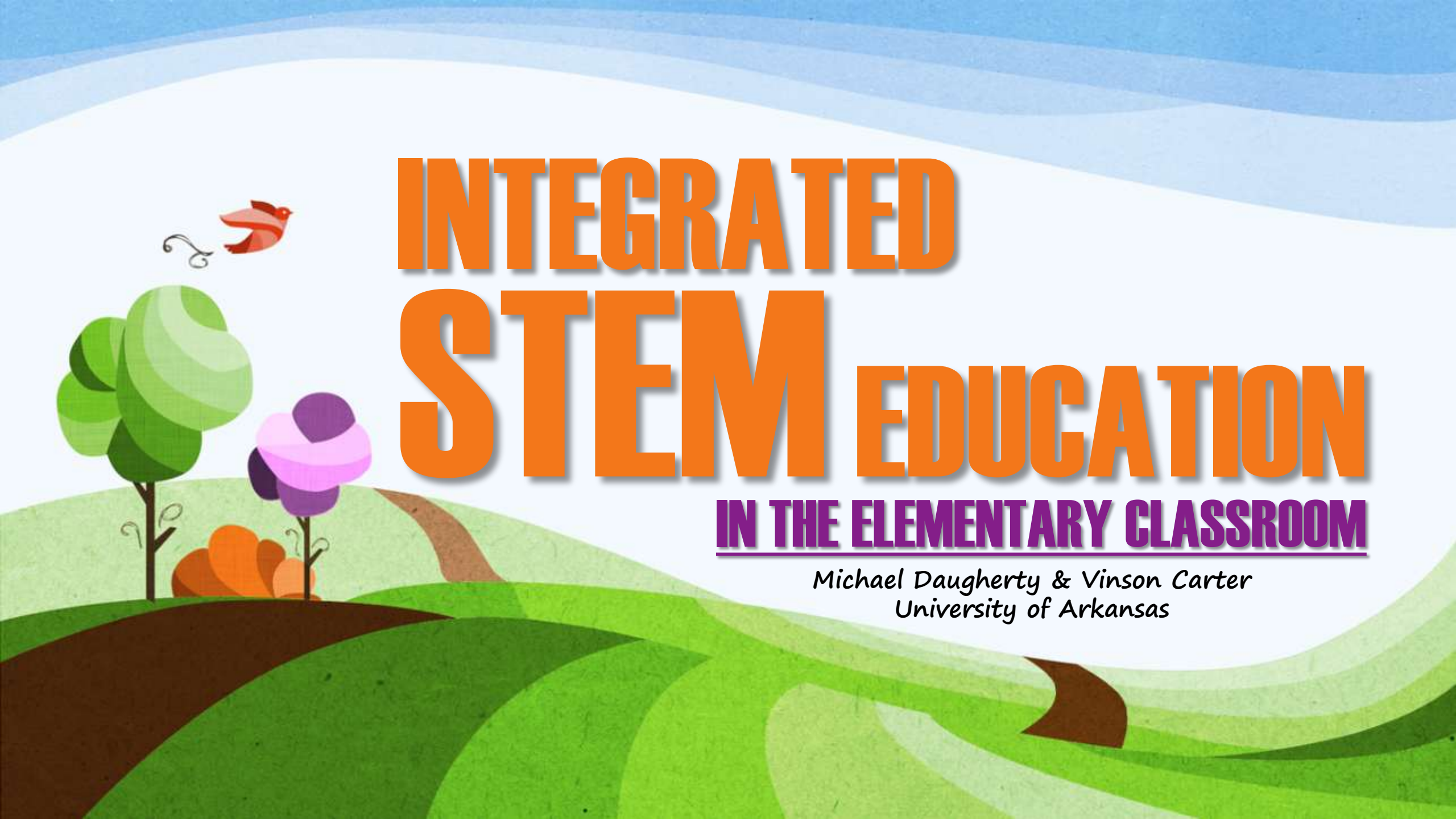
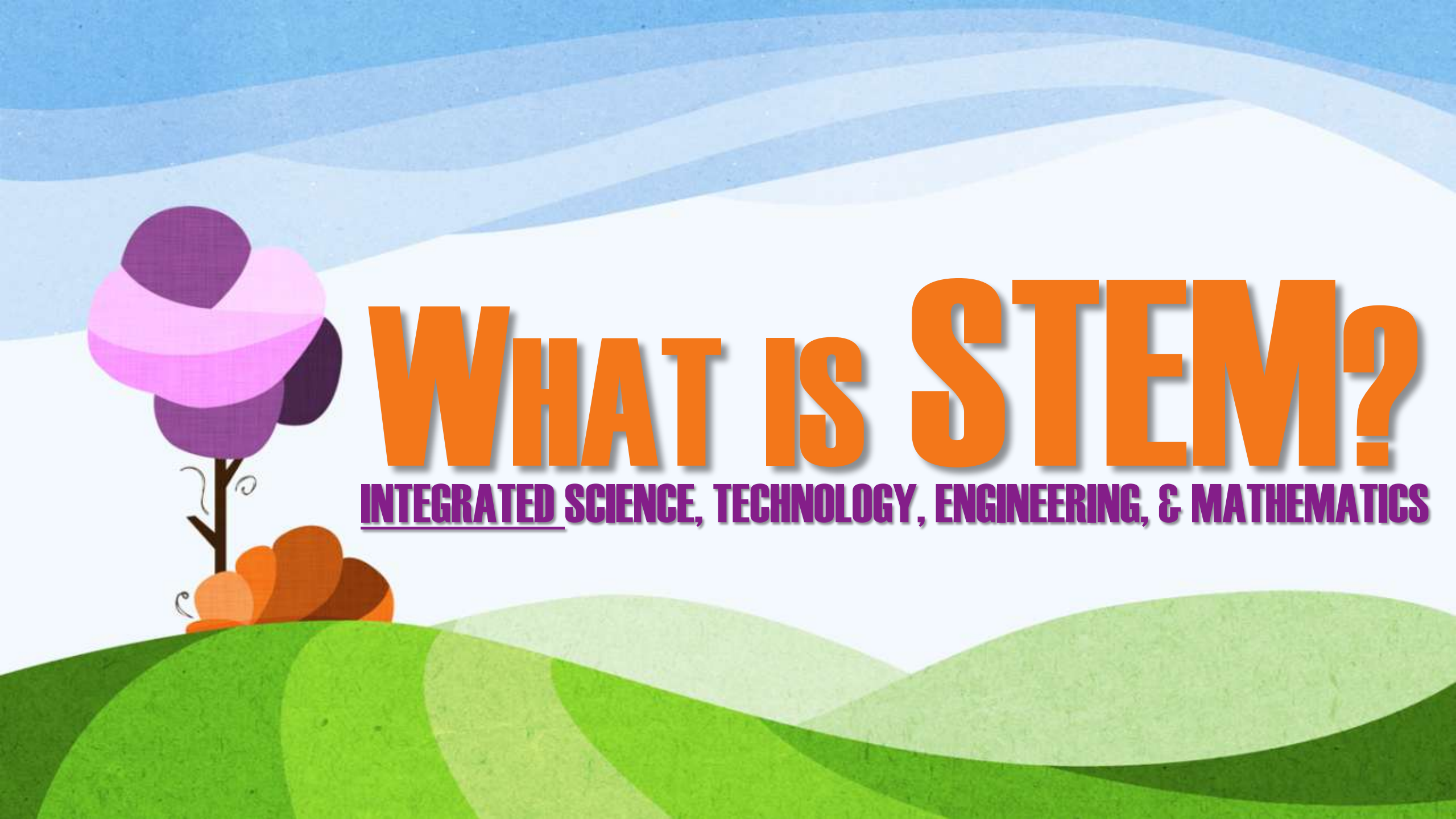


