The How and Why of Integrated STEM Model-Eliciting Activities

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Overview

- Introduction
- Rationale for integrated STEM education
- Define integrated STEM education
- Define model-eliciting activities (MEA)
- Discuss MEAs in the classroom
- Example of MEA

Introduction

- 8.5 million jobs in STEM fields
- 80% of all jobs will require technology
- 65% of jobs in the future do not exist today
- Gain access to new technology through mathematics and science
- “the hidden culture of the computer is math” (Moses, 1994, p. 13)
- Need some STEM literacy to participate in society

Rationale

- "Acquiring scientific, technological, engineering, and mathematical knowledge and using that knowledge to identify issues, acquire new knowledge, and apply the knowledge to STEM-related issues. Understanding the characteristic features of STEM disciplines as forms of human endeavors that include the processes of inquiry, design, and analysis. Recognizing how STEM disciplines shape our material, intellectual, and cultural world. Engaging in STEM-related issues and with the ideas of science, technology, engineering, and mathematics as concerned, affective, and constructive citizens." (Bybee, 2010)

What is integrated STEM education

- Integrated STEM education is defined as the effort to combine science, technology, engineering, and mathematics into one activity based on connections between the subjects and real world problems (Stohlmann, Moore and Roehrig, 2012).

Five characteristics of STEM education

- Motivating and engaging for the students
- Mathematics and/or science must be the main focus of the activity
- Student centered
- Students should become more technologically literate
- Students should participate in the engineering design process

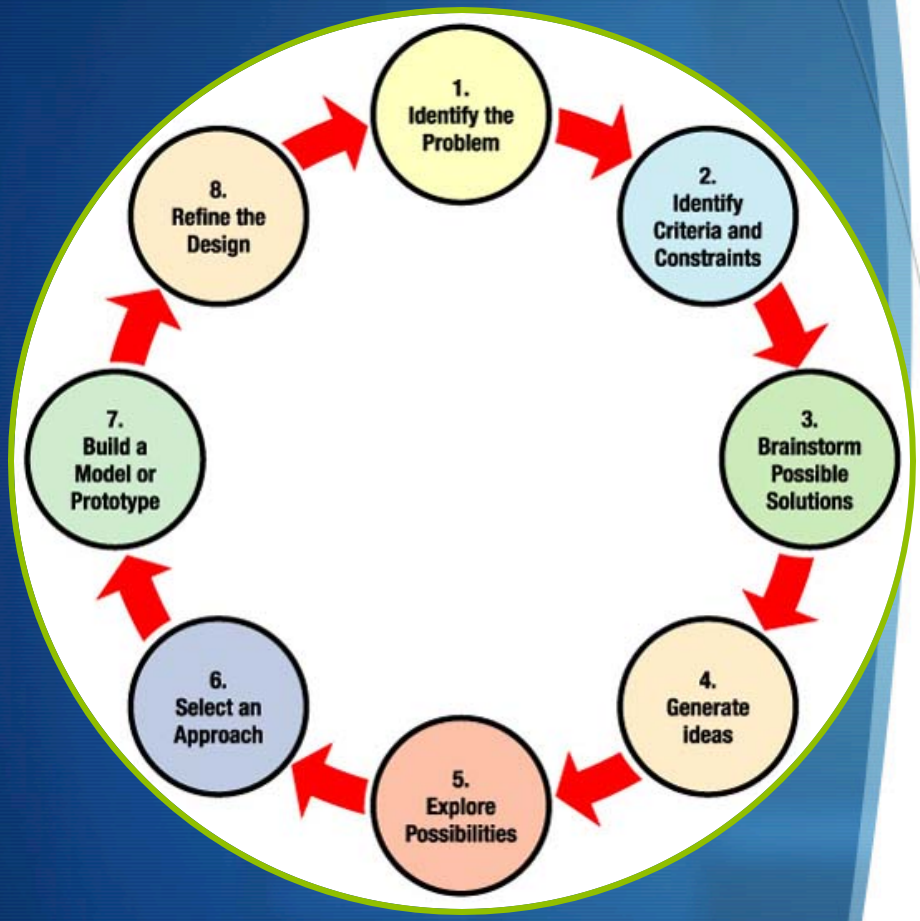
Integrated STEM & MEAs

- STEM integration should only be used when there are natural connections between subjects.
- An effective structure for accomplishing this is through the use of Model-Eliciting Activities (MEAs)
- engineering design concept

What is a Model-Eliciting Activity (MEA)

- Open-ended
- Client driven
- Uses the engineering design process
- Mathematics similar to real life

Engineering Design Process



1) Identify the problem
2) Identify constraints & criteria
3) Brainstorm for solutions
4) Generate ideas
5) Explore possibilities
6) Select solution
7) Build the model
8) Refine the design

(NASA, 2008)

