Math Modeling and Sustainability: Using Service Learning Projects to Deepen Student Engagement with Modeling.

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July 10, 2018

What are some issues facing the nation and the world that you are concerned about?

What are some issues facing the nation and the world that you are concerned about?

A goal of my presentation is to show how mathematics can be connected to these issues you care about.

Math Modeling and Sustainability Course

Taught at various levels:

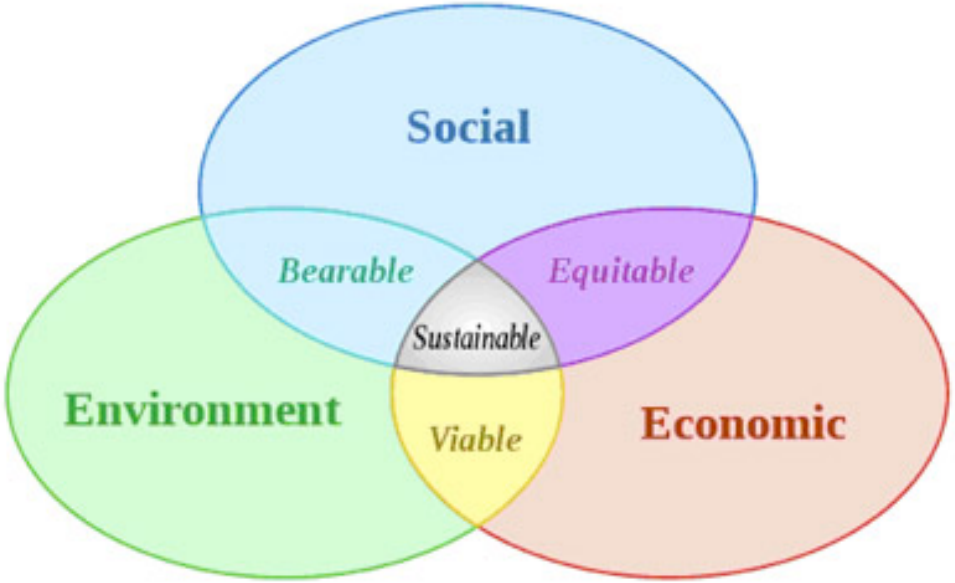
Gen Ed, math major course, senior seminar,
Secondary teacher institute

Service Learning/Community Based Learning:
student projects in partnership with community

Syllabus, course assignments:
https://tinyurl.com/ya6e2msy

Sustainability:

Meeting the needs of present and future generation by reconciling economic growth, social development and environmental protection**.**



Education for Sustainability

From the Cloud Institute

THE 9 CORE EfS STANDARDS

Cultural Preservation & Transformation

Responsible Local & Global Citizenship

The Dynamics of Systems & Change

Sustainable Economics

Healthy Commons

Natural Laws & Ecological Principles

Inventing & Affecting The Future

Multiple Perspectives

Strong Sense Of Place

Topics:

Curve fitting using real data

Rates of change (derivatives)

Area under curve (integration)

- Riemann sums
- Energy is area under power curve
- Total water run-off is integral of rate of flow

Energy Modeling

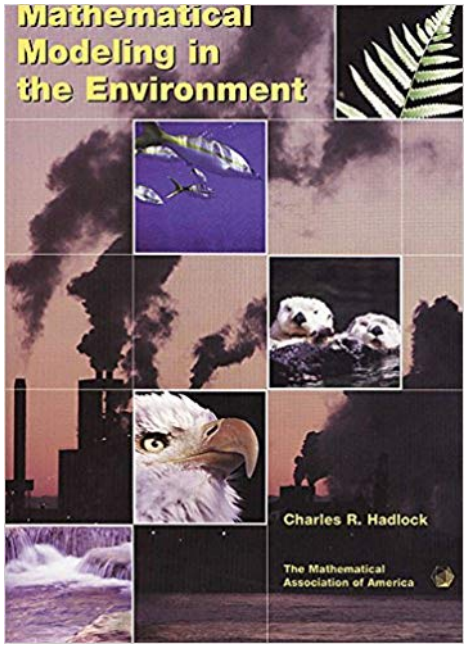
- cost of energy use; units kWh
- carbon footprint of energy generation
- potential for energy generation (solar, wind)

Financial Modeling:

- Fixed (capital) costs, operating costs
- Pay back time
- Net present value

Math Modeling and the Environment

Charles Hadlock, Bentley University



- Ground water flow
- Darcy's Law
- Laplace equation
- Heat flow

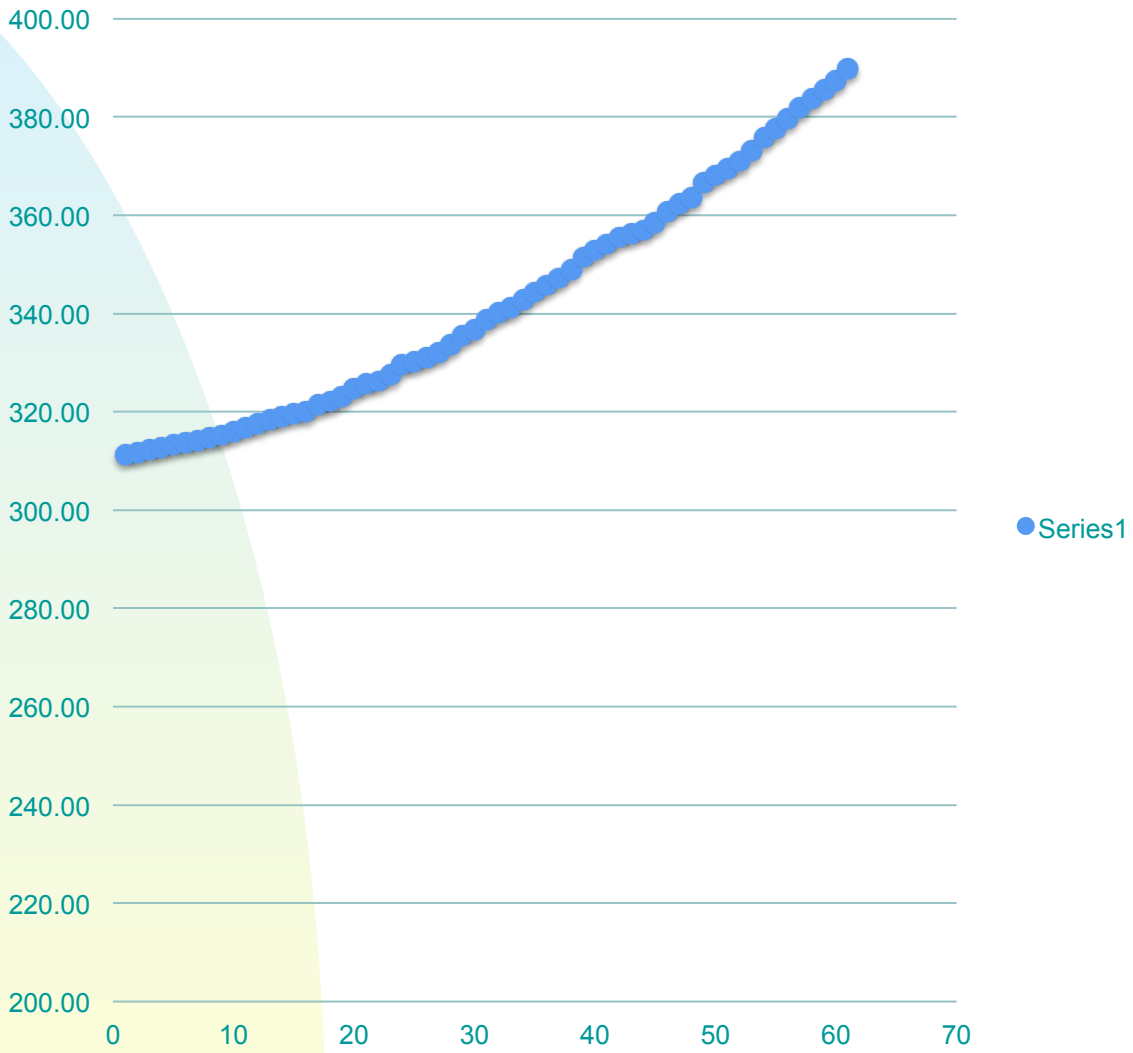
Math Modeling and Sustainability

Tom Pfaff, Ithaca College

Developed teaching units on sustainability for a variety of courses

Blog site: http://sustainabilitymath.org/

Are CO2 levels rising?

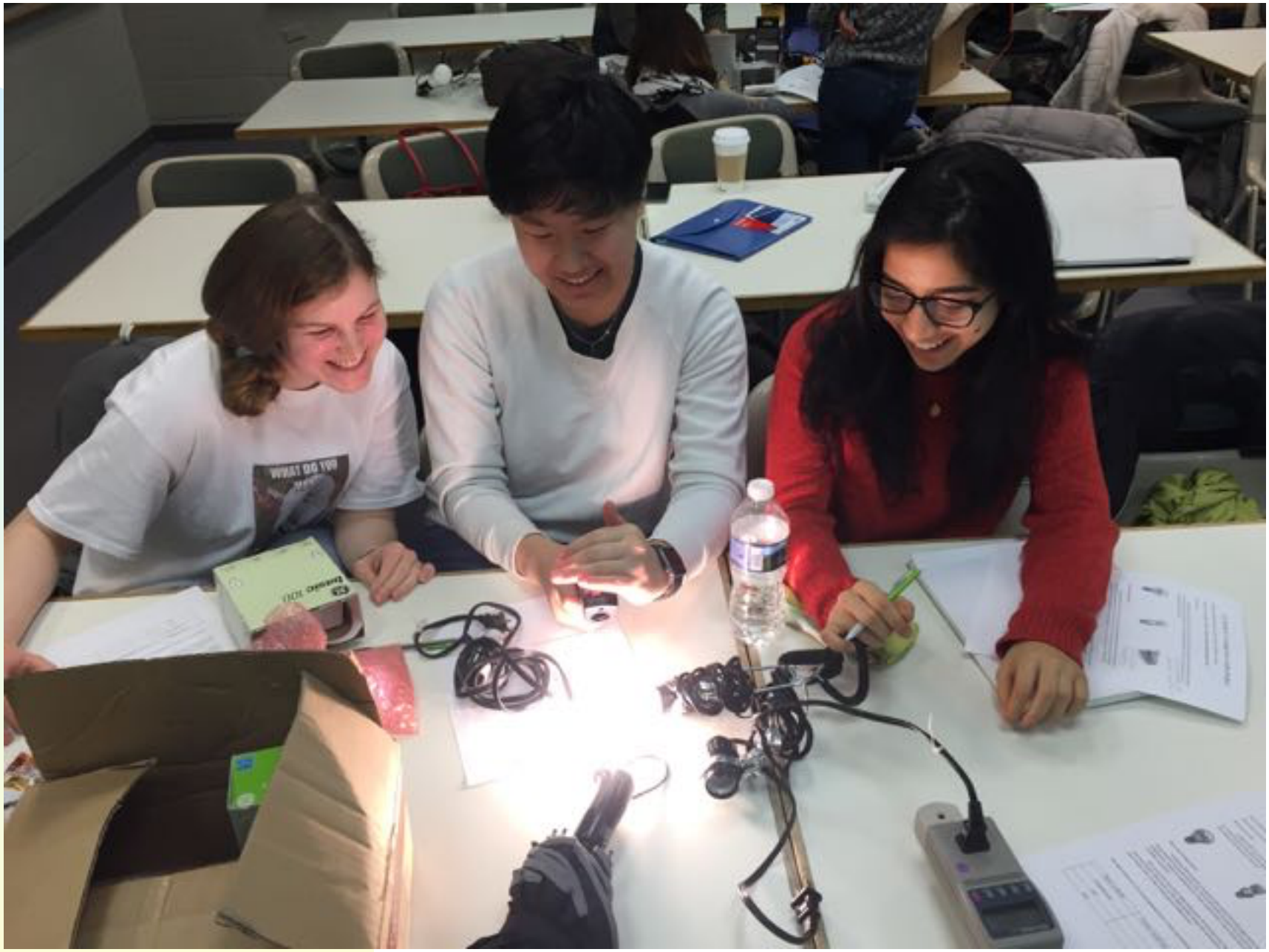


Is it "Worth It" to Change your Light Bulbs?

Betsy Biernat and Hannah Weinstein, Bryn Mawr College

Brainstorm!

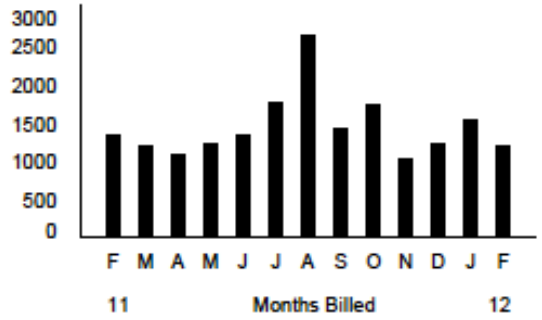
A light bulb in your home has burned out and you have no light bulbs stock-piled to replace it! Group brainstorm for 2 minutes: what factors would you take into account in deciding whether to buy an incandescent, CFL, or LED light bulb for your home?



Home Electrical Bill

Electric Residential Service - Current Period Detail					Service 01/05/2012 to 02/06/2012 - 32 days
Customer charge					$7.20
Generation Charges	1,179	kWh	X	$0.09180	108.23
Transmission Charges	1,179	kWh	X	0.00740	8.72
Wind Energy Service Charge	300	kWh	X	0.02540	7.62
Distribution Charges	1,179	kWh	X	0.06000	70.74
State Tax Adjustment					-0.04
Total Current Charges					**$202.47**

13-Month Usage (Total kWh)



Your Usage Profile

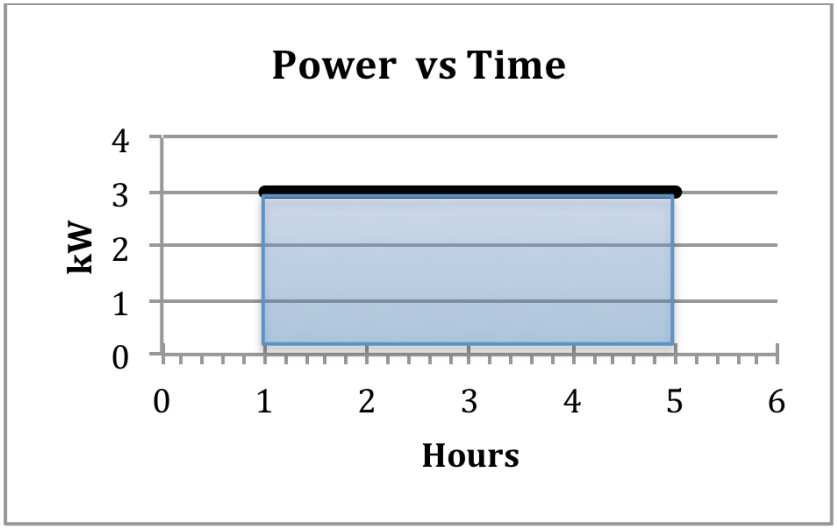
Period	Usage	Avg Daily Usage	Days	Avg Daily Temp
Current Month	**1,179**	**36.8**	**32**	**39**
Last Month	1,519	47.4	32	42
Last Year	1,332	41.6	32	29

Avg kWh per Month	1,442
Total Annual kWh Usage	17,305

Units are kWh = Kilowatt hours

1. a. If a household is using 3 kW (kilowatt) of power continuously from 1pm to 5 pm (see Figure 1), how much energy is used?

b. What is the area = height x width under the power curve for $1 \leq t \leq 5$? Give the units for this area that you get by multiplying the units for the height by the units for the width.



