Math, Computing and Sustainability Institute

Day 1: 7.8.13

Introductions.

Problems facing world

Worksheet.

Goals of Institute:

i. Learn about issues of sustainability, the connection of sustainability with mathematics, science, computing, including the use of authentic data linked to sustainability, and how math modeling can address issues of sustainability.
ii. Build connections with other area educators and learn from each other.
iii. Develop a unit that you will teach in the fall linking math/science and sustainability. Assess the impact of the unit in terms of interest/motivation/learning. Team approach.
iv. In partnership with school facilities personnel and/or administrator, develop a project in which students green their school or community and that links to curriculum.
v. Start school on path to becoming a Green Ribbon School.

Institute Details:

a. W9 Forms; payment; $500 now; $100 mini-grant - must write 1 page description what you would do with it;
b. Parking pass.
c. Computers and internet access.
d. Sustainable Energy without the Hot Air
e. Special Events:
    - Friday July 12th: Fairmont Park Water Works Interpretive Center:
        - Meet there 8:45. Who wants to car pool/van from Bryn Mawr?
        - Free parking on Sedgely Drive off of Kelly Drive.
    - Monday July 15th Green Ribbon Schools workshop
f. Pre- Institute Assessment:

Founding Questions: (Quick write in your journals).

a. What is sustainability?

Sustainability involves improving everyone's quality of life, including that of future generations,

by reconciling economic growth, social development and environmental protection [1].
United Nations Decade of Education for Sustainable Development 2005 - 2014, The DESD at a Glance. (2005). Available at
http://unesdoc.unesco.org/images/0014/001416/141629e.pdf

Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations.Sustainability is important to making sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment.
http://www.epa.gov/sustainability/basicinfo.htm

Environmental, Human/social, Economic components.
Using math/science to analyze issues of sustainability; what are effective solutions for thes issues.

b. Why does it matter?
c. Why do we want to include it in our teaching?
(d. Link of pre-service teacher preparation to sustainability (new paradigm))

Motivation: William James. Talks to Teachers. 1899 . Chapter 10. Interest.

Any object not interesting in itself may become interesting through becoming associated with an object in which an interest already exists. The two associated objects grow, as it were, together: the interesting portion sheds its quality over the whole; and thus things not interesting in their own right borrow an interest which becomes as real and as strong as that of any natively interesting thing.

Begin with the line of his native interests, and offer him objects that have some immediate connection with these. Next, step by step, connect with these first objects and experiences the later objects and ideas which you wish to instill. Associate the new with the old in some natural and telling way, so that the interest, being shed along from point to point, finally suffuses the entire system of objects of thought.

But interest, once shed upon a subject, is liable to remain always with that subject. Our acquisitions become in a measure portions of our personal self; and little by little, as cross-associations multiply and habits of familiarity and practice grow, the entire system of our objects of thought consolidates, most of it becoming interesting for some purposes and in some degree.

3 Key Principles of How People Learn:

Quantitative Literacy:

Sustainability can be a natural link with Quantitative Literacy.
Math and Democracy. The Case for Quantitative Literacy

PREFACE Mathematics, Numeracy, and Democracy, xiii, Robert Orrill (p. 13 of pdf).

The Case for Quantitative Literacy, 1, The Quantitative Literacy Design Team (p. 21 of pdf).
Read pages 1 - 6 (at a minimum).

Comments that caught my eye (VJD):
data deluge,
"an innumerate citizen today is as vulnerable as the illiterate peasant of Gutenberg's time"
Lynn Steen, 1997

unlike mathematics, numeracy does not so much lead upward in an ascending pursuit of abstraction as it moves outward toward an ever richer engagement with life's diverse contexts and situations.

Quantitative literacy is more a habit of mind, an approach to problemsthat employs and enhances both statistics and mathematics. Unlike statistics, which is primarily about uncertainty, numeracy is often about the logic of certainty. (p. 25 pdf)

Few can doubt that the tradition of decontextualized mathematics instruction has failed many students, including large numbers of women and minorities, who leave high school with neither the numeracy skills nor the quantitative confidence required in contemporary society. The tradition of using mathematics as a filter for future academic performance is reinforced by increasing demand for admission to selective colleges and universities. These pressures skew school curricula in directions that are difficult to justify because they leave many students functionally innumerate. (p. 25-26 pdf)

Typical numeracy challenges involve real data and uncertain procedures but require primarily elementary mathematics. (p. 26 pdf). Disconnect of math in class from use in the world.

Math Modeling: - use math to study real world situations. Various types of modeling: descriptive, analytic.

Common Core Standards. How can we use issues of sustainability to meet common core Math and English Language Arts standards.

Challenge of discussing non-math topics in a math course. Article by Hadlock: interdisciplinary orientation.

Light Bulb Challenge

Article about new LED lightbulbs.

Question: Is it worth it to change the lightbulbs in your house from incandescent to compact florescent or LED?

There is a list of equipment that we used in the Light Bulb Lab in our Resources List under "Other," with links to where you can buy them.

HW:

i. Get PECO energy bill from your home (if you do not have? share mine).
ii. Examine the light bulbs in your house. Record information you might need to make your case.

