Engineering and Thinking Skills… the missing link

Focus on PreK-5 Grade

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Background

- We are losing out to other nations in educating Students in STEM.

- Our education system still often operates in “Silos” versus interdisciplinary learning, making our students unable to see the relevance of what they are studying.

- Elementary teachers are often more comfortable with Language Arts than with STEM subjects.

The core idea of the approach is that engineering need not “stand alone” in the curriculum, but can and should leverage other curricular elements, in particular literature.

WHY ENGINEERING?

Engineering is ***ACADEMIC GLUE*** – it binds complex math and science concepts to real-world experiences and leads to learning that sticks with students

Engineering is ***CREATIVITY*** – it brings out the best ideas from the students

Engineering is ***GROUP WORK*** –students learn to communicate and work together while they learn math and science

Engineering is ***EVERYWHERE*** –students learn that engineers have designed, created or modified nearly everything they touch, wear, see and hear in their daily lives

Objectives for the teachers:

1. Increase familiarity with Technology that results from Science, Engineering and Math.
2. Utilize Design Thinking process across all disciplines.
3. Use of Thinking Skills in the learning process.
4. Understanding of what engineers, mathematicians, and scientists do.
5. Connect literacy with engineering, math, and science instruction.
6. Creating an interdisciplinary learning environment.

Essential Question

How do we excite our students about engineering, problem solving and thinking skills in a playful and interdisciplinary manner?

What problem are we solving?

The bigger the problem, the bigger the opportunity (Vinod Khosla) https://youtu.be/f9LM88h-l-U

Tell me and I'll forget.
Show me and I'll remember.
Involve me and I'll understand
- Confucius

Using Project Based Learning

Goals

We hope to expose you to the exciting **world** of engineering design and thinking skills. We have taught this to many teachers over the past few years and seen how it excites both the teacher and the student about learning.

- **Show the connection between thinking skills and engineering**
- **Show how design thinking can tie subjects together, especial literature, social studies to math and science**
- **Encourage students to be excited about STEM (Science, Technology, Engineering and Math.) learning.**

What would you like to take away from this session?

What can you do as a Tech.ED teacher to get this to work?

- Be the Catalyst with other teachers.
- Support the Language art teachers/Social studies with the STEM subjects
- Explain the Problem Solving Process within the school
- Show how this process can facilitate learning life skills (Team work, Values)

Thinking Skills

- Questioning
- Creative and Critical thinking
- Meta-cognitive reflection
- Strategies

Learning environment

Can someone give examples of these?

Setting up the team: TEAM CHARTER

Learning life skills

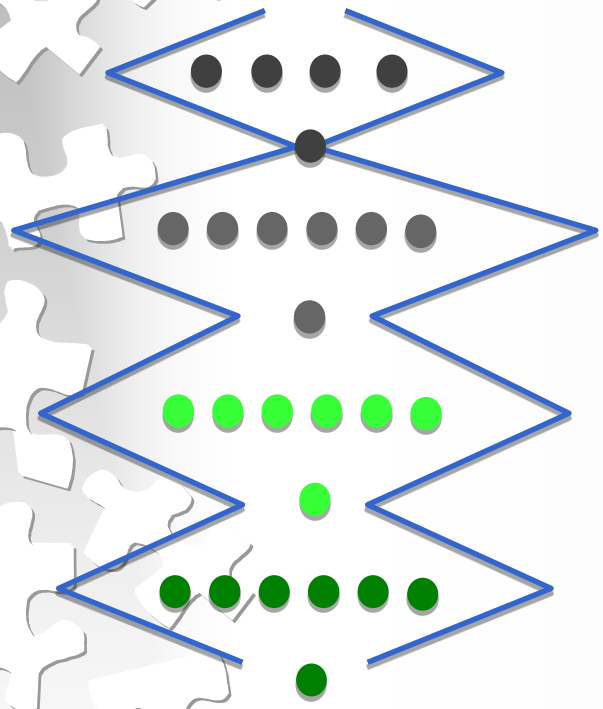
- OVERVIEW OF THE PROJECT
- MEASURABLE TEAM GOALS, ROLES, DELIVERABLES
- HOW WILL WE MEASURE SUCCESS?
- EXPECTATIONS … HOW ARE WE GOING TO WORK TOGETHER? HANDLE CONFLICTS?