Solar Panels on Campus

Firefox File Edit View History Bookmarks Tools Window Help (1:02) Fri 9:27 PM Victor Donnay

Enphase Energy – Enlighten | Bryn Mawr College

https://enlighten.enphaseenergy.com/systems/132956/graphs?range=last7Days&view=

Bryn Mawr College | Pennsylvania Voter ID Law Is S... | Enphase Energy | Enphase Energy – Enlighten | B...

[e] Enlighten Manager

SYSTEM ACCOUNT SUPPORT

My Account Help

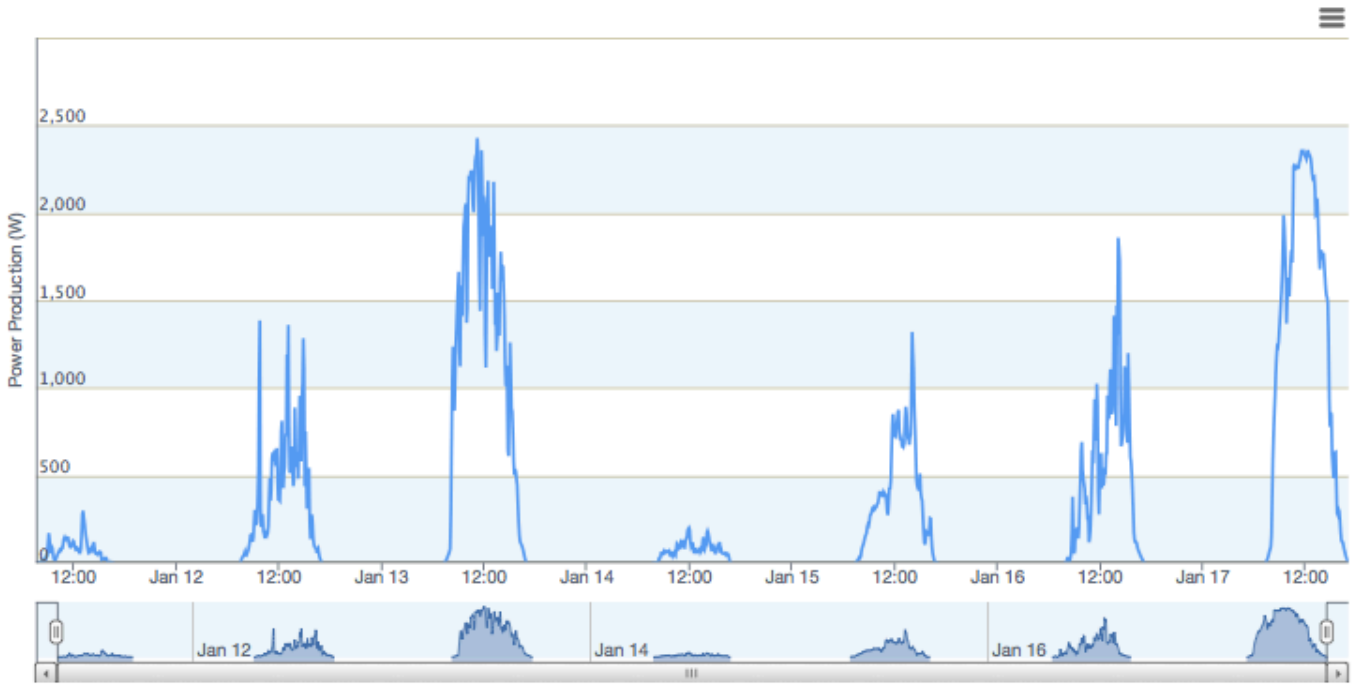
MyEnlighten View

GREENENERGY

Bryn Mawr College Full System

View Graph Reports Devices Events

Power: Past 7 Days Jan 11, 2014 - Jan 17, 2014



Maximum Produced
2.43 kW

14 Microinverters
Philadelphia, PA

30°F

System Normal

Full System

Energy Status

Today
13.0 kWh
Peak Power: **2.36** kW at 12:15 PM
Latest Power: **3** W at 5:00 PM

Past 7 Days
39.2 kWh

Month To Date
95.7 kWh

Lifetime
4.91 MWh

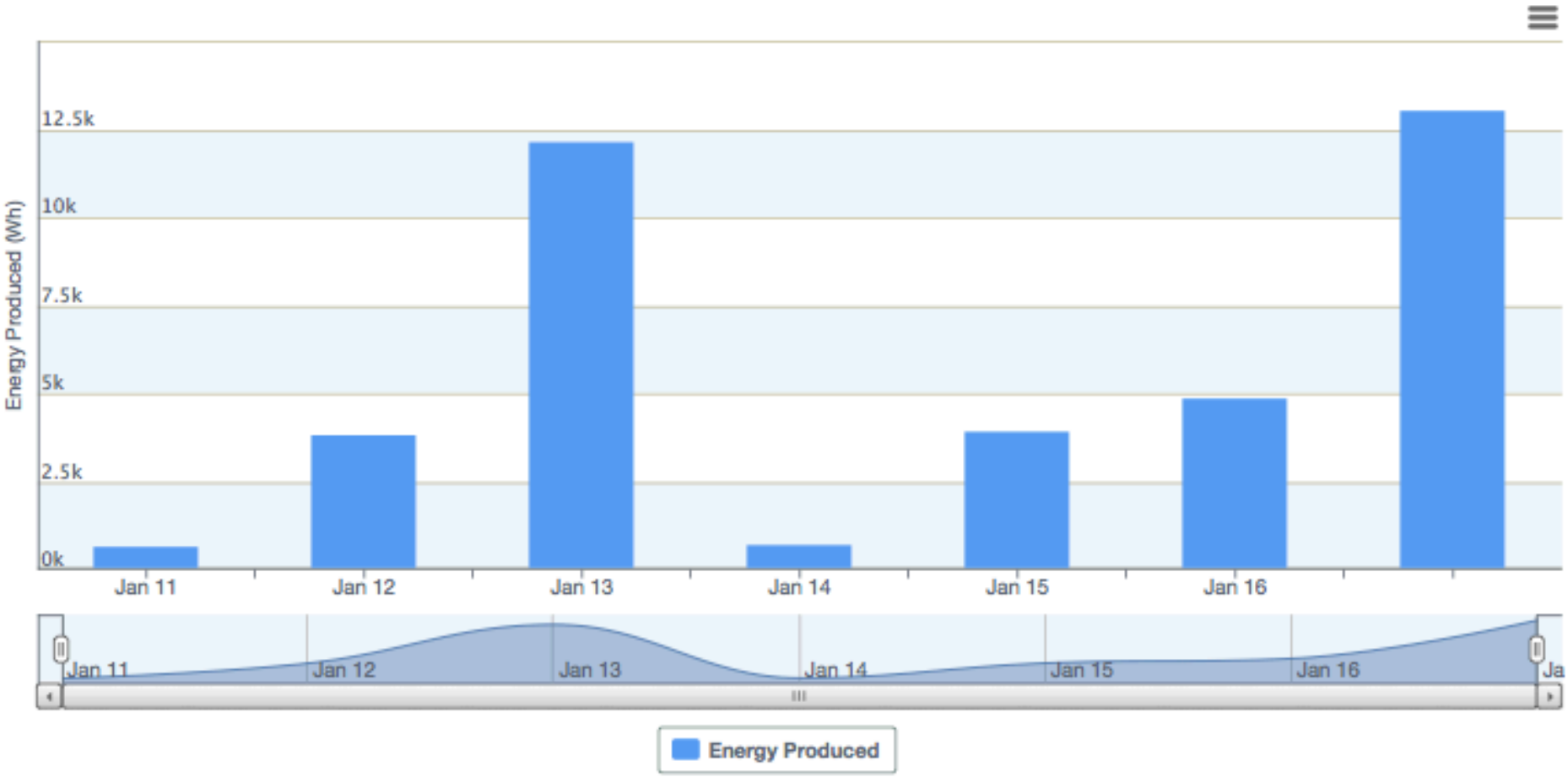
Feedback

[e] enphase ENERGY

Bryn Mawr College Full System

View | Graph | Reports | Devices

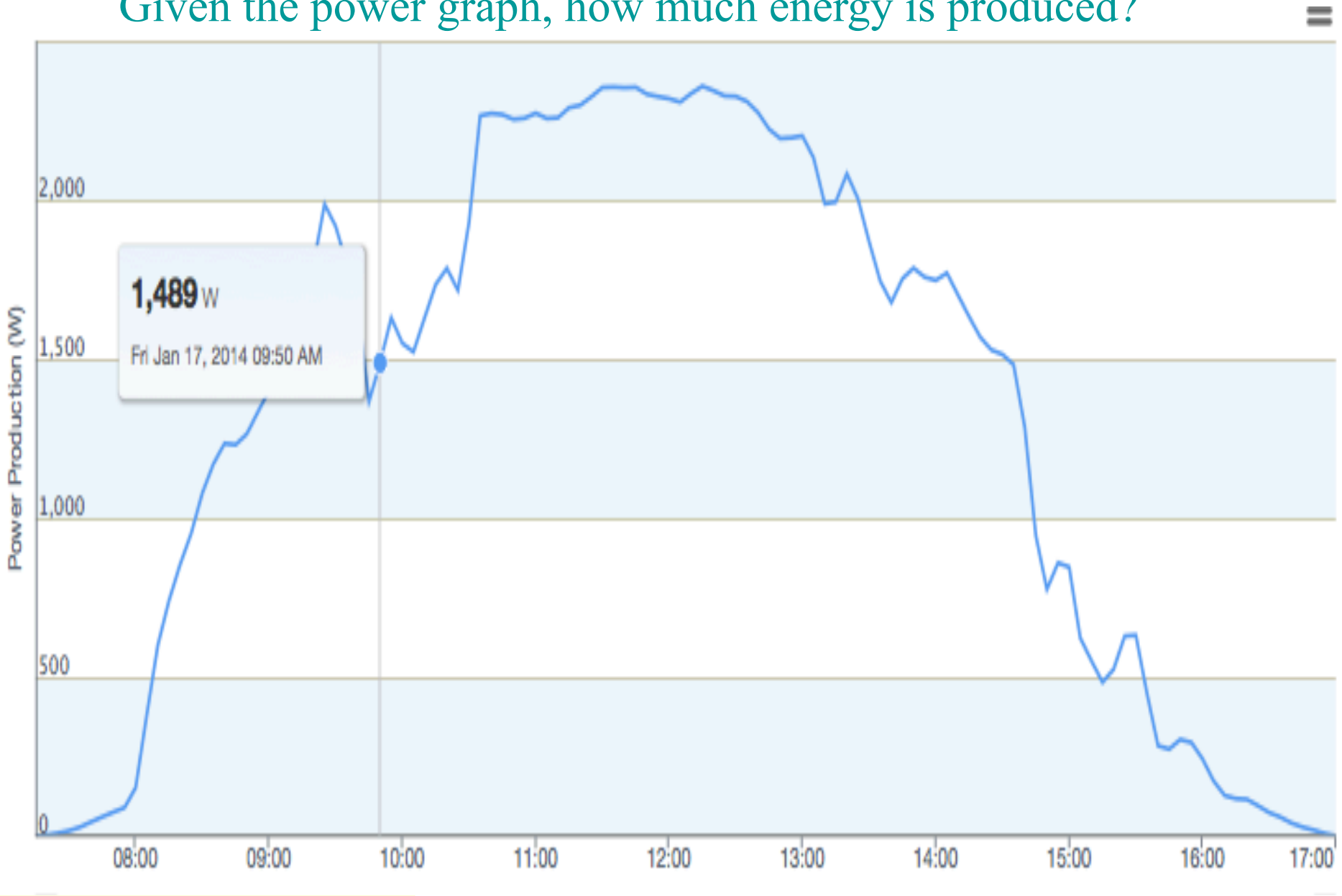
Energy: Past 7 Days Jan 11, 2014 – Jan 17, 2014



Maximum Produced
13.0 kWh

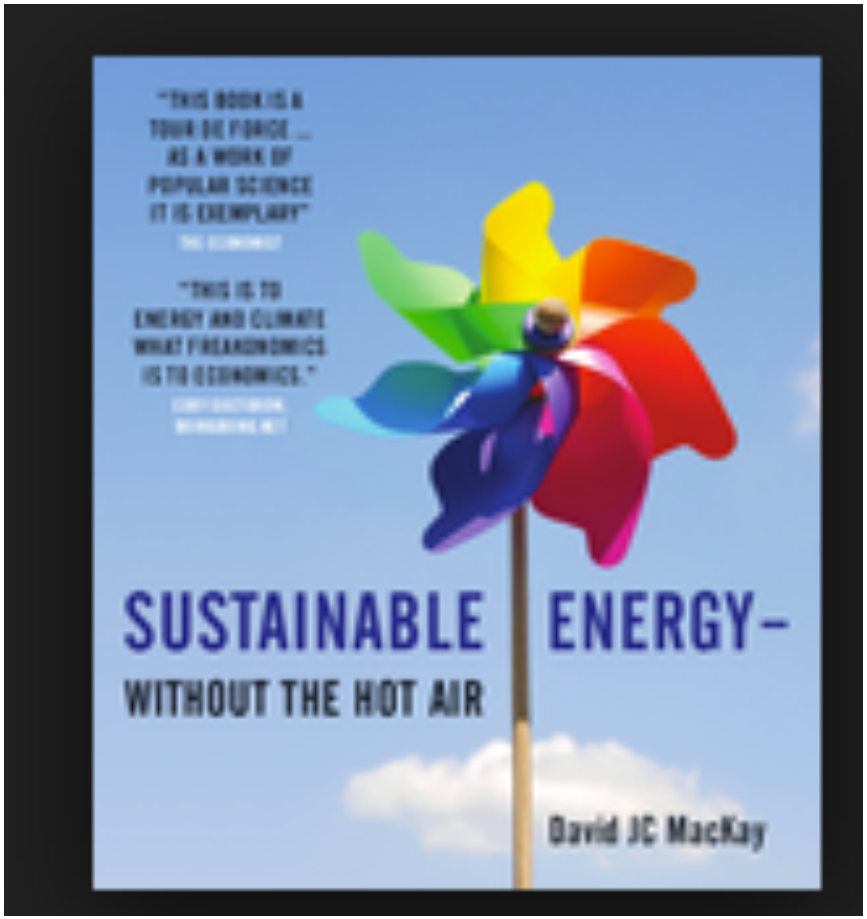
Total Energy
39.2 kWh

What is the relationship between power and energy?
Given the power graph, how much energy is produced?