Day 2: Tuesday July 9

1. Google Docs:
    - creating class document: (i) What is sustainability; (ii) Why teach it; (iii) What approaches do you take to motivate students/ build interest?
    - Show how to search on name and content.
    - How to "move" .
    - make folders read only.

2. Small groups: discuss your findings about bulbs in your home.

3. Energy bill;

4. Discussion of energy units.

5. Campus visit of sustainability sites. Class ideas for green projects

6. Detailed calculations of energy, footprint of lightbulb:
    Create a mathematical model of cost of lightbulbs.
    a. Start with simplest possible model. Use fixed values.
    State clearly your assumptions!!

Figure out the calculations needed to determine total cost.

b. Transfer these calculations into a spreadsheet in which the important values are entered and then the calculations are done automatically by the spreadsheet using formulas.

c. Make a more complicated model in which you can change the values and the spreadsheet will automatically redo the calculations.

presentation by 75 watt bulb team. , spreadsheet with calculations.
spreadsheet with graphs of another bulb

Article about LED bulbs at Bryn Mawr College in dorm and in Thomas Great Hall.

7. Computer: Android apps

8. Spreadsheet: doing calculations for energy; light bulb.

Day 3: Wednesday July 10

0. To dos:

- trip to Water Works: who wants to carpool from Bryn Mawr.
- Word Wall
- Facilities Day next Monday. ; Agenda for the workshop.

Invite to Dr. Hite. , Invite to Mayor Nutter.

- Future workshop: Delaware Valley Green Schools Symposium, Tuesday July 23rd.

1. Review of power and energy. Worksheet.

- trouble: language - in everyday use, we are causal about terms and use power, energy interchangeable. In science/ math we are very precise.
- units: for a “rate” we want to say … per time = something/time. But kW unit does not seem to have “per time” in in. Remember watt = joules per second = joules/sec do there a “per time” already in the unit.

- how much energy do appliances use when plugged in but not running: vampire or ghost energy?
- when you first turn an appliance on, is there a “power spike/surge” where it uses extra power to get started? Is it better to keep an appliance (ex. air conditioner, florescent lights, computers, car, heating/AC at home - programmable thermostats,
- if we know about these savings, how can we actually do it without forgetting (programmable thermostat prevents user from forgetting. Thermostas can ‘learn” and program themselves.). Motion sensors for lights. Will be able to turn our LED lights off (with proper linking to wireless)

from our celll phones.

- even if appliances use a lot of power, if they are not turned on for very long, then they won't be using a lot of energy.

Energy = Power x time

---> Power = Energy/time

2. Group work on math model of light bulb problem.

Group presentations/spreadsheets.
- 40 watt equivalents.

Math Concepts:
- lines y = mx + b
- intersection of lines: when costs are equal. pay back time.
- idealized model of reality gives continuous function
- true reality gives a discontinuous function
- different types of graphs
- the visual impact of a graph.
- choice of time unit (month, year, 25,000 hours, continous) to base comparison on.
- **slope has a real world meaning: rate of electricity charge**
- intercept is the initial cost of bulb.

Slope of energy curve is power
Area under power curve is energy.
Area and slopes are related.

More than one way to solve the same problem. Here we had the same problem but we all did it differently. **Key Misconception: "there is only one way to do a problem". This gets in the way of student learning.**

We make use of the math findings but then we can interprete the data in different ways. We can use the same data to answer slightly different questions. We ask different questeions of our numbers.

Objective vs subjective. We thought math would give ojective view. But the outcome depended on our assumptions and the assumptions are subjective. What are the assumptions that led to the choice of number.

3. Apps: LIghtbulb Finder.

4. Interesting graphs from Peco Data (Marie).

Day 4 July 11, 2013

Teacher presentations:
- Marie: graphs from PECO bills
- Anne: GPS, trees and economic benefit.

With student discussion/writing.

Afternoon: Paula Miller, Abraham Lincoln; sustainability projects in school

Start developing ideas for lessons.

Rule of 3: When you deal with a new math concept
- numbers (data table)
- graphicallly
- analytically (formulas)

4th component: talkling and/or writing about it. (Metacognition).

Plug Loads Lab

- Plug Loads Sample Spreadsheet
- Plug Loads with Formulas
- Plug Loads without Formulas

What is a Carbon Footprint?

- Average CO2 Emissions Rate and Electricity Cost by State

Great Quote: 7.11.13 in NY Times:

The filibuster is a needed tradition, but the methodology needs to change for a new century," said Senator Barbara A. Mikulski, Democrat of Maryland. Asked whether they were stepping onto a slippery slope, Ms. Mikulski responded blithely: ***"Every slope is slippery. That's why they call it a slope."***

Day 5 Friday July 12, 2013

Visit to Water Works Interpretive Center and Greenfield Elementary School.

Fairmount Water Works Interpretive Center

Greening Greenfield

Day 6 Monday July 15, 2013

One day Facilites workshop: Agenda with power points attached.

Bryn Mawr College Solar Panel Display

Math Problems worksheet.

List of readings for the institute.

