Science and Mathematics Strategies for Limited English Proficient Students

How to Design Collaborative Cross-Curricular Activities to Strengthen Student Understanding

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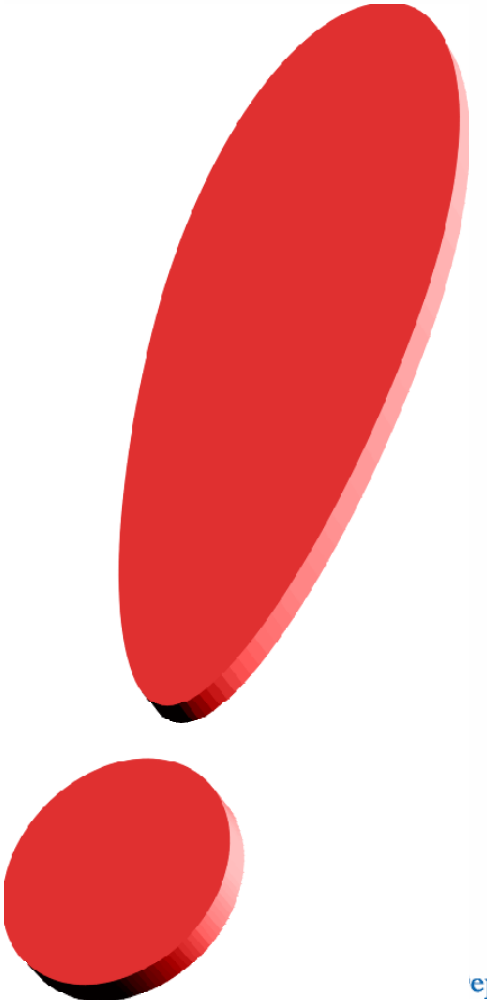
No Child LEFT BEHIND

U.S. Department of Education • Teacher to Teacher Initiative • Supporting Success

teacher workshops

Our Philosophy For Today



Collaboration is the Key!

- We all have experiences
- We all have successes
- We will leave here with more if we ***all*** share what we know

What are your needs?

- One person sitting near each poster please read aloud the comments
- As we progress today, these are the questions I will try to answer.

Outcomes for Session

By the end of this session you will have:

1. Reviewed and discussed strategies to improve language acquisition for your LEP students.

2. Demonstrated a basic understanding of graphing calculators and how to use them with a motion detector.

3. Discussed and performed a series of hands on group activities that can be used to strengthen your students basic understanding of the parameters of fundamental functions.

4. Collaborated with your peers to improve lessons you already use with your students.

Outline of Presentation

- Part I
  - Overview of Strategies for LEP learners for Science and Mathematics
- Part II
  - Quick Introduction to Graphing Calculators and Motion Detectors
- Part III
  - Example of Math/Science "*Labs*"
    - Pendulum Sinusoids
    - Exponential Decay of a Bouncing Ball
    - Suggestions for other investigations
- Part IV
  - How to develop your own activity
- Questions and Comments

Relevant Research

Educational research has shown:

- LEP students retain information better when they are given ***ADVANCED ORGANIZERS.*** They give students a sense of what is coming and what is important to retain.
- LEP students benefit from ***CONSISTENT INSTRUCTIONAL PROCESS***. If every teacher uses same vocabulary methods, chameleon pedagogy is averted which makes it difficult for students to know what is going on.
- LEP students need ***VISUAL REPRESENTATIONS*** of words. If critical information about a word is entrusted primarily to auditory processing, it often results in linguistic approximations

Kate Kinsela, Ed.D- San Francisco St. University
SCOE Publications, October, 2005

