California Math & Science Project

Teacher Leadership Capacity Collaborative

Audra Carr & Holly Moore
5th grade teachers
Paso Robles Joint Unified

Dr. Lola Berber-Jimenez
Chair Liberal Studies
Cal Poly State Univ SLO

Trina Nicklas
Project Director, CaMSP
Paso Robles Joint Unified
Welcome!

Who do you agree with the most?
- Rae
- Scott
- Yolanda
- Miles
- Violet
Goals for Today

❖ Engineering challenge: Arrows to Rockets
❖ CaMSP TLC project overview
❖ Caine’s Arcade: a classroom engineering project
❖ STEM in the Environment: a look at the Framework
❖ Earth Systems & Interactions: classroom brochure project
❖ Module building with NGSS
Rocket Balloon Challenge

NGSS Performance Expectation

3-5 ETS1-3 Engineering Design

Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Learning Objective

Participants will plan and design a rocket that can meet the goal of the challenge: to land on the moon safely.
Materials

Straws of different diameters

Balloons of different shapes and sizes

Tape: clear and masking

Fishing line: for testing your rocket

Stopwatch: (5 min to build & 5 min to test)

Penny: serves as astronaut that must safely land on Mars
Disciplinary Core Ideas

PS1.A  Structure and Properties of Matter
PS2.A  Forces and Motion
PS3.B  Conservation of Energy and Energy Transfer
ETS1.A  Defining and Delimiting an Engineering Problem
ETS1.B  Developing Possible Solutions
ETS1.C  Optimizing the Design Solution
Crosscutting Concepts

Cause and Effect

Stability and Change

Systems and System Models
Science & Engineering Practices

Asking Questions/Define Problems

Develop and Use Models

Planning and Carrying Out Investigations
CaMSP
California Math & Science Project
Teacher Leadership Capacity Collaborative

❖ Three year partnership with five local school districts and Cal Poly SLO
❖ Dedicated and ambitious professors that deliver exemplary professional development.
❖ Fifty-four driven elementary teachers representing grades 3 to 5.
❖ Goal of developing STEM modules of instruction using NGSS
Professional Development Design

❖ Summer Institute consists of two four-day weeks (52 hours)
  ➢ Four professors take on specific grade levels to provide content knowledge
  ➢ Guest speakers share their expertise

❖ Follow-up meetings: four spread throughout the academic year (12 hours)
  ➢ Consists of instruction that supports module development such as lesson study, digging into NGSS, or the 5E instructional model

❖ Super STEM Saturdays: All day event combines intensive and follow-up hours.
  ➢ Teachers share out in grade-level groups their lesson study and practices
  ➢ Guest presenters provide valuable instruction
  ➢ Mini-conference event opened up to local teachers
Year 1: STEM in the Environment

- Teachers were instructed in the Engineering Design Process (EDP)
- Professors used Engineering is Elementary units to familiarize teachers with the ‘E’ in STEM
  - Each grade had a unit that focused on the environment
- The NGSS were studied closely on an organizational view and as independent grade levels
- In the academic year teachers completed lesson study
- In the spring teachers put together lessons that supported their module
- National Engineering Week: invite an engineer to your classroom (February)
Year 2: Energizing STEM

- Professors bundled together similar Performance Expectations (PEs)
- Began each day with an engineering design challenge
- Teachers received in depth content instruction by grade level
  - 3rd grade “Magnets to Monsoon”
  - 4th grade “Exploring Energy & Waves”
  - 5th grade “Particles to Reactions & Beyond”
- A module template was introduced
  - Teachers will input their work from year 1 and turn in at one SSS of their choice
  - Teachers will design a module from the content introduced at summer institute and turn in at the SSS of their choice
Students Introduction to the Engineering Design process

Students were taught the design process the first week of school.

Practice using the process by building a display case for our school mascot.

Students were given 12 inches of tape and 100 index cards and told to build a display case out of the supplies given.

Constraints: it must hold a small replica of the mascot for 1 minute and it must be 36 inches in height.
Next Engineering Challenge/ Cardboard Challenge

Introduction to Caine's Arcade
Fifth Grade Standards

Next Generation Science Standards

3-5 ETS1: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1)

Language Arts

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS-2)
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1),(3-5-ETS1-3)
Applying the Engineering Design Process

Imagine/Plan

Students were given two weeks in class to research arcade games.

