

Phenomenon Based Learning

Promoting Student Questioning and Wonder with Real Life Events

By Conor Hunt

Professional Development Project Summary

Title – Phenomenon Based Learning

Justification – Phenomenon Based Learning is a framework that engages students in learning by grabbing their attention with a real-world “phenomenon” that sparks their curiosity. It is a means to get students to “do science” and engaging in a number of NGSS Science and Engineering Practices. I’ve been aware of this framework for some time, but the “Methods of STEM Education” class provided insight into how to implement this framework in a way that is effective and meaningful.

Educators Present – 30 Staff Members, Across all High School Departments

Summary of Project

1. Whole Staff Activity – Modelling Stacked Ball Bounce
2. Share Out of Descriptive Models
3. Introduced Definition of Phenomenon Based Learning + NGSS Alignment
4. Description of 5E Lesson Plans/Cycles
5. Student Work Samples

How Does This Work...

Directions: Take a look at the gif to the right. Work with those at your tables to describe **what happens** and **how it happens**. You will document this on a piece of paper.

In addition to your writing, you may draw pictures, diagrams, or any other visual representations you feel might be helpful in your explanation.

You and your groups will share your written/visual description

Note: As you work, think about what your knowledge gaps are. What do you need to learn more about?



Phenomenon Based Learning

Phenomenon Based Learning is a teaching method that engages students in learning by grabbing their attention with a real-world “phenomenon” that sparks their curiosity

These phenomenon can be rare/extraordinary events, or more “benign” everyday occurrences

The idea is that these types of real-world stories are complex, wacky, and/or intriguing enough to encourage *all* students to start asking questions and form deeper connections with the material.

Examples of Phenomenon Based Learning



Arrow vs. Concrete

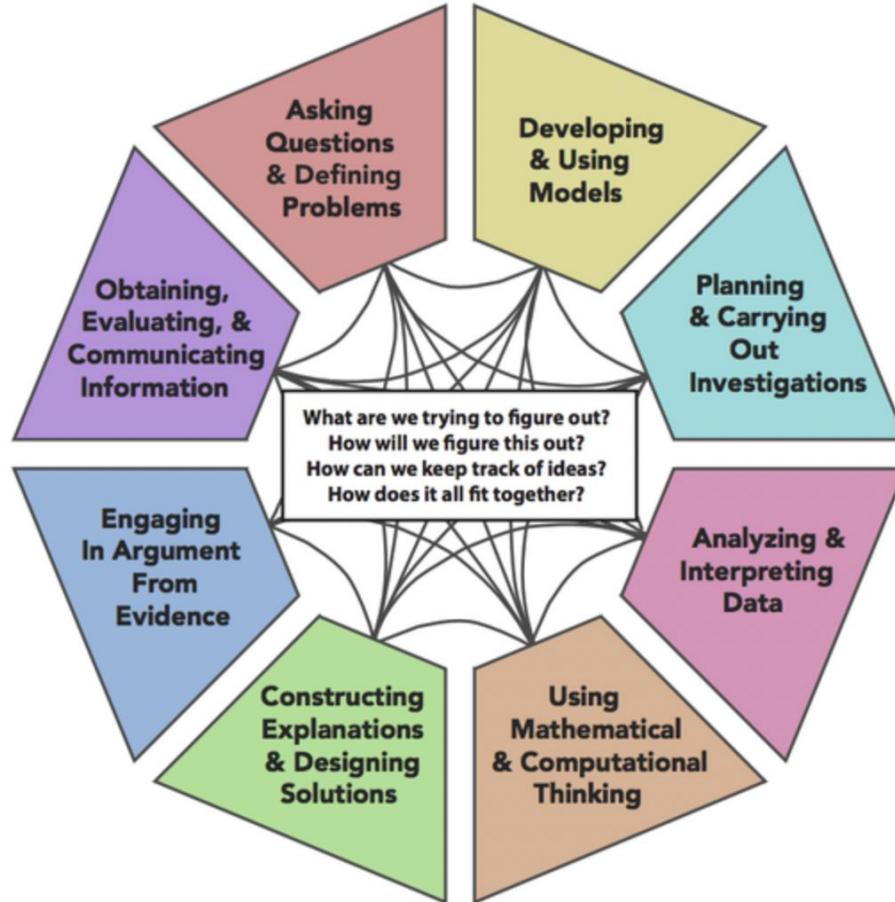


Lady Bug Flight



Sledding Inertia

NGSS Standards Alignment - Science and Engineering Practices



Developing and Using Models

“Developing and Using Models – A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations.