INTEGRATED STEM EDUCATION

IN THE ELEMENTARY CLASSROOM

Michael Daugherty & Vinson Carter
University of Arkansas


WHAT IS STEM?
INTEGRATED SCIENCE, TECHNOLOGY, ENGINEERING, & MATHEMATICS

Integrated STEM Education

- Authentic, engaging, hands-on learning
- Teaching students how to think critically and deeply
- Using curiosity/imagination to engage students in the disciplines
- Building agility, adaptability, and entrepreneurialism spirit
- Building a mental warehouse
  - learning transfer: Basic skills—application—synthesis
- Augmenting collaborative team skill development

Five Course STEM Graduate Certificate

- Introduction to STEM Education
- Creativity & Innovation in the Early Grades (Technology & Engineering)
- Math Methods in STEM Education
- Science Methods in STEM Education
- Curriculum Development in STEM Education

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First Course: Introduction to STEM Education

- Clearly defining Science, Technology, Engineering, and Mathematics
- Rationale/purpose for integrated STEM education
- STEM content and pedagogy
- The nature & pedagogies of the STEM disciplines
- Modeling the methods of STEM
- Research focused and driven
- STEM standards & assessments are central

Second Course: Creativity & Innovation in the Early Grades

- Facilitating creativity and innovation
- Focus on using Technology & Engineering to support Science and Mathematics
- Apply technical tools and resources toward solving human and environmental problems
- NXT Robotics
- Research focused and driven
- STEM standards & assessments are central

Third Course:

Teaching Problem-based Science in the Elementary Grades

- The field of science and the connection to technology, engineering and mathematics
- Understanding the nature of science and scientific inquiry through solving real-world problems
- Foundational theories and current research related to the integration of STEM
- Applying science toward solving human and environmental problems
- Evidence-based rationale for integrating STEM curricula at the elementary level

Fourth Course:

Teaching Problem-based Mathematics in the Elementary Grades

- Math connections to science, engineering and technology
- Enriching mathematics learning by building connections
- Solving human and environmental problems
- Using math modeling to solve STEM problems
- Using mathematical assumptions to understand problems
- Communicating through mathematics
- Developing alternative teaching methods for STEM

Fifth Course: Curriculum Design for STEM

- Curriculum models
- Scope and sequence
- Integration models
- Assessment models
- Problem-based instruction
- Lesson and unit planning
- Internship