LEP Strategies

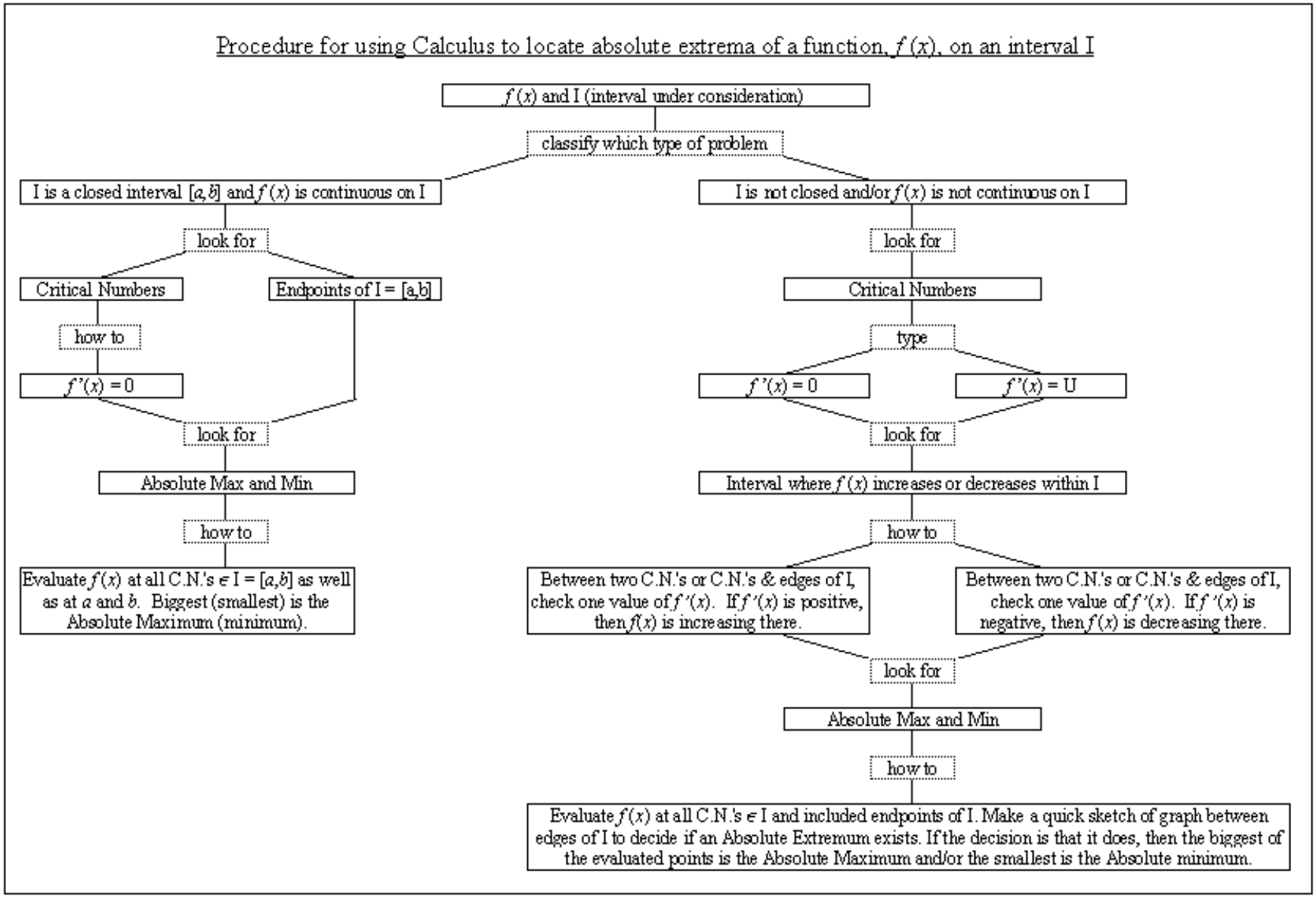
- What is good for your LEP students is good for ***ALL*** of your students!

- There is not one master plan for LEP students, rather a collection of best practices that improve conceptualization of science/math topics
  - Link concepts to other things besides language
  - Give students an opportunity to VISUALIZE material

LEP Strategies

- Involve Students in Scientific Inquiry
  - Inquiry techniques, such as data collection and reporting, allow LEP's to use language in a purposeful and meaningful way
- Advocate for a ***Less-Is-More*** Curriculum
  - Involving students as active participants in the process of scientific inquiry often requires more time
  - Focus on major principles and unanswered questions rather than a accumulation of random bits of knowledge
  - Use a unit organizer or conceptual map that lays out a picture of the big ideas and how they are connected

Example- Concept Map for Math



LEP Strategies

- Teach the Language of Science
  - Encourage students to ask questions, propose answers, make predictions, and evaluate evidence
  - Research suggests that advanced reasoning used in scientific communication is dependent on the acquisition of specific linguistic structures.