Once they had an idea of what game they wanted to design, then they drew it in their science journal.

Next, each student presented a proposal of what they were planning to create.

Students used a graphic organizer (Engineering Design Process Worksheet) to keep notes of their progress.

Also, the notes served as a check off for each step of the Engineering Design Process.

Building began once the Engineering Design Process worksheet was complete.
Constraints

Students needed to design a game that had a variation to the original design.

The game must be constructed from cardboard and be able to withstand multiple uses.

A ticket dispenser must be created within the game.
Create

Students took approximately three weeks to complete building their game.

All work was done in class.

Parent volunteers were paired with students who were struggling and needed extra support.
Improve

GATE students reviewed games and offered suggestions and compliments.

Students made modifications as necessary.

Of note, some students had to make completely different games because of difficulties they faced when they tried to create their original design.
Student outcome

Research skills

Communicating instructions verbally and written

Overwhelming sense of pride in their accomplishment

Raised $1,066 for 5th grade Science Camp
Teacher suggestions

The task seemed overwhelming at first, but we just jumped in and got started.

Begin by asking staff members and parents for cardboard as soon as you decide on beginning this project.

Be prepared for a mess and a cluttered classroom.

Get as many volunteers as you can, so they can help with cutting.

Have enough packing tape and duct tape available.

Parent Volunteers is a necessity
Butler Arcade/ Cardboard Challenge
STEM in the Environment

3rd grade

Unit 1: Forces and Interactions
Unit 2: Life Cycles and Inheritance of Traits
Unit 3: Ecosystems and Interdependence
Unit 4: Weather, Climate and Its Impacts
STEM in the Environment

4th grade

Unit 1: Exploring Energy

Unit 2: Waves

Unit 3: The Earth is Constantly Changing

Unit 4: Structure and Function of Animals and Plants
STEM in the Environment

5th grade

Unit 1: Matter and Interactions

Unit 2: From Matter to Organisms

Unit 3: Earth Systems and Processes

Unit 4: Patterns in Earth and Space
Fifth Grade Earth Systems Interaction Module

NGSS 5-ESS2-1  Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact

Clarification statement: Examples could include the influence of the ocean on ecosystems, landform shapes, and climate, the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.
Earth System Interaction Module

In this module, students learn about the four earth systems, focusing on the hydrosphere, and the interactions that it has with the other 3 systems (biosphere, atmosphere, and geosphere).

Lesson 1: Engage: Nature Walk Observation of nature interactions. Classroom discussion on observations and connections. Connecting the Spheres lesson and powerpoint are used from NASA website GPM Education and Public Outreach team.
Engage: For example: a bird flew from one branch to another

Birds need water to survive

Bird’s habitat grows in the soil
Exploration and Explanation

Lesson 2: Exploration: Students create a water cycle in a bag and conduct explorations of what happens inside the bag. Record their observations each day.

Lesson 3: Explanation: Water Cycle in a bag is discussed, What the observations represent. For example: the bubbles in the water represent evaporation where a water molecule has escaped from the collection. Read and learn about the water cycle and hydrosphere. Learn about the other earth systems.
Exploration:
Explaination

- Resources used:
  - Powerpoint from Global Precipitation Measurement Mission: Connecting the Spheres: Earth Systems Interactions *Developed by the Nasa GPM Education and Public Outreach Team.* gpm.nasa.gov/education
  - Earth System Interactions Keynote Presentation: made by Audra Carr
  - California Science/Macmillan McGraw Hill
  - Videos and Photos
Lesson 4: Elaboration: Students brainstorm and discuss interactions they know and see between earth systems. Research, look at pictures and make observations. Walking field trip to observe interactions again if possible, or video footage and pictures of mudslides, storms, etc. Discussion of some of the problems created by earth system interactions.
Elaboration

Students study photos and collaborate on the interactions they see.

They prepare explanations of the interactions and identify which systems are interacting in each of the pictures.