These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations”

– Appendix F of the *Next Generation Science Standards*

Developing and Using Models

High School (9-12)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).

- i** Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.
- i** Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
- i** Use a model to provide mechanistic accounts of phenomena.

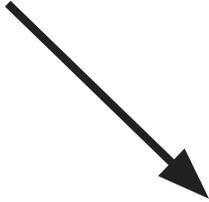
NGSS Standards Alignment

HS Energy (PS3–1)

Performance Expectation – Create a computational model to calculate the change in energy, of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

5E Lesson Plan

Introduce Phenomenon



ENGAGE
Pique students' natural curiosity and activate prior knowledge of the topic.

EXPLORE
Get students involved in the topic, providing them with a chance to build their own understanding.

EXPLAIN
Involve students in the topic, providing opportunity to build understanding.

Revisit Phenomenon



EVALUATE
Students determine what they have learned and what they understand.

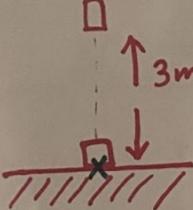
ELABORATE
Challenge and extend students' understanding and skills by engaging them in new experiences and activities.



5E Lesson Plan

1. **Engage** → Students are introduced to the Stacked Ball Bounce Phenomenon and develop initial explanatory model
2. **Explore** → Identifying Energy Types in Lab Stations, Introduced to New Tool known as **Energy Bar Diagrams (LOL Diagrams)**
3. **Explain** → Students explain what they saw in their lab stations using the conservation of energy (concept introduced) and LOL diagrams (instructional tool introduced)
4. **Elaborate** → **Use LOL Diagrams** to analyze energy transfer in a novel situations
5. **Evaluate** → Reflect on what they're learned and they revise initial models to describe Stacked Ball Phenomenon

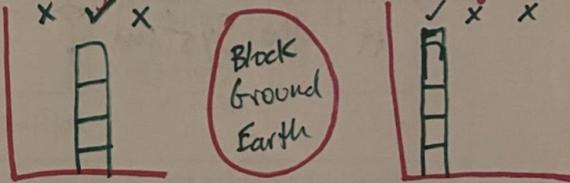
Energy Bar Diagrams (LOL Diagrams)

① 

② Diagram/Graph

System

K U_g U_s
x x x



Block
Ground
Earth

③ Equation - $U_g = K$

④ Written Description - At first, the ^{Box} Block started w/ Gravitational Potential Energy. The Box is propped. At the exact moment that the Box hits the ground, the Box has only Kinetic E.
→ The Energy Type was Converted from GPE to KE.

Student Work Sample I

BEFORE

revisit this model in 2 weeks time

Developing and Using Models

Initial Model

1 Describe the Phenomenon **Stacked Ball Bounce**

2 Define the Boundary **System**

3 Draw and label the Components

4 Identify relationships between the Components

5 Use the model to Explain

When the balls were bounced the basketball stayed in place but the tennis did not stay in place.

Next time I will include a more detailed picture of what happened piece by piece.

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Student Work Sample I

AFTER

Directions: Use your knowledge of energy types and energy transfer to construct a graphical model (LOL diagram) as well as a computational model (i.e. an equation) to describe how the stacked ball set up results in the smaller ball bouncing higher than where it was dropped from. Use the same template as before (reprinted below) to construct this model!