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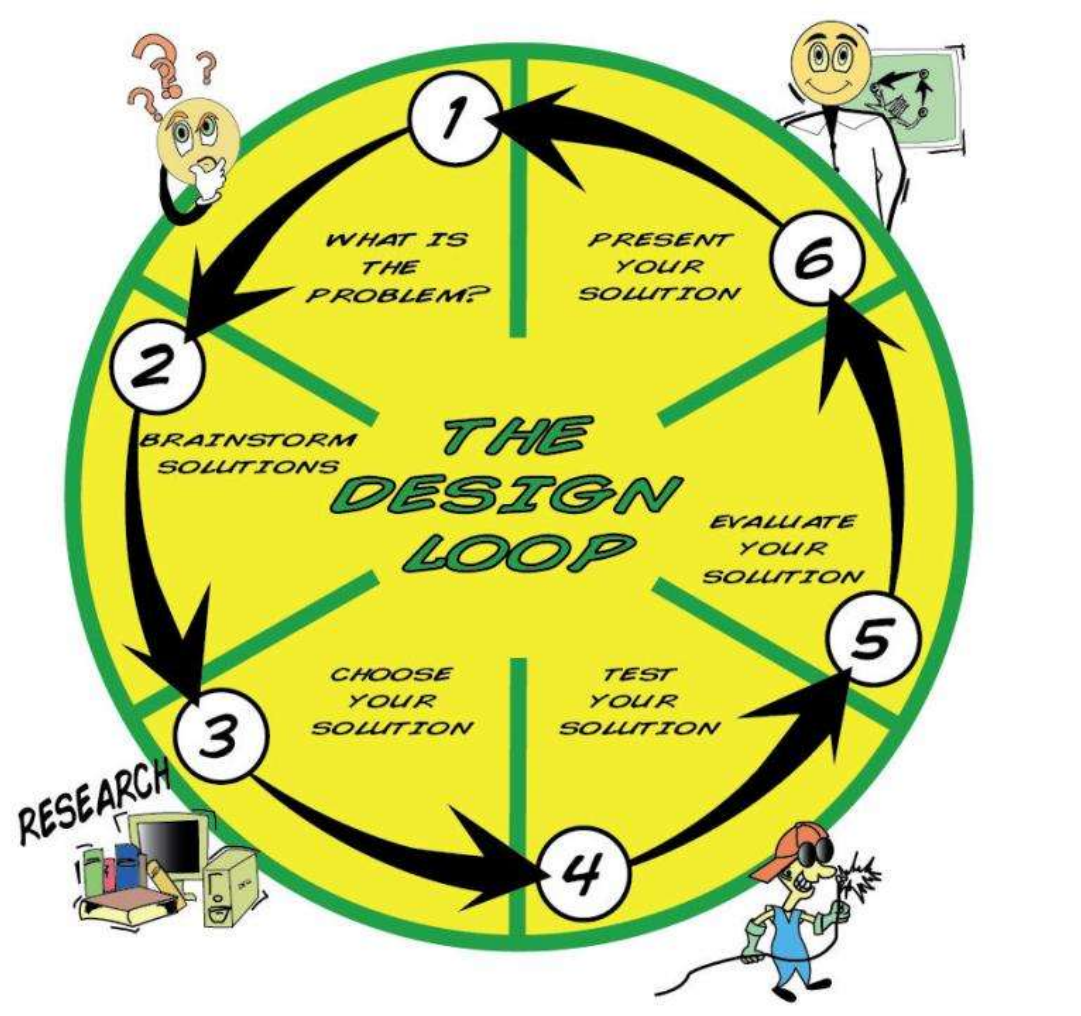
Cognitive Tools:

Scientific inquiry & the engineering design process



Curriculum Models & Standards

- Understanding by Design – Curriculum filters
- Problem/project based learning
- Discipline based heuristics & engineering design
- Standards and frameworks
- Collaborative learning format
- Lesson & unit plan model
- Performance-based assessment

WHAT IS PROJECT-BASED LEARNING (PBL)?

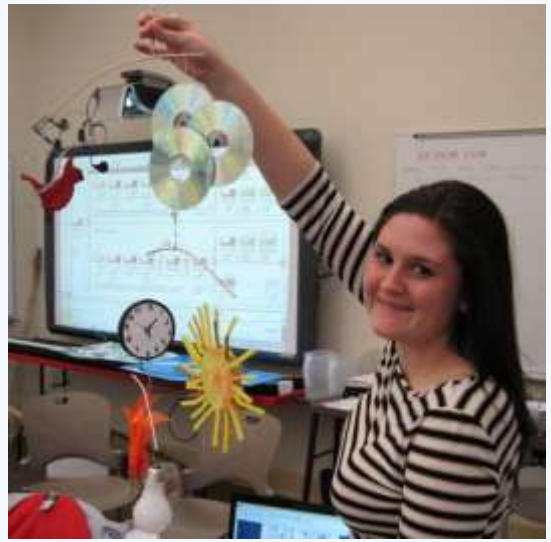
- Investigation and resolution of messy, real-world problems.
- Learning in relevant and connected ways.
- Increasing exposure to higher order thinking.
- Facilitating deeper application and understandings.

WHAT IS PROJECT-BASED LEARNING (PBL)?

- Using ill-structured problems to increase personal responsibility for learning
- Engaging students in math, science, engineering at an early age.
- Causing students to gather information, assess its validity, provide evidence to support decisions.
- Encouraging learning transfer
- Treating teamwork as an important outcome
- Teaching students how to learn and transfer knowledge

Example Projects

- STEM assessment
- Flash cards
- Mobile design
- Engineering portfolio
- Resource procurement
- Electronics project
- Pop-up book activity
- Narrative curriculum



Example Projects

- Programmable control project
- NXT Robotics projects
- KEVA planks
- Creating/solving long-term design challenges:
  - Human-power challenge
  - Earthquake proof shelter
  - Wind-powered vehicle

Kinds of problems

- Exploring a question, Investigating a historical event, Problem solving situation, Examining controversial issue, Designing an artifact, Create a piece of writing, art, or multimedia

Where to start?