They research online problems that can be caused by the interactions or non-interactions of these systems: Example: Mudslides, erosion, tornados, hurricanes, droughts.
Lesson 5 Evaluation: Students create a travel brochure (model) and/or foldable about the hydrosphere where they incorporate their learning, and elaborate on their discoveries of the interactions that the hydrosphere has with at least two other systems. See handout

Extension Ideas: Incorporate an engineering task where the students have to choose a problem that is caused by the interaction, and design a tool to help fix the problem. Example: a barrier that will withstand a mudslide, a wall that will keep water from eroding away a surface. They would need to research what has already been done in the past before being set to the task.
Earth Systems Travel Brochure

An earth system has been assigned for you to advertise in a travel brochure. A travel brochure is a pamphlet that gives information about a location that people may want to visit. For example: What you would see in Paso Robles, what attractions, places to visit when you come etc. Your brochure will be on one of the earth’s systems, for example: the geosphere, hydrosphere, atmosphere, or biosphere. It must include the following sections: Each numbered section should be in one column each.

1. A detailed description (2 paragraphs) of what this system is: including details about the system, how it supports the earth, and what kind of things you would see in this system. For example, the atmosphere and geosphere have many different layers, you should describe those layers in detail along with their purpose.

2. A total view of your earth’s system. A picture of everything that is included (this will take up two sections).

3. Choose one of the other earth systems that interacts with your system in some way. Describe in great detail, what role it plays in the system, how the two systems interact and what effects these interactions have on both systems. Include a picture showing the effects of this interaction.

4. Choose another of earth systems that interacts with your system in some way. Describe in great detail, what role it plays in the system, how the two systems interact and what effects these interactions have on both systems. Include a picture showing the effects of this interaction.

5. Include a front cover that is decorated colorfully and identifies your earth system and your name.

6. Include what type of studies have been done about your earth systems, what kind of difficulties the system may be having as a result of pollutions of the world. Describe what kind of scientists there are that study and research about this system.
Evaluation/ Models
Module Building!

Structure and Function: Plants and animals have internal and external structures to support survival growth, behavior, and reproduction... Ask questions, define problems... Plan and carry out investigations... Consider explanations and design solutions...
### Planning a NGSS Module

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<thead>
<tr>
<th>Driving Questions</th>
<th>Anchoring Phenomena</th>
<th>Bundled PEs</th>
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<tbody>
<tr>
<td>c.g. Why are the types of living things in the jungle different from living things in the desert?</td>
<td>c.g. Students begin with close observations of two plants from two different environments.</td>
<td>c.g. 2-LS4-1 Make Observations of plants and animals to compare the diversity of life in different habitats. K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.</td>
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<tr>
<th>Phenomena-Driven Question</th>
<th>Key Science Ideas</th>
<th>Practices Used</th>
<th>Key Cross Cutting Concepts</th>
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<td>Lesson 1</td>
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| Lesson 2                  |                   |                |                           |
| Lesson 3                  |                   |                |                           |
Module 5 Es

Module Links To 5-E’s
How are lessons or activities within your module addressing each of the following? Make the links explicit. There may be more than one activity/lesson per E section!

ENGAGE: Opening Activity/Activities
What activity or activities will access prior knowledge, stimulate interest, and generate questions? How will you hook them?

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions
What activity or activities will allow them to use science and engineering practices to explore and allow them to begin to deepen their understanding of core ideas that support the Performance Expectation?

EXPLAIN: Concepts Explained and Vocabulary Defined
How will you provide experiences to allow student to explain and clarify their thinking. What might you do to help them further understand core ideas and cross cutting concepts?

ELABORATE: Applications and Extensions
What else might students do to further develop their final ability to be successful with their performance expectation?

EVALUATE:
How will you have students show their mastery and understanding of the performance expectation you chose?
Module Building with NGSS

❖ Backwards design
  ➢ Begin with bundled performance expectations - directly aligned with the Framework draft
  ➢ Anchoring phenomenon
  ➢ Driving questions - phenomenon driven questions
  ➢ Key science ideas
  ➢ Practices used
  ➢ Key cross-cutting concepts
  ➢ Lessons are planned using the 5E instructional model
    ■ Connections to CCCSS
  ➢ Assessment, both formative & summative - how will students demonstrate mastery
Thanks

CaMSP cohort 10 grant

tnicklas@pasoschools.org

Cal Poly San Luis Obispo

lberberj@calpoly.edu

Paso Robles USD

acarr@pasoschools.org

hmoore@pasoschools.org

California Science Project: Central Coast Science Project