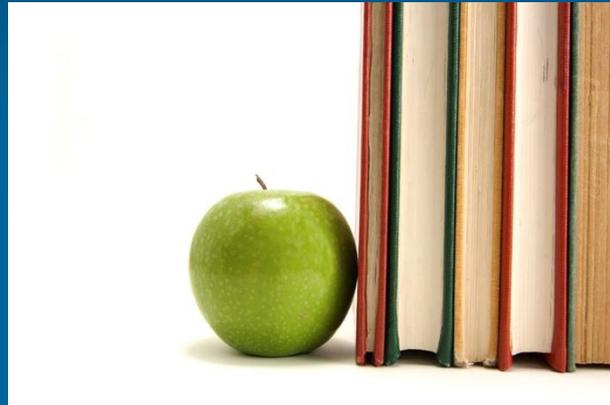


Engineer your Classroom!



A Pre-University Teacher Training Module

**Brought to you by
www.TryEngineering.org**



Introduction

This pre-university training module will illustrate how engineering concepts and the design process featured on [TryEngineering.org](https://www.tryengineering.org) can be used to reinforce content in traditional subject areas while building students' problem solving skills and motivation to learn.

Overview:

- About www.TryEngineering.org
- Benefits to including engineering concepts and design principles
- Ways to integrate engineering concepts and design principles into your classroom instruction with Tryengineering.org
- Sample lesson plans from TryEngineering.org
- Engineering background information

About TryEngineering.org

TryEngineering.org is a resource for students, their teachers, parents and school counselors

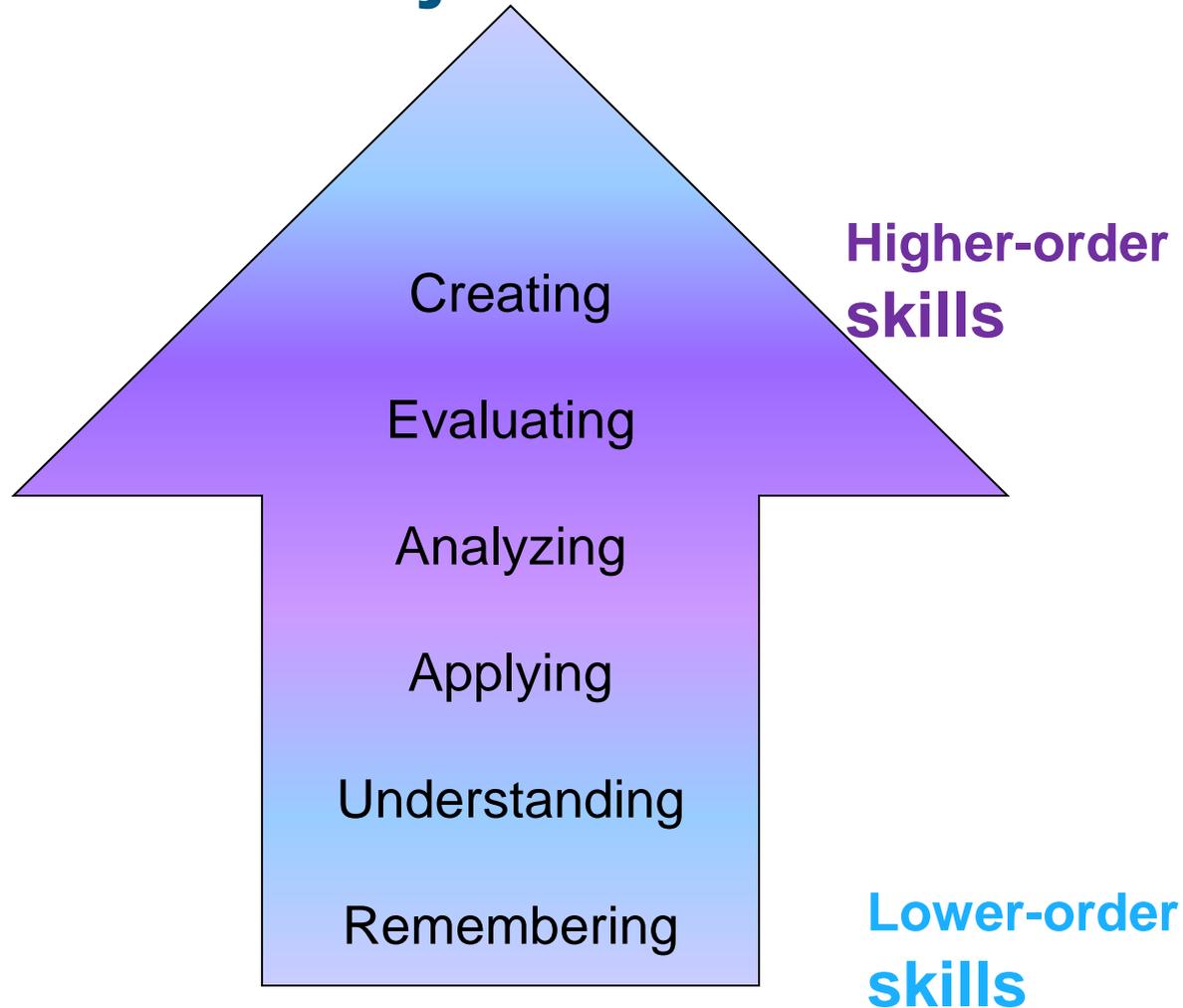
- Resources on the site include:
 - information about engineering disciplines and careers
 - profiles of practicing engineers and engineering students
 - opportunities for students
 - university finder
 - lesson plans reviewed and approved by teachers and engineers
 - frequently asked questions answered by engineers and engineering students
 - interactive games
 - printable TryEngineering Today newsletter