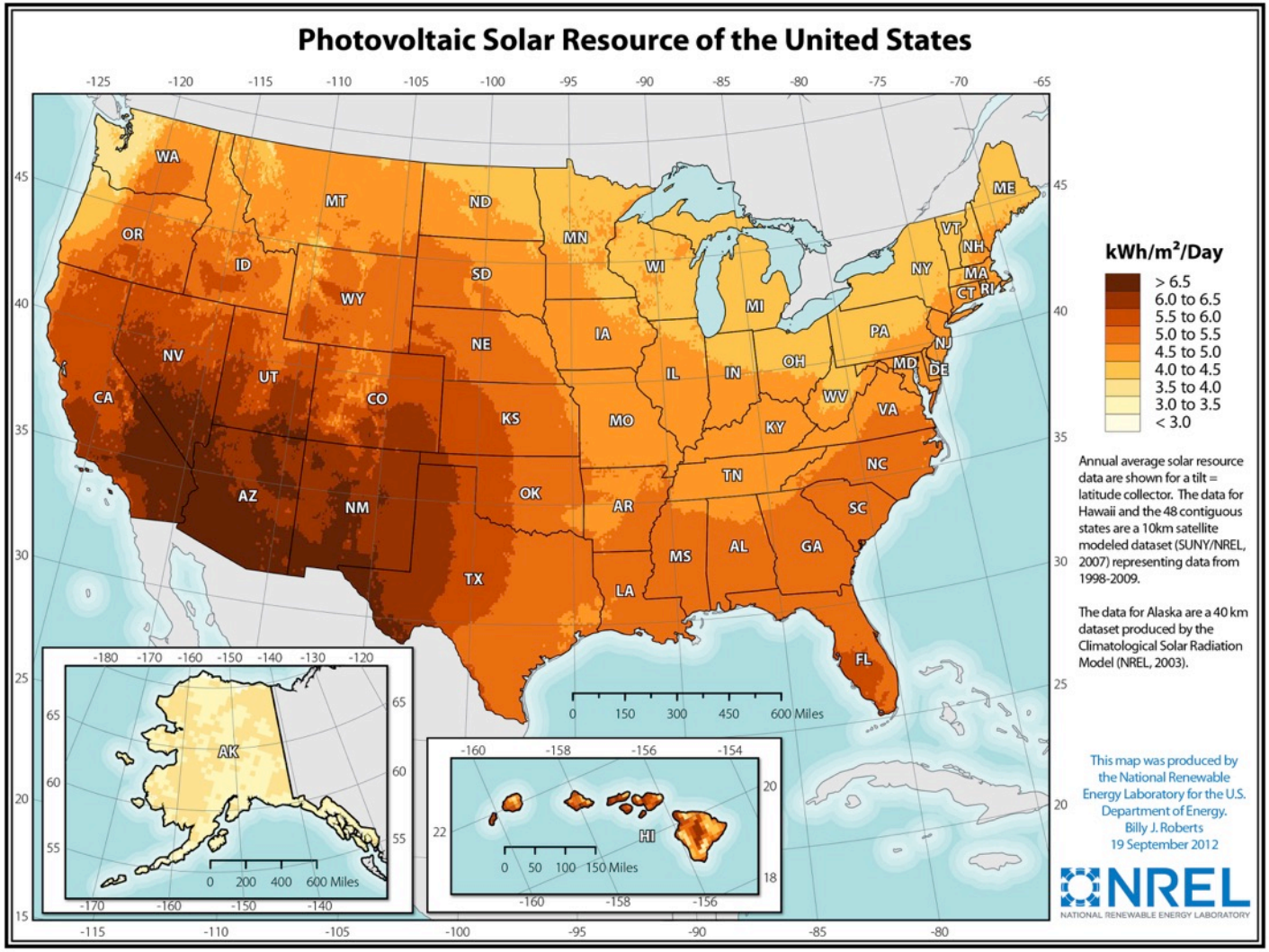
Sustainable Energy without the Hot Air
David JC MacKay

Can we meet our energy needs using renewables?



http://www.withouthotair.com/

National Renewable Energy Lab (NREL):www.nrel.gov/gis/solar.html



Student Mini Presentations

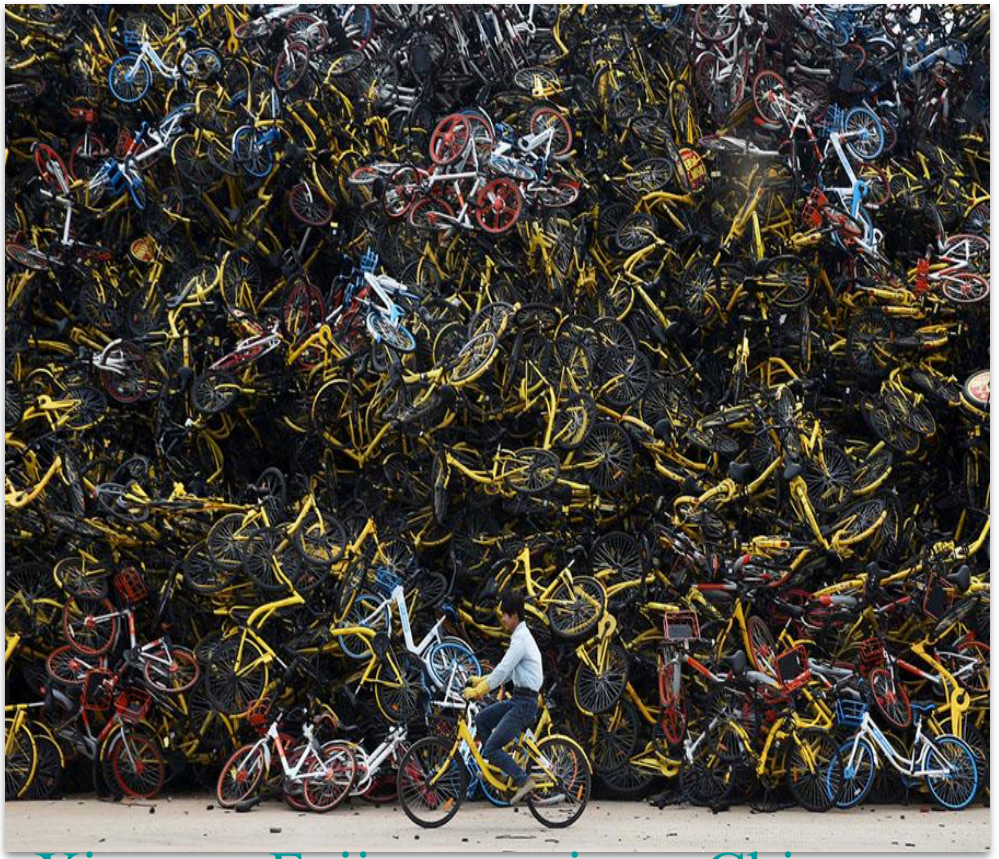
Dockless Bike Sharing - Sustainable or Not?

Charlotte Lin

- Start in San Diego in Feb & spread in North County coastal communities
- Short-term rentals based on phone app.
- Can pick up in one and leave is anywhere else within the company's service area.
- Reduce pollution & encourage more people to get out of their vehicles and exercise

However

- Parked bikes blocking busy sidewalks
- Riding illegally on the sidewalks
- People riding without helmets
- The idea began in China, where it spreads rapidly to more than 200 cities
- Large markets have become saturated with the service



Xiamen, Fujian province, China, on December 13, 2017.

Links:
https://www.theatlantic.com/photo/2018/03/bike-share-oversupply-in-china-huge-piles-of-abandoned-and-broken-bicycles/556268/
http://www.sandiegouniontribune.com/communities/north-county/sd-no-bike-share-20180305-story.html

Transforming German Cities Into Organic Food Gardens

Biostädte (organic cities):

- Growth of urban centers and food security/quality
- Make food production healthier/more sustainable
- Promote organic farming
- Increase share of local organic food in public institutions

Increase demand organic products

Urban agriculture

Reduce costs

http://www.dw.com/en/transforming-german-cities-into-organic-food-gardens/a-42460922

Dutch Supermarket Introduces Plastic-Free Aisle

South Korea Reduces Capital Food Waste

Separating food waste from garbage waste is required by law

This policy in Korea has decreased food waste overall by 10% by more than 300 tons a day and increasing percentage by the year.

Hee-Eun Kim

World Hacks: A surprising new afterlife for chewing gum

http://www.bbc.com/news/stories-43198104

- The second most common street litter
- UK spends £50m each year cleaning up gum
- Anna Bullus, founder of Gumdrop, is trying to reuse chewed gum and transform it into meaningful things, such as boots, phone covers, and packaging

Madelin
e

NEGATIVE IMPACT AREAS OF THE APPAREL INDUSTRY

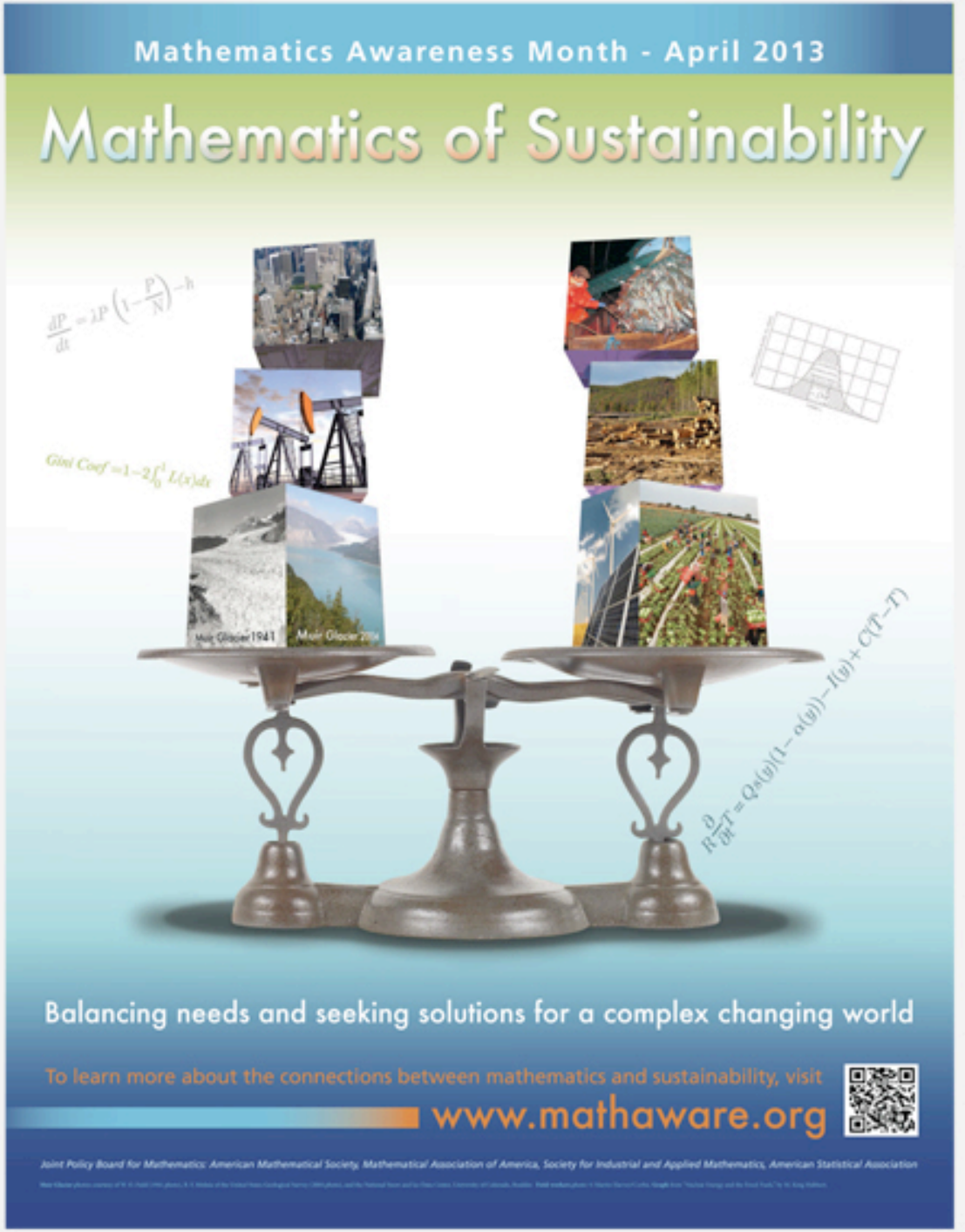
Kamikatz Public House

https://www.forbes.com/sites/yjeanmundelsalle/2018/03/25/the-design-of-kamikatz-public-house-in-a-trashless-town-in-japan-

PUBLIC USES IN TRASH: NEW YORK'S NEWEST NATURAL WONDER

Who had the great idea of putting this park on a capped landfill?

http://www.mathaware.org/mam/2013/



TED Ed

http://ed.ted.com/lessons/is-our-climate-headed-for-mathematical-chaos-victor-j-donnay#review

Is our climate headed for a mathematical tipping point?

Service/Community Based Learning Sustainability Projects (Praxis)

Mechanics

Finding Projects

Student voice in selecting their project

Managing Expectations

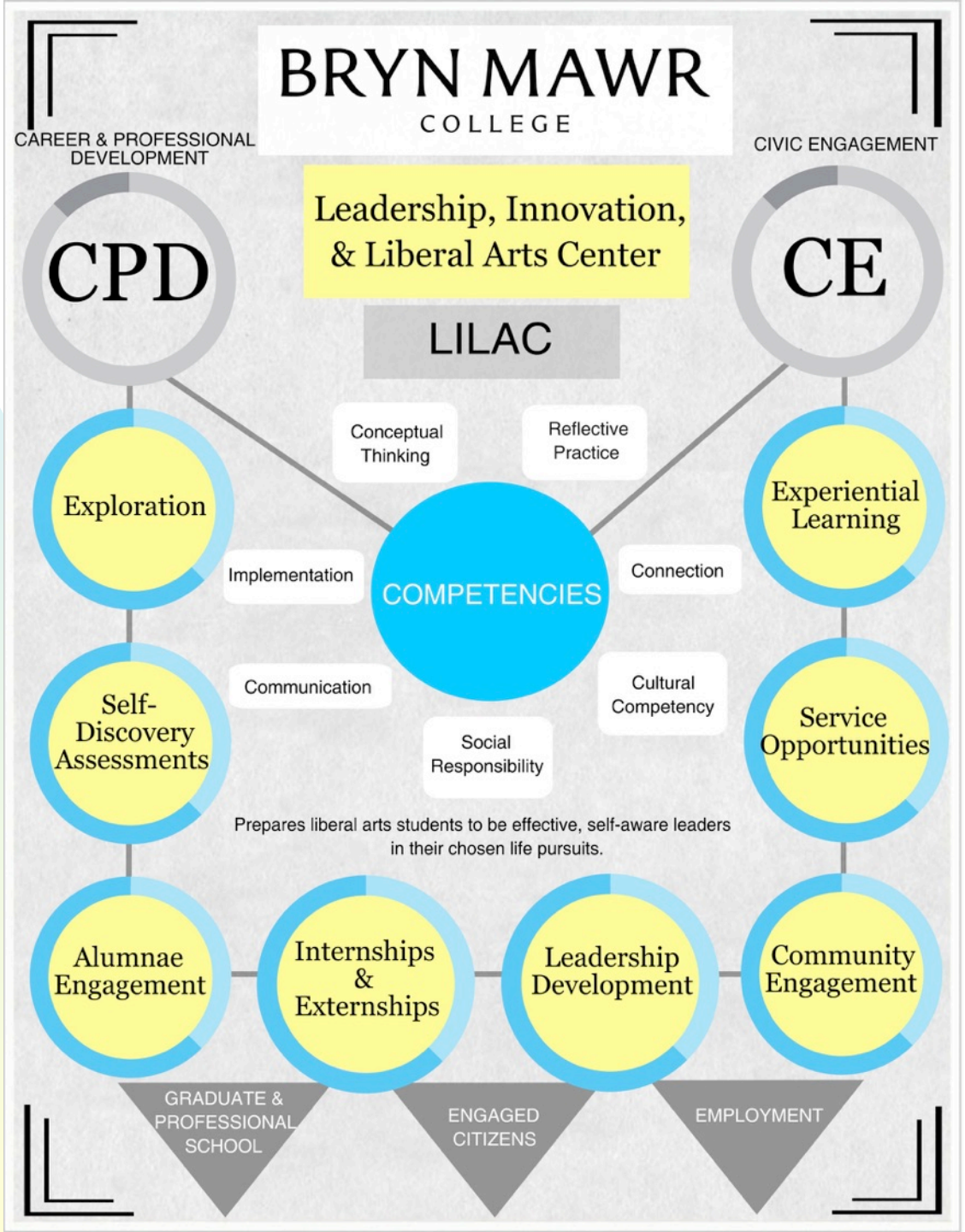
Linking to learning goals

Keeping track of student progress

Final presentation/ report


txt file._ WC
Ngram
Igram
Unigram
The Energy Co-op
Sustainable Energy
Community Powered