How?

- Make it relevant
- Make it engaging
- Make it fun

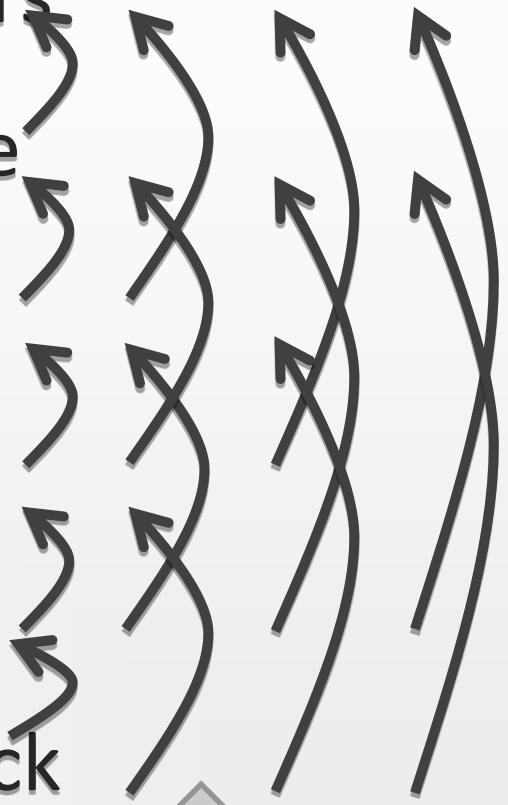
Attitude:
An open mind is playful and willing to be silly because the best ideas are often hidden within our minds away from our watchful judgmental selves. The free flow of conflicting ideas is essential for creative thinking.

Problem Solving (Design) Process



- Story/Characters
- Design Challenge
- Specification
- Designs
- Product
- Testing/ Feedback

Reporting



Divergent/Convergent thinking

Iterative process

Mark Somerville .. Olin College

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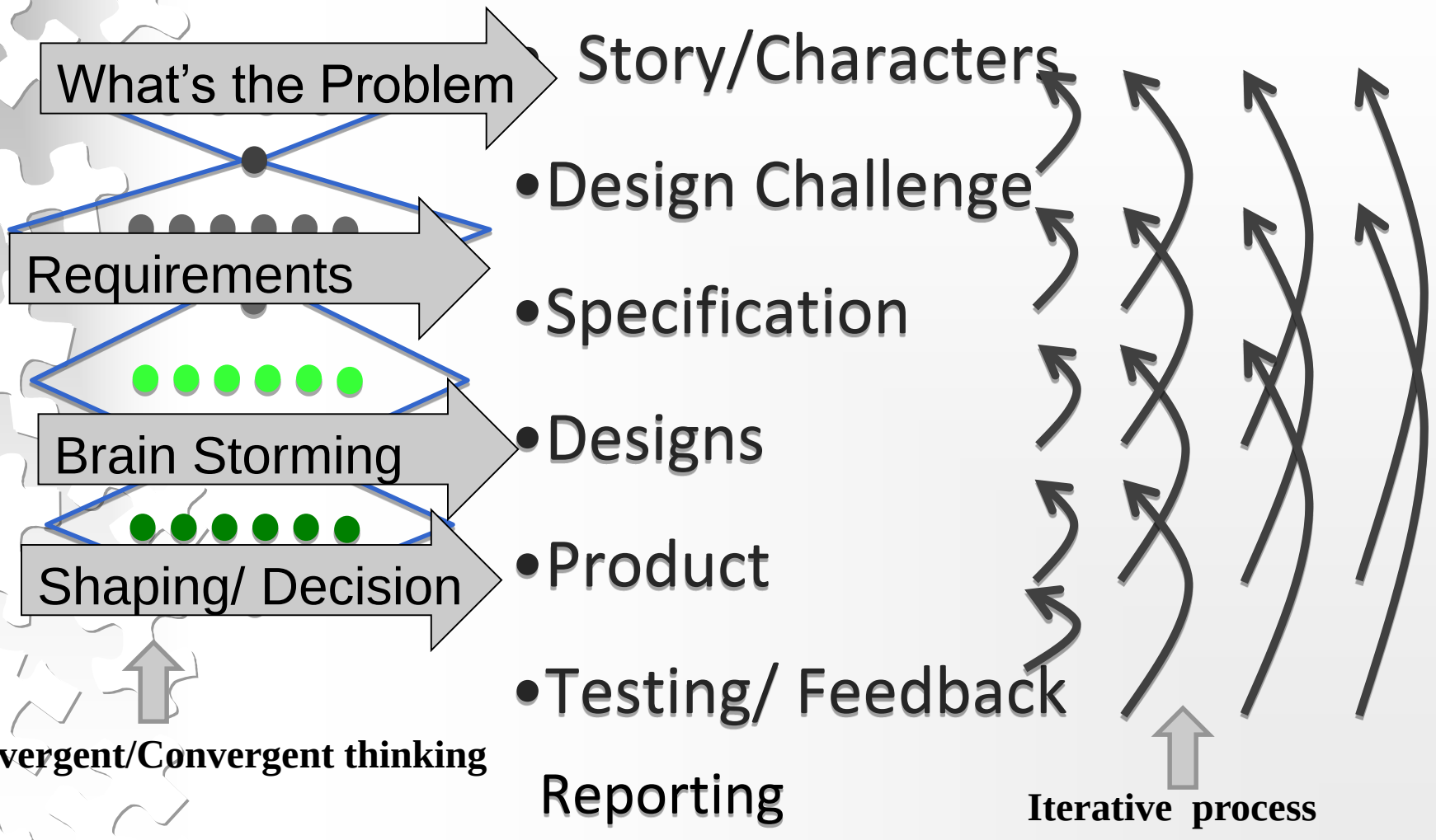
Problem Solving (Design) Process



