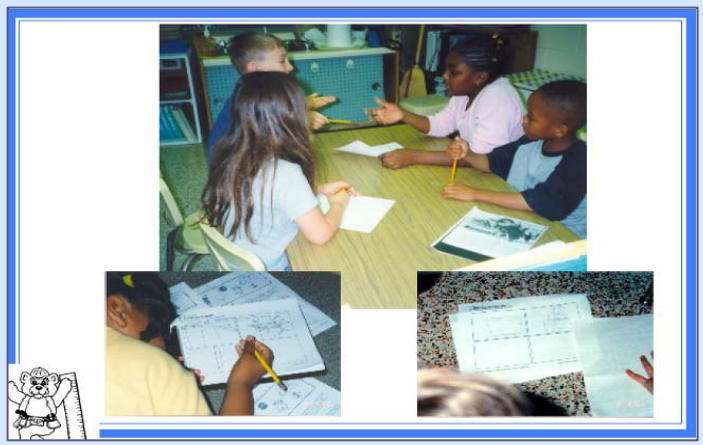


Third Grade — Geometric Creatures 4

Then in their groups they brainstorm ideas by either sketching or writing.

Everyone contributes.

All ideas are accepted.



Once the group has decided, they build. As they progress, they record any problems they may have encountered.

Children make decisions about their designs in various ways.

Guided Portfolio—3

Name _____

3. Create the solution you think is best.

Keep notes below about the problems you have and how you solve them.

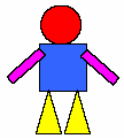
Third Grade

Creating Native American Shelters

Guided Portfolio—4
Name _____

4. Test your solution.

- Does your creature have at least five plane shapes? YES NO
- Does your creature have at least three solid shapes? YES NO
- Does your creature have two parts that use levers, pneumatics, or pulleys to move? YES NO
- Does your creature stand by itself for at least five minutes? YES NO
- Does your creature remain standing when its parts are moving? YES NO
- Is all of your work colorful and neatly done? YES NO



Third Grade

Testing to be sure criteria has been met is important.

Guided Portfolio—5
Name _____

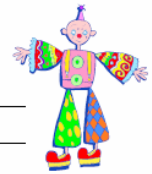
5. Evaluate your solution.

Was it the best solution? Would one of your other ideas have been better? Why or why not?

_____

_____

_____



What would you have done differently?

_____

_____

_____

Could you add to it to make it better? What would you add to it?

_____

_____

_____

Third Grade Geometric Creatures 7

Evaluating the solution allows the students look at what they would change or do differently.

Authentic Assessment

Rubric for *Geometric Creatures*

Name_____ Date_____

Design Brief Rubric	no evidence 0	limited understanding 1	some understanding with room for improvement 2	good understanding with room for improvement 3	substantial understanding 4
The student restated the problem in his/her own words.					
The student brainstormed more than one idea.					
The student created and labeled a sketch to use as a "blueprint."					
The student included notes about problems that occurred and their solutions.					
The student tested the creature					
• for at least five different plane shapes					
• for at least three solid shapes					
• for two parts that use levers, pneumatics, or pulleys to move					
• to see if it could stand alone for at least five minutes					
• to see if it remained standing when its parts were moving					
• to see if the work was colorful and neatly done.					
The student evaluated how he/she could make it better next time.					
The student spoke clearly and confidently during oral presentation.					

Rubric for *Geometric Creatures*

Name_____ Date_____

Oral Communication Rubric	no evidence 0	limited understanding 1	some understanding with room for improvement 2	good understanding with room for improvement 3	substantial understanding 4
3.1 The student will use effective communication skills in group activities.					
a) Listen attentively by making eye contact, facing the speaker, asking questions, and summarizing what is said.					
b) Ask and respond to questions from teachers and other group members.					
c) Explain what has been learned.					
3.2 The student will present brief oral reports.					
a) Speak clearly.					
b) Use appropriate volume and pitch.					
c) Speak at an understandable rate.					
d) Organize ideas sequentially or around major points of information.					
e) Use grammatically correct language and specific vocabulary to communicate ideas.					

Connecting to Virginia's **Standards of Learning**

Standards of Learning

English (2002)

Oral Language

3.1 The student will use effective communication skills in group activities.

a) Listen attentively by making eye contact, facing the speaker, asking questions, and summarizing what is said.
b) Ask and respond to questions from teachers and other group members.
c) Explain what has been learned.

3.2 The student will present brief oral reports.

a) Speak clearly.
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c) Speak at an understandable rate.
d) Organize ideas sequentially or around major points of information.
e) Use clear grammatically correct language and specific vocabulary to communicate ideas.

Reading

3.4 The student will use strategies to read a variety of fiction and nonfiction materials.

a) Preview and use text formats.
b) Set a purpose for reading.
c) Apply meaning clues, language structure, and phonetic strategies.
d) Use context to clarify meaning of unfamiliar words.
e) Read fiction and nonfiction fluently and accurately.
f) Reread and self-correct when necessary.

Science (2003)

Scientific Investigation, Reasoning, and Logic

3.1 The student will plan and conduct investigations in which

a) predictions and observations are made;
b) objects with similar characteristics are classified into at least two sets and two subsets;
c) questions are developed to formulate hypotheses;
d) volume is measured to the nearest milliliter and liter;
e) length is measured to the nearest centimeter;
f) mass is measured to the nearest gram;
g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
h) temperature is measured to the nearest degree Celsius;

Science (2003) continued

Scientific Investigation, Reasoning, and Logic

i) time is measured to the nearest minute;
j) inferences are made and conclusions are drawn; and
k) natural events are sequenced chronologically.