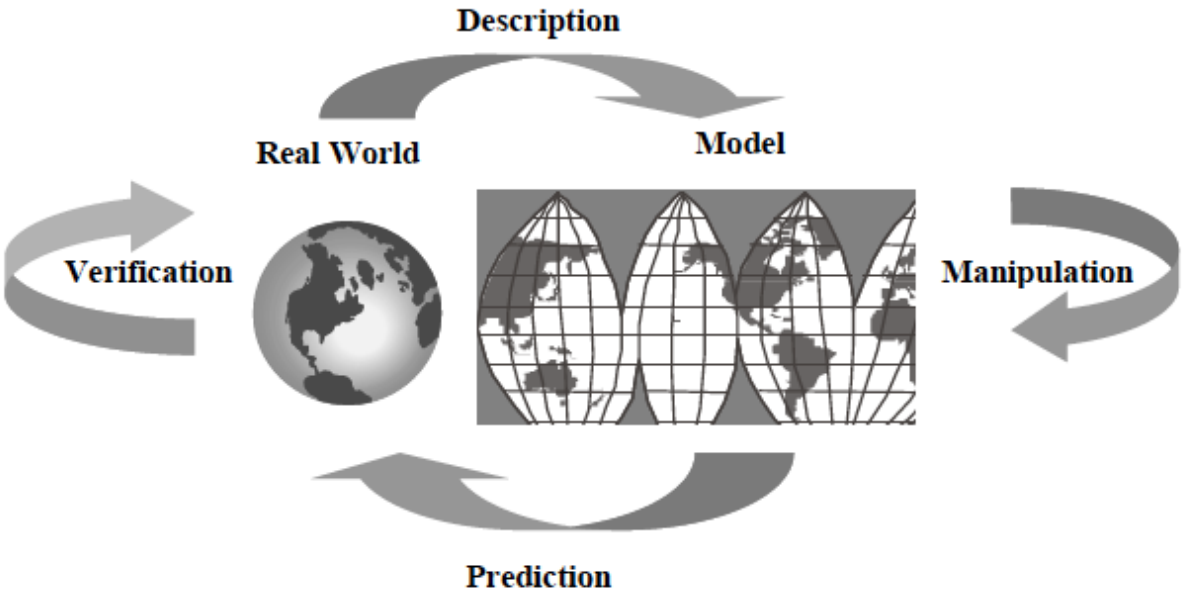
Advantages of MEAs

- Original purpose of MEAs
- Address diverse learning styles
- Low level students perform better
- Understand the development of important mathematical concepts

Implementation of MEAs

- Before an instructional unit
  - Making practice mathematical
- After an instructional unit
  - Making mathematics practical

Modeling Cycle



Lesh, Doerr, Carmona, & Hjalmarson, 2003

Standards for Mathematical Practice and How They Occur in MEAs

1. Make sense of problems and persevere in solving them.

2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others.

4. Model with mathematics.

5. Use appropriate tools strategically.

6. Attend to precision.

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

MEA Format in the Classroom

- Background article or video and readiness questions
- Discussion of the readiness questions and introduction to the problem
- Group work time
- Presentations of solutions
- Time to revise and reflect

Survivor MEA

- Key Question: How do you design a shelter that is sturdy, water resistant, and spacious enough to survive while stranded on an island?
- Mathematical "big ideas": Scale drawing, volume, area, and surface area
- Science: Weather and climate systems
- Technology: Technology design
- Engineering: design process

Survivor MEA Readiness Questions

- What things would you have to consider when building a shelter?
- How would you describe the rain in Costa Rica?
- If you have ever seen Survivor would you consider going on the show?
- What is the benefit of building a scale model?

Survivor MEA Problem Statement

Survivor returns to Costa Rica and Mark Burnett, the producer of Survivor, has decided to give survivors the materials to build a shelter as a reward for a challenge. He wants to provide materials to make the shelter as realistic as possible to one that the survivors of a plane crash might build. He will be providing a strip of metal supposedly from a plane, tarp from the rescue raft, rope that has washed ashore and of course mud from the island. To determine who will be the contestants on the show he wants to see who can design the best scale model of a shelter. The shelter must fit three people and withstand both wind and rain. Design a quality shelter and your team could be on the next show of survivor.

- Your shelter must:
  - Not move, tip or be damaged when given three gusts of wind
  - Remain dry when given three squirts of water to simulate rain
  - Have enough room to fit three people with at least 1 cubic meter of space

Survivor MEA Continued

Before building your scale model decide on a scale that you will use to determine how much of each material that you will use. For example, if your scale was 1 meter: 2cm, then you would have 20 craft sticks that are 6 cm long.

Actual materials that will be provided on the island	**Materials that you will be given**
Logs (20 logs, 3 meters long each) (Total of 60 meters)	Craft sticks: 20 sticks x ____cm: Total of _____cm
Plane siding (2.5 meters x 4 meters)	Aluminum foil: ____ cm x ____ cm
Tarp (1 piece 3 meters x 5 meters)	Wax paper: ____cm x ____ cm
Rope (6 meters)	String: ____ cm
Mud (1 bucket with 1 cubic meter (m^3)(1m x 1m x 1m)	Playdough: ___ cm x____cm x____cm

After designing and testing the shelter write Mark Burnett a letter describing why your shelter is the best. Include in the letter the design for the shelter, the materials that you used, and general guidelines for how to make scale models for any purpose. A few example shelters are provided below for your team to begin to develop ideas.

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