Guidelines for Brain Writing

- Lots of ideas
- Wild ideas encouraged
- Withhold judgment
- Build on others' ideas
- One speaker at a time

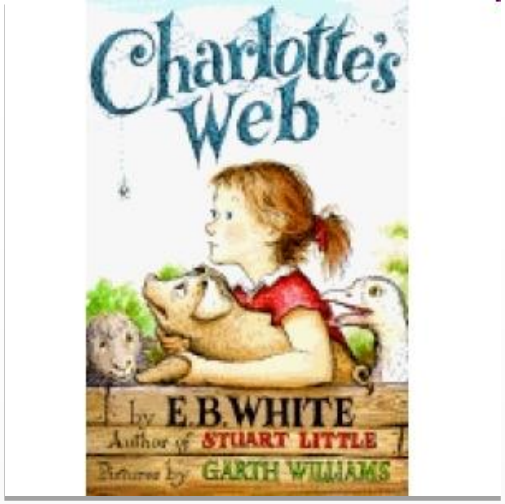
Now Shape your ideas!

- Map (i.e. everyday, innovative, magical) and shape your ideas from brain-writing.
- Remember that you can shape ideas to meet constraints and values
- Choose 2-3 “favorites”, taking values and constraints into account. Create innovative ideas
- Be bold!
- Be prepared to share!

Take 10 minutes to sort and select

Using Stories to learn & Engage

Charlotte's Web by E.B. White



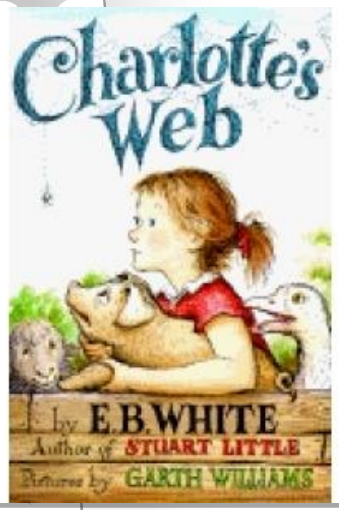
Design Challenges:

- Killing of the runt P1
- Keeping warm at night in the yard. P9
- Mr. Zuckerman knew that a manure pile is a good place to keep a young pig P14
- Wilber was lonely, he wanted love P27
- Have you ever tried to sleep while sitting on eight eggs asked the goose. P33
- "I happen to be a trapper", says Charlotte P39