Benefits of Engineering in the Classroom

There are many benefits to incorporating engineering activities in the classroom. Engineering:

- Encourages students to utilize higher order thinking skills
- Allows students to apply what they have learned in other subject areas
- Encourages creativity and innovation
- Is interdisciplinary
- Facilitates cooperative learning and teamwork
- Is intrinsically motivating and engaging!

Bloom's Revised Taxonomy of Educational Objectives



Bloom et al., 1956 ; Anderson and Krathwohl, 2001

Engineering Encourages Higher Order Thinking Skills

■ **Analyzing**

- identifying design problems, organizing ideas, developing data representations



■ **Evaluating**

- choosing materials, debating with teammates, deciding on a course of action, testing designs, assessing failures

■ **Creating**

- generating new ideas, designing solutions, hypothesizing what will happen, constructing models, redesigning models

Engineering is about Application

- Engineering activities help students answer the age old question “When will I ever use that?”
- Engineering activities let students experience hands-on application of concepts learned in other subjects which may enhance understanding¹
- Engineering activities allow teachers to become facilitators of knowledge in the learning process by allowing their students to work collaboratively on student driven, inquiry based problems

[1] Schaefer, Malinda R., Sullivan, Jacquelyn F. and Yowell, Janet L. (2003) "Standards-Based Engineering Curricula as a Vehicle for K-12 Science and Math Integration," *Proceedings, Frontiers in Education Annual Conference, Boulder, CO*, pp. F3A-1-F3A-5

Engineering Fosters Creativity and Innovation

- Engineering activities foster students' creativity and innovation by encouraging students to:
 - brainstorm ideas
 - develop novel solutions to open-ended problems
 - examine a problem from numerous angles
 - work collaboratively
 - predict what will happen
 - test and experiment
 - troubleshoot
 - reflect on successes and failures
 - communicate results

Engineering is Interdisciplinary!

Engineering is a great way to reinforce content taught in subject areas including:

- Science
- Math
- Technology
- Language Arts
- Social Studies/History
- Connections to these subject areas are evident in lessons found on TryEngineering.org

Engineering is Interdisciplinary!

Science

- Materials – Designing improved sports equipment
- Machines/mechanisms – Designing devices using the six simple machines
- Structures - Designing and constructing bridges, towers
- Electricity – Designing and constructing electrical circuits
- Energy – Using various forms of energy to improve quality of life
- Motion & forces – Designing gliders, sailboats, cars
- Human body – Engineering heart valves, hand biometrics
- The environment – Designing ways to clean up an oil spill or irrigation systems

Engineering is Interdisciplinary!