- Standards/frameworks, Your community (recycling, community history, pets), Items relevant to students (cars, toys, etc.), What people do outside school (farmers, construction workers, engineers, dentists), Colleagues, and On-line resources

THE DESIGN CHALLENGE

Use children's literature to promote STEM

- Expand upon a book commonly shared in schools
- Move from comfortable to uncomfortable/known to unknown

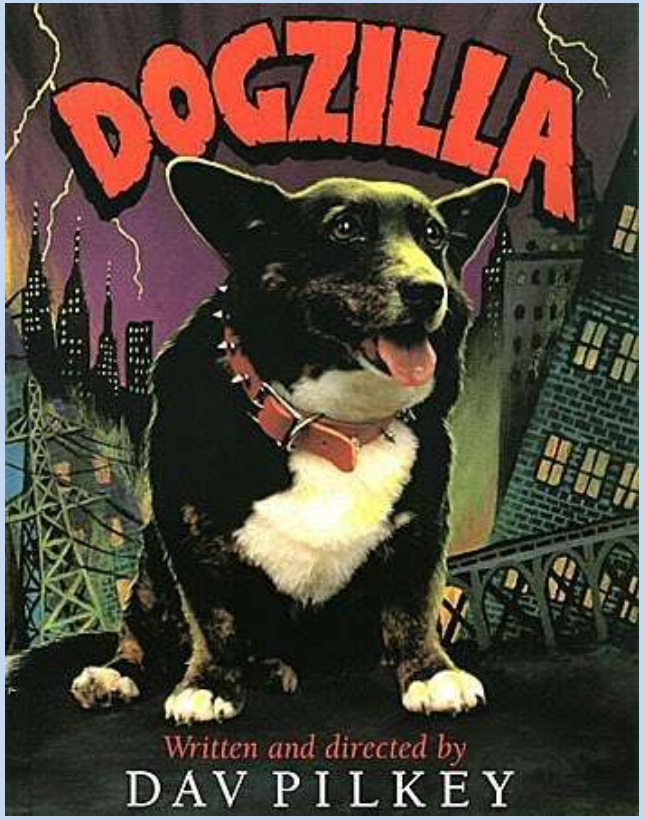
Story-centric problem solving activities

- Compelling virtual worlds
- Believable characters
- Thought provoking themes

THE NARRATIVE CURRICULUM

NARRATIVE-CENTERED LEARNING ENVIRONMENTS

Dog Bone Slinger Design Challenge



Situation:

The city of Mousopolis is in trouble once again now that Dogzilla's puppies are free! The Big Cheese and all the other mice must find a new way to keep the puppies away from their precious city and of course the Second Annual Barbeque Cook-Off! They decide to create the incredible Dog Bone Slinger to run the pups far, far away from the city. The only problem is that the mice don't know how to build it!

Pre-service teachers use a narrative curriculum (Lauritzen & Jaeger, 1996) approach to set-up the background organization, motivation, and structure for creating meaningful engineering design challenges.

Using children's literature to expand upon and promote STEM learning by engaging students with a problem that may arise in both fiction and informational text.

Challenge:

In your assigned groups, you will help the mice design the most incredible Dog Bone Slinger. Using the design loop and the materials below, create a machine that is easy to operate and will fling dog bones as far away as possible from the city.

Parameters:

The completed machine must:

- be capable of shooting a dog bone as far as possible from the machine
- be easy to operate
- be designed with the engineering design process in mind
- be turned in to instructor along with brain blast activity sheets, showing that the ideas were purposeful, thoughtful, and creative
- demonstrate the knowledge of force and motion through design

Tools and Materials:

- rubber bands
- pencils
- pencil spring
- bottle cap
- clothes hanger
- plastic spoon
- toilet paper roll
- masking tape
- recycled paper & cardboard
- ruler
- hot glue gun
- scissors

Brain Blast!

Idea 1)

Idea 2)

Idea 3)

Are your ideas thoughtful? Are they creative? Do they accomplish the goal?

Evaluation:

Constructing a Dog Bone Slinger Rubric

Machine Name: _____

Group Members: _____

Assessment Criteria:

1) Machine was submitted along with brain blast activity ideas _____/10

2) Machine demonstrated creative, thoughtful and intentional use of materials to carry out design _____/25

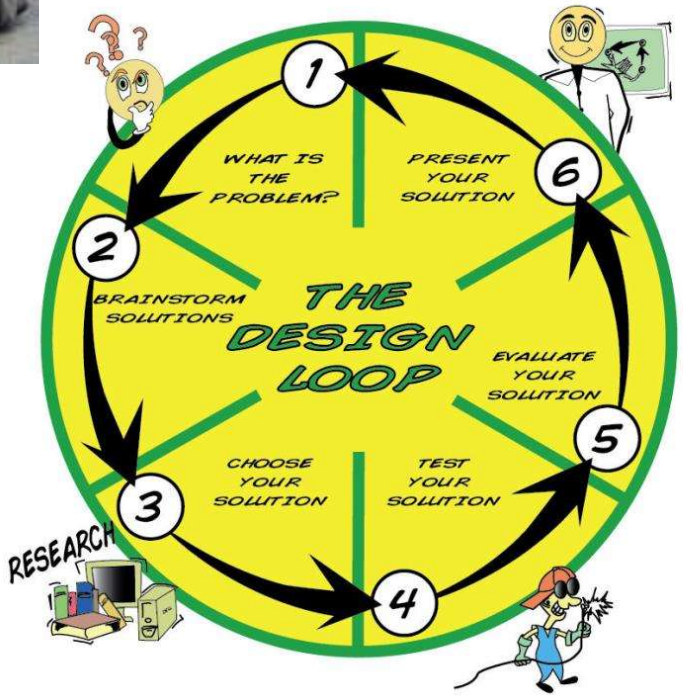
4) Students in group clearly and effectively presented their project to the class _____/15