EQAT


BRYN MAWR
COLLEGE
CAREER & PROFESSIONAL DEVELOPMENT
CIVIC ENGAGEMENT
CPD
Leadership, Innovation, & Liberal Arts Center
CE
LILAC
Conceptual Thinking
Reflective Practice
Exploration
Experiential Learning
Implementation
COMPETENCIES
Connection
Communication
Cultural Competency
Self-Discovery Assessments
Service Opportunities
Social Responsibility
Prepares liberal arts students to be effective, self-aware leaders in their chosen life pursuits.
Alumnae Engagement
Internships & Externships
Leadership Development
Community Engagement
GRADUATE & PROFESSIONAL SCHOOL
ENGAGED CITIZENS
EMPLOYMENT

Sustainability Service Learning Projects (Praxis)

College Partners

Dining Services:

- Trays in dining hall
- Composting
- Freight Farming*

Facilities Department

- Trash audits
- Landfill or Incinerator
- Energy savings in buildings from conservation mode
- Pay back time for LED bulbs
- On/Off switch for Chemistry hoods
- Energy footprint for Science building renovation

Admissions Office

- Paperless admissions system

Sustainability Service Learning Projects (Praxis)

Community Partners:

- Energy efficiency at Retirement Center
- Math education materials on recycling for School District
- Storm water management via rain gardens*
- EQAT social action: social cost of carbon*

Local Governments

- Alternative energy system for township recreation center
- Level of safety analysis for bike routes
- Which city owned buildings would be best candidates for solar panels? *

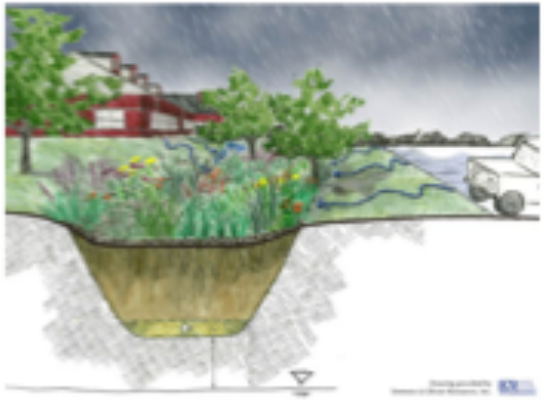
Businesses:

- Comcast: Electric service vans – home garaging or central garage?*

Freight Farm Team: Justification of Purchase

Goal: Produce a cost benefit analysis for a Freight Farm to present to the college. Through out analysis, freight farm will make Bryn Mawr a socially responsible presence in the
community in a way that well rewards the initial purchase.

Watershed Project
To reduce flooding, build rain gardens!



Cost of carbon: $40/metric ton

31% coal, 31% natural gas, 4% renewables plus nuclear

Social cost in the decade 2025-2035:	$6.5 billion
Increase renewables to 20%, decrease coal:	$2.9 billion
Savings:	$3.5 billion

Solar Team

Situation: Office of Sustainability in Philadelphia wanted to know which buildings would be the best for installing solar panels.

Which city owned buildings would be best candidates for Solar panels?

Solar Team

Situation: Office of Sustainability in Philadelphia wanted to know which buildings would be the best for installing solar panels.

#1 building, the Philadelphia Detention Center, could produce a savings of $170,000 per year in electricity costs.

Comcast Team

Problem:
Comcast Corp. is considering replacing its gasoline-fueled vans with electric vans in its technician fleet, in order to adopt more sustainable corporate practices.

Our Project:
Conducting cost & benefit analysis for owning a gasoline-fueled fleet vs. an electric-fueled fleet in two parking scenarios: technician home garaging, and Comcast office garaging.

Solution:
A 30-year lifetime cost model and Net Present Value (NPV) calculation for each scenarios.

Cost to operate a gas powered vehicle: $3,247/yr

Electric vehicle: $672/yr

Student Reaction

“I liked that the projects we worked on were meaningful and that this course was extremely applied in nature. It was nice to do something that affected our college and/or community directly”

“ The end results of all the projects were pretty satisfying; it made you feel like you were making a contribution and that you might actually be able to affect something.”

Quantitative Reasoning, Math Modeling

“the math involved in most of these applications was pretty basic”

“… there were more numbers than mathematics involved in our projects.”

Using Sustainability to Incorporate Service-Learning Into a Mathematics Course: A Case Study, Victor Donnay, PRIMUS, Volume 23, Number 6, 1 May 2013 , pp. 519-537(19)

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Best math senior conference everrr! — with Sebastian Tilson, Tapashi Narine, Alisha Pradhan, Hoang Ha, Victor Donnay, Lynne Ammar, Julia Yoo, Wendy Shengyun Huang, Linda Yoo and Dorothy Shu.

Tag Photo | Add Location

Like · Comment · Stop Notifications · Share

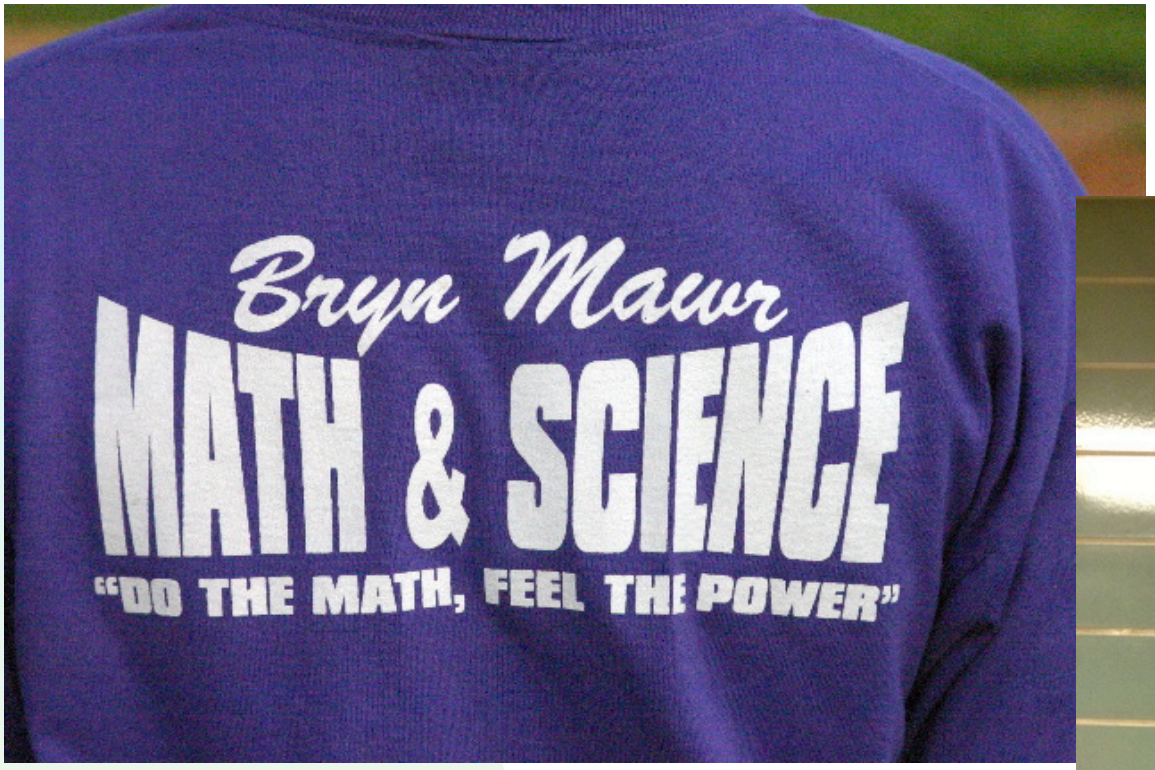
Alisha Pradhan, Lynne Ammar and Linda Yoo like this.

2 shares

Lynne Ammar Thanks Julia lol
December 12, 2012 at 12:59am · Like

Wendy Shengyun Huang A great semester with you~
December 12, 2012 at 10:31am · Like

Yashaswini Singh This has been my favorite math class in all 4 years! :')
December 12, 2012 at 1:27pm · Like · 3

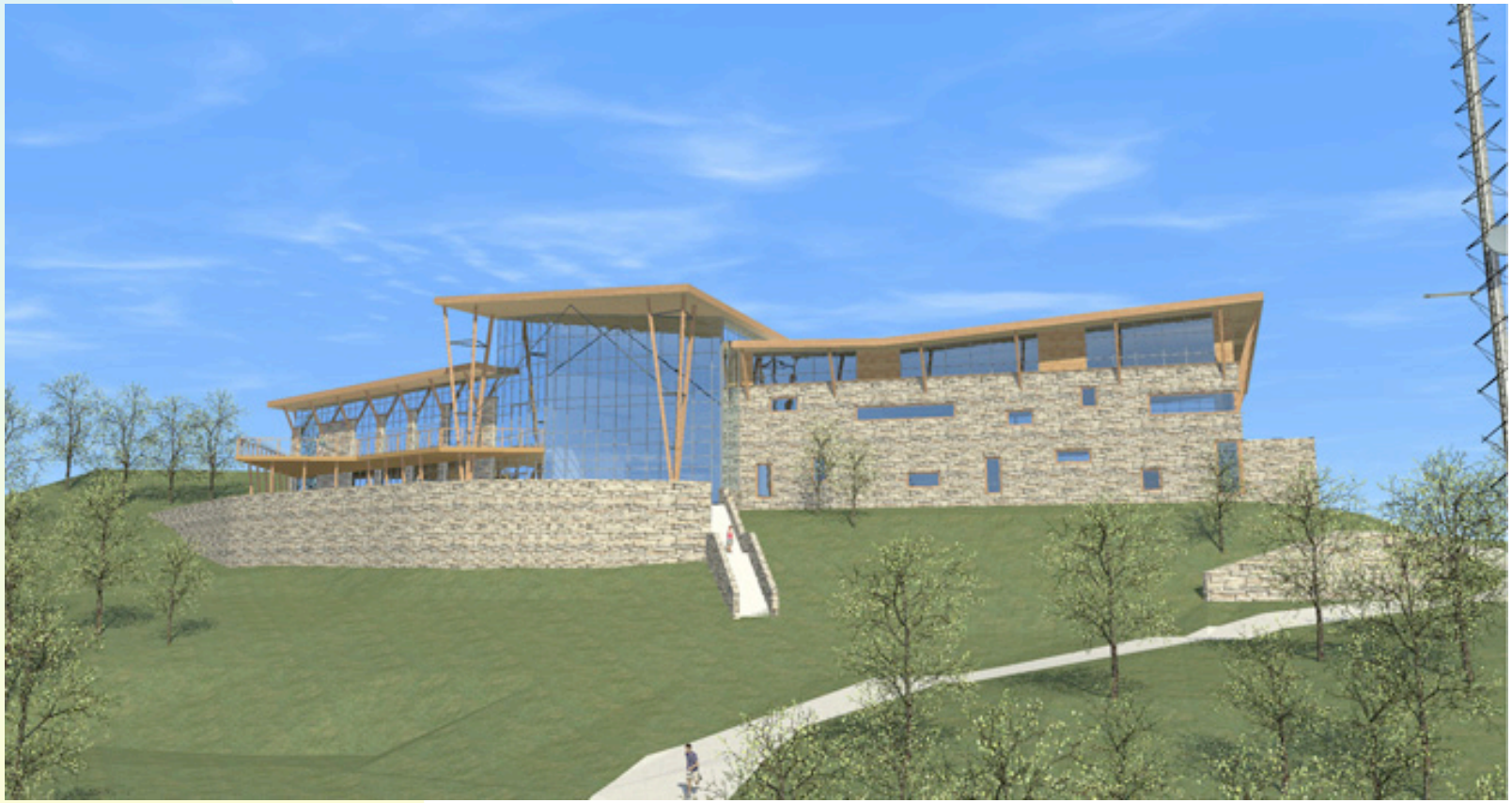


2012 AMS Exemplary Department Award

2012 AMS Exemplary Department Award

Haverford 2011

Recreation and Environmental Education Center



Math and Sustainability:

Cost – Benefit Analysis for Commissioners

Bethany Giblin, Amy Veprauskas, Jenny Sichel, Teresa Palasits

PROCLAMATION

WHEREAS: the Board of Commissioners takes great pride in recognizing those people who perform outstanding contributions for the good of the township and its residents; and

WHEREAS: the Community Recreation Environmental Center will be a showcase for the residents of Haverford Township for many years, contributing to residents' health; as well as educating the residents about ways to preserve the environment and appreciate nature; and

WHEREAS: the Board of Commissioners adopted a Climate Action Plan in 2008 to serve as a model of leadership in reducing the carbon footprint in the township, and this past June, approved that a geothermal system be included in the design of the Community Center; and

WHEREAS: Katie Link and Yufan Wang, students at Bryn Mawr College, worked diligently under the direction of Professor Victor Dunnay in assisting Tim Denny to make the deadline in successfully applying for a $300,000 grant from the Pennsylvania Energy Department Authority, to help fund the geothermal system - which will save over $2 million dollars in energy costs; as well as greatly reducing the carbon footprint over the lifetime of the building.

NOW, THEREFORE BE IT PROCLAIMED, that the Board of Commissioners wish to formally thank Katie Link and Yufan Wang and acknowledge their extraordinary effort on this project and wish them every success as they continue their life's pursuits.