First- Then

Cause- Effect

Theory- Fact

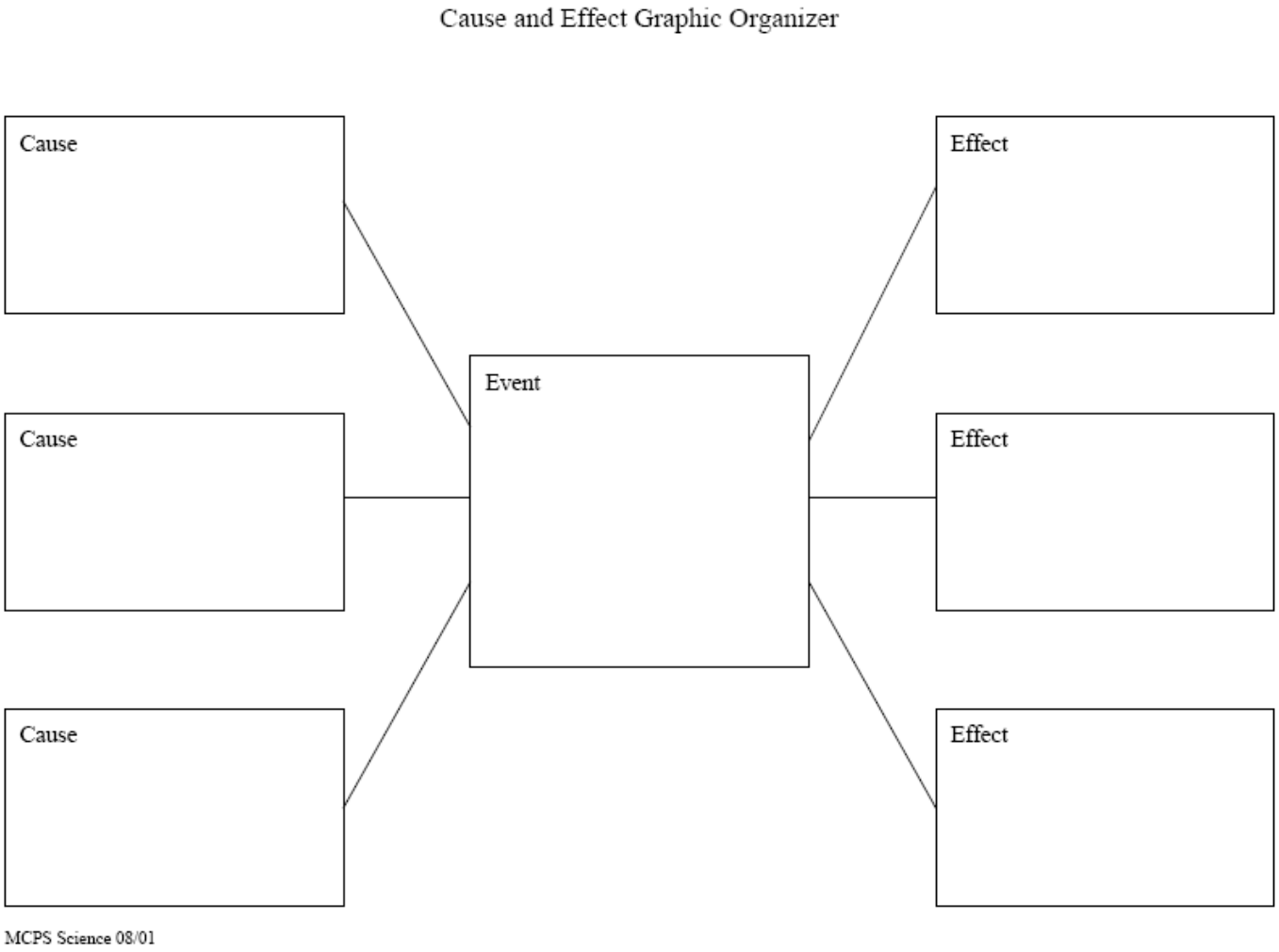
Why- Because

If- Then

LEP Strategies

- Make Oral and Written Language Comprehensible
  - Limit the number of new terms. paraphrase or repeating difficult concepts and use visual or real referents is necessary
  - A flowchart can convey a scientific process to students more rapidly that several paragraphs of text
    - Emphasize essential points and reduce extraneous information