Force, Motion, and Energy

3.2 The student will investigate and understand simple machines and their uses. Key concepts include

a) types of simple machines (lever, screw, pulley, wheel and axle, inclined plane, and wedge);
b) how simple machines function;
c) compound machines (scissors, wheelbarrow, and bicycle); and
c) examples of simple and compound machines found in the school, home, and work environment.

Mathematics (2001)

Measurement

3.14 The student will estimate and then use actual measuring devices with metric and U.S. Customary units to measure

a) length–inches, feet, yards, centimeters, and meters;
b) liquid volume–cups, pints, quarts, gallons, and liters; and
c) weight/mass–ounces, pounds, grams, and kilograms.

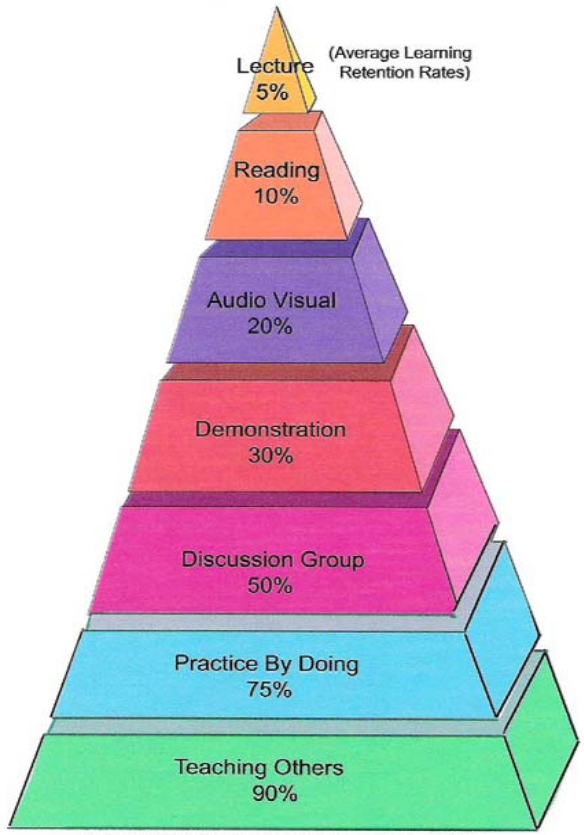
Geometry

3.18 The student will analyze two-dimensional (plane) and three-dimensional (solid) geometric figures (circle, square, rectangle, triangle, cube, rectangular solid [prism], square pyramid, sphere, cone, and cylinder) and identify relevant properties, including the number of corners, square corners, edges, and the number and shape of faces, using concrete models.

Standards for Technological Literacy

Standard 8: Students will develop an understanding of the attributes of design.
Standard 9: Students will develop an understanding of engineering design.
Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
Standard 11: Students will develop the abilities to apply the design process.

Learning Pyramid



(National Training Laboratories, Bethel, Maine)

Research says…

- The brain does better when it "does" rather than when it "absorbs."
- The brain needs to make its own meaning of ideas and skills.

Carol Ann Tomlinson, 1998

Curry School of Education

Research also says…

- The single best way to grow a better brain is through challenging problem solving.

  Eric Jensen, *Teaching with the Brain in Mind*, 1998

- Studies show that it is analysis of the material that aids in the recall of it.

  R.C. Matthews, "Semantic Judgments as Encoding Operations" *Journal of Exceptional Learning, 1977*

Benefits from using Children's Engineering in the Elementary Classroom

- Develops **active learners**, not passive learners
- Develops **self directed learners**
- Develops **intrinsically driven learners**
- Involves children in **problem solving, critical thinking, decision making**, and **small group participation—cooperative learning groups**

- Engages children of **all learning styles and abilities**
- Provides opportunities and tools for **authentic assessment**
- Provides **differentiation of instruction**
- **Supports and integrates** the total curriculum not as an add on to the already busy school day.
- Promotes **technological literacy** for all children.

Technological Literacy

- A major consequence of our accelerating technological change is a growing gap in levels of technological ability and understanding.

- Society and individuals need to decide what, how and when to develop or use various technological systems.

Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards ITEA, 2003.

Where Does Virginia Stand?

- The **Children's Engineering Convention**, in its 10 year history, has provided professional development experiences for over 1,650 K-5 teachers and administrators.

- In 2003 **A *Teacher Resource Guide for Design and Technology in Grades K-5*** was published by the Department of Education.

Since the Guide…

- **Since the guide** was published in 2003, the convention has educated 480 teachers and administrators. That is just shy of 1.8% of Virginia's elementary teaching population.
- 150 teachers have received school division level in-service training through Design &Technology workshops, 0.5% of Virginia's teaching population.
- 100 (0.3%) teachers have taken graduate Design & Technology classes for recertification offered through James Madison University.

What Still Needs to Be Done?

Professional Development!

Teachers need to be trained so that they can be confident in implementing design and technology as a means to extend and support Virginia's Standards of Learning.

Preparing the Next Generation for Their Tomorrow

- By infusing the Standards for Technological Literacy in the elementary school curriculum, the Commonwealth will strengthen the educational foundation of children in Virginia.

Preparing the Next Generation for Their Tomorrow

Integrate

Technology, Innovation, Design,

& Children's Engineering

in

Virginia's Elementary Classrooms