5) Machine shot the dog bone some distance across the room _____/20

6) Machine was easy to operate _____/10

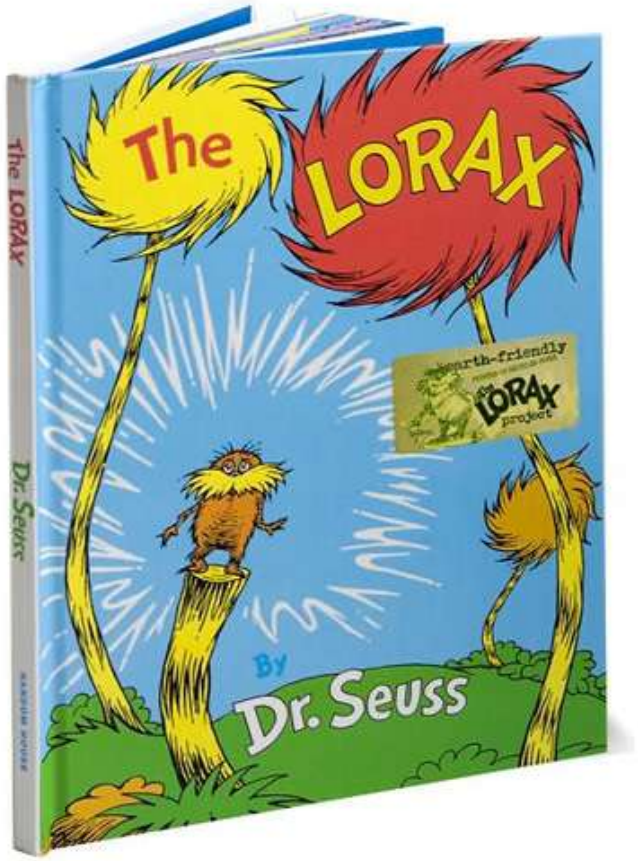
7) Evidence that team followed the design loop to create their machine _____/20

Total _____/100



Solve the Problem

Using the design loop!



Big Ideas

- Recycling is important and everyone should be doing it.
- Measuring and geometry are applicable for building and designing objects.

Essential Question

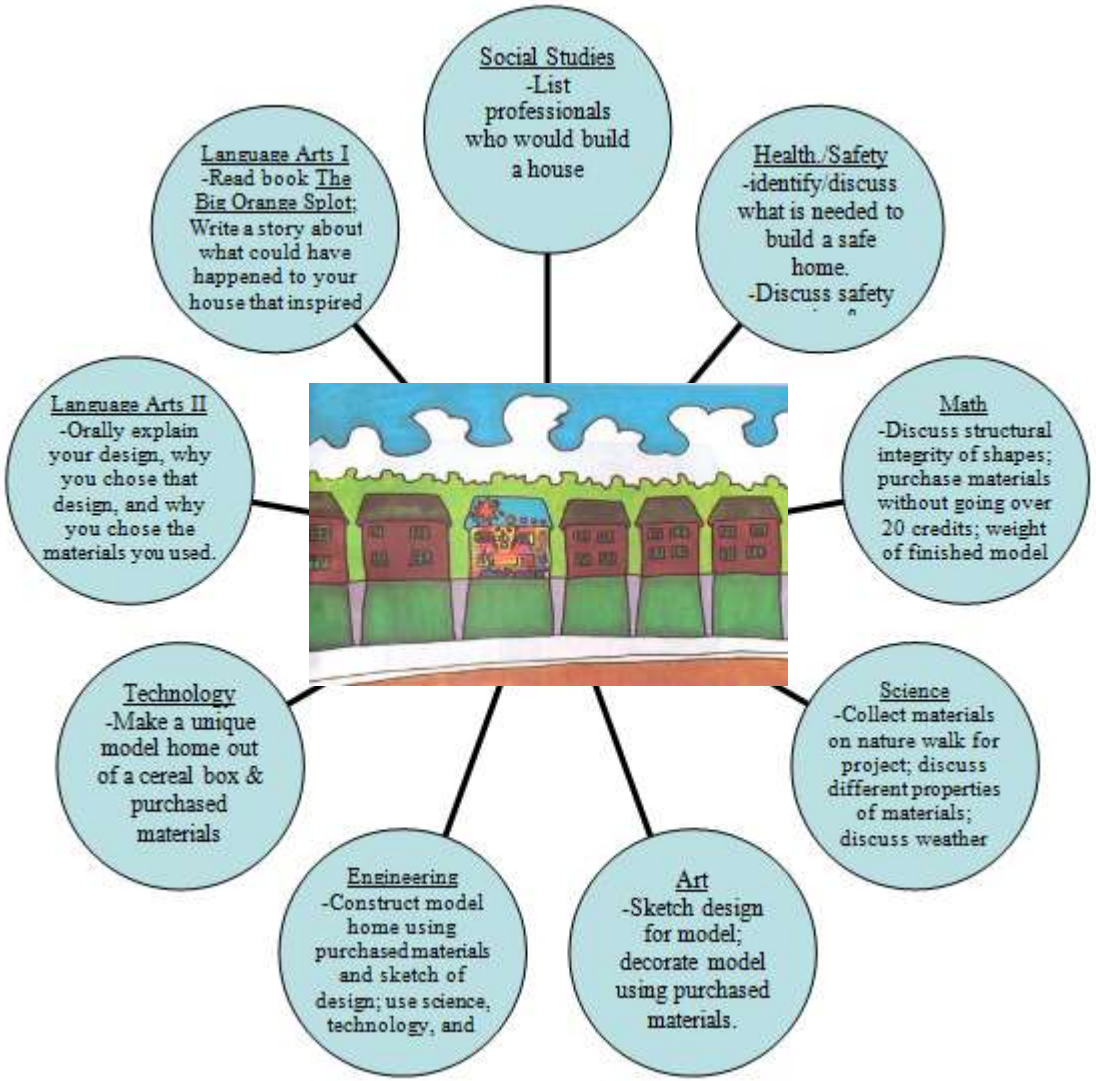
- Can we build a recycling device that resembles a character from the **Lorax** that will be appealing to students and motivate them to recycle?