Math

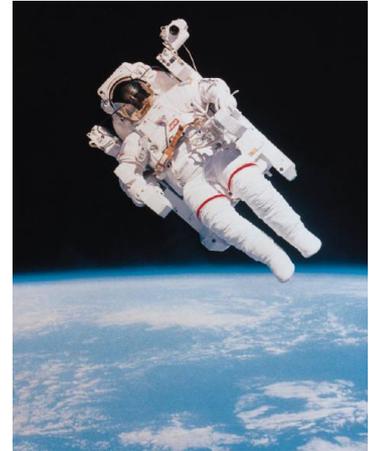
- Numerical operations – Calculating mean, median, mode from experimental data
- Measurement – Determining the surface area, distance, volume, mass or other value from a proposed design solution
- Data organization/representations – Collecting, graphically analyzing and drawing conclusions from data obtained during design tests
- Money - Comparing cost vs. performance between a set of proposed design solutions
- Algebra – Representing digital circuits algebraically to create the most efficient design



Engineering is Interdisciplinary!

Technology

- Attributes of design – Designing solutions to design problems, working within criteria and constraints
- Engineering design – Developing ideas, selecting solutions, building prototypes, testing, evaluating, and communicating results, thinking creatively and abstractly
- Problem solving - Troubleshooting, experimenting, researching



Engineering is Interdisciplinary!

Language Arts

- Speaking – Effectively communicating design plan, results, tests, redesigns
- Documenting – Documenting design plans, design drawings, design changes, test results
- Articulating – Explaining a particular approach to a design, what went wrong with a design and what steps were taken to correct it
- Researching – Gathering and analyzing resources to synthesize findings into a coherent body of documents

Engineering is Interdisciplinary!

History/Social Studies

- Exploration of history of engineering
- Learning about famous engineers
- Researching the history of everyday inventions
- Learning about the impact of engineering on civilization/society
- Debating engineering and ethics

Engineering Fosters Teamwork

- Students can work in small groups
- Students can be assigned different roles such as planner, manager, budgeter, builder
- To design effective solutions students need to listen to the ideas of others
- Compromise



Engineering is Intrinsically Motivating and Engaging!

- Engineering positively impacts our world which is appealing to students, especially girls¹
- Engineering can be a great hook for reinforcing concepts in other disciplines
- Engineering activities take a hands-on approach that can be very motivating and rewarding for students
- Engineering excites students because it deals with the products and technologies they use in their everyday lives
- And of course... engineering is fun!



[1] Source: Extraordinary Women Engineers Project

Ways to Integrate Engineering

- Use engineering lessons to reinforce concepts in other subjects
- Use as part of career education
- Integrate into afterschool or summer programs
- Start an engineering club
- Begin a community service project team
- Organize a team for an engineering competition (FIRST, BEST)
- Use at family learning events
- Have a guest speaker
- Arrange a field trip to science center, university, engineering industry facility