TOWNSHIP OF HAVERFORD

BY: WILLIAM F. WECHSLER
President

Attest: Lawrence J. Gentile
Township Manager/Secretary

Sustainability Projects for Math Senior Seminar

- Trays in dining hall
- Energy savings in buildings from conservation mode.
- Pay back time for LED bulbs.
- Paperless admissions system
- Level of safety for bike routes
- On/Off switch for Chemistry hoods.
- Composting
- Trash audits
- Alternative Energy for recreation center

Mathematics Awareness Month 2013

On Aug 30, 2012, at 8:00 AM, Robert Daverman, AMS Secretary wrote:

Dear Professor Donnay,

I am writing with hopes of interesting you in chairing the Advisory Committee for next year's Math Awareness Month. The theme will be "Mathematics and Sustainability”

Mathematics Awareness Month 2013: The Mathematics of Sustainability

http://www.mathaware.org/mam/2013/

Essays at: http://www.mathaware.org/mam/2013/essays/

Sustainability Counts! Educational materials: http://www.mathaware.org/mam/2013/sustainability/

Teaching Units:

- CO_2 levels
- Artic Sea Ice
- Solar Panels

Other Resources: http://www.mathaware.org/mam/2013/related/

The Practical, the Sublime, and the Sinister

by David Shiller, Lighting Solution Development

"Why do we have a global environmental crisis? How did humanity get to this point? The deeper I dug, the more philosophical the issues became….."

Turning Point by Fritjof Capra

Descarte: Rationalist, mechanistic, and reductionist thinking

Mathematical ideas shape our worldview of man as separate from and above nature.

Our mathematics is a direct contributor to the global environmental crisis.

Descarte
“I think, therefore I am”

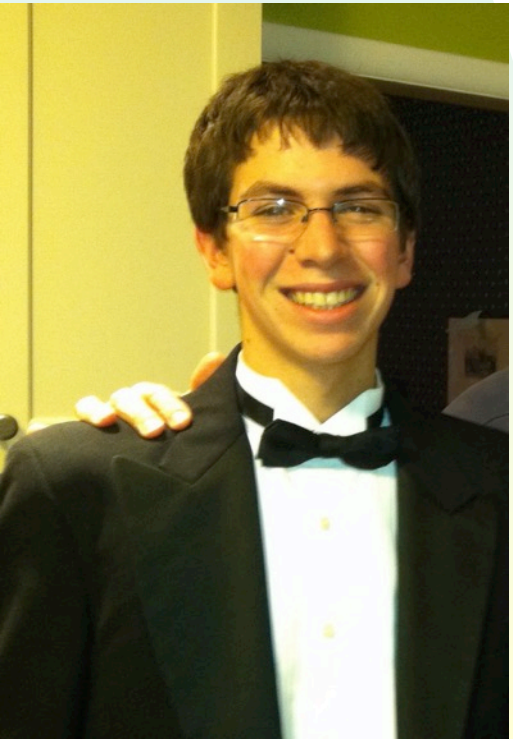
Descarte
“I think, therefore I am”

Holistic View
“We are connected to each other and to the earth, therefore we are”

Think, Pair, Share

What do you love about nature and the environment?

2012 AMS Exemplary Department Award




Calc
Prob/Stat
Alg II
Mathematics of Sustainability

Math to Life Connections
Final Project Multivariable Calculus

Take some topic in the world in which you are interested and some topic from our course and show how they are connected.

Thanks to Mrs. Jane Scanlon, Coopertown Elementary School, 1st grade teacher.

Everyday Math Program

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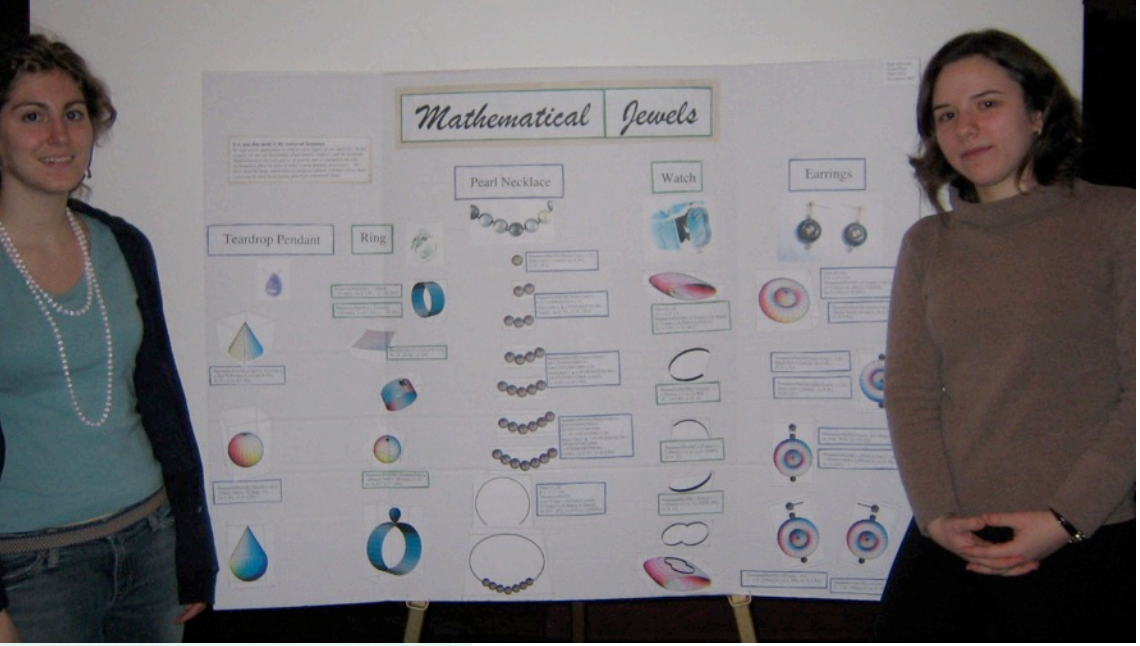
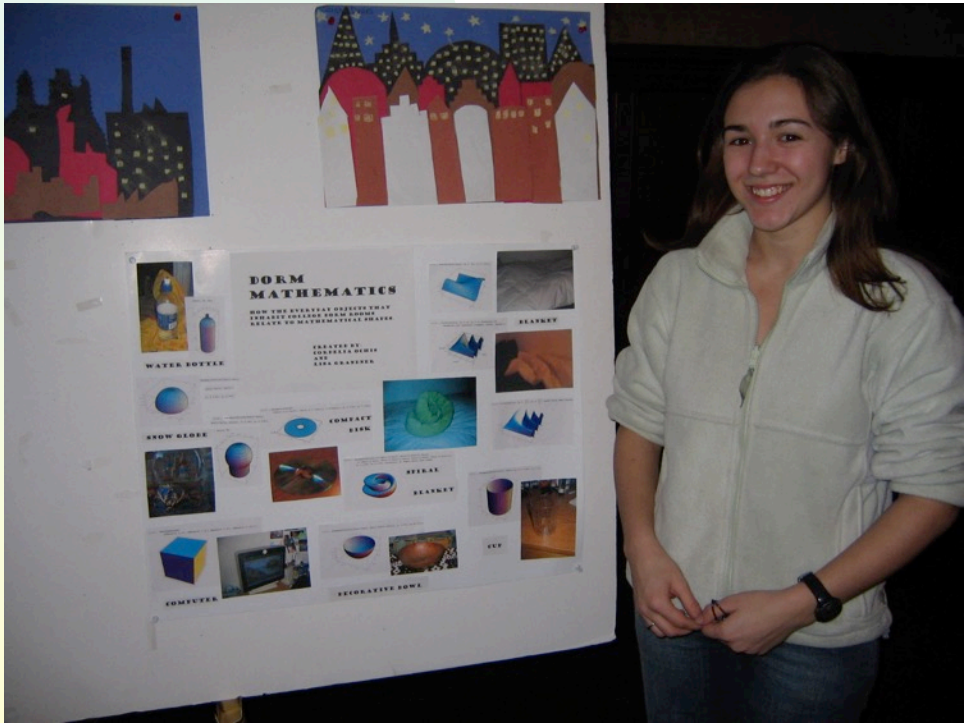
WHAT'S YOUR FUNCTION ?


Multivariable Japanese
Calculus in Architecture
Carolyn Graybeal & Sarah Jang


Mathematical Jewels
Pearl Necklace
Watch
Earrings
Teardrop Pendant
Ring


DORM MATHEMATICS

REU Summer Program

REU Summer Program

Research Experience for Undergraduates

TEU Summer Program

TEU Summer Program

Teaching Experience for Undergraduates

REU Summer Program

Teaching Experience for Undergraduates

Summer 2016:
Math Education at Brown University
Science Education at Trinity University

How People Learn: Brain, Mind, Experience, and School

National Academy of Science

Washington, D.C.

Three Key Principles

How People Learn: Brain, Mind, Experience, and School

National Academy of Science

Washington, D.C.

Three Key Principles

0. To learn, people need to be interested and motivated.

The New Science of Learning

Three Fundamental Principals of Learning

Key Findings	Implications for Teaching
1. Students come to the classroom with preconceptions about how the world works. New understandings are constructed on a foundation of existing understandings and experiences. If their initial understanding is not engaged, students may fail to grasp the new concepts and information that are taught, or they may learn for purposes of a test but revert back to their preconceptions outside the classroom.	1. Teachers must draw out and work with the preexisting understandings that their students bring with them including misconceptions.

The New Science of Learning

Three Fundamental Principals of Learning

Key Findings	Implications for Teaching
2. To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.	2. Teachers must teach subject matter in depth, providing many examples in which the same concept is at work and providing a firm foundation of factual knowledge. Teachers should help students organize their knowledge into a coherent structure using key concepts.

The New Science of Learning

Three Fundamental Principals of Learning

Key Findings	Implications for Teaching
3. A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. '	3. The teaching of metacognitive skills should be integrated into the curriculum in a variety of subject areas.

3 Key Principals of HPL

0. To learn, people need to be interested and motivated

1. Pre-existing knowledge, misconceptions, connect old and new knowledge

2. Factual knowledge organized around key concepts

3. Meta-cognition

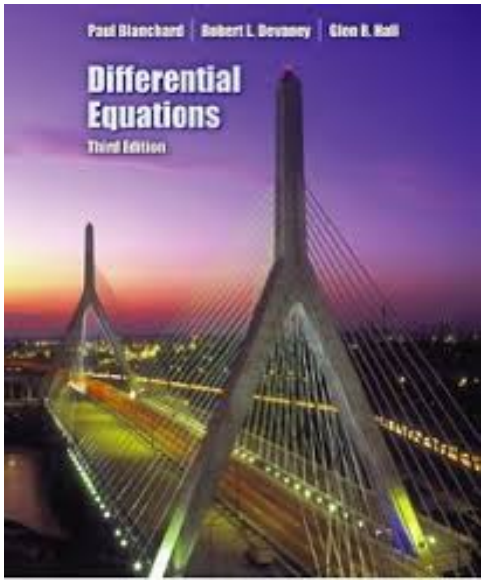
Applying Principles of How People Learn to our Teaching

1. How do we find out what students pre-existing knowledge/misconceptions are? How do we link new material to students' pre-existing knowledge?

2. What are the key concepts in the courses we teach? How can we determine if students have learned these key concepts?

3. How do we give students opportunities to think about their thinking?

Differential Equations and Modeling



Blanchard, Devaney, Hall text

Dynamical Systems approach

Qualitative methods

Environmental/Sustainability applications

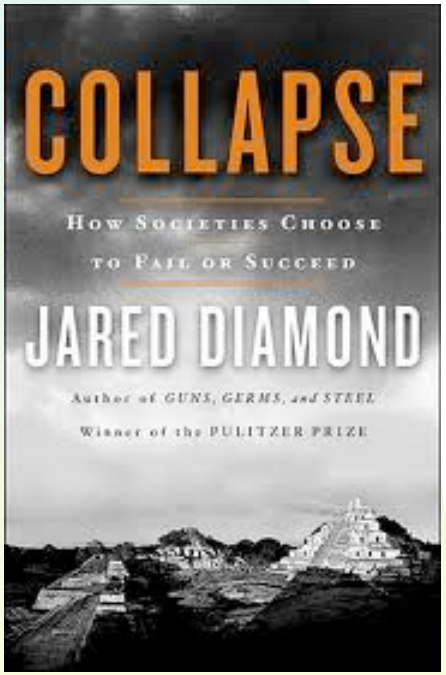
Population Growth

Bifurcations – Tipping Points

Use Readings from Interesting Books

Jared Diamond

Collapse: How Societies Choose to Fail or Succeed.

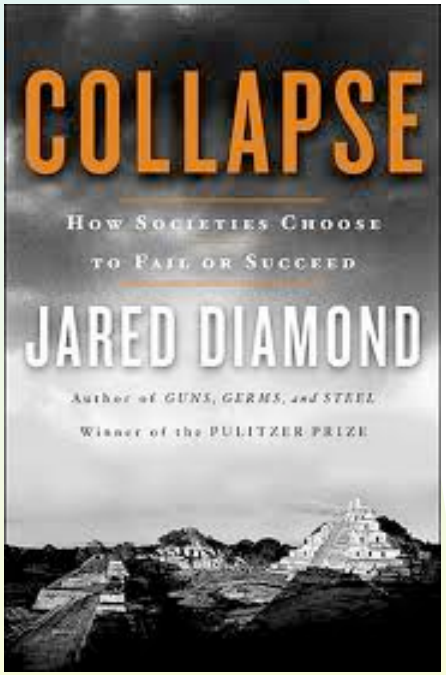


What links do you see to topics from our course?

Use Readings from Interesting Books

Jared Diamond

Collapse: How Societies Choose to Fail or Succeed.



Rwanda: Genocide

Use Readings from Interesting Books

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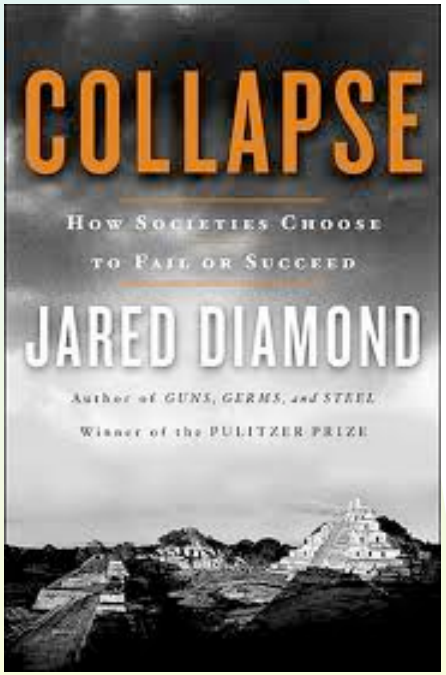

Rwanda: Genocide

Contributing factor: over-population

Population growth: Exponential

$$\frac{dP}{dt} = kP \Rightarrow P(t) = P_0 e^{kt}$$

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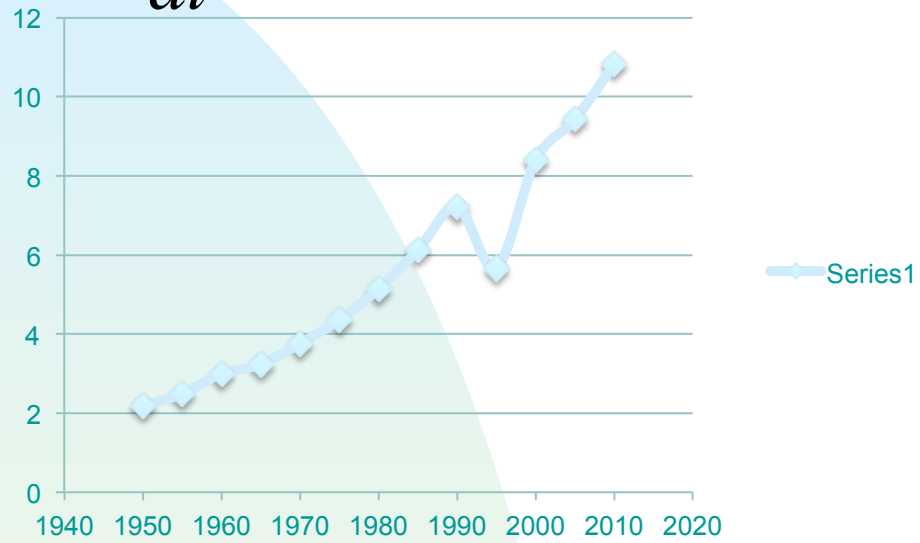


Year	Rwanda Population (millions)
1950	2.186
1955	2.485
1960	2.993
1965	3.233
1970	3.754
1975	4.359
1980	5.141
1985	6.113
1990	7.214
1995	5.664
2000	8.396
2005	9.429
2010	10.814

Population Growth (Wen Gao, BMC '07: Math and Social Justice Conference, Lafayette College 2006)

1. What does the book claim is the relative growth rate of the Rwanda population (k value)?

2. What would be the doubling time with this relative growth rate?

3. Looking at the population data table, calculate the relative growth rate (k) of population using the data from 1980 and 1985.