I SPEAK FOR THE TREES

DESIGN CHALLENGE

The Big Orange Splot

DESIGN CHALLENGE

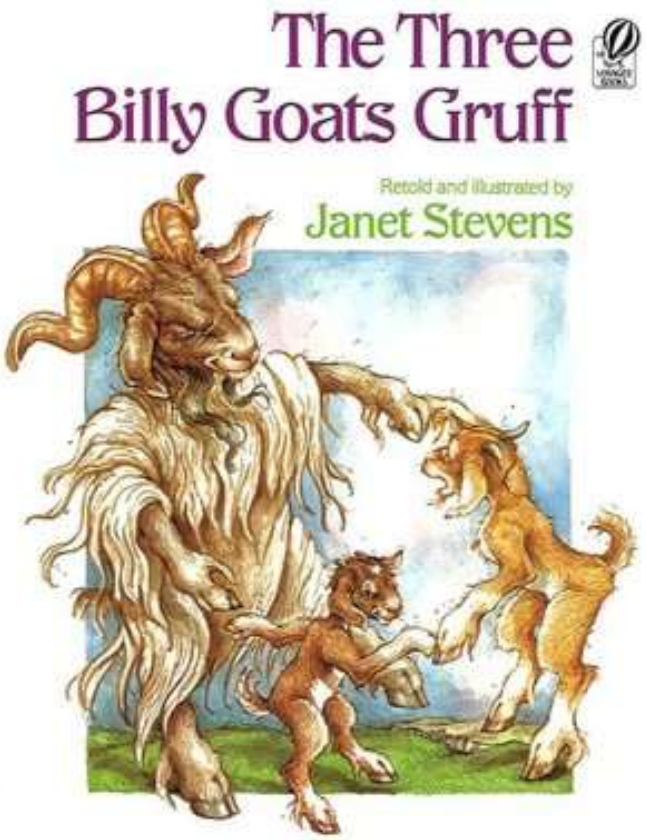


Essential Question

- If you could build a house that was completely unique, what would it look like, what would you use to build it, and how does your design reflect your personality?

Evaluation

- Test stability and weight, refine your design.
- Evaluate and record your solution.
- Present and demonstrate your solution to the class.

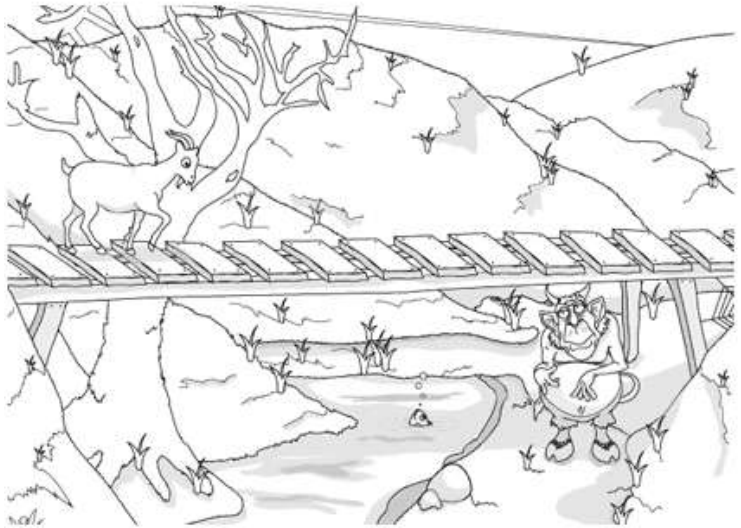


Surviving the Troll

DESIGN CHALLENGE

Big Ideas

- Science is a process for producing knowledge
- Engineering is the application of science and technology
- Tools and Techniques
- The role of creativity and problem solving
- Engineering design
- Design under constraint
- Fundamental concepts of science and technology



Essential Question

- Can you design a structure to get the 3 Billy goats from one side of the creek to the other?