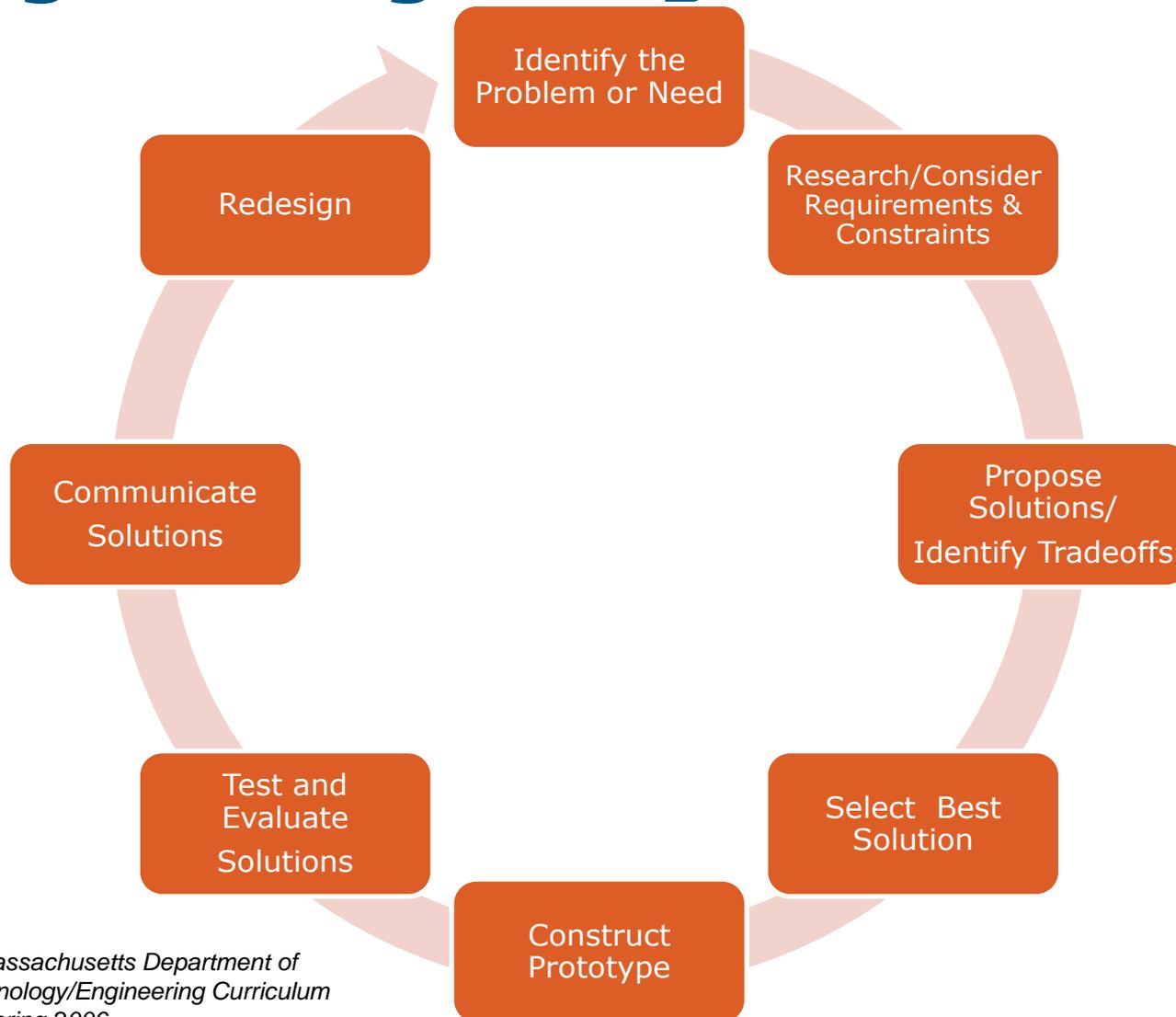
How to Get Started

- Tryengineering.org offers dozens of engineering lessons on a variety of engineering topics
- You don't need to have an engineering background to share these lessons with your students. Each lesson provides everything you need to easily and effectively implement the lesson including:
 - Educational objectives and outcomes
 - Connections to national education standards
 - Recommended age level
 - A list of simple materials
 - Step by step instructions
 - Background information on the topic for students
 - Reproducible student worksheets
 - Internet resources and recommended reading

What is the Engineering Design Process?

- Lessons featured on Tryengineering.org apply the engineering design process (EDP) which is a multi-step process used by engineers to efficiently create solutions to complex problems

Engineering Design Process



Adapted from *Massachusetts Department of Education, Technology/Engineering Curriculum Frameworks - Spring 2006*

Sample Lesson Plan from Tryengineering.org



Design and Build a Better Candy Bag

Lesson Focus

Demonstrate how product design differences can affect the success of a final product -- in this case a bag for holding candy. Students work in pairs to evaluate, design, and build a better candy bag.

Age Levels: 8-18

Sample Lesson Plan from Tryengineering.org

Objectives

- Learn how design impacts product performance.
- ▣ Design a better candy bag using science, mathematics, and engineering concepts and applications.
- ▣ Build a better candy bag using science, mathematics and engineering design concepts and applications.
- ▣ Use the engineering design process to solve the problem.
- ▣ Employ the use of data collection and analysis to help solve the problem.

Education Standards Addressed

National Science Education Standards*



CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- Properties of objects and materials
- Properties and changes of properties in matter

*These standards are US-based, but are representative of the unit focus, and may differ in other regions of the world.

Education Standards Addressed

Principles and Standards for School Mathematics*

Data Analysis and Probability Standards

Instructional programs from prekindergarten through grade 12 should enable all students to:

- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- develop and evaluate inferences and predictions that are based on data.

*These standards are US-based, but are representative of the unit focus, and may differ in other regions of the world.

Education Standards Addressed

Standards for Technological Literacy*

Design

- 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.

*These standards are US-based, but are representative of the unit focus, and may differ in other regions of the world.