Example- Flow Chart



Example – Word Walls

www.itrc.ucf.edu

LEP Strategies

- Use Appropriate Assessment
  - Science exhibits or lab reports
  - Cooperative small groups
  - Individual Conferences
  - Visual Prompts
  - Permit Students to use dictionaries or word lists
  - Simplify directions
    - Step them through the process…

LEP Strategies

- Provide a unified method of instruction across the curriculum
  - The development of linguistic skills can best be achieved when different core subject teachers stress the same concepts
  - Work together to develop learning strategies that work in several subjects, then provide opportunities for LEP's to practice these strategies

Now Lets Look at an example…

Relevant Research

Educational research has shown:

- The increasing value of using technology in teaching Science and Mathematics
  - *Transforming Ideas for Teaching and Learning Mathematics, Office of Research, U.S. Department of Education*, Washington, DC, 1993 http://www.ed.gov/pubs/StateArt/Math/idea7.html

- The value of group problem solving
  - Cooperative Learning Methods: A Meta-Analysis, Johnson, D. W., R.T. Johnson, and M.B. Stanne; May 2000 http://www.co-operation.org/pages/cl-methods.html

- The importance of having students have a grounding experience to link abstract concepts
  - *The Process of Experiential Learning:Experience as The Source of Learning and Development;* David A Kolb; Case Western Reserve University; 1983; http://www.learningfromexperience.com/images/uploads/process-of-experiential-learning.pdf

Evidence of Success

The Math and Science Departments at BBAHS have made a commitment to hands on collaborative education.

Since this decision we have:

- Not missed our Annual Performance Benchmarks for Math as gauged by NCLB *(87% Proficient 2006)*
- Improved Classroom atmosphere by "*Making Math/Science Fun*" as reported by our students
  - Nearly 95% of our 12th Grade Students elect to take a Math or Science class (30% at advanced levels)
- Students who complete activities on average score higher on internal assessments than students who have not done hands on activities.
- Had no problems fitting "*extra*" activities to Local Mathematics Standards

Introduction to the calculator based motion detector

- Uses ultrasonic sound waves to track position of an object.
  - ➢ Uses the same principle as police radar guns
- Can be connected to many different types calculators or computers and used to perform many hands on mathematics experiments
- Contains all relevant programs internally

How to set up the motion detector

- Connect sensor to calculator
- Press the "***APPS***" button
- Select option ***4: CBL/CBR***
- Press "***ENTER***" button, then select option ***3:RANGER***
- On the main menu select option ***1:SETUP/SAMPLE***
- Move cursor up to "***START NOW***" and press "***ENTER***"
- Put you hand in front of motion detector and press "***ENTER***" to begin your data collection.
- Move you hand towards and away from the detector and watch the graph