Huff & Puff

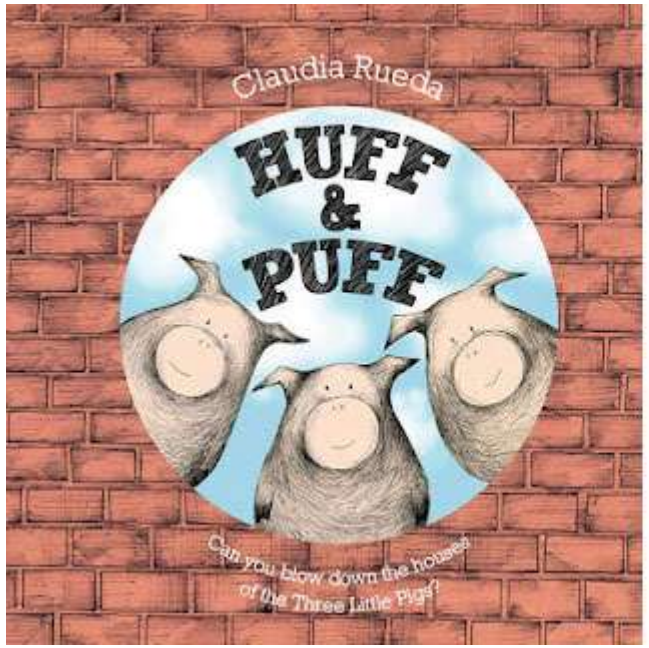
DESIGN CHALLENGE

Essential Question

- Can a model shelter be designed to withstand a tornado?

Big Ideas

- Attributes of shapes used in structures
- Properties of materials
- Use of the engineering design loop
- Ability to clearly demonstrate and present final project



Building a Castle

DESIGN CHALLENGE

Essential Question

- Can students help the other turtles (townspeople) build a castle for the king to see for "miles"?

Big Ideas

- Attributes of Structural Design
- Tools and Techniques
- Teamwork

Will Humpty Go Splat or Will He Last?

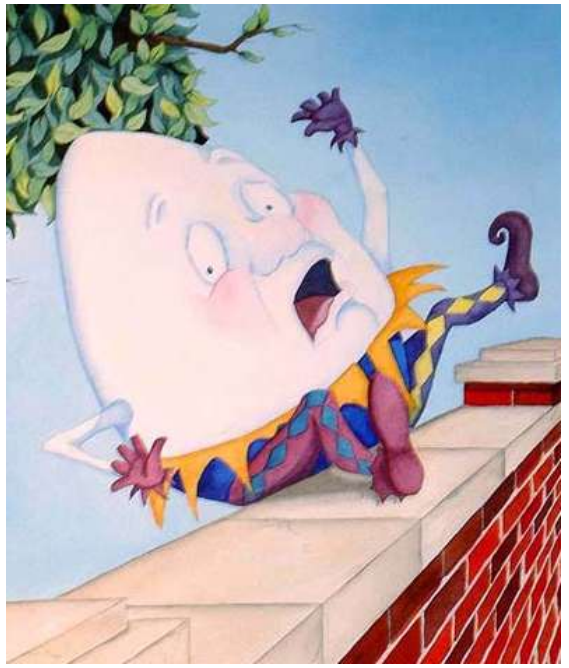
DESIGN CHALLENGE

Essential Question

- How might you design a structure that would help Old Humpty survive his fall off of the wall?

Big Ideas

- Attributes of scientific principles – gravity, force, impact, and motion.
- Develop the skills necessary to describe methods, predictions, explanations, and generalizations experienced trial and error.

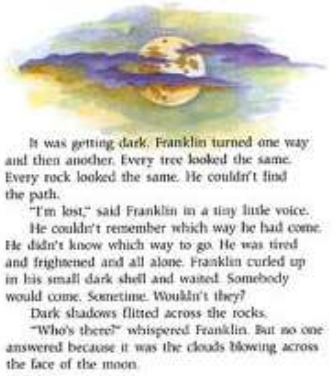


Franklin is Lost: Map Making

DESIGN CHALLENGE

Essential Question
- How would you design a 3-dimensional map?

Big Ideas
- Cardinal Directions
- Understanding Maps
- Geological & Industrial Landmarks



It was getting dark. Franklin turned one way and then another. Every tree looked the same. Every rock looked the same. He couldn't find the path.

"I'm lost," said Franklin in a tiny little voice.

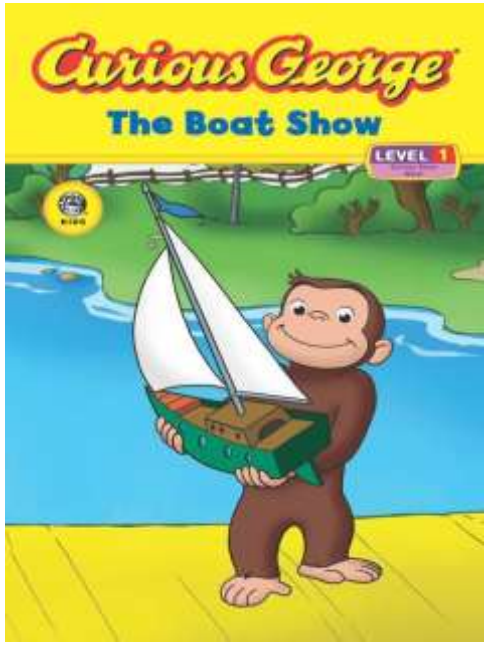
He couldn't remember which way he had come. He didn't know which way to go. He was tired and frightened and all alone. Franklin curled up in his small dark shell and waited. Somebody would come. Sometime. Wouldn't they?