4. With this k value, predict Rowanda's population n in 1995. Does your prediction agree with the value given in the table? Discuss reasons for the difference.

Population growth:

What are problems with the Exponential Model?

Population growth:

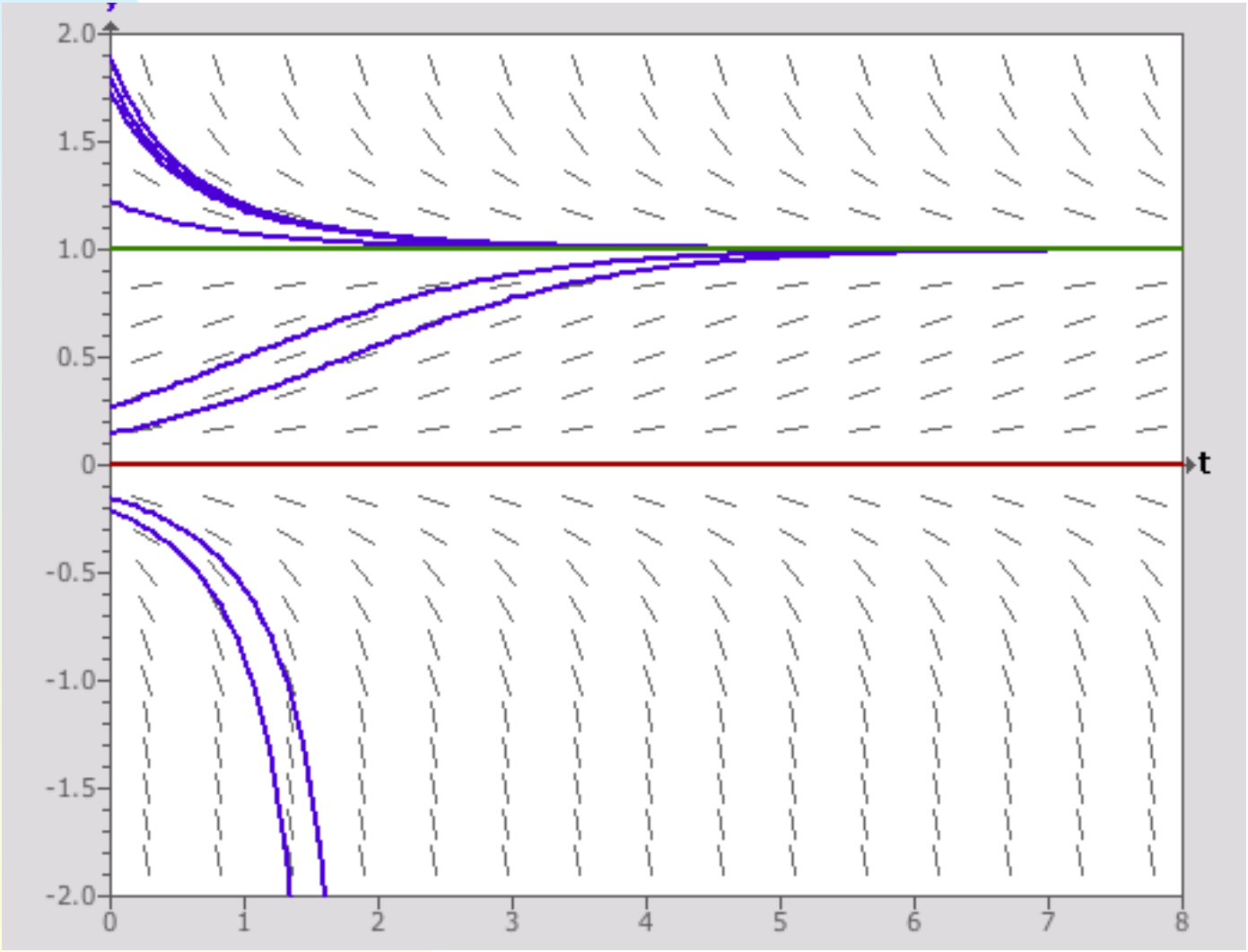
What are problems with the Exponential Model?

Logistic model – limits to growth

Carrying capacity N

$$\frac{dP}{dt} = kP(1 - P/N)$$

Logistic Population growth: $\frac{dP}{dt} = kP(1 - P/N)$



Phase line

Logistic Population growth with harvesting

"h" members of population harvested per year

$$\frac{dP}{dt} = kP(1 - P/N) - h$$

What types of populations can be "harvested"?

Logistic Population growth with harvesting

"h" members of population harvested per year

$$\frac{dP}{dt} = kP(1 - P/N) - h$$

What types of populations can be "harvested"?

Key Concept:
Tipping Points = Bifurcations

TED Ed

TED Ed

Is our climate headed
for a mathematical tipping point?

Lead-in to Tipping Points

Collapse

Easter Island

Lead-in to Tipping Points

Collapse

Easter Island

What factors contributed to the collapse of the society?

Fishbanks: A Renewable Resource Management Simulation

DEVELOPERS
Dennis Meadows, John Sterman and Andrew King

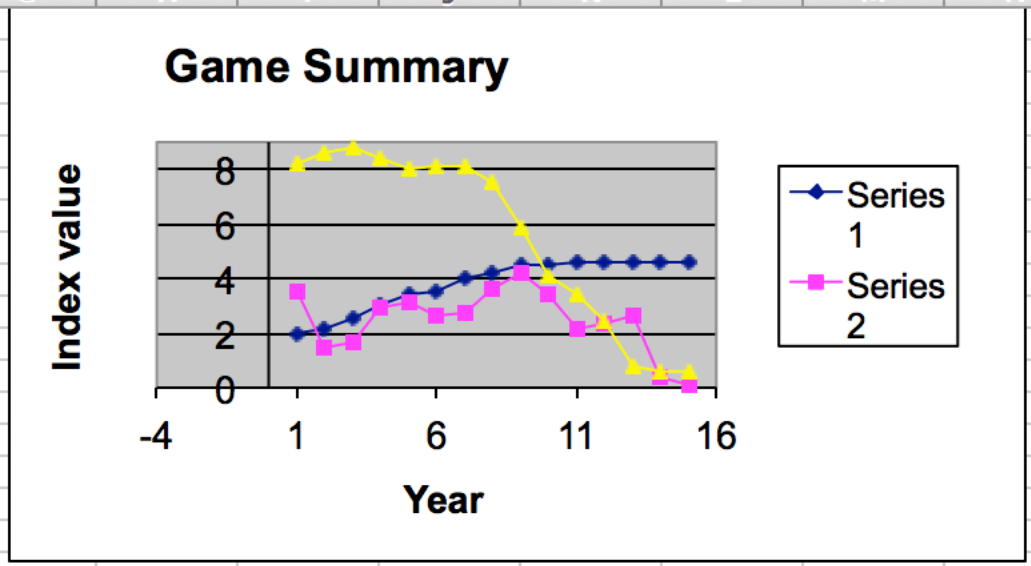
Share

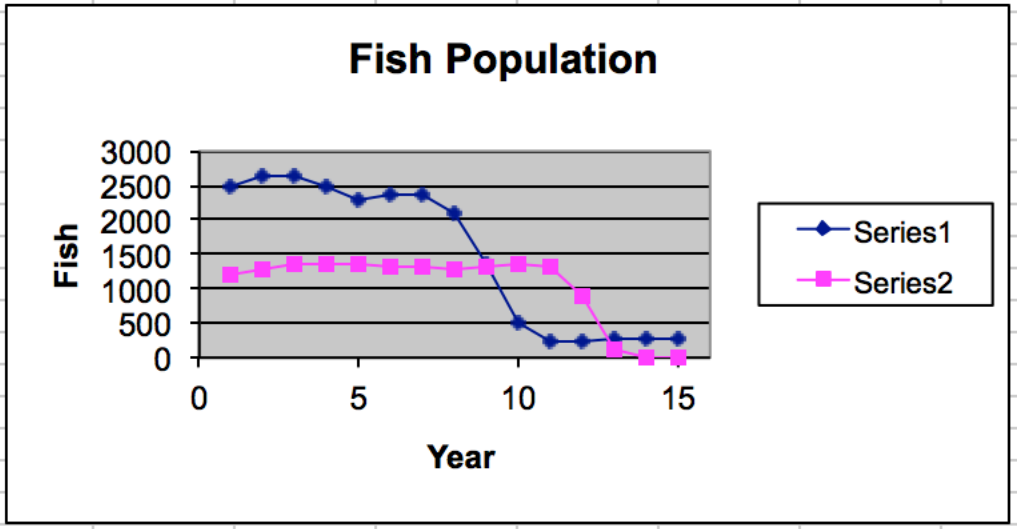
Goal: Maximize your profit

Year	Deep Sea	Coastal	Ship	Catch	Fish
1	2500	1200	2	3.5	8.2
2	2622	1288	2.2	1.5	8.6
3	2625	1348	2.5	1.7	8.8
4	2476	1346	3	2.9	8.4
5	2281	1353	3.4	3.1	8
6	2357	1319	3.5	2.6	8.1
7	2378	1305	4	2.7	8.1
8	2100	1299	4.2	3.6	7.5
9	1360	1328	4.5	4.2	5.9
10	504	1375	4.5	3.4	4.1
11	238	1302	4.6	2.2	3.4
12	227	877	4.6	2.3	2.4
13	260	106	4.6	2.6	0.8
14	280	0	4.6	0.4	0.6
15	291	0	4.6	0.1	0.6

Differenential Equations
Spring 2015
15-Feb-15

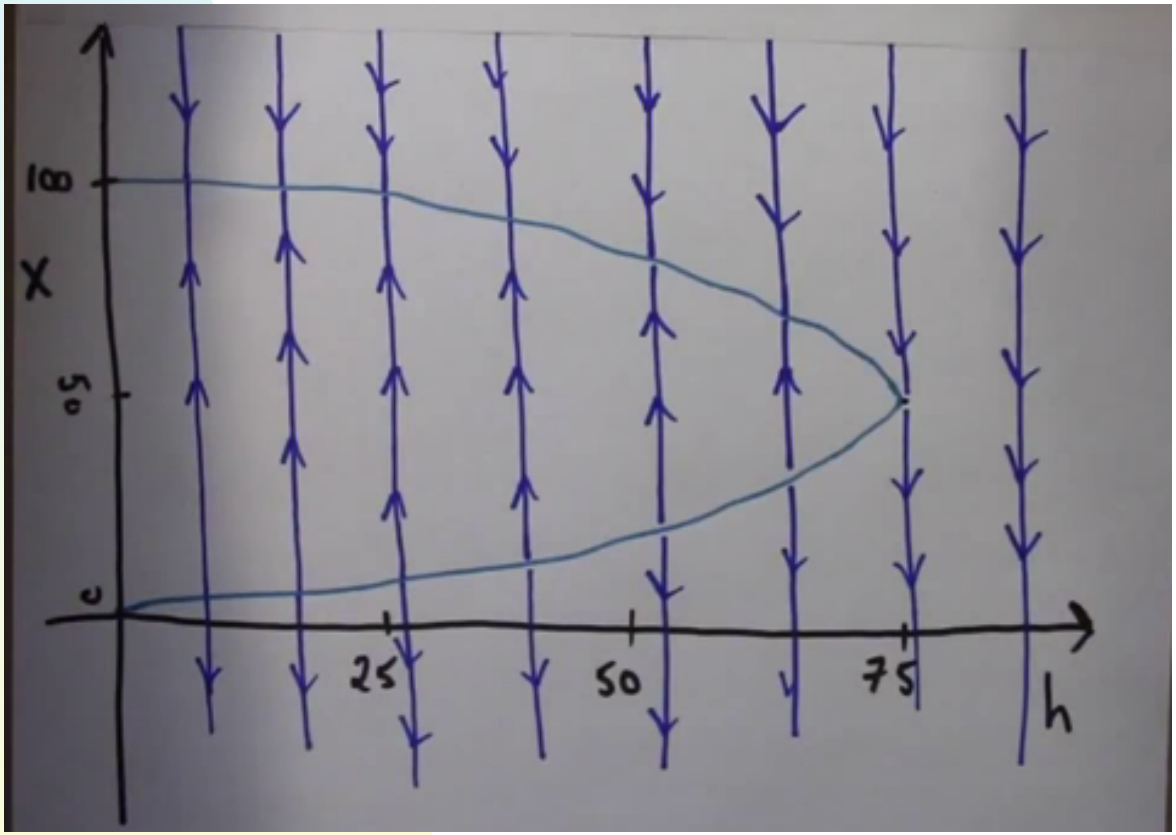
Deep sea and
Inshore fishing





Bifurcation Diagram

$$\frac{dP}{dt} = kP(1 - P/N) - h$$



Created by class via "jig-saw" exercise.

See YouTube video by Jacob Bains: https://www.youtube.com/watch?v=ayuqqcOjBnQ

Bifurcation – Tipping Point:

A small change in the condition of the system (parameter) can lead to drastically different outcomes.