Day 7 Tuesday July 16, 2013

Appreciations for Facilities Workshop

Ways to use Lightbulb/Plug Load material in class lessons

Check out the Lessons and Projects that the teachers from the 2012 Institute did!

Solar Energy:

- Bryn Mawr solar panel output webpage.
- raw data from Bryn Mawr solar panels.
- lesson on solar power (see #10) at Mathematics Awareness website in Sustainability Counts section.
- Solar energy map of the nation from the National Renewable Energy Laboratory
    - Solar map for PA
- Bryn Mawr Solar panels dimensions: 14 panels each 3 ft x 5 ft.

You can review what we covered on Solar Panels on our class lecture notes page.

Home Solar panels - Susan White

- Peco $44,000 rebate for Haverford Recreation Center.

CO 2 Levels: Atmospheric CO2 Levels and Rates of Change (lesson #11 in Sustainability Counts at Mathematics Awareness web site). Learning how to plot data in Excel and then to fit a trendline of best fit to the data.

Video showing CO2 levels over last 800,000 years from Earth Systems Research Laboratory.

This unit was developed by Tom Pfaff who has a range of lessons (at Calculus and Statistics levels) which use real world data on various aspects of sustainability. See also his Sustainability Math web page.

Using real world data

Pfaff Modules:

I. CO2 and Temperature model.
   - Websites related to CO2 levels:
     - Trends in Atmospheric Science, NOAA:
     - CO2Now.com - Scripts Institute with monthly updates on the CO2 levels.
     - http://www.350.org - website for grass roots organization engaged in activism with the goal of getting the CO2 levels to 350 ppm which some scientists think is the safe level.
     - CO2 and seasonal variation
     - Ocean Acidity is a Major Reef Threat (philly.com)

II. Look at other modules. Go explore data sets and sites that they come from

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Day 8 Wednesday July 17, 2013

Please arrive a bit before 9am. We will have a visit with **Jeff Salvage** about his experience owning a Tesla, an electric car (blog here). He includes the math to compare energy efficiency with other vehicle types, as well as his observations about the practical issues involved, especially cost.

Read the Hot Air chapter 3 on Cars. Look for energy lost in combustion and the energy used per day by the typical person driving.

Visit to Haverford College and then to the Haverford Township Community Recreation and Environmental Education Center (CREC).

- **Haverford College Sustainable Campus Operations**
  - Green Buildings
  - Greening Haverford, the big picture

From Mathematics Awareness Month website read theme essays. Read the Introductory Essay: Balancing needs and seeking solutions for a complex changing world: The role of mathematics in addressing issues of sustainability
and then read one other.
Post some reflections on the readings.

The table at http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb0802a
gives information on that amount of electrical energy that is generated by different methods in the US system. From the US Energy Information Agency

Brian Forney, Math, Ridley High School. - Presentation

Arctic Sea Ice Unit (Math Awareness Month, Sustainability Counts Lesson #8)

Arctic sea ice video

Slope, rate of changes, units, meaning. How to use a data set at various levels.

Day 9 Thursday, july 18

Citizen Scientists - Article on Citizen Scientists using mobile devices

- Philly Tree Map
- Project Budburst
- Monarch Butterfly - Journey North
- Bird Tracking

Marie's powerpoint for NASA Education Resources

Caitlin: games to build community.

Video about Energy Grid

Day 10 Friday, July 19

Hours of Daylight Graph/Animation

Where does the mass of a tree come from?

The DVD that this mass of a tree video came from is **A Private Universe** and **Minds of Our Own.** These are two separate programs, and this video called “Lesson from Thin Air” is a part of the Minds of Our Own program.

Here is a link to the video Minds of Our Own from Annenberg Learner. The mass of a tree clip we watched in class starts around 3:20.

The power of geothermal heat pump.(Debbie’s Module, in honor of Penn Delco).

Suppose your winter heating bill is for 100 units of energy.

a. If you furnace is 90% efficient, how many units of energy were actually used to heat the building (vs for example escaping through the chimny or heating up the furnace).

A geothermal heat pump system has an amazing efficiency of 3 (or 3.5). That means for each one unit of energy put in to run the system (running the pump and compressor), 3 units of heat are produced. It is so efficient because it is not creating the heat, it is only moving the heat from the ground and bringing it into the building.

b. How much energy would it take for a geothermal system to produce the same amount of heating energy as produced by the furnace in (a)?

c. Express the savings produced by the geothermal system as a percentage.

Math, Computing & Sustainability Institute Evaluation

Also, if you did not fill out the Institute Pre-Survey, please do so!

Presentations!

Lyrics to our Institute Song! Video of JD singing.

Math, Computing & Sustainability Institute Photos

Tuesday July 24

Victor visits Shippensburg to present at PREP workshop on math and sustainability.

Alliance to Save Energy: Campus conservation program including Energy Competition

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Some additional Links

Our Resource List and our Interesting Websites List

A Google Map marking the schools of the participants from this year

A resource for wind power:

- **Map - Average Annual Wind Speed at 80m** from the US Energy Information Administration

A page to keep each other updated on what we have accomplished in our schools! (viewable by institute participants only)

A **Contact List** of institute participants from the past two years (viewable by institute participants only)