Dark shadows flitted across the rocks.

"Who's there?" whispered Franklin. But no one answered because it was the clouds blowing across the face of the moon.

Staying Afloat

DESIGN CHALLENGE



Essential Question

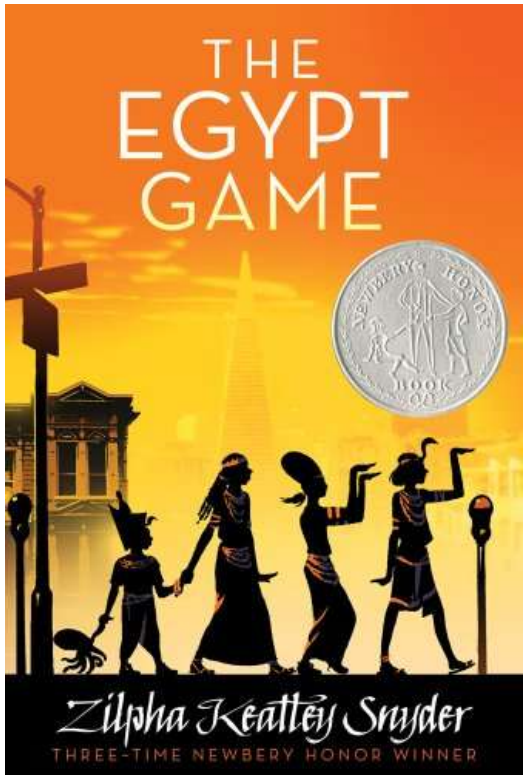
- Can you help Curious George design a boat that will float?

Big Ideas

- The role of creativity and problem solving
- Design under constrain
- Turning something known into something understood

The New Game

DESIGN CHALLENGE



Essential Question

- Can you design a game that is fun and appropriate for the whole family to play?

Big Ideas

- The role of creativity and design
- Design under constraint
- Fundamental concepts of geometry
- Game design

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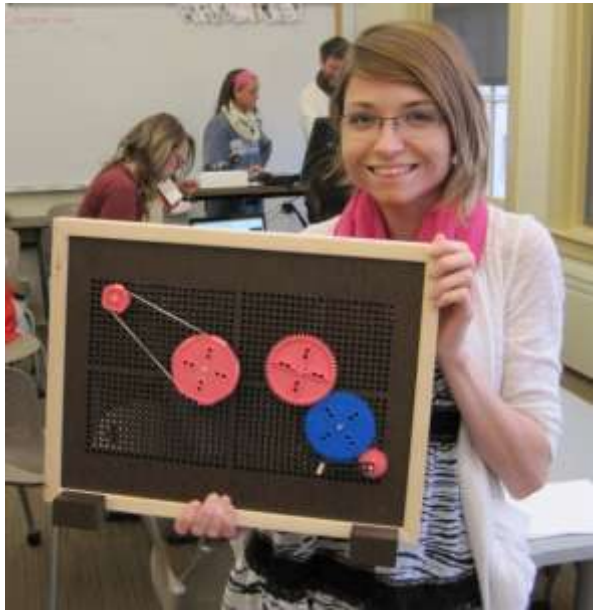

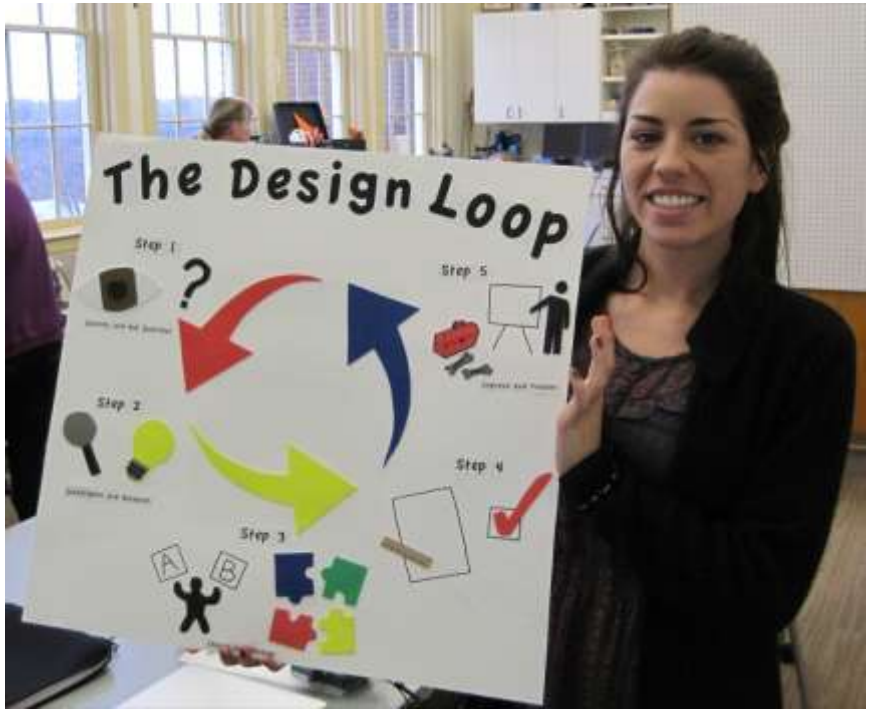

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