Note: just thru pg 39 out of 184

Example

- Mr. Zuckerman knew that a manure pile is a good place to keep a young pig (P14)

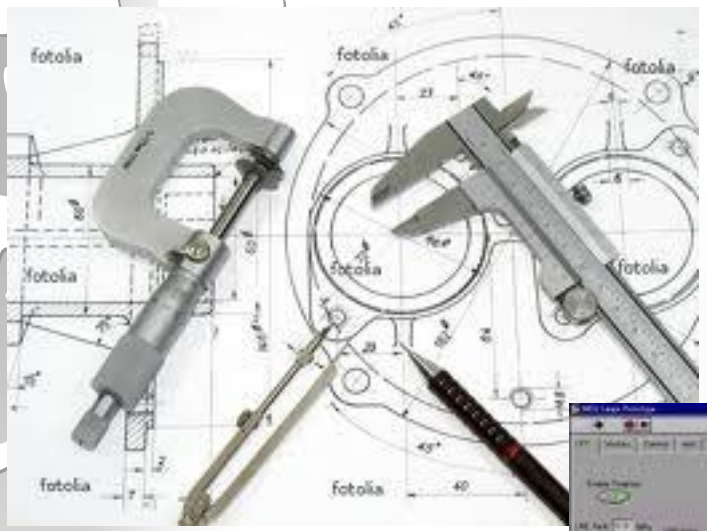


Charlottes Web

Challenge	Math	Life	Earth & Space	Physics & Chemistry	Simple Machines	????
Keeping warm at night	Use manure	Give him more food to eat	Build a house	Use a fire	Use a ramp to lift him off the ground	

Design Challenge: Keeping warm at night

What do we think of engineering?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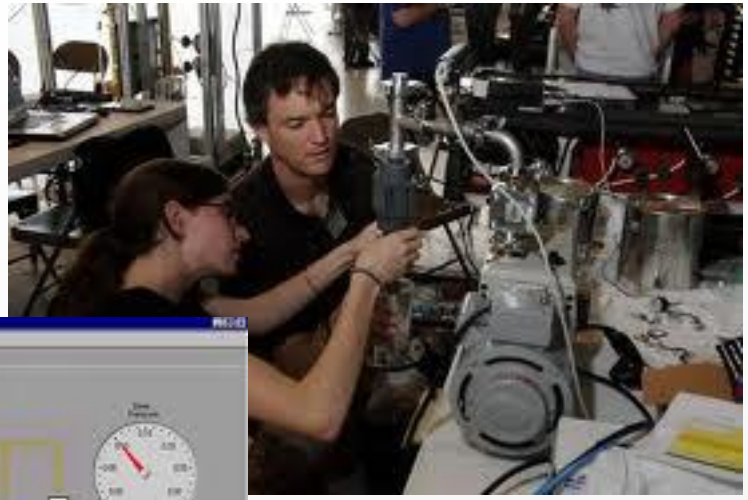