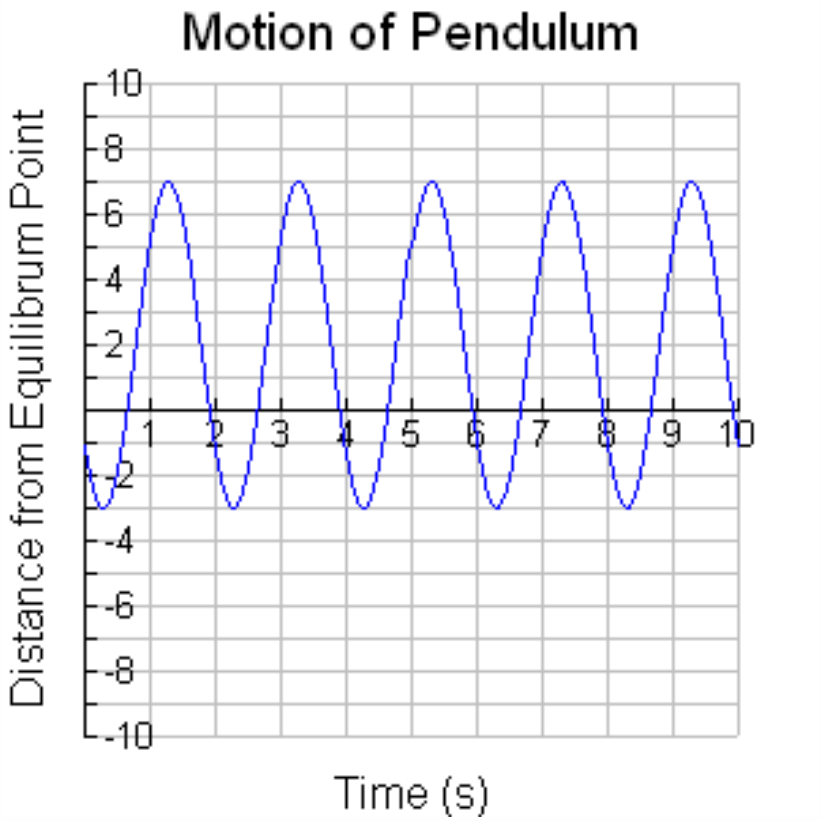
Project : Pendulum Sinusoids

- Students are drilled that the basic form of a sinusoidal equation is:

$$y = A \cdot \sin(B(x + C)) + D$$

- Do your Students have a good understanding of what each of A, B, C, and D do for the function?

Pendulum Sinusoids Continued



- Students must match the Period of motion, the Amplitude of the swing, as well as understand the concepts of Phase Shift and Horizontal Displacement

Pendulum Sinusoids Continued

This activity connects to many District of Columbia Standards of Learning for Precalculus and Trigonometry

- ***PCT.P.2-*** Demonstrate an understanding of trigonometric functions and relate them to geometric figures
- ***PCT.P.8-*** Describe the translation of scale changes of a given function *f(x)* resulting from substitutions of the parameters a,b,c,d in $y = af(b(x + c/b)) + d$
- ***PCT.P.11-*** Understand, predict, and interpret the effects of the parameters a,b,c,d on the graph $y = a\sin(\omega(x - b)) + c$ Use to model periodic processes

Connections to Science

Remember, this activity is not done in isolation!

- DCPS High School Physics Standard
  - Students will describe waves in terms of their fundamental characteristics of speed, ***v***; wavelength, λ; frequency, ***f***; or period, ***T***, and amplitude, ***A***, and the relationships among them. For example, $f\lambda = v$, $f = 1/T$. Solve problems involving wavelength, frequency, and wave speed.
  - Students will describe the motion of pendulum in terms of the fundamental characteristics of acceleration due to the earth gravity, ***g***; length of string, ***l***; and their relationship to period, ***T***; For example $T = 2\pi\sqrt{l/g}$