Critical value h_{cr} of fishing/harvesting levels

If $h > h_{cr}$ then the population will ***crash***

$$\frac{dP}{dt} = kP(1 - P/N) - h$$

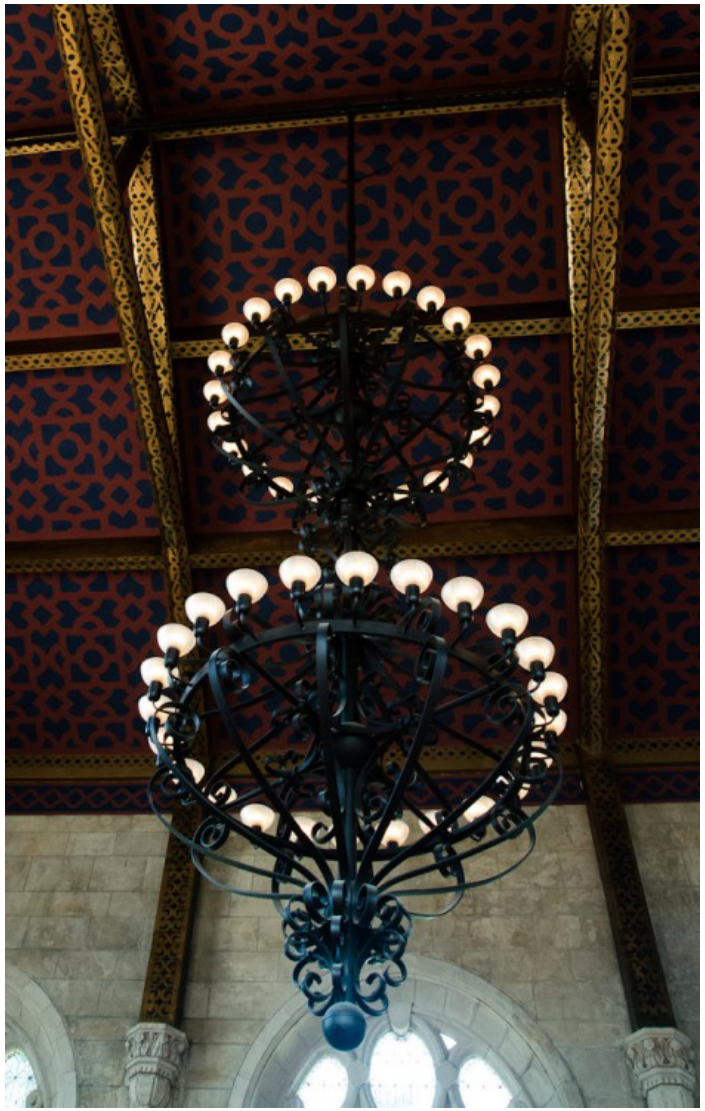
"h" fish caught per year

Sustainability Improves Student Learning (SISL)
http://serc.carleton.edu/sisl

Ben Galluzzo, Shippensburg University
Corrine Taylor, Wellesley College

PREP
Professional Enhancement Programs of the MAA

Replace CF bulbs with LED.



1164 days.

Assignments:

II. a. Find article about mathematics in newspaper, on web. Post on class website; write a one paragraph summary.

b. Read three other posts and write comments.

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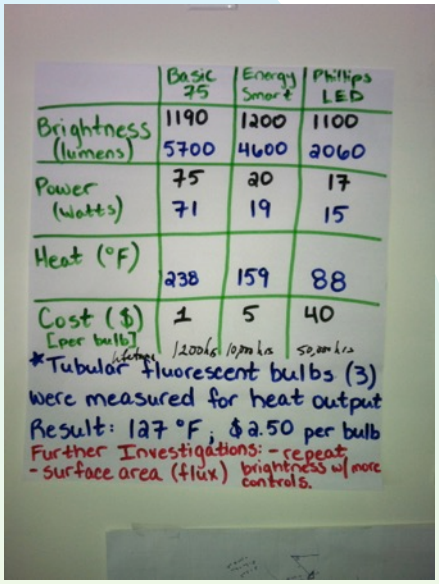
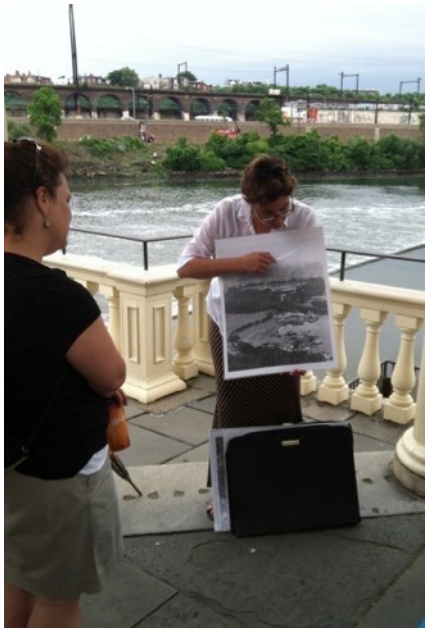
Math and Sustainability Summer Institute for Teachers

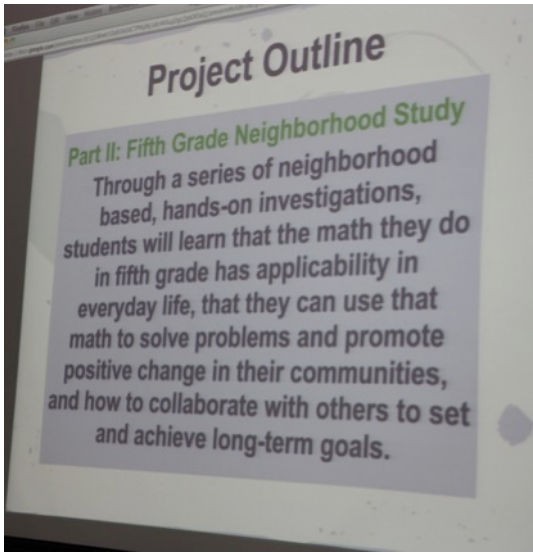
All materials from this institute available free at:
https://docs.google.com/document/d/1Ma9wYo83i10OLBf6R8WdYov0pd534n0yZbcObScYMUw/edit

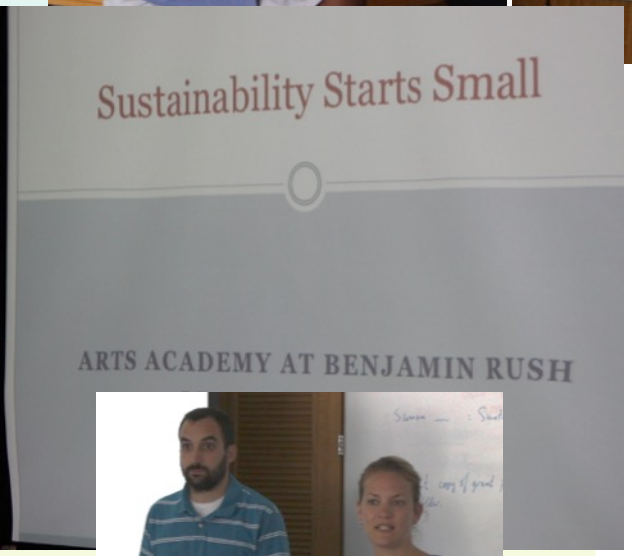


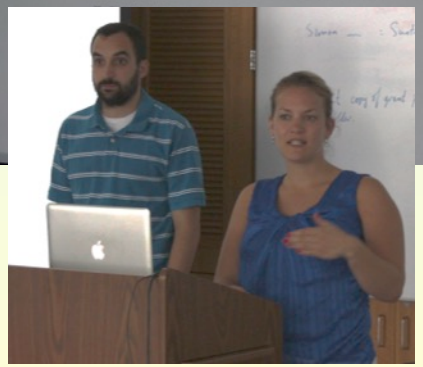


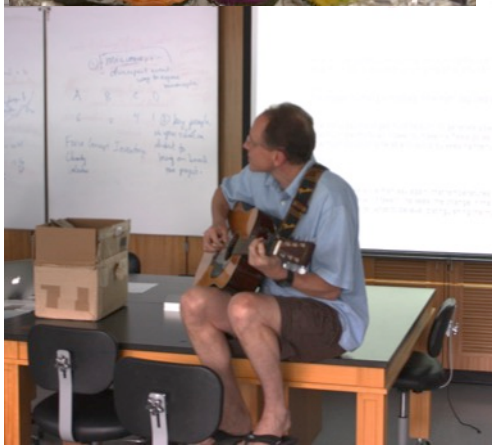
Is it "worth it" to change bulbs?

Math and Sustainability Summer Institute for Teachers









Workshop: Engaging Mathematics

Victor Donnay, Bryn Mawr College,
Brainstorming lessons around recycling and trash to support Philadelphia SD

Tony Dunlap, Normandale Community College,
Math Modeling in a "Math for Liberal Arts" course.
Lake volumes, creek flow, storm water runoff

Cathy Evans, Barbara Gonzalez, Roosevelt University,
College Algebra: Modeling the Chicago Homicide Rate

Alioune Khoule, Mangala Kothari, Marina Nechayeva, LaGuardia Community College,
Elementary Statistics: Learning concepts through social and environmental issues.

1. Demographics of my class, my college and my neighborhood
2. Global warming
3. Basal Metabolic Rate (BMR)

Frank Wattenberg, United States Military Academy,
Data analysis courses at all levels. Keeling Atmospheric Carbon Dioxide Concentration Data to Practice Data Fitting and to Tell a Cautionary Tale About Using Data Fitting for Prediction.

Summary

Launch lesson/unit by connecting to students' previous experience

Give up control

Trust the students and their natural love of learning

Let students have voice – power of student voices to bring about change

Use real data

Link classroom learning with student action

Bring your whole self to the classroom

"If you want to build a ship,
don't drum up people to collect wood and
don't assign them tasks and work, but rather
teach them to long for the endless immensity
of the sea."

Antoine de Saint-Exupéry
As cited in *A Mathematician's Lament*

Thanks Ellie Goldberg, Brown Summer HS Program

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.

William James, Talks to Teachers, 1899.

http://www.uky.edu/~eushe2/Pajares/tt10.html

Thanks David Burns, SENCER

Related Rates:

1. A cylindrical tank with radius 5m is being filled with water at a rate of $3m^3/min$. How fast is the height of the water increasing?

Real World: How fast is sea level rising if the ice in Greenland is melting at a rate of 195 $km^3/year$

2. Airplane A is going east at 420 mph. Airplane B is going north at 375 mph. How fast are they moving apart from one another.

Real World:

Consider two children born to families in different socio-economic groups. One child is born into a middle class family; one into a working class family. The vocabulary of the child with the middle class parents increases at 350 words per year. The vocabulary of the child with working call parents increases at 150 words per year. At what rate is the difference in the size of their vocabularies growing?

Math and Sustainability

- Interdisciplinary topic.
- Authentic issue facing the world.
- Opportunities for Community Based/Service Learning

Assignment:

Connections Paragraphs:

Take a HW problem and describe how the mathematics involved might be used to address a real world problem.

Post your paragraph on Blackboard. Read three other students' posts.

Calculus 1 and 2.

What are students interested in?

What are students interested in?

Ask them!

SUSTAINABLE BY DESIGN

LEED PLATINUM CERTIFICATION

The new Millikan Laboratory and Andrew Science Hall achieved LEED Platinum Certification due to its exceptional construction as a high performance sustainable building. Millikan features a whole-building approach to sustainability in areas such as landscaping, lighting, materials, and alternative energy. Read below to learn more about some of Millikan's green features.

WATER & LANDSCAPING

Millikan's landscaping design removed impermeable asphalt and now features rainwater harvesting and water-efficient landscaping. Landscaping improvements include infiltration trenches and a 75-foot long bioswale. This promotes natural filtration and improves the quality of the stormwater entering the aquifer below. The reconstructed Millikan landscaping **retains 66% more stormwater** than previously. Millikan's landscaping also features a wide variety of plants with low to medium water requirements, as well as drought-tolerant native plants. All plants use high-efficiency drip irrigation. Millikan's landscaping uses **60% less water than traditional landscaping**, while the low-flow plumbing features indoors result in a 42% water use reduction. Total water savings equates to filling **168 hot tubs** each year.

LIGHTING & ENERGY

Millikan features skylights on the north side and horizontal louver shades on the south side of the building. All exterior windows feature solar control glass with low-emissivity coating. The skylights and louvers are designed to provide constant illumination while minimizing unwanted solar heat gain. The windows **transmit more than 70% of visible light** into the building, increasing occupant health and productivity. The windows transmit 50% less unwanted solar heat gain and **insulate 50% better than standard glass**. This and other energy-saving measures such as LED light fixtures, radiant ceiling panels, solar reflecting clay roof tiles, and ceiling fans **reduce the energy of the new Millikan building by 46.6%** compared to a baseline building. The greenhouse gas emissions avoided is equivalent to taking **49.7 homes** off the grid.

INDOORS ENVIRONMENTAL QUALITY

Millikan created a healthy educational environment by using specific interior materials and finishes such as paint, flooring, and composite wood for cabinetry which meet or exceed the highest building air quality standards. **By supplying outdoor air and increasing the supply of air ventilation**, the building's environment promotes occupant comfort, well-being and productivity. During construction, indoor air quality management techniques were implemented and an outdoor air exchange was performed to assure clean air or low Volatile Organic Compounds (VOCs) levels were reached prior to people moving into the building. This process **improved air quality during construction for the workers and after construction for students, faculty and staff.**

SOLAR ELECTRICITY

Millikan produces nearly **16%** of its own electricity needs through on-site renewable energy generation. This comes from 105 solar photovoltaic panels mounted on the roof of the Argue Auditorium rated at 34 kW and a second array of an additional 105 panels on Seaver Hall rated at 35kW. This PV system is a visible sign of Pomona College's commitment to sustainable building and its path to carbon neutrality. The renewable energy produced by the PV panels offsets the same amount of carbon sequestered by **60.7 acres of US forests annually**.

Sustainable by Practice

LEED® DYNAMIC PLAQUE™

The LEED Dynamic Plaque™ you see on the wall measures, monitors, and scores Millikan's real-time building performance. **The plaque recalibrates** the LEED score based on the current energy and water use for the building. The waste points are calculated through regular waste audits. Occupant surveys evaluate commuting methods and comfort levels to determine transportation and human experience scores. The Dynamic Plaque measures operational outcomes and connecting occupant behavior to the building's environmental design.