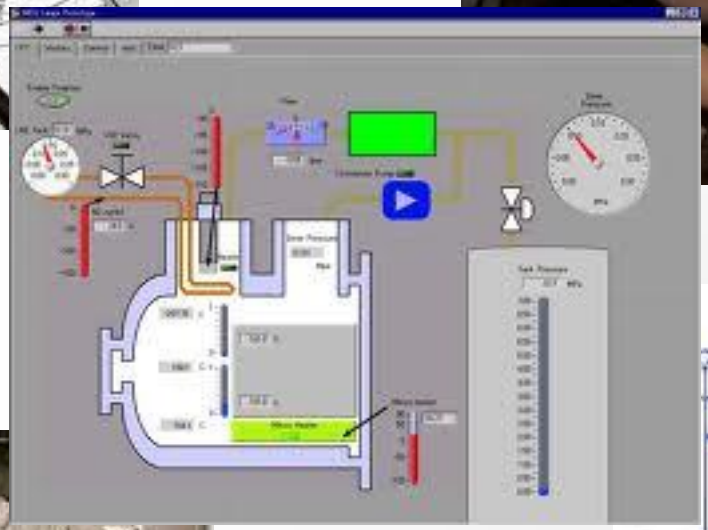

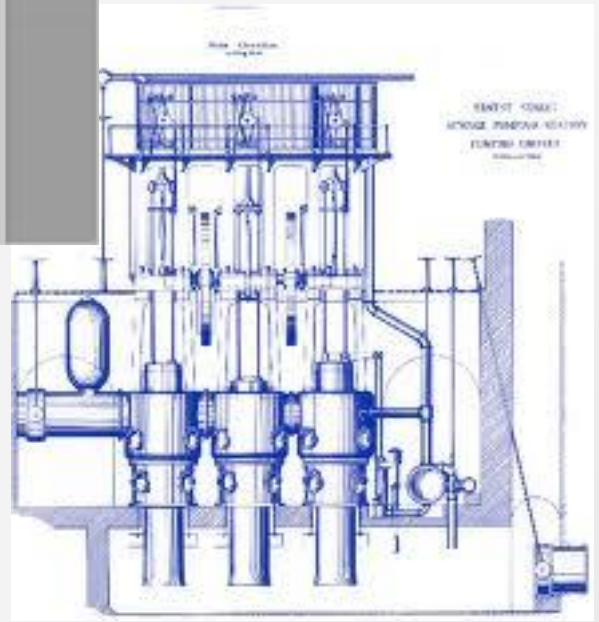

We start with the definition of an engineer:

… Designs useful product and processes for society based on all disciplines but mainly Science and Math.

Science: Finding the patterns in nature

Mathematics: The language to describe the patterns and the engineering design

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Lets’ do a story

Identify Needs/Problems in the Story ("Design Challenges")

Activity: In your teams, take 10-15 minutes to generate a list of needs/challenges in the story. These are problems that the characters in the story are having, opportunities to make things better, etc.

Who are you going to work for?
What's the real Design Challenge/ Problem?

You as the teacher can also do the following:

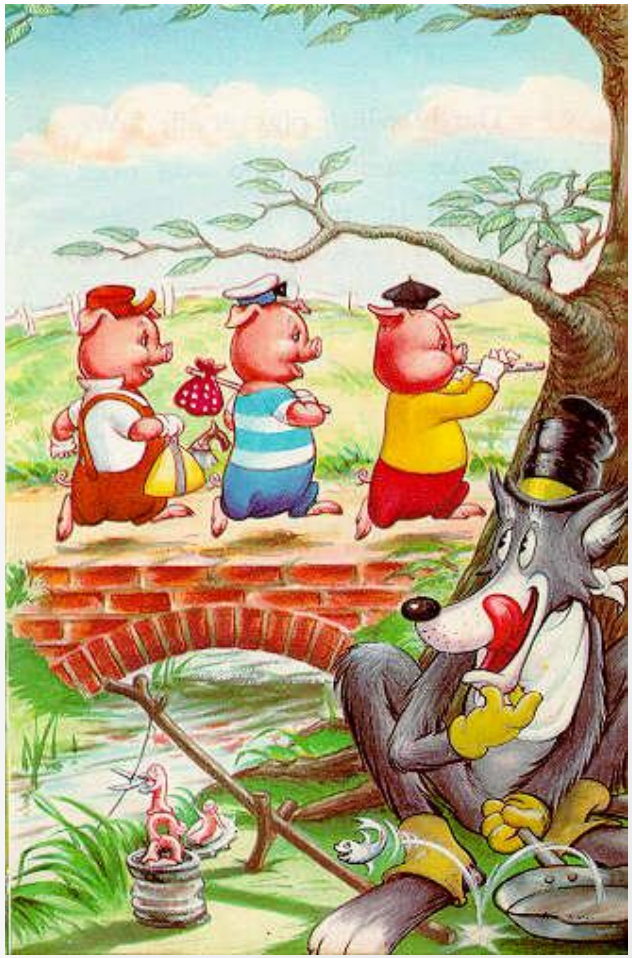
Change where the story takes place to enhance the learning:
IE studying about earthquakes you can move the location to the San Andrea fault area

Do a story

1. Listen to the needs and values of the characters in the story
2. Generate raw ideas for a given challenge
3. Select an idea that is particularly interesting
4. Identify the requirements for that concept
5. Come up with multiple solutions that meet the requirements
6. Select a solution, based on the requirements

3 pigs .. What is the problem?