Developing and Using Models

1 Describe the Phenomenon **Stacked Ball Bounce**

2 Define the Boundary **System**

3 Draw and label the Components

4 Identify relationships between the Components

5 Use the model to Explain

Note: The Little Ball is the Tennis Ball and the Big ball is the Basketball

** Tennis Ball is Red.*

** Basketball is Green.*

** Blue represents the initial Point/height.*

** Black represents the final Point/height.*

Adapted from: George Stiekel, Amy & Jeremy Posnock

Explanation → When the instructor is holding up the ball, it has gravitational energy because it was above the ground. However, when he drops the balls, the basketball will bounce but it will eventually stay down there. In the final point/height of the tennis ball it has only kinetic and gravitational energy. The gravitational energy in the beginning converts into kinetic + gravitational energy in the final snapshot.

U_g + U_s = K + U_g

Student Reflection I

Directions: Use your knowledge of energy types and energy transfer to construct a graphical model (LOL diagram) as well as a computational model (i.e. an equation) to describe how the stacked ball set up results in the smaller ball bouncing higher than where it was dropped from. Use the same template as before (reprinted below) to construct this model

Developing and Using Models

1 Describe the Phenomenon **Stacked Ball Bounce**

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3 Use the model to Explain

Note: The Little Ball is the Tennis Ball and the Big ball is the Basketball

$U_g + U_s = K + U_g$

4 Identify relationships between the Components

5 Draw and label Components

* Tennis Ball is Red.
* Basketball is Green.
* Blue represents the initial Point/height.
* Black represents the final Point/height.

Explanation → When the instructor is holding up the balls, it has gravitational energy because it was above the ground. However, when he drops the balls, the basketball will bounce but it will eventually stay down there. In the final point/height of the tennis ball it has only kinetic and gravitational energy. The gravitational energy in the beginning converts into kinetic + gravitational energy in the final snapshot.

“After this activity, my thinking on energy transfer did change because before I did not know anything about energy transfer but now I know about kinetic gravitational, and elastic energy. Knowing this now helps me be able to explain the “Stacked Ball Bounce”

Student Work Sample 2

BEFORE

revisit this model in 2 weeks time.

Initial Model

Developing and Using Models

1 Describe the Phenomenon

Stacked Ball Bounce

2 Define the Boundary

System

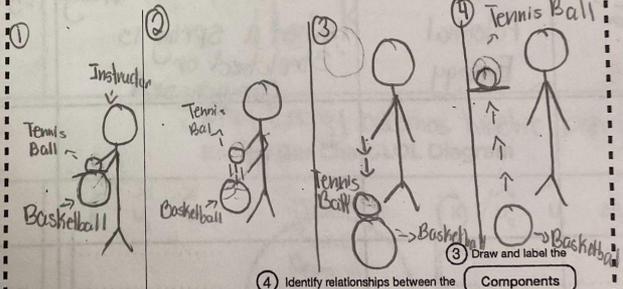
→ Objects of Relevance



5 Use the model to Explain

Drawing of Diagram:

When the instructor dropped both balls, the basketball which had been on the bottom bounced off the floor but stayed on the ground. However, since the tennis ball was on top of the basketball, it had bounced off the basketball and jumped higher.



4 Identify relationships between the Components

thewonderofscience.com

Adapted from: George Sickel, Amy & Jeremy Peacock

Next Time I will include a clear explanation of each step that happened and what took place during/after.

Pros and Cons

Current Positives

- Promotes Student Questioning/Inquiry
- Pushes Students to Communicate Ideas Using Multiple Representations
- Allows for Student Reflection on How They've Learned Over a Learning Cycle

Areas for Improvement

- Need for More Meaningful Phenomenon
- Descriptive Models Vary on Bloom's Taxonomy
- Models can and should be **Predictive Tools**
- Currently Using a Single Point Rubric...There is a Need for a Four Point Rubric

Reflections

- Positive reactions to modeling the Stacked Ball Bounce Phenomenon
 - Put on “Student Hats”
 - Model Presentations showed how we all enter into the learning cycle with different entry points
- “I feel like this would have made physics more engaging...also provides a structure for the learning timeline” – Math Teacher
- “I want to use the 5E Lesson Cycle to introduce a poem in my reading class...I feel like you can use this cycle to introduce any type of interesting topic or event” – ELA Teacher