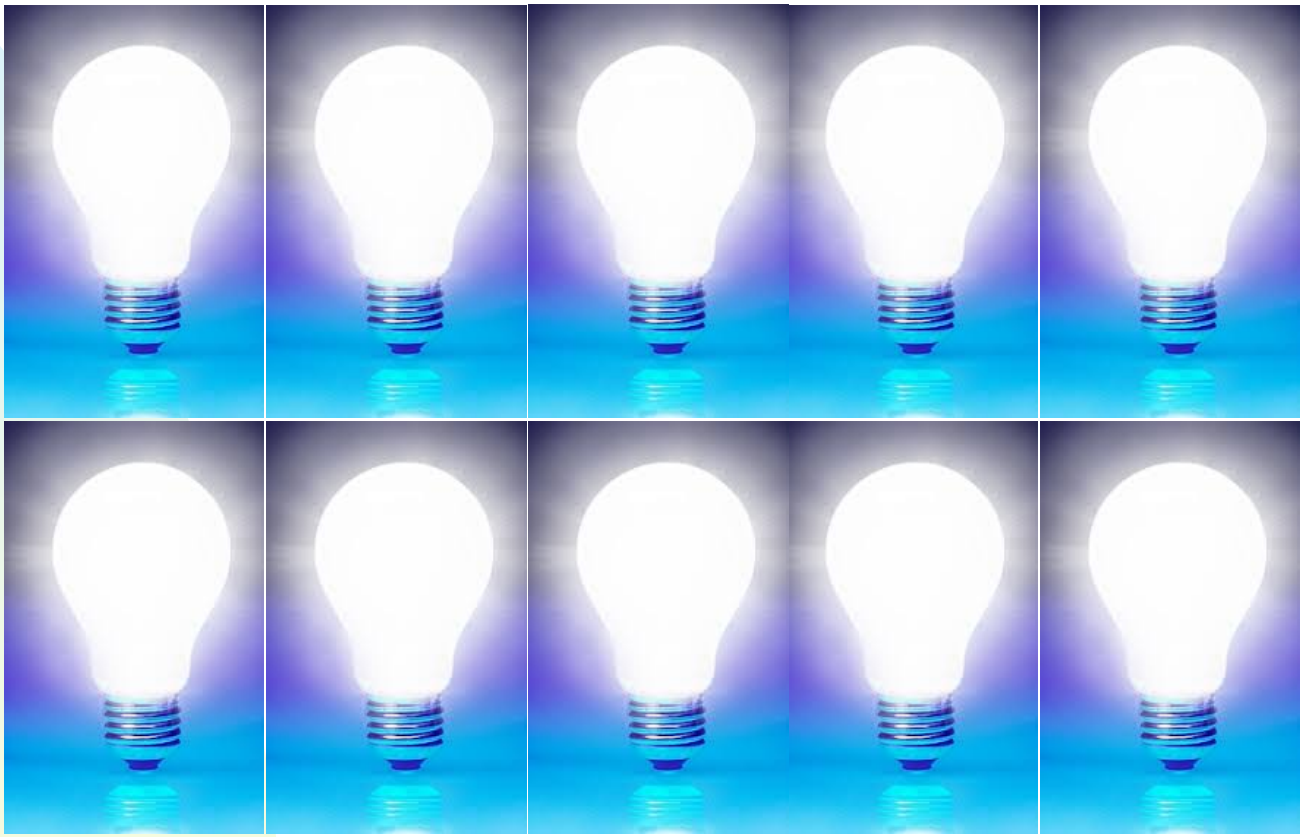
How is Millikan doing today? What can you do to help?

Examine Lesson Plan about Solar Energy

100 watt

Power

10 x 100 watt = 1000 watts = 1 kw = 1 kilowatt



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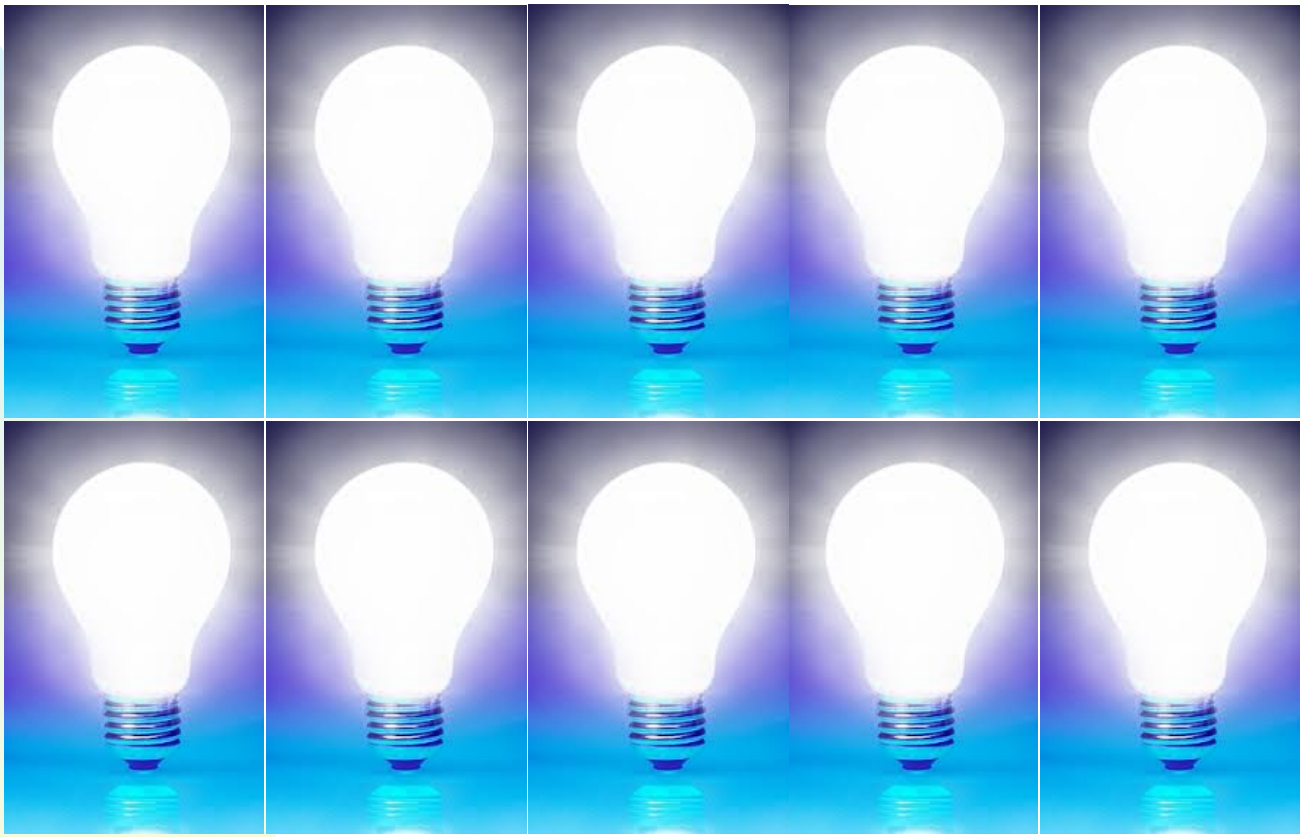


Lights on for 5 hours:

Energy used = 1 kw x 5 hours = 5 kw-hours = 5 kwh

Key Concept of the Lesson

Key Concept of the Lesson

Integration

Key Concept of the Lesson

Integration

How People Learn: Brain, Mind, Experience, and School

National Academy of Science
Washington, D.C.

Free online

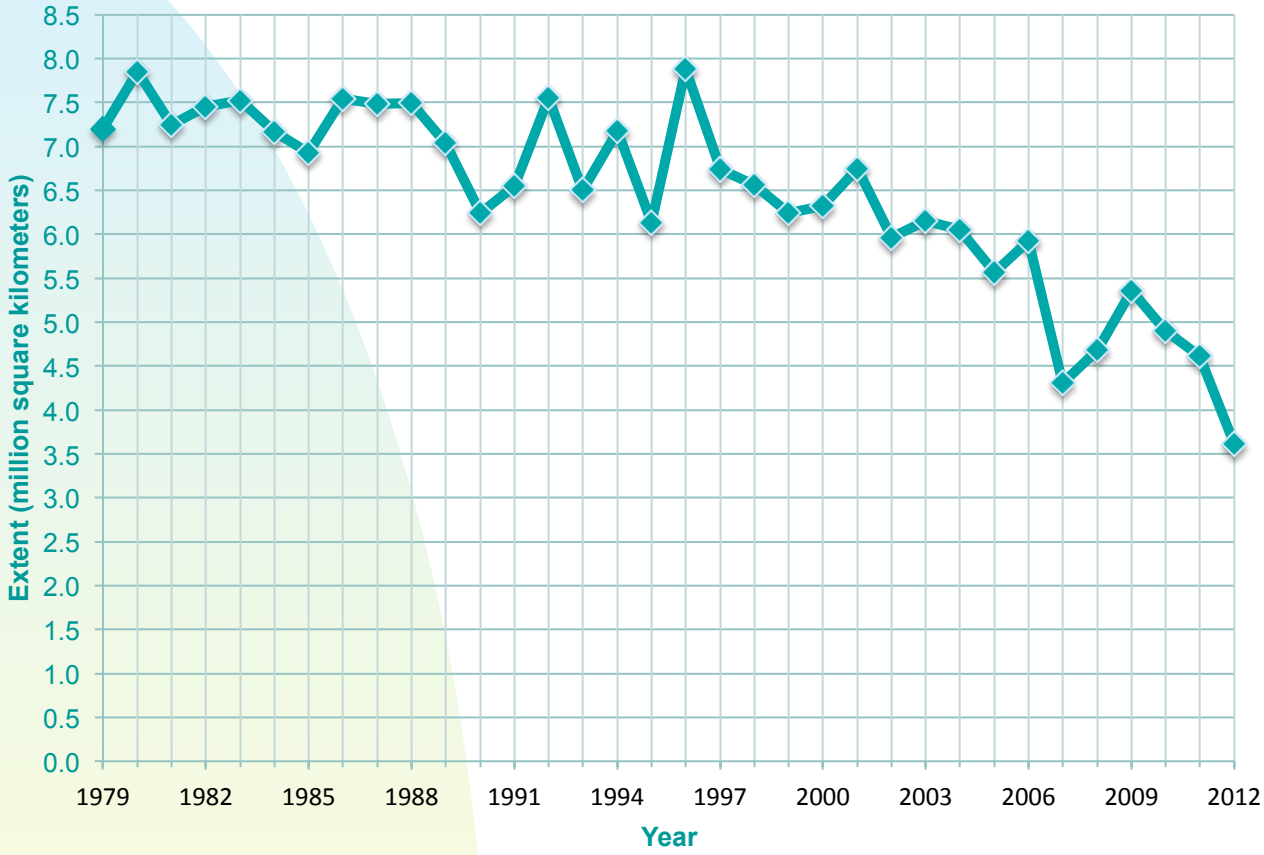
Additional References:

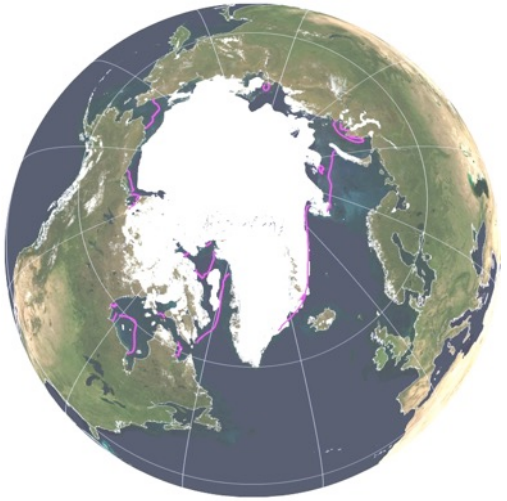
How People Learn: **Brain, Mind, Experience, and School,** National Academies Press, http://www.nap.edu/openbook.php?isbn=0309070368

Sustainable Energy – Without the Hot Air, David JC MacKay, http://www.withouthotair.com/
Great book that does all types of interesting calculations to model the potential for scaling up renewable energy use to a national scale. Only requires high school math.

The materials from Mathematics Awareness Month 2013 – Mathematics and Sustainable are archieved and available at:
http://www.mathaware.org/mam/2013/
Essays at: http://www.mathaware.org/mam/2013/essays/
Sustainability Counts! Educational materials:
http://www.mathaware.org/mam/2013/sustainability/
Other Resources: http://www.mathaware.org/mam/2013/related/

Curve Fitting: When will the Artic be ice free in summer?





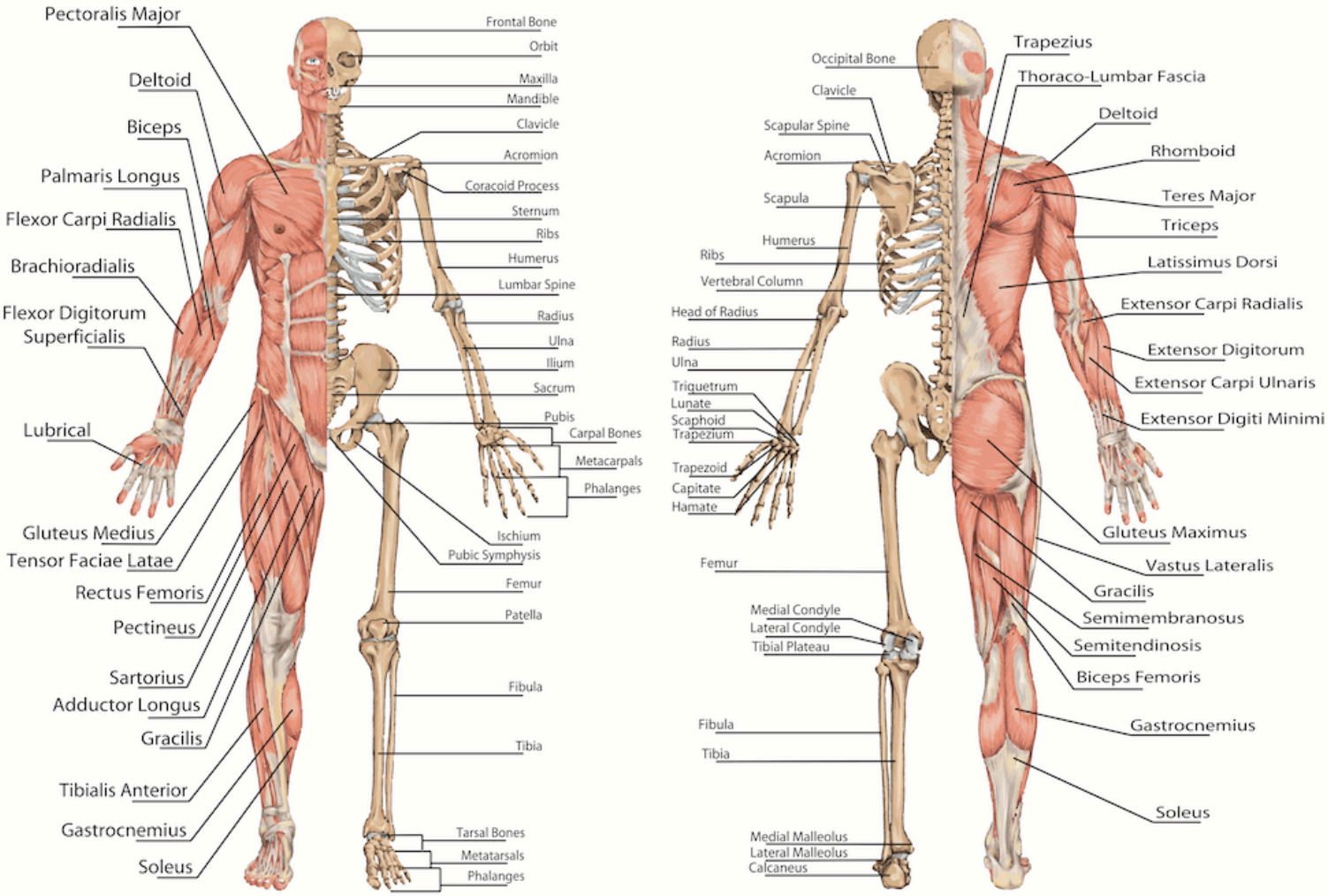
All images courtesy of NASA and the National Snow and Ice Data Center, U.C., Boulder. (http://nsidc.org). Lesson plan by William Bauldry, Appalachian State University, Victor Donnay, Bryn Mawr College, Thomas J. Pfaff, Ithaca College.

What the Best College Teacher Do

Ken Bain

Teaching Anatomy

Teaching Anatomy.



Teaching Anatomy.