- Discuss the story and the characters.
- What are some of the problems/ design challenges?
- Who do you want to work for?
- What science are you going to use to solve the design challenge?
- How is the team going to approach this design?



Book Summary: The 3- Pigs

Fairy tale

Major Characters:

- The 3 pigs
- The mother Pig
- The Wolf
- Society

Setting: a Farm location of your choose

Plot Summary:

3-Pigs Variation

- How do we design a house to also protect against the weather?
- The pigs move to an earthquake zone, build a house to protect them from earthquakes as well
- The pigs live in Outer Mongolia , What type of house would they build?
- You work for the wolf, design a suite that can protect the wolf when it goes down the chimney ; design a machine that can be used to create air pressure to blow the houses down.
- You live in a community that wants to provide a nice living space for its Pig population, what would you design and why? What would you do with the wolf population? Can you apply this to humans?
- Build house on hill and use rollers to knock down the wolf
- Build house on hill in the shape of a triangle so wind can hit only corners.
- Design a house with a strong foundation and internal structure.

Extra activities:

- Invite a parent who works in the construction industry to talk about materials and building a structure
- Draw pictures of the scenes and do role plays around the story with the engineering.
- Create a game around the story.

3-Pigs

Challenges	Materials & Energy Resources	Systems in Living Things	Position & Motion of Objects	Simple Machines
				
Build a house on a hill	Build a house			Use a ramp to roll rocks to knock the wolf off
Build a manure moot around the house (smell & energy)		Use manure		
Design food for the wolf that looks and tastes like a Pig		Give him more food to eat		

What makes a good design challenge?

- Fun
- Solves a real problem
- Tied to science and math
- Can be done with paper or using simple materials
- Can create many learning extensions from it
- Can add your requirements to change the location or theme to suit your learning needs

Benefits

- Meets all the learning principles of the Massachusetts Science Framework
- Promotes higher-order thinking skills using design learning.
- Invites the incorporation of instructional technology into the curriculum. Engineering is differentiated
- Rich cross-curricular possibilities.
- Integration with science and math is an important way to show students how and why both are relevant and useful in the world.
- Directly connected with improvement of living conditions/safety/health and welfare of people.

Diana Mason, Missy Taft,

EngineeringLens

Learning Summary:

1. Engineering is about Learning and is not difficult to add into your curriculum
2. Thinking skills are the tools of engineering
3. Engineering is everywhere
4. Learning should be interdisciplinary
5. Stories are a good place to start your learning journey

WPI-K-12 Program
Designing a Story

Tufts CEEO group
Literacy and Engineering

2016 Massachusetts Science and Technology/Engineering Curriculum Framework

Standards for grades 3 through 5 integrate all eight science and engineering practices.

1. **Ask questions and predict outcomes** about the changes in energy when objects collide; distinguish between scientific (testable) and non-scientific (non-testable) questions; define a simple design problem, including criteria for success and constraints on materials or time.
2. Use graphical representations to show differences in organisms' life cycles; develop a model of a wave to communicate wave features; use a particulate model of matter to explain phase changes; identify limitations of models; use a model to test cause and effect relationships.
3. Conduct an investigation to determine the nature of forces between magnets; make observations and collect data about the effects of mechanical weathering; conduct an experiment on mixing of substances; evaluate appropriate methods for collecting data; make predictions about what would happen if a variable changes.
4. Use graphs and tables of weather data to describe and predict typical weather during a season; analyze and interpret maps of Earth's physical features; use data to evaluate and refine design solutions.
5. Graph and describe the amounts and percentages of fresh and salt water in various reservoirs; measure and graph weights of substances before and after a chemical reaction.
6. Use evidence to explain how variations among individuals can provide advantages in survival and reproduction; provide evidence to explain the effect of multiple forces on the motion of an object; test and refine a simple system designed to filter impurities out of water.
7. Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction; distinguish among facts, reasoned judgment based on data, and speculation in an argument.
8. Obtain and summarize information about the climate of different regions; gather information on possible solutions to a given design problem; obtain information about renewable and nonrenewable energy sources.

Feedback/ Assessment

Did we meet your learning goals?

End
Thank you