Lesson Highlights

The Design and Build a Better Candy Bag lesson facilitates:

- open inquiry
 - observations and predictions
 - exploration of the properties of materials
 - mathematical applications, such as calculating volume
 - troubleshooting
 - engaging in the engineering design process
 - documenting and communicating results
- Promotes problem-solving and critical thinking skills
 - Encourages students' creativity and cognitive flexibility
 - Has students working collaboratively
 - Encourages student reflection and discussion

Local Resources

Local resources in your area may be able to provide additional support for engineering education in your classroom/school

- Technology education department members
- Professional engineering organizations
- Local college/university outreach programs
- Industry outreach programs
- Science centers/museums
- Parents of students

Additional Engineering Background Information

- The remaining slides in this training module provide additional background information about engineering
- These slides can be used for your own information or can be shared with your students
- Further information can be found in the [Explore Engineering](#) section of TryEngineering

What is Engineering & What do Engineers Do?

- Engineering involves developing innovative solutions to benefit humanity
- Engineering is essential to our health happiness and safety
- Engineers devise creative solutions to problems
- They design products and technologies to improve our quality of life
- Engineers shape our future



What do Engineers Design?

- Technology – Computers, Ipods, televisions
- Structures – Buildings, bridges
- Equipment – Medical Equipment
- Chemicals – Pharmaceuticals, household products, cosmetics
- Materials – Polymers, plastics, sports equipment
- Transportation – Automobiles, aircraft
- And much more!



Engineering Disciplines

Here are a few engineering disciplines which can be explored further on [TryEngineering.org](https://www.tryengineering.org).

- **Aerospace Engineering** - Aerospace Engineers design, develop, and test aircraft, spacecraft, and missiles and supervise the manufacture of these products.
- **Architectural Engineering** - Architectural engineers apply engineering principles to the construction, planning, and design of buildings and other structures.
- **Bioengineering** – Bioengineers are of service to people, work with living systems, and apply advanced technology to the complex problems of medical care.

Engineering Disciplines cont'd.

- **Chemical Engineering** - Chemical engineers work in manufacturing, pharmaceuticals, healthcare, design and construction, pulp and paper, petrochemicals, food processing, specialty chemicals, polymers, biotechnology, and environmental health and safety industries.
- **Civil Engineering** –Civil engineers are involved in the conception, planning, design, construction, and operation of facilities essential to modern life, ranging from transit systems to offshore structures to space satellites.
- **Computer Engineering** - Computer engineers analyze and evaluate computer systems, both hardware and software. They might work on system such as a flexible manufacturing system or a "smart" device or instrument.

Engineering Disciplines cont'd.

- **Computer Science** - Computer scientists design technologies such as the next generation computer systems, computer networking, biomedical information systems, gaming systems, search engines, web browsers, and computerized package distribution systems.
- **Electrical Engineering** - Electrical and electronics engineers conduct research, and design, develop, test, and oversee the development of electronic systems and the manufacture of electrical and electronic equipment and devices.
- **Environmental Engineering** – Environmental engineers use the principles of biology and chemistry, environmental engineers develop solutions to environmental problems.

Engineering Disciplines cont'd.

- **Industrial Engineering** - Industrial engineers determine the most effective ways to use the basic factors of production — people, machines, materials, information, and energy — to make a product or to provide a service.
- **Manufacturing Engineering** - Manufacturing engineers are involved with the process of manufacturing from planning to packaging of the finished product.
- **Materials Engineering** - Materials engineering is a field of engineering that encompasses the spectrum of materials types and how to use them in manufacturing. Materials span the range: metals, ceramics, polymers (plastics), semiconductors, and combinations of materials called composites.

Engineering Disciplines cont'd.

- **Mechanical Engineering** - Mechanical engineers use the principles of energy, materials, and mechanics to design and manufacture machines and devices of all types.
- **Nuclear Engineering** - Nuclear engineers research and develop the processes, instruments, and systems for national laboratories, private industry, and universities that derive benefits from nuclear energy and radiation for society.
- **Software Engineering** - Software engineers working in applications or systems development analyze users' needs and design, construct, test, and maintain computer applications software or systems.

Careers in Engineering

- A greater diversity of engineers is needed in the field to develop the best possible designs, products and processes
- Many pre-university students do not choose engineering because they have little awareness of what engineers really do and have distorted perceptions about what engineering entails (its nerdy, really hard, male only, have to be really good in math and science, doesn't make a difference in the world etc...)
- According to the Occupational Outlook Handbook, engineers held 1.5 million jobs in 2006 in the US alone so career opportunities are plentiful

Thank You!

- Thank you for participating in this training module
- Be sure to visit www.TryEngineering.org often as new educational resources are added regularly!