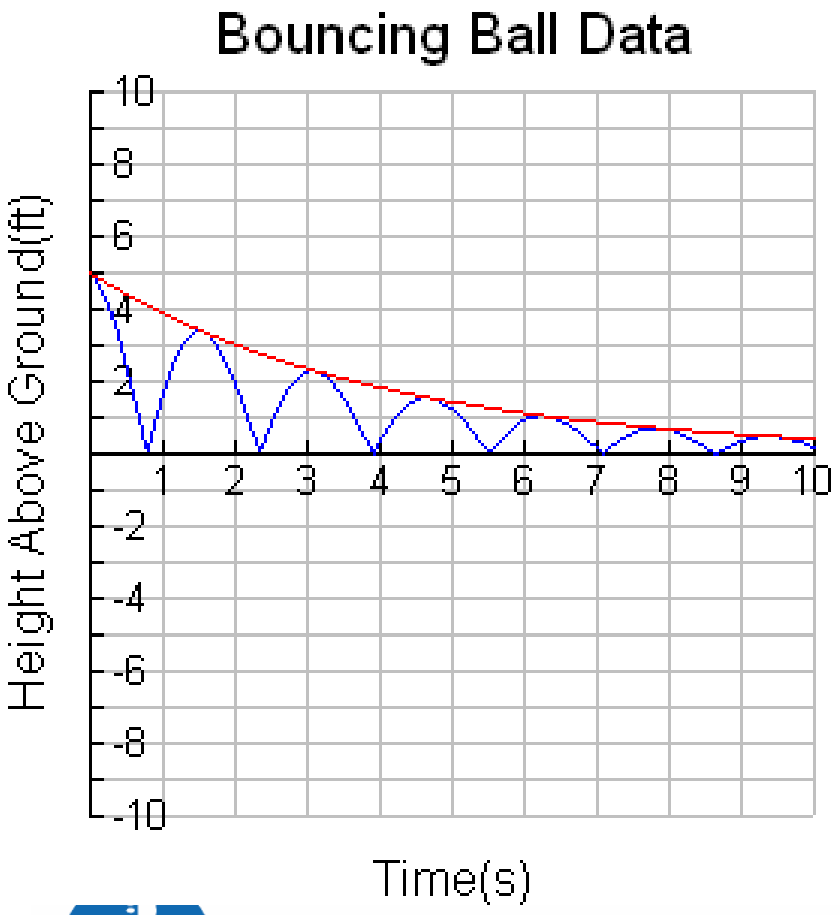
Pendulum Sinusoids Continued

Lets try some Hands on Math!

– Take out worksheet entitled

"Pendulum Sinusoids"

Project 2: Exponential Decay



- Mount the Motion Detector from above
- Drop a Basketball directly underneath and collect position data
- Your students can work in groups to model the exponential decay of the bouncing ball
- For extra credit, have them bounce the ball on different materials (i.e. carpet, tile, wood) What does this say about decay rate?

Exponential Decay

What Math and Science Standards are linked in this activity?

Mathematics:

- Basic Form of Exponential $y = A(B)^x$
- Graphing Exponentials
- Using Logarithms to solve problems

Physical Science/ Physics:

- Conversion of Potential Energy to Kinetic Energy
- Momentum is a conserved quantity that can only be altered by an impulse
- Solve elastic/ inelastic collision problems

Suggestions for other Activities

- Model The Heating and Cooling of a liquid
  (Exponential Functions)
- Model Kinetic Energy Loss due to Friction
  (Quadratic Functions)
- Damped Pendulums
  (Exponential and Trigonometric Functions)
- Hours of Sunlight at your Latitude
  (Trigonometric Functions)
- Acid-Base Titration
  (Logarithmic Functions)
- Surveying your School
  (Right Triangle Trigonometry, Law of Sines & Cosines)

All of these examples can be extended for advanced or college level courses

What makes a good activity?

- It takes two (*or more*) to tango…
  - Collaborate with Math/Science/Other coworkers
- Look at your students work…
  - What math concept is preventing them from fully understanding your science topic
- Start at the end…
  - Together, define specific skills you want your student to perform/display
- To see it is to believe it…
  - How can students use calculators to visualize/experience the concepts

What makes a good activity?

- Presentation is everything…
  - Clearly outline the means by which your students will communicate the desired outcomes
- Duct tape can fix anything…
  - Gather available equipment, how can it be used in conjunction with a calculator to get your students' "hands dirty"
- If at first you don't succeed…
  - Put it all together, try it with your students, but be prepared to revise and improve

Your Turn now

- Working at you table, develop a collaborative math/science activity that:
  - Is LEP friendly
  - Contains a single math/science concept that your students have difficulty with
  - Emphasizes visualization of concepts (*via calculators, graphic organizers, etc*)
  - Contains a "hands on activity" (*data collection*)
  - Specifically addresses how students will covey understanding to you, or others

- Designate someone at your table who will report your activity back to the group

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- Before we leave please do the following:
  - Share three new ideas or facts you learned today with the person sitting next to you.
  - Write down two questions that you have still that are related to what we did today on the evaluation form.
  - Share one thing that will stick with you today with the